ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #40799

From De Facto To De Jure and Beyond. It's More Than Just Weather. What The "Chilly" Climate Really Feels Like for Black Doctoral Students in STEM

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I am Motahareh Darvishpour Ahandani, and I am currently pursuing my Ph.D. in Engineering Education System and Design at Arizona State University. I serve as a Research Assistant and bring with me six years of industry experience as a woman engineer. My research interests revolve around the mental health of international engineering graduate students, with a particular focus on the experiences of international women of color. I am deeply committed to improving the well-being of underrepresented groups in STEM, as I personally identify with this mission. As part of my previous work, I had the privilege of co-authoring a paper presented at the 2023 ASEE conference titled "It's No Mystery, So It Must Be Intentional: How Institutions Fail to Support Black STEM Doctoral Students' Mental Health." I am an enthusiastic member of the American Society for Engineering Education (ASEE), and I remain dedicated to my field. If you'd like to get in touch or explore potential collaboration opportunities, feel free to reach out to me at mdarvis2@asu.edu.

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Brooke C. Coley, Ph.D. is Founding Executive Director of the Center for Research Advancing Racial Equity, Justice, and Sociotechnical Innovation Centered in Engineering (RARE JUSTICE)—an unprecedented testbed for innovating and modeling antiracist and equitable engineering futures—and Assistant Professor of Engineering, both at Arizona State University. Across several national projects funded primarily by the National Science Foundation, Dr. Coley's research lies at the intersection of racial equity, mental health and qualitative research methods encompassing critical theory, participatory action research, and arts-based research methods. Her work is anchored in an intentional amplification of the voices of minoritized populations in STEM with the goal of informing disruption of the pervasive systemic inequities found in racialized organizations such as institutions of higher learning. Leveraging the outcomes of this work, Dr. Coley will continue to create exemplars of equity in action across realms of the academic enterprise—lived experience and restorative justice, scholarship generation and metrics, and rewards systems and structures. Dr. Coley recently received the 2021 Diversity and Inclusion Award from the Ira A. Fulton Schools of Engineering for her commitment to creating and fostering a diverse and inclusive environment. Dr. Coley earned her Doctor of Philosophy degree in Bioengineering with a concentration in Biomechanics from the University of Pittsburgh. She also completed her Bachelor of Science in Chemical Engineering at the University of Maryland Baltimore County as a Meyherhoff Scholar.

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"There's the de facto and the de jure, high school world history, there's the outward racism that socially you interact with, and also the structural, and the systemic, and the legal racism." -- Harry Nyquist (Study Co-Constructor)

While universities may desire to be race-neutral (i.e., a place in which the experience of faculty, students, and staff do not depend on race), a corpus of research highlights the reality that navigating racist bureaucratic structures within U.S.-based academic institutions have profound implications for Black doctoral students in STEM fields. The STEM culture has long been described as "chilly," which ambiguously describes the lived reality for Black members of our academic communities. Burt et al. (2021) has more clearly identified this culture as racially segregated, centering whiteness and positioning Black faculty, students, and staff as outsiders, forcing them to endure frequent microaggressions, simultaneous invisibility and hypervisibility, and perceived incompetence, for example, underscore the importance of enhancing advising practices at Historically Predominantly White Institutions (HPWIs) to foster a more inclusive and supportive culture for Black male students. Within the organizational culture of universities and STEM institutions, there exists an inherent disconnect that can perpetuate the "chilly" climate by not adequately addressing the distinctive needs and experiences of these students (Burt et al., 2021). Furthermore, amid our increasingly hyper-divided socio-political landscape, the experiences of Black doctoral students are not insulated by the university boundaries. McGee (2023) delves into the career decisions of Black STEM doctoral students during the Trump presidency, revealing how the prevalent organizational culture interacts with external political factors. This interaction exacerbates the "chilly" climate, amplifying stress and uncertainty within these bureaucratic structures and adversely affecting the students' academic and career paths (McGee, 2023).

The organizational culture also significantly contributes to the stress experienced by Black doctoral students in STEM. This culture, embedded within universities and STEM institutions, leads to feelings of isolation and imposter syndrome, intensifying the "chilly" climate and impeding academic progress and success (McGee et al., 2019). McGee et al. (2022) also shed light on the influence of organizational culture in fostering racism camouflaged as impostorism within STEM institutions. This perpetuates the "chilly" climate by reinforcing feelings of not belonging and self-doubt among Black STEM doctoral students. The organizational culture's role in shaping these negative experiences hampers academic advancement (McGee et al., 2022). Finally, Coley and Thomas (2023) offer insights into how the organizational culture of universities can impact Black engineering graduate students' value prioritization. The interplay between organizational culture and external challenges exacerbates the "chilly" climate, causing students to reassess their values within the bureaucratic system, further contributing to their sense of disconnection (Coley & Thomas, 2023).

Addressing these challenges necessitates a comprehensive reevaluation of the organizational culture. Coley, Maitra, and McClain (2023) propose strategies for an antiracist approach to engineering education. This approach seeks to reshape the organizational culture within universities and STEM institutions, actively combating the "chilly" climate by acknowledging and dismantling systemic barriers (Coley et al., 2023). The current paper will provide current (e.g., pseudo-post COVID-19 pandemic, pseudo-post Donald Trump presidency, and pseudo-post the country's racial reckoning initiated in 2020 after the murder of George Floyd) and operationalization of the "chilly" climate descriptor and its impact on the lived experiences of Black doctoral students.

Conceptual Framing

The conceptual framing of this study is grounded in the Theory of Racialized Organizations (TRO), as originally articulated by Ray (2019). Ray's theory posits that ostensibly neutral bureaucratic structures within academic institutions, such as universities, can inadvertently sustain racial hierarchies and disparities through embedded cultural norms, practices, and power dynamics that limit the agency of Black members of their organization, and according to TRO, there are three tenets that limit the agency of Black members of organizations:

1. *Unequal distribution of resources*: Racialized organizations legitimize the unequal distribution of resources, which can lead to disparities in access to opportunities and outcomes for Black members.
2. *Credentialing of whiteness*: Whiteness is often treated as a credential within racialized organizations, which can lead to the exclusion of Black members who do not fit the dominant cultural norms and practices.
3. *Racialized decoupling*: The decoupling of formal rules from organizational practice is often racialized, meaning that the formal rules may appear neutral, but in practice, they can reinforce racial hierarchies and disparities. This can limit the agency of Black members who may not have access to the informal networks and power dynamics that shape organizational practices (Ray et al., 2019).

This theory gains further resonance for our work from its application by Coley, Maitra, and McClain (2023), who employed it to highlight how organizational culture influences the experiences of Black doctoral students in engineering students and underscores the importance of addressing racialized dynamics to create an anti-racist educational environment. By drawing on Ray's (2019) TRO and the insights of Coley et al. (2023), this study explored the current

implications to Black doctoral students of navigating racialized organizational cultures within their STEM programs. The adoption of this conceptual framing provides a guide for interpreting their experiences when cultural norms, practices, and power structures intersect to shape the "chilly" climate experienced by these students.

Methods

Co-Constructors

We gathered data for this study from semi-structured interviews with four Black doctoral students. Throughout the paper, we refer to the interviewees as “co-constructors” rather than “participants” to emphasize their active contribution to the data collection phase. Using the “co-constructors” term holds significance in underlining the collaborative nature of the research procedure in contrast to seeing the interviewees as subjects from which we extracted information. This term also centers on the experiences of Black graduate students in STEM, affording influence and agency to this community while dismissing traditional notions rooted in white supremacy.

Co-constructors in this study include two doctoral students enrolled at Historically Black Colleges and Universities (HBCUs) and two enrolled at Traditionally White Institutions (TWIs). Two co-constructors were enrolled in doctoral degrees in engineering, while the other two were enrolled in doctoral degrees in computer science. Additional demographic information about the co-constructors is presented in Table 1.

Procedure

The data collected for this study was part of a larger project funded by the National Science Foundation. We defined eligibility for participation to individuals who self-identified as Black and were actively enrolled in a STEM doctoral program in the United States during the

data collection phase. We shared a recruitment flyer via social media platforms and email listservs to engage Black STEM doctoral candidates interested in sharing their experiences within the culture of their doctoral program. The flier also noted our interest in understanding their relationship with their advisor and how the department climate affected their mental health and career trajectory decisions. The flier included a link to join the study and details about compensation.

Table 1

Co-Constructor Pseudonym*	**Gender Identity**	**International or Domestic Student Status**	**Institution Type**	**Discipline**	**Year in PhD Program**
Jasmine	Woman	Domestic	HBCU	Computer Science	5th
Hassan	Man	International	HBCU	Engineering	2nd
Keisha	Woman	International	TWI	Computer Science	3rd
Harry Nyquist*	Man	Domestic	TWI	Engineering	2nd

* Pseudonym self-selected by co-constructor

We sent a screening and demographic survey to co-constructors interested in the study. Upon review of survey responses, we invited eligible co-constructors to complete an individual, semi-structured Zoom interview. Interviews ranged from 80 minutes to 153 minutes (average interview length was 123 minutes) and were conducted by two research team members. We were intentional in including at least one team member who identified as Black in each interview. Recognizing the delicate and culturally significant nature of the interview topics, our primary focus was on ensuring the co-constructors' comfort and fostering an alliance between the co-constructors and the interview team (Razon & Ross, 2012; Tillman, 2002). Our interview

research team included faculty principal investigators in engineering education and counseling psychology, post-doctoral scholar in curriculum and instruction, and graduate research assistants in counseling psychology, linguistics, and engineering education.

We conducted interviews during the spring, summer, and fall of 2022. We wrote interview questions that were intended to uncover the co-constructors' experiences with support (or lack of support) within their STEM department's academic culture and in context to their identity as a Black student. Example questions from the interview protocol include: *How if at all, are your lived experiences in STEM influenced by you being Black? How would you describe the culture of your STEM program for Black doctoral students?* and *How is the experience of Black students in your program different compared to non-Black students?* After the interview, we distributed a $50 Amazon e-gift card to the co-constructors.

Positionality

In alignment with Secules et al.'s (2021) conceptualization of positionality, we considered various facets of our team's positionality during this study. The two co-leads on this manuscript are graduate students, each specializing in distinct fields: one in education/higher and postsecondary education and the other in engineering/engineering education. These leads encompass diverse identities; one identifies as a Black woman, while the other identifies as a Woman of Color. Furthermore, their academic levels vary, with one pursuing a master's degree and the other engaged in a Ph.D. program. Our authorship team also includes the three Principal Investigators (PIs) from the project. These PIs hold faculty positions, with two specializing in the field of engineering/engineering education and one in counseling psychology. Among them, two faculty leads self-identify as Black women, while one identifies as a white woman. Their

collective backgrounds are marked by prior scholarly contributions and personal dedication to addressing systemic issues entrenched within doctoral education.

Every member of our research team actively participated in the tasks of data collection and/or data analysis. In addition to the leads and PIs, our team includes a faculty member, a Ph.D. scholar, and two undergraduate students. This diverse assembly comprises individuals of varying backgrounds, including a woman of Color, a Latinx researcher, a Black woman, and a Black man. Our faculty researcher holds the position of curriculum and instruction assistant professor, while the doctoral researcher possesses a Ph.D. in linguistics; the remainder of the team is oriented toward engineering education. Of the two undergraduate students, one is pursuing her degree in Civil and the other one in Architectural engineering. Each team member assumes both an insider role (in terms of racial identity, professional identity, and doctoral student vs. faculty status) and an outsider role (across the same dimensions). During data collection, we emphasized alignment along racial identities, prioritizing the co-constructors' comfort. As we engaged in the process of making meaning from the data, we were deliberate, both individually and collectively, in acknowledging our dual insider/outsider perspectives.

Analytic Approach

We grounded our thematic analysis in the critical and constructivist paradigms (Braun & Clark, 2006). We used Rev, a commercial transcription service, to transcribe each interview, and final transcripts were de-identified (names and institutions) to maintain confidentiality.

Our analytical approach involved a two-stage coding process, following the methodology outlined by Saldana (2021). All four transcripts included in this analysis were made accessible to every member of the research team. Working in pairs or trios, we analyzed the transcripts, identifying recurring concepts across the experiences of the co-constructors as related to their

description of how they experienced their STEM program's culture. Regular weekly meetings were held to compare observations and inferences. Drawing from these collaborative discussions, a deductive codebook was formulated, featuring two primary first-cycle codes to demonstrate how academic department culture forces Black doctoral students to ask themselves: What are other students getting that I'm not, and what am I having to do that other students aren't? During the first-cycle of coding, at least two team members coded each transcript using Dedoose, a web-based qualitative data analysis tool. Among each transcript coding team was at least one Black team member. Following first-cycle coding, the team met to review and conduct second-cycle coding, during which we made meaning of salient ideas that emerged in the first cycle coding.

Results

Our findings are discussed in two parts to present the underlying factors that contributed to a "chilly" climate for Black doctoral students in STEM. First, we discuss what co-constructors described other students receiving that they did not receive. Second, we discuss experiences that co-constructors reported having that their non-Black peers did not have. These include inequitable distribution of financial resources, disparities in individual values, undertaking extra burdens, and invisible labor.

Theme #1: What are other students getting that I'm not?

One co-constructor was under the impression their program had his best interest in mind, however, after noticing differential funding treatment, he began to question, "What are other students getting that I'm not?" Hassan described:

> Even when I was struggling, there were people who also got their tuition fully paid for. So, it just depends. I don't know what they did. I don't know who they spoke to, but even when

> I came in, someone I came in with had his tuition fully paid. I don't know how, but he just happened to have the situation. Everyone didn't get the same amount of funding. I don't know why that would happen. - Co-Constructor Hassan

Hassan's narrative indicated that there were noticeable inequities in the financial support provided by his department. Although he was unsure of why these inequities existed, he could see firsthand that his compensation package was less, which in turn, contributed to him experiencing financial struggles while his counterparts, to the best of his knowledge, did not have similar concerns. Alternatively, Jasmine described how her experience affected her ability to engage in academic spaces:

> So there was another student, a male student who was closer to another advisor, and his travel was funded versus my travel not being funded. And I just kind of... I kind of didn't necessarily appreciate that because... Okay, so even though I'm funded by my fellowship, they pay for... conferences that are... domestic. So any international conference they will not cover, and that makes sense because of DOD or federal funding. And so this conference was in Canada, and so the [other] student was able to go and present [and] experience the conference. I had to give mine virtually. And I was grateful that I could give my presentation, but it's a big difference, as we all know, being in the virtual space versus actually physically being there, and this was way before we knew anything about COVID. So it was just something that I kind of had to chalk up as an experience. - Co-constructor Jasmine

Jasmine's experience illustrates how inequitable distribution of financial resources hinder Black students' opportunities for professional growth. Aside from finances, Kiesha shared her experience with the inequitable distribution of responsibilities without acknowledgment or recognition. She details being tasked with less significant responsibilities while her classmates are given opportunities that better showcase their academic strengths. She expressed:

> And I think that's been really frustrating because it is kind of a game, the academia is in terms of, you're judged by how many papers you publish. You're judged by if you have teaching experience; you're judged by service, which is ridiculously overwhelming if you're a Black student or female student because they just want you to do everything. But they never want you to... They never cite you, and they never want to work with you in a way that would lead to a paper. It's always these things where they expect you to do these things that, I wouldn't say that they're not important, but they have less weight than the goal. My friend calls it currency, which is my publication is my currency. So it's, they're

> giving you quarters and dimes and everybody else is getting paid in cash. And you're looking at this and you're, why am I getting change? Right? Why do I keep getting change? – Co-Constructor Keisha

Keisha comes to the realization that the contributions she is asked to make do not carry the same weight as those given to her peers, especially as a Black woman. This creates an environment built around a lack of trust. Conversely, after receiving opportunities from outside of her program to display her academic merit, she received conflicting guidance. She goes on to describe her relationship with her advisor, and how difficult it was to understand whether they actually wanted to help her succeed. She explained:

> So my second advisor, when I first started, people kept asking me to be a reviewer and stuff and he would literally tell me... I can't. He'd tell me that I was only getting these opportunities because no one wanted to do them. And I only found out later on that it's actually an honor when people ask you to... They were literally telling me that like, "Oh, you're just getting these things because no one wants to do them. When you get an opportunity to review or an opportunity to talk, this is just because nobody likes doing these kinds of things and it's not a big deal. - Co-constructor Keisha

Keisha did not receive guidance that would help her succeed academically. When she is met with this type of resistance, this conveys her advisor cannot be a source of support for her. There is an added burden of having to question why she is receiving guidance others are not. As a Black woman doctoral student there is an added burden of determining how to navigate spaces that should be safe but prove not to be. While higher education institutions may intend to provide a safe sense of community for all students, Harry Nyquist shares the decisions his lived experiences as a Black man on campus. Harry shared:

> Even walking home late at night. There was a couple times I wasn't sleeping a ton in undergrad because I was working a lot on race car. And I would walk home late at night and I would just feel really awful. And it was like, "Fuck man, I'm kind of scared." I think a month or a month or a couple months before some perfect professor got harassed by the police for walking in the same spot. I'm like, "Man. Oof." -- Co-constructor Harry Nyqust

Harry described the unique challenges of walking while Black late at night. Evident from his narrative is the fear and worry that arose from this experience, especially when another 'perfect' faculty member was harassed by the police in the same vicinity in which he was walking. While this may seem like an isolated experience, non-Black students likely do not have these worries, which in turn, affords them additional time and cognitive energy to participate in labs without fear.

Theme #2: What am I having to do that other students aren't?

Next, we bring attention to situations in which co-constructors describe feelings that lead them to ask, "What am I having to do that other students aren't?" Jasmine recounts instances where she was expected to work harder than others:

> I'm not going to say that I quickly moved on, but there were times where it was like… I may have had more duties to complete than my colleagues. So then, again, I'm asking myself, "You just told me this, but you're needing this." It was kind of like things just did not add up, so just trying to put things into perspective. - Co-constructor Jasmine

This quote exemplifies how Jasmine had to exert additional effort while her peers do not. Additionally, the tasks Jasmine completed were not always standard responsibilities given to graduate students. She shared:

> During the summer at REU, an undergraduate research summer experience, one of the professors was not able to teach a programming language. And he was like, 'I spoke to person X and they said that you can teach the course.' And I thought, 'Okay. Sure, I'll do it.' Kind of like, "Yes, no problem. I'm willing to help out. - Co-constructor Jasmine

The power dynamic between her and the faculty member created a setting that heavily influenced the decisions she was asked to make. These stressors are exacerbated due to Black doctoral students having to navigate this within a program without a supportive community. Again, there is the added work of expending effort to find these essential communities of support. Hassan described:

> So, I didn't necessarily have this family connection back there. No [people from my home country] were there. And so, I had to make, but here it's different. I feel just work on me, like I said. There's a huge, not like necessarily huge, but at least there's a community [from my region of the world]. I could fit into that could direct me, and, "Here is what to do. Here's not what to do. This is the Walmart in town," things like that, little things like that. So, it felt better here. - Co-constructor Hassan

This quote depicts how Black doctoral students must turn to social communities outside of the classroom to build the connections not available to them within their doctoral community. Keisha also conveyed how bothersome it was to find support outside of her program and how this has affected her academic progress:

> But what is frustrating is that I had a couple friends, because I was making friends outside and I saw the difference between what I was experiencing. That is what rang home for me. When I saw how far ahead they were - Co-constructor Keisha

Beyond seeking physical communities, when Black doctoral students attempt to improve the program culture around them, they are forced to take full responsibility in seeing that their issues are addressed and managed appropriately. Harry Nyquist describes the toll of convincing his department the racial issues within his lab are worth their attention.

> Yeah, so there's been a couple incidents over the past years, a couple racist incidents or whatever, between a member of our own group and then a member of [another faculty member's] group, and talking to our graduate students in our group who aren't Black and figuring out what to do with the situation was insightful, and obviously upsetting, because the event happened, but also upsetting from this perspective of, "Goddamn, why do I have to deal with this? This is so not productive. I'm not able to do research or whatever. Why is the group culture structured such that when this incident occurs, all the burden falls on us, the Black students who are dealing with this," rather than [my advisor], our PI, or the department or something? - Co-constructor Harry Nyquist

Harry's experience highlights the added stress Black students have of raising concerns with department leadership, only to find themselves responsible for resolving issues independently or being exhausted to the point of giving up.

Discussion and Implications

This paper unpacked what “chilly” really felt like from the perspective of Black doctoral students in STEM fields. The experiences of the co-constructors outlined how they are expected to persevere within a doctoral community that does not value their contributions in the same way their peers are valued. The significance of our findings challenges the notion that institutions function as racially neutral spaces for all students to succeed. These findings can inform university policy to promote more inclusive and supportive academic environments for Black doctoral students in STEM (Ray et al., 2019). By failing to address the experiences our co-constructors described, higher education institutions will continue to operate as racialized organizations sustaining racial hierarchies within department culture, ultimately forcing Black doctoral students to find their community elsewhere (Ray et al., 2019). Which is a burden in and of itself.

Our findings emphasize the importance of instituting recommendations from previous research. Coley, Maitra, and McClain (2023) found that a common theme within the experiences of Black scholars in engineering was the lack of institutional accountability within their doctoral program. Our co-constructors’ experiences affirm instituting “explicit and transparent mechanisms for reporting racism and/or equity-related concerns and grievances" (Coley et al., 2023, p.9). If Black students are continually expected to call attention to and resolve the racial tensions rooted in department program culture, higher education institutions are free from acknowledging their issues as worthy.

This study highlights how systemic racism and bias continue to impact the experiences of Black doctoral students in STEM fields, challenging the idea that academic success is solely based on merit. The implications of these findings highlight why simply admitting Black students into STEM programs does not create an inclusive environment. In actuality, the

institution must address any practices that are inequitable or rooted in bias. These practices include downplaying opportunities to further their research and disproportionally assigning responsibilities. The co-constructors detail a lack of trust in the guidance received by program advisors, feelings of invisibility, and questioning their place in their doctoral community, all of which are stressors Black doctoral students experience at an additional cost (McGee et al., 2019).

Previous research documents how lack of recognition impacts women of color in STEM fields and the lasting effects this can have on their science identity (Carlone & Johnson, 2007). The Black women included in this study described how their program refused to highlight their achievements and assign differential tasks. The co-constructors recounted taking on additional administrative and emotional labor while others do not. When there are underlying power dynamics influencing these decisions, this is an additional tax they must manage while also performing well academically.

The findings in this paper serve as additional motivation for the efforts that STEM academic programs can and must take in order to become healthy spaces in which Black doctoral students can thrive. More specifically, findings from this paper show how universities and doctoral advisors should offer explicit guidance on financial support structures; celebrate accomplishments uniformly; question internal biases as they relate to delegating tasks and assigning importance to those tasks; and creating reporting structures for equity-related issues.

Ultimately, our findings challenge institutions to acknowledge that Black doctoral students experience unique stressors within their STEM doctoral programs. They do not have the luxury of always expressing their authentic selves and instead must determine how to succeed in STEM programs that claim to embrace inclusivity while they constantly receive messages that

showcase the opposite. To transform STEM doctoral programs into spaces where Black students are supported, acknowledged, and celebrated, institutions must institute broad cultural shifts.

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