The Future of Engineering Education

2024 Annual Conference & Exposition

Oregon Convention Center
Portland, OR . June 23 - 26, 2024

ASEE

Paper ID #43481

"How You Got Me Messed Up": A Critical Analysis of Doctoral Engineering Education through the Lens of Black PhD Candidates

Mrs. Crystal Alicia Nattoo, Stanford University

Crystal Nattoo (she/her) is a first-generation college student from South Florida. She graduated with her bachelors from the University of Miami in 2019 as an Electrical Engineering (EE) major and Graphic Design minor. She then received her EE M.S. degree at Stanford University in 2021, and is currently continuing in the EE Ph.D program. Her current research focuses on the fabrication and characterization of flexible sensors and circuits using 2D transition metal dichalcogenides. She is a recipient of the NSF Graduate Fellowship.

Crystal E Winston, Stanford University

Crystal E. Winston is a fourth year PhD candidate in the Mechanical Engineering Department at Stanford University, Stanford CA, USA. Before pursuing the PhD, Crystal received a B.S. in mechanical engineering from the Massachusetts Institute of Technology, Cambridge MA, USA in 2019 and an MPhil degree from Imperial College London, London, UK in 2021. Crystal's research interests include origami robot design and haptics. Crystal's research is supported by the Stanford Graduate Fellowship and the Stanford Enhancing Diversity in Graduate Education Fellowship.

Rachel A. G. Adenekan, Stanford University

Rachel A. G. Adenekan received the S.B. degree in Mechanical Engineering and a minor in music from Massachusetts Institute of Technology, Cambridge, MA, USA, in 2017 and the M.S. degree in Mechanical Engineering from Stanford University, Stanford, CA, USA, in 2019. She defended her PhD dissertation at Stanford University in April 2024, and her PhD in Mechanical Engineering will be conferred in June 2024). Her research interests include smartphone-based tools for continuous monitoring, digital / wearable health technologies, and biomechanics, and her work was supported by the National Science Foundation Graduate Research Fellowship, the Stanford Graduate Fellowship (Medtronic Foundations), the Stanford Precision Health and Integrated Diagnostics Center, the Stanford Center for Digital Health, the Stanford Diabetes Research Center, and the Stanford Enhancing Diversity in Graduate Education Fellowship.

"How You Got Me Messed Up": A Critical Analysis of Doctoral Engineering Education through the Lens of Black PhD Candidates

Crystal A. Nattoo, Crystal E. Winston, Rachel A. G. Adenekan

Abstract

Engineering graduate education has been the machine keeping research and development afloat for decades. There have been recent efforts to increase the number of students from underrepresented backgrounds admitted to doctoral programs. However, after admission, the problem of retention becomes salient for underrepresented minority groups (URMs) in academia[1]. As young Black engineers continue to enter advanced graduate studies, it becomes important to examine the factors that impact how they enter and ultimately decide to leave the institution. In this work, we used the autoethnographic method to share our experiences and illustrate the issues faced by Black PhD students at elite research institutions. We relate our experiences chronologically starting with the expectations from peers once arriving on campus, moving into the expectation of solving a university's equity problems, and ending with the mental burdens of coping with an unhealthy work environment. All of these become factors that can impact whether or not Black PhD students decide to leave the program before completion.

Doctoral education begins with the submission of a strong application. While many resources lay out how to tailor an application to increase a student's chances of acceptance, there is little criticism of the existing rhetoric surrounding doctoral programs and what they may offer a student long-term, especially in terms of education quality and support systems in place to ensure student retention. Once admitted to the graduate program of their dreams, challenges of identity alignment with peers can make integration a burden for minoritized groups like Black PhD candidates[2]. This integration struggle bleeds into the lab setting, which lacks proper internal oversight. A lack of emphasis on selecting PIs who are well-equipped to lead supportive and diverse laboratories coupled with a lack of diversity in the researcher and PI populations frequently leads to an unhealthy work environment that Black PhD students have the burden of navigating throughout their entire doctoral program. We hope that sharing our experiences will serve as a reference point in the reformation of the graduate engineering education system. By challenging biases and fostering a more inclusive academic space, we aim to see an improvement in the graduation rates of Black doctoral candidates.

Introduction

Academic spaces are experiencing an influx of diverse students feeling empowered to pursue higher education[1]. As these traditionally cis-white male spaces are expanded, there are many issues that have arisen due to the incongruence between who these spaces were designed for and who now exists in these spaces. To assume that the system gives equal opportunity to all who make it past admission would be naive and also contrary to what the literature has shown[3,4,5,6]. Underrepresented minority groups (URMs), such as Black, Latinx, Indigenous, and Queer students, tend to have a different experience compared to their non-URM peers, often navigating extra barriers that can affect graduation rates of these students. In order to achieve true justice, equity, diversity, and inclusion (JEDI), we need to examine the reasons for this difference of experience in spaces of higher education.

In this work, we will use autoethnographic narratives to investigate common barriers faced by Black students entering engineering graduate education and present recommendations on strategies for making academia more inclusive to Black PhD students specifically. The issues will be illustrated chronologically and narratively from the lived experiences of the authors in order to allow the reader to understand the consequences of these issues. There will be a discussion of the experience starting from the social implications of being easily identified as different in one's cohort, continuing with the experience of being pressured to solve a university's JEDI issues, and ending with the tension of working in the presence of biases against minoritized doctoral students in an unhealthy work environment. We aim to share these experiences and insights to help academic leaders alleviate some of the issues faced by Black PhD students and thus improve retention. We will make these recommendations with the consideration of the existing literature on this topic. While retention disparities affect many different URMs, there is a sociocultural nuance that makes it impossible to create a one size fits all solution.

For the purpose of this work, we will focus on Black PhD students since that group most closely aligns with the lived experiences of the authors. However, due to the consequences of intersectionality, there will be useful crossover with other minoritized identities. It is our hope that while this work is meant to mainly improve the graduate experience of Black PhD students, since some of these issues extend to all levels of higher education for all URMs, our recommendation can be extended to benefit other groups of students.

Methods: Autoethnography and Literature Review

This paper arose out of the recognition by Crystal N. that not enough of the Black PhD experience had been documented to motivate administration to make an effort to improve retention rates. Since retention of PhD students is not a metric that is publicly available and unlikely to be properly documented, disparities in retention of students are often unnoticed by communities who are not directly affected. Due to the social phenomena of stereotype threat and confirmation bias, the lack of a Black PhD population that is representative of the relative US population of Black people is often seen as an intellectual deficiency within the Black community. The structural challenges that Black PhD candidates experience in graduate programs are often overlooked. Although the goal of JEDI is not to simply increase the number of minoritized students, the importance of diversity of

thought and experience is becoming more apparent in STEM fields[7]. The need for Black students to be able to express their real experiences, on their own terms was clear, so Crystal N. reached out to the wider Black Engineering PhD community to find others interested in documenting their experiences. From that, she connected with Crystal W. and Rachel A. in order to create this work, over the period of several months by means of virtual and in-person discussions.

The method chosen as the centerpiece of this work was autoethnographic narrative. First introduced to the academic world through Ellis and Bochner in 2000[8], autoethnography has proven to be a powerful tool for researching lived experiences. It allows the researcher to become the subject of their research and provide a view into experience more intimately. Although autobiographies existed prior to the introduction of this method, autoethnography is more often used as a tool of connecting lived experience to the current body of literature with the goal of adding to an ongoing discussion rather than reflecting on the past[9]. There any many examples in the literature of works using this method for centering the experiences of individuals with marginalized identities[10,11,12]. In order to emphasize the need for this work, we have reviewed the literature to find examples of lived experiences similar to ours to emphasize that these are not isolated incidences of struggle.

Doctoral education begins not with admission to a university, but instead application to programs within that university according to their alignment with a student's research interests. Once matriculated into a graduate program, young academics bring diverse life experiences that may conflict with the typical impression of who belongs. These feelings which have been termed as "imposter syndrome"[13] tend to subside as students shape their research trajectory with the aid of experienced mentors. However, this is not a one-size-fits-all solution since social fit, defined as "the degree to which other people in the current environment accept and validate a person's sense of who they are", heavily depends on identity alignment with peers, which often eludes URMs[2]. This necessitates an intentional challenging of biases to foster diversity and inclusion in academic and professional spaces and improve the retention of minoritized academics.

The burden of addressing the lack of diversity on college campuses often falls on the few minorities working, teaching, and doing research in those spaces. This is particularly well documented among faculty in STEM, where it has been shown that minoritized faculty are disproportionately involved in recruiting minoritized undergraduates and faculty, serving on DEI (Diversity, Equity, and Inclusion) committees, engaging in K-12 outreach, authoring diversity publications, and running and attending diversity workshops[14]. While this is not as well researched among minoritized graduate students[15], our experiences and observations as Black PhD candidates suggest that many of these same responsibilities fall on us as well. In addition to the added stressors that Black PhD students face as a result of their identities, we have observed that many Black PhD students are also expected to participate in DEI committees and run outreach programs because they are viewed as most qualified for these roles due to their lived experiences. Unfortunately, these added responsibilities tend to become emotionally draining and incredibly time consuming, which can make it even more difficult for Black PhD students to graduate in a timely manner.

In addition to the burden of challenging internalized beliefs of competence and dealing with an extra load of social responsibility, graduate students must also contend with the external beliefs of their principal investigator (PI). In contrast to corporate work settings with multiple hierarchical levels and dedicated human resources (HR) departments, academic laboratories in research insti-

tutions typically consist of just two levels: the PI and the researchers. This absence of HR support and the protective tenure system can lead to challenges in addressing mistreatment of researchers by principal investigators. Furthermore, professors bear the responsibility of fostering inclusive and safe lab environments, though this aspect is often overlooked during their application and interview process, which centers research achievements[16]. Consequently, professors often lack management and culture-building skills, and their limited diversity representation[17] hinders the support of URMs, particularly Black students, in thriving within the academic environment.

A key works that connected with our lived experiences, as it relates to the retention of Black PhD students to graduation historically, was the scoping paper from Rutledge, Cater-Veale, and Tull which presented the emerging themes that came from interviewing a large sample of Black Women who had successfully completed a PhD as of 2011[18]. This work highlighted a wide range of common obstacles, reasons for persisting, and advice for future Black academics. Despite the 13 year gap between that work and the present day, most of the obstacles that were mentioned still seem to persist to this day from the author's experience. A few specific examples of these obstacles include "condescending advisor", "isolation", "finances", and "personal illness". While this work provided a much needed investigation on the obstacles that Black students face, the tone of this work seemed to suggest that Black students should expect these issues and prepare to struggle through rather than actively resist and demand change. We hope to change this narrative while holding onto the persevering spirit of our resilient predecessors.

To focus more poignantly on the issue of retention, a recent analytical work by Shaw served as another reference point[1]. As mentioned previously, this kind of data is not directly available, so an algorithmic approach was taken to approximate the retention of different demographics based on the increase or decrease of a demographic over time at different stages of an academic journey. Specifically, the groups included were undergraduate students, graduate students, postdoctoral researchers, assistant professors, and tenured professors. The trends at face value are not surprising. Since 1990, there has been an increase in Asian, Black, and Hispanic scholars across all academic stages, with varying rates of increase. The more compelling figure breaks these values down to their conversion from one academic stage to the next, i.e. graduate students becoming postdoctoral researchers. This revealed that almost every single demographic group except White faced a relative decline from the graduate stage onwards. For the Black demographic specifically, it seemed that the transition from undergraduate to graduate was average, but the transition from graduate student to postdoctoral researcher or assistant professor was significantly diminished. Although this work shows the issue at hand, it is not able to provide substantive reasons for this failing in the retention of Black PhDs to the professoriate. This is where we hope our work will fill a gap as it pertains to the Black population specifically.

In the next sections, we will present our experiences as Black Ph.D. students within our separate and shared positionalities. We will then share our personal narrative accounts followed by a discussion of the similarities between our experiences and how they connect to the current literature. Finally, we will provide relevant recommendations for academic institutions hoping to create a more supportive and inclusive environment.

Positionality

Crystal Nattoo

I am pursuing a PhD in the Electrical Engineering department at Stanford University. After being introduced to the world of engineering education two years ago, I have been interested in more thoroughly investigating the literature as it relates to the intersectionality of being a Black academic and an engineering researcher. To my suprise, although I have had several conversations about the issues in this regard within academia, there did not seem to be a substantial written account of what the experience is really like. From my perspective, this has resulted in many Black prospective PhD students choosing a path without the proper guidance on what kinds of environments would allow them to thrive and what to look out for when starting a PhD. As a queer Jamaican-American first generation low-income (FLI) alumna from the University of Miami, I was often the only Black and/or woman-identifying student in my engineering coursework for the entirety of my undergraduate degree. Unfortunately, this did not change when I decided to pursue a graduate degree with the hopes of getting into engineering Research and Development (R&D). My goal is to continue the investigation into why folks that look like me tend to be sparse in academia and help provide guidance to the relevant leadership to make a meaningful improvement in retention of Black PhD candidates, as well as Black academics in general.

Crystal Winston

I am a Black, queer, PhD candidate at Stanford University studying Mechanical Engineering. Before attending Stanford, I completed my undergraduate degree at the Massachusetts Institute of Technology (MIT) in Mechanical Engineering and my master's degree in Aerospace Engineering at Imperial College London through the Marshall Scholarship. Like my co-authors, these experiences have exposed me to the struggles of being a Black student in predominantly white institutions and the stressors that are unique to the Black PhD student experience. One of my primary motivations for contributing to this paper is to highlight some of these stressors and express why they make retention for Black PhD students so challenging. As a result of experiencing these stressors throughout my PhD and wanting to address them for future generations of Black students, I chose to contribute my story and recommendations as part of this work.

Rachel Adenekan

I am a Black, Second Generation American PhD candidate, studying Mechanical Engineering at Stanford University. Previously, I completed my master's degree at Stanford and my bachelor's degree at MIT, both in Mechanical Engineering. To date, less than 10 Black women have graduated from Stanford's PhD in Mechanical Engineering program[19]. Throughout my time at the university I observed that several students did not complete the doctoral program, and many who completed the program felt burnt out because of the series of painful experiences they faced during graduate school. I contributed to this paper to shed light on the harmful practices that plague academic institutions and create space for meaningful dialogue with individuals who are interested in building academic environments that are healthy for Black PhD candidates.

Shared Positionality

The authors are all Black Womxn PhD candidates at the same university studying engineering. This paper arose out of the conversations they saw consistently come up within the small Black graduate student community at their university. They acknowledge that their experiences are limited as they have only attended predominantly white institutions (PWIs) and have no experience attending historically black colleges or universities (HBCUs). Although they have different research interests, they share the same belief that there is a lot of room for improvement in making academia more hospitable for Black PhD students. The fact that so many accomplished individuals are being admitted and then facing the same barriers, highlights the fact that significant preparation for doctoral level rigor is insufficient for thriving in academia as a Black student. While they acknowledge that they hold additional identities beyond their race, they would like to focus this paper on their experiences as Black Ph.D. students, as addressing the intersectional nature of their other identities would go beyond the scope of this work.

The social expectations of being "the Black girl"

Autoethnographic Narrative 1

I was the only Black woman in the Electrical Engineering PhD cohort entering Stanford University in 2019. This was not something that was new for me, unfortunately, since I had regularly been "the only" starting in my elementary school gifted student classes at the tender age of seven years old. The main difference in this situation was the magnitude of the population that I was entering. Being the only Black girl or woman in a group of 10 or 20 students feels proportional or to be expected, but amongst the 418 graduate students in Electrical Engineering PhD students at the time, I was not able to find any other Electrical Engineering PhD students with the same racial and gender identity as me. In that same year, there were only 43 Black identified graduate students in the 3,492 engineering graduate student population, making the Black graduate student population 1.2% in the School of Engineering[20]. Although I was eventually able to find community amongst this small pool of folks, it was still a very isolating experience for me.

During the admitted student visit weekends that I attended earlier that same year, I had some inkling of this reality, but it didn't hit as hard for me as it did during orientation week. All of the first year students were ushered from place to place to socialize with their cohort mates and learn everything they needed to know about degree progress in their respective graduate programs. It was a mix of Master's and Doctoral students so it was difficult to tell who in the room were there for the long haul and who would be moving on in a short two years. As it was typical for me as a Black person in historically white spaces, I looked around the room to see if there were any other Black students in the room. I could count on my hands how many there were, but I just assumed some had skipped orientation since it was not necessarily mandatory, just highly recommended. In the weeks following, the reality slowly started to set in for me, that I was once again "the only" despite my hopes and wishes that I would not be. This is not to say that I had no friendship amongst my cohort because there were many lovely people that I met my first year at Stanford, it is just an additional labor to have to endure the kinds of unintentional microaggressions that are now expected for me in these kinds of spaces. I can't count the amount of times that I have had to

explain to people that my hair has not magically grown from my last hair cut and that it takes close to 12 hours of labor for me to redo my box braids every two months.

Once I had settled into my new reality of being "the Black girl" for at least another year, the burden of this started to set in. On top of the typical imposter syndrome that almost every first year PhD experiences, I felt the responsibility of being perfect so that no one could question my place there. Had I been admitted out of pity? Was I the "diversity hire" so to say? I had worked so hard in my undergraduate years to be at the top of my class. I spent two of my three summers participating in research experiences for undergraduate students (REUs) and got published as the second or third author on papers from that work. Was that not good enough? It was an additional emotional labor that I held with little to no company that could truly understand how I felt.

The isolation of this experience started to take a major toll on my mental health. I went from being a top student to struggling to pay attention to my lectures. These issues only compounded when everything became virtual due to the COVID-19 lockdown in March of 2020. It was not clear to me that first year, but I had started to develop severe depression. It wasn't until the second year of my PhD that things transformed for me after I was able to connect with other minoritized PhD students in therapy and began to realize that my story wasn't isolated. Although it was sad to hear of their struggles and emotional battles, it was also freeing to realize that my experience was not a result of a failing on my part, but rather the culture of the space I was trying to fit into. This perspective helped me to advocate for myself more when I felt uncomfortable and led me to find positive role models in the broader PhD community who showed me that my dreams were still possible.

Discussion of Narrative 1

All of the co-authors have experienced the feeling of being "the Black Girl" in their programs and related to the story described in Narrative 1. One of the authors noted that they felt this most strongly in their courses. Their cohort of Ph.D. students had only one other black person and unfortunately, the two of them did not share any classes. Consequently, this author was often the only black student in their courses. They found it much more difficult to find students who were willing to work on assignments with them. They would often reach out to their classmates and other students would say that they "weren't working with anyone" or "weren't available" at the times this author planned to work. Those same students would later be seen working together at the same times and locations where they were working.

Another author noted having the same experience and also struggled to find students to study with for qualifying exams. The few Black students who entered this author's PhD program before warned her that the qualifying exam experience is often quite isolating. They mentioned that other students claimed they were "not yet studying," but they were in fact studying, just not with them. This author did not expect this to be true and optimistically tried to work with other students in her cohort. In the end, she realized that the warning the senior PhD students gave her was warranted. The exam process was isolating, and she saw the same students who "weren't studying yet," working together, without her. This was quite a shocking experience to her as she had quite the opposite experience during her undergraduate program. In her undergraduate program, students were committed to working together. They understood that the program was rigorous and working

together, not excluding peers, would benefit everyone

This experience has also been documented in the literature going back as far as 2004[21]. Gay documents the same experience of paying to take a class and then feeling the burden of having to teach herself the content. For many Black students, this only compounds onto pressure of doing well because if they are to struggle or fail it will likely be attributed to the stereotypes that are already ingrained into how their peers view them. In Blosser's work[22], this is described as being "hypervisible", a state of being constantly on display or constantly surveilled by engineering peers. This phenomenon can make a difficult course even more stressful, especially when those same peers refuse to collaborate in studying efforts. Although disadvantaged by not having the ability to collaborate with peers, Black students often are able to persevere and still succeed in their course work. Despite this demonstration of capability, they may come out the other end of the experience still questioning their worth and ability as discussed in the work by Gildersleeve, Croom, and Vasquez[15]. Unfortunately, this can leave a lasting impact on students self-worth long after leaving the academic setting, following them into the workplace.

The burden of additional labor to address a lack of diversity

Autoethnographic Narrative 2

Like many other Black PhD students I've met, feeling the isolating affects of being a minoritized student at a PWI propelled me to get involved in JEDI related work. For me, this specifically involved outreach. As a high school student I had participated in outreach programs for minoritized students interested in engineering and those programs played a huge role in my decision to study Mechanical Engineering in college by helping boost my confidence and exposing me to different engineering fields. As an undergraduate student, I was involved in running a similar high school outreach program targeted at introducing minoritized students to STEM. When I started my PhD at Stanford, I was keen to get involved in similar work.

During the second and third years of my PhD I partnered with a lab-mate to run a high school outreach program for racially minoritized FLI students in the Bay Area. When we initially proposed the idea, we received lots of verbal support from professors and administrators at the University. After all, such a program was directly aligned with the values Stanford set out in their IDEAL Strategy Plan, where they state a desire to "Expand ongoing outreach programs that increase access for high school and community college students from underrepresented populations and include programs that make Stanford more accessible to students from minority-serving organizations and institutions of learning."[23]. However, while we received initial excitement and enthusiasm from many people at the university, when we asked for financial support for costs associated with running the program, it was hard to get that support. We ended up reaching out to six different offices for small amounts of funding, and even then, were not able to fully fund the program with Stanford resources. Instead, we also needed to reach out to corporate sponsors and even take a donation from a local high school robotics team in order to fully fund the program. In addition to not fully funding the program outright, the university also then took 8% of the money that we raised from these external sources, which was originally intended to provide stipends and food for the students while they participated in the program.

In addition to our financial struggles, we also received very little administrative help from the university when it came to setting up the program. As a result, my lab-mate and I ended up spending a combined 20 hours/week getting the program set up during the entire 2022-2023 academic year. In order to launch the program and recruit applicants we met with five different educational experts, contacted 19 non-profit organizations and high schools for potential partnerships, researched similar outreach programs, read and reviewed 59 applications, and selected 10 students. We also recruited and trained mentors, developed workshops and found speakers to facilitate them, and performed various administrative tasks like ordering food, booking rooms, helping mentors get background checks, and managing funding from different sources. After we planned out the program during that academic year, my lab-mate then ran the program over the summer while also mentoring two program participants. These students were originally assigned to another mentor, but because their lab was unable to provide the students with a working environment where they felt welcome, the students asked to be moved and my lab-mate took on the additional task of mentoring them. This resulted in him spending 20 hours/week by himself in order to keep the program afloat and mentor students over the summer. This is half of the time that a full-time PhD student is expected to spend on their research each week.

Running this program was a substantial burden on our PhD progress due to the considerable time commitment. Consequently, we asked the university to provide a part-time employee to run the program for future years so that we could focus on our PhD's. They refused to do this and my lab-mate even received pressure from professors in our department to continue running the program, unpaid, even though it had already eaten away at so much of his research time. Instead, we both decided to step down so that we could invest our time into completing our degrees, and the program no longer exists. Not only is this unfortunate because the program aimed to address some of the JEDI issues the university claims to be invested in fixing, but it also was a lot of uncompensated labor that a non-minoritized PhD student would rarely find themselves being pressured to manage. Ultimately, issues of JEDI in academia are in large part created and perpetuated by the academic institutions themselves. However, in our case, their attempts to resolve them had insufficient financial backing and relied upon a large amount of uncompensated labor from students most affected by these issues themselves.

Discussion of Narrative 2

As illustrated in this narrative, the JEDI work being done at the university is often a reflection of the good intentions of the minoritized graduate population, at the expense of that same population. Another author has also had similar experience with getting involved in JEDI outreach programs and departmental town hall discussions. Since she was not on the board formally, she would instead submit questions to the committee to address in department wide town hall discussion in order to keep them accountable for the issues she noticed. This made for an uncomfortable situation when the questions she asked were skipped over and not even discussed while more light-hearted or trivial questions were dwelled upon. It further solidified for her that the department did not have the same serious intention she had to ask the hard questions and make meaningful changes. Thus, she focused her efforts on outreach efforts that were already well established and just needed dedicated mentors for the students selected for the programs.

Similarly, a different author had the experience of struggling to find faculty who held her

same interest in supporting outreach that included Black students. She noticed that many outreach programs catered to women of various racial backgrounds, but Black students were often not intentionally invited to participate. She served on multiple lab outreach teams and proposed many ideas to engage Black students specifically, but faced difficulty in gaining advisor and peer support for these specific initiatives. They were disproportionately more interested in focusing on White and Asian women rather than other minoritized groups.

Not only are Black students severely underrepresented in engineering academic spaces, universities expect their unpaid or underpaid labor as part of the solution through our participation in DEI committees and outreach programs. This issue has been described as "problematic popularity" in previous works[21]. When minortized students are called on to fix the issues they are currently dealing with, they are caught in a *Catch 22*. If they refuse to give their labor, these JEDI issues often sit unresolved or ignored. If they take on the additional labor, it can delay their research progress and graduation prospects. As rigorous PhD researchers, they do not have the bandwidth to take on such an expansive issue, nor should they be responsible to solve it.

In addition to the time impact, it also can require a large amount of emotional labor to share the difficult experiences have had, followed by little to no support to recover from the share out. Microaggressions are faced regularly by minoritized students[6,24,25,26,27,28], but are only considered as potentially impactful when arduously detailed by those being aggressed. This means not only surviving being picked at little by little, but also later being asked to prove the scars are real. The impact of this can be adverse to the point of Black PhD students leaving a degree program, not because of technical difficulty, but in order to preserve their mental wellbeing in an act of self-preservation.

The obstacle of navigating an unhealthy work environment

Autoethnographic Narrative 3

Many people believe that toxic experiences in graduate school can be avoided if students are *well prepared*, and if that were the case, I would've been destined for a smooth sailing journey. I was more than prepared. Education provided a path to America for my parents, and they passed on this high regard for education to me. My parents both hold advanced degrees in science and engineering from prestigious American universities, and they trained me for academic success from a young age. I went to regular school during the day, but nights and weekends were dedicated to *family school*, a school in which my parents pushed me beyond any public curriculum. They tutored me personally, never outsourcing my education to teachers or private tutors, and I reaped the fruit of their labor. I graduated from one of the best public high schools in the country at the time and from the best engineering undergraduate program in the world. I also completed multiple research projects during my undergraduate program, and I had stellar letters of recommendation from both course instructors and research advisors. I was highly prepared to succeed, and Stanford recognized this potential by offering me their highest-paying fellowship at the time, the three-year Stanford Graduate Fellowship (SGF), awarded to a small percentage of "outstanding students." Despite all this preparation and excitement for research, my experience navigating Stanford's Mechanical Engineering department has left me questioning my capabilities, and this

experience mirrors many of the other Black students in the department who graduated before me. Regardless of background (research interests, undergraduate programs, funding situations, etc), we all ended up at the impasse of having to change labs due to an unhealthy work environment.

My experience was characterized by persistent bullying that started soon after I committed to a lab. Prior to joining, I was promised that I could work on a specific project, but after committing, I was told that I could not work on that project. I then reviewed the literature and proposed several project ideas, but every idea was dismissed. No attempts were made to work together on finding a project of mutual interest, and instead, I was presented with a single project option. I was condescendingly told "There are students lined up outside of my door waiting to join this lab. I'm just trying to do you a favor [by allowing you to work in my lab]." It did not matter that I had entered the program with Stanford's highest-paying fellowship at the time. I was viewed as a *charity case*. Truly I should have left at that point, but I made the novice mistake of thinking that if I just "ignored the noise and continued working," I could convince any professor to respect me. I failed to recognize that my job was not to convince anyone to respect me, but rather to leave when respect was not being served. I continued working and later earned the prestigious National Science Foundation-Graduate Research Fellowship; this fellowship combined with my SGF fellowship amounted to 5 years of full fellowship funding. The treatment did not improve.

Another challenging aspect of the graduate school experience was the lack of mentorship. I had no one in the lab with whom I could collaborate. All other students were immediately paired with a postdoc or a senior graduate student who heavily supported the new student. The postdocs and senior graduate students often had elements of their work that they had already planned but simply did not have bandwidth to complete, and these new students were given a major advantage by being handed projects that were well planned and could be executed with immense support from more advanced lab-mates. The few students who did not have the support of an advanced graduate student or postdoc were grouped together such that they could complete a team project. I was the only first-year student who was being forced to work entirely alone on a new project.

Over the duration of this program, my confidence has been eroded due to hurtful and untrue comments that make me question whether I belong in academia. One of multiple examples of this is when I was working on a figure for a conference abstract. After receiving criticism, I decided to remake one of my conference figures and then ask a more advanced graduate student to provide feedback. This seemed like the perfect opportunity to seek constructive feedback from a more experienced lab member who had mastered the art of figure-making. The student kindly reviewed my revised figure, but while he was providing the feedback, a professor said to me "You need to learn critical thinking. Another student should not be doing your work for you." I was stunned that the assumption was that I did not know how to think and was planning to outsource my work to other students. Despite this, I calmly and respectfully explained that the student was not "doing my work" or "making my figure" for me. I was simply gathering feedback on my revised figure, a common exercise for early-stage students. I never received an apology for this false accusation. I sought advice from other professors, hoping this would help.

The false accusations continued and became especially hurtful when some highly traumatizing events occurred in my personal life. The trauma caused serious emotional and physical health issues for me, and as such I had to leave campus and return home so I could focus on improving my health with the support of my health-care providers and my family. I notified the professors that I

was very unwell and needed to seek professional help, and we agreed that while away from campus, I would focus on completing my remaining course-work and also on completing my required TA-ship. Since it was a COVID year, these tasks were able to be completed remotely. I wanted to return to campus within a few months of leaving, and continually tried to do so, but it was not safe for me to return, so I stayed at home longer than planned. I spent a total of five months at home. During this time, I had multiple check-ins with both student services staff and professors to discuss how I was recovering, any additional support I needed, additional work I could complete from home, and when I expected to be able to return to campus. After such a long period of being unwell, I was ecstatic when I was cleared to return to campus and continue my research. However, this excitement was quickly tainted by a video call I had with a professor shortly after my return. The professor insinuated that I was lying about my health situation over the past several months. He kept insisting that I tell him exactly what happened. I repeatedly said that highly traumatic situations occurred in my personal life and caused serious emotional and physical health issues for me, and I needed extensive support from medical professionals and my family. This was insufficient for him. He demanded to know more sensitive details. When I refused, since he is not part of my health team and has no legal right to this information, he got angry and exclaimed "Is it even that serious?" He did not respect my privacy, nor did he believe that I was honest.

After this experience, I knew that working in this environment was unsustainable. The lack of respect and trust was too damaging, so I informed another professor about the situation. This professor suggested that other professors attend my weekly advising meetings. For five months, I continued working and presented my progress weekly to a group of professors. This makeshift arrangement worked until a professor wrote an untrue and demeaning statement against me, horrifying the other professors and staff. I was *accidentally* cc'd on this email, and once received, I immediately informed the professors that I would no longer continue working with the team. It took a complete shattering for me to finally respect myself and refuse to continue working in such a hostile environment.

Since joining a new lab, my situation has drastically improved. I am incredibly grateful that I was able to find a healthier environment and complete my degree. I have been given the freedom to explore my own project directions and build collaborative relationships across different departments at the university, and I have been supported in presenting and publishing my work. Most importantly, I have never been falsely accused, unfairly criticized, or degraded. My work is appreciated. While I am no longer in an actively unhealthy work environment, I still carry the scars from my traumatic graduate school experience. When I came to Stanford I was curious, excited, and confident about my ability to contribute meaningful research to the field, but now my mind is constantly battling disparaging voices. I've formed multiple interdisciplinary collaborations at Stanford, have won several grants to support my work, and have completed an entire dissertation in less than half the usual time, all while battling health challenges. As I apply for coveted professional positions in my field, leaders of these organizations tell me that I'm a highly qualified candidate — but I now struggle to see myself clearly. It's not modesty when I say that I'm not sure I'd be the best candidate. My confidence has been eroded, and it will likely take years of painstaking work to recover.

Discussion of Narrative 3

The accounts from this author were very moving for her co-authors to hear and definitely a prime example of what can happen when students are not properly protected. While accounts like this seem few and far between, cases of unhealthy lab environments are all too common. In fact, 24% of respondents to a recent survey of doctoral students experienced some form of abuse of power by their advisors[29]. Upon experiencing such abuse, many students are *blacklisted* since administrators and staff often side with their colleagues rather than a student[30]. Students are forced to face the harsh reality that universities are not neutral institutions. As Mahmoudi stated "universities often minimize and keep confidential corrective actions against bullies, probably for the sake of the institution's reputation, the desire to protect their most prolific and well-known scientists, and the fear of being sued by the targets of bullying"[31]. Furthermore, the kind of negative relationship between PhD student and advisor discussed in Narrative 3 can be a major contributing factor to a students' decision to either leave the PhD program or to complete the PhD program but abandon a faculty career[32]. A 2018 Nature editiorial stated "[we] will never know how many promising scientific careers around the world have been brought to a premature end because young researchers felt they could not continue to work under a bullying senior figure"[33].

Another author of this work had a very similar experience in their previous lab. They had originally been enrolled in a Ph.D. program at another institution and left with a master's degree to pursue a PhD at Stanford. They were able to empathize with the experience of having a difficult advisor and lab mates who did not respect them. This author also shared similar experiences regarding the mental and emotional toll that takes on a student. These additional stressors made it so much more difficult for this author to go into the lab even though they really enjoyed their research, and ultimately, they decided it was best to leave and pursue their PhD elsewhere. They have now found a much healthier work environment and are currently in a lab where they feel respected, supported, and free to explore their research ideas. Despite this change, they still struggle with self-confidence and strongly identify with the sentiment that recovering confidence after such an experience is a long and difficult process.

For another author, the professional relationship with her research advisor was healthy, but strained by other members of the lab. She experienced a string of hard personal difficulties ranging from family deaths to health issues that required her to utilize accessibility resources from the university frequently. Although her advisor was understanding and gave her the space and time she needed, she often received disapproving looks or comments from some of her lab mates who saw this as her receiving special treatment. When she brought these things up with her advisor, his advice revealed how limited he truly was in controlling the lab environment, since it functioned mostly through the collaboration of whichever students are most interested and dedicated to the lab's niche research topic. When there are uncomfortable relationships between lab members, an advisor may not always want to step in and handle conflict under the guise of being "neutral".

Even in the best of student-advisor relationships, the phenomena of "benign neglect" can effect research outcomes for minoritized students[3]. This phenomena is described by Gay as "professors in classes and as advisors who do not provide the kind of critical and constructive instruction that they need to develop their intellectual, research, writing and teaching skills." This is likely a symptom of professors not being able to socially identify with minoritized students[2,34] and sub-

sequently treating them differently when compared to their peers. This difference in treatment creates a compounding effect of students questioning their place in academic institutions, when even their designated advisor is not able to affirm their value and give them constructive feedback to grow. This is supported by the finding of De Valero[35] that "nurturance and support are more effective in promoting student success than professionalism and formality."

The story discussed in Narrative 3 highlights how a Black student can be particularly vulnerable to bullying and abuse of power as this student was mistreated to the point of needing to leave her lab despite having frequent contact with multiple professors who were aware of the situation, but unwilling to hold their tenured colleague accountable. Ultimately, this kind of mistreatment is common and well documented throughout academia[30]. In addition to this mistreatment, the experiences of her co-authors also speak to the additional affects that "benign-neglect" can have on minoritized students in academic research labs. In some cases, the advisors themselves may not be mistreating their students, but because they do not share the same minoritized backgrounds and have not sought training in supporting these students, they are ill-equipped to manage potential interpersonal conflicts these students may experience in their labs. Specific measures need to be taken to protect PhD students at large and especially those who are even more vulnerable as minoritized students.

Recommendations

Based on our personal narratives and subsequent discussions, we have distilled a few recommendations for academic administrators who would like to mitigate the issues we have faced.

1. **Design thoughtfully inclusive orientations to foster a true culture of belonging amongst incoming cohorts.** There needs to be an intentional effort put into creating authentic community amongst cohorts early on, when long lasting connections are created. Allowing members of the cohort to express themselves as a whole person can help mitigate issues of some being viewed as out of place. In addition to this, minoritized students should be properly introduced to relevant cultural communities on campus as soon as they arrive so they won't feel as isolated.

2. **Invest financially in outreach programs by hiring part-time staff to help run the programs and find funding for them should the university not be capable of funding the program outright.** As shown by the second narrative, outreach programs require lots of time and financial investment. Universities should invest financially in these programs by hiring part-time staff that handle administrative tasks and find funding for the programs. This responsibility should not be the responsibility of unpaid minoritized students.

3. **Pay for external DEI audits.** There are organizations with professionals trained in JEDI work that perform audits for corporations. Universities should hire similar groups to perform audits on their departments rather than forming DEI committees as these committees are run on uncompensated labor by students and faculty with little to no JEDI expertise.

4. **Ask interview questions that allow departments to identify professors who may hold harmful biases against students from minoritized backgrounds in addition to harmful**

behaviors generally. In the interview process, universities need to prioritize the safety of their minoritized students by identifying professors that hold harmful biases. While research experience is incredibly important when choosing engineering faculty, the safety of the students working under them should be of equal importance, and the faculty interview questions should reflect that.

5. **Create an academic "Human Resources" department that can protect the interests of students who are being mistreated by their advisors.** As demonstrated by the third narrative, once a minoritized student finds themselves in an unhealthy work environment, it can be incredibly difficult to get help. This is in part because there is very little oversight built into the academic structure that allows students to get help in these types of situations if they need it. Universities should widen the reach of current Human Resources departments to include protection of graduate student workers in order to shield students from unhealthy lab environments.

6. **Enforce mandatory reporting of abusive advising situations for all professors.** Often, conflicts of interest and power dynamics make it such that professors find it difficult to report their colleague on behalf of a student. The colleague's relationship is viewed as more permanent and it can seem easier to simply ignore a student rather than expose a tenured professor. However, professors need to be held accountable for their colleague's harmful actions if they become aware of them. It should be mandatory to bring these issues to light early to avoid prolonged issues that may go on to affect a larger population of young researchers.

Conclusion

As a more diverse set of individuals prepare to enter the professional ranks, we must consider how we, as individuals, may subtly perpetuate ideas of who belongs. We have talked about the experience from the lens of Black Womxn PhD candidates, but these same issues were once just as pervasive for women in STEM generally. One of the main contributing factors for women leaving STEM academic and professional spaces is being made to feel like they don't belong by men, despite women being just as technically capable as their male counterparts[36]. Considering other minoritized identities, such as LGBTQ individuals, reveals a similar trend of needing to employ protective heuristics to be perceived as a social fit and gain the same professional opportunities readily available to their cisgender heterosexual peers.[37] This additional emotional labor involved in trying to prove that we belong becomes mandatory for many minoritized individuals, resulting in lower professional retention rates for these populations.

We hope that graduate research institutions nationwide can make steps to improving the climate for Black PhD candidates, by means of the recommendations from this work. There is still work to be done towards creating a true culture of belonging within academia. Once admitted, all students should be able to focus on their studies while also being given authentic platforms to address any issues they may notice. Lastly, lab structure must be augmented to avoid situations in which students are emotionally broken down by the person meant to be a holistic mentor for them. Fostering a healthy academic environment where all intellectually qualified students are given the same opportunities for growth should be the goal for true equity.

Acknowledgements

The authors thank Abisola Kusimo for her insightful edits to our manuscript.

References

[1] A. Shaw, J. Chaco, T. Mueller, M. Vaugeois, Y. Yang, and N. Sekar, "Differential retention contributes to racial/ethnic disparity in u.s. academia," *PLoS One*, 2021.

[2] T. Schmader and C. Sedikides, "State authenticity as fit to environment: The implications of social identity for fit, authenticity, and self-segregation," *Personality and Social Psychology Review*, vol. 22, no. 3, pp. 228–259, 2018.

[3] M. Gasman, C. Gerstl-Pepin, S. Anderson-Thompkins, L. Rasheed, and K. Hathaway, "Negotiating power, developing trust: Transgressing race and status in the academy," *Teachers College Record*, vol. 106, no. 4, pp. 689–715, 2004.

[4] M. Ong, C. Wright, L. Espinosa, and G. Orfield, "Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics," *Harvard educational review*, vol. 81, no. 2, pp. 172–209, 2011.

[5] F. Nicole and J. DeBoer, "A systematized literature review of the factors that predict the retention of racially minoritized students in stem graduate degree programs," in *2020 ASEE virtual annual conference content access*, 2020.

[6] B. A. Burt, K. L. Williams, and W. A. Smith, "Into the storm: Ecological and sociological impediments to black males' persistence in engineering graduate programs," *American Educational Research Journal*, vol. 55, no. 5, pp. 965–1006, 2018.

[7] M. W. Makgoba, "Black scientists matter," *Science*, vol. 369, no. 6506, pp. 884–884, 2020. [Online]. Available: https://www.science.org/doi/abs/10.1126/science.abe3234

[8] C. Ellis and A. Bochner, "Autoethnography, personal narrative, reflexivity: Researcher as subject," 2000.

[9] C. Ellis, T. E. Adams, and A. P. Bochner, "Autoethnography: An overview," *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, vol. 12, no. 1, Nov. 2010. [Online]. Available: https://www.qualitative-research.net/index.php/fqs/article/view/1589

[10] J. P. Martin and C. Garza, "Centering the marginalized student's voice through autoethnography: Implications for engineering education research," *Studies in Engineering Education*, vol. 1, no. 1, pp. 1–19, 2020.

[11] J. Yang and C. Nattoo, "Balancing social, personal, and work responsibilities for minoritized doctoral students in engineering," in *2022 ASEE Annual Conference & Exposition*, 2022.

[12] J. A. Yang, "Engineer, asian, and gay af: Counterstory as means for methodological activism and intersectional healing in engineering education," *Studies in Engineering Education*, Mar 2024.

[13] P. R. Clance and S. A. Imes, "The imposter phenomenon in high achieving women: Dynamics and therapeutic intervention," *Psychotherapy: Theory, Research Practice*, 1978.

[14] M. F. Jimenez, T. M. Laverty, S. P. Bombaci, K. Wilkins, D. E. Bennett, and L. Pejchar, "Underrepresented faculty play a disproportionate role in advancing diversity and inclusion," *Nature ecology & evolution*, vol. 3, no. 7, pp. 1030–1033, 2019.

[15] R. E. Gildersleeve, N. N. Croom, and P. L. Vasquez, ""am i going crazy?!": A critical race analysis of doctoral education," *Equity & Excellence in Education*, vol. 44, no. 1, pp. 93–114, 2011.

[16] J. Wu, T. Cropps, C. M. L. Phillips, S. Boyle, and Y. E. Pearson, "Applicant qualifications and characteristics in stem faculty hiring: an analysis of faculty and administrator perspectives," *International Journal of STEM Education*, vol. 10, no. 1, pp. 1–20, 2023.

[17] D. J. Nelson, "Diversity of science and engineering faculty at research universities," in *Diversity in the Scientific Community Volume 1: Quantifying Diversity and Formulating Success*. ACS Publications, 2017, pp. 15–86.

[18] J. Rutledge, W. Carter-Veale, and R. G. Tull, "Successful phd pathways to advanced stem careers for black women," *Diversity in Higher Education*, 2011.

[19] "Ipeds completions survey from department of education table builder," National Center for Education Statistics, Tech. Rep., 1997-2022.

[20] S. University, "Ideal dashboards," 2024. [Online]. Available: https://ideal.stanford.edu/data-reports/ideal-dashboards

[21] G. Gay*, "Navigating marginality en route to the professoriate: Graduate students of color learning and living in academia," *International Journal of Qualitative Studies in Education*, vol. 17, no. 2, pp. 265–288, 2004.

[22] E. Blosser, "An examination of black women's experiences in undergraduate engineering on a primarily white campus: Considering institutional strategies for change," *Journal of Engineering Education*, vol. 109, no. 1, pp. 52–71, 2020.

[23] P. Drell, P. Dunkly, and S. Everett, "Ideal (inclusion, diversity, equity, and access in a learning environment) strategic plan," Stanford University, Tech. Rep., 2023.

[24] M. M. Camacho and S. M. Lord, *The borderlands of education: Latinas in engineering*. Lexington Books, 2013.

[25] J. R. Feagin and M. P. Sikes, "How black students cope with racism on white campuses," *The Journal of Blacks in Higher Education*, no. 8, pp. 91–97, 1995.

[26] S. Fries-Britt and K. M. Holmes, "Prepared and progressing: Black women in physics," in *Black female undergraduates on campus: Successes and challenges*. Emerald Group Publishing Limited, 2012, pp. 199–218.

[27] S. R. Harper and S. Hurtado, "Nine themes in campus racial climates and implications for institutional transformation," *New directions for student services*, vol. 2007, no. 120, pp. 7–24, 2007.

[28] D. Solorzano, M. Ceja, and T. Yosso, "Critical race theory, racial microaggressions, and campus racial climate: The experiences of african american college students," *Journal of Negro education*, pp. 60–73, 2000.

[29] R. Jacob, I. Kuzmanovska, and N. Ripin, "Aveth survey on supervision of doctoral students," ETH Zurich, Tech. Rep., 2018.

[30] A. Cohen and Y. Baruch, "Abuse and exploitation of doctoral students: A conceptual model for traversing a long and winding road to academia," *Journal of Business Ethics*, vol. 180, no. 2, pp. 505–522, 2022.

[31] M. Mahmoudi, "Academic bullies leave no trace," *BioImpacts: BI*, vol. 9, no. 3, p. 129, 2019.

[32] S. K. Gardner, ""i heard it through the grapevine": Doctoral student socialization in chemistry and history," *Higher education*, vol. 54, pp. 723–740, 2007.

[33] "No place for bullies in science," *Nature*, vol. 559, p. 151, 2018.

[34] B. L. Duncan, "Minority students," *Scholars in the making: The development of graduate and professional students*, pp. 227–242, 1976.

[35] Y. F. De Valero, "Departmental factors affecting time-to-degree and completion rates of doctoral students at one land-grant research institution," *The Journal of higher education*, vol. 72, no. 3, pp. 341–367, 2001.

[36] D. B. Thoman, J. A. Arizaga, J. L. Smith, T. S. Story, and G. Soncuya, "The grass is greener in non-science, technology, engineering, and math classes: Examining the role of competing belonging to undergraduate women's vulnerability to being pulled away from science," *Psychology of Women Quarterly*, vol. 38, no. 2, pp. 246–258, 2014.

[37] J. A. Yang, M. K. Sherard, C. Julien, and M. Borrego, "Lgbtq+ in ece: Culture and (non) visibility," *IEEE Transactions on Education*, vol. 64, no. 4, pp. 345–352, 2021.