

Work in Progress: Towards a Participatory Action Research Approach to Improve Representation of Black Ph.D.s in Engineering

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Abstract

This work-in-progress introduces a conceived participatory action research approach to improve representation and support for Black Ph.D.s in engineering. In 2019, only 3.9% of doctoral engineering degrees were awarded to Black students (ASEE, 2020), thereby affecting who goes on to become future faculty members, leaders, and role models (Burt et al., 2019). Most research on broadening participation in engineering has focused on undergraduate education with relatively limited work on graduate populations (Burt et al., 2018). A recent systematic literature review on Black students in engineering a larger research pool on undergraduate students instead of graduate students (Holloman et al., 2020). This statistic speaks to the need to improve the support of Black graduate students in engineering. For this work, we envisioned a use-inspired approach where the target population, Black engineering Ph.D. students and their faculty advisors, along with recent Black engineering Ph.D. alumni, become academic partners in co-creating a professional development curriculum, procedures, and policies needed to equip individuals to be agents of change. For this paper, we will discuss ideations that were generated to propose a participatory action research for a recently funded grant whose goal will be to build inclusive and equitable engineering educational spaces for Black Ph.D. students in engineering, even when the environments are exclusionary and systemically inequitable in power.

Introduction

The current national reckoning with racial injustice presents an urgent impetus for examining the experiences of Black students and the extent to which global power (i.e., that of the larger entity such as the institution or academic unit) influences individual students' power. Nationwide numbers show a dearth of Black engineering Ph.D. students in the United States. In 2019, only 3.9% of doctoral engineering degrees were awarded to Black students (ASEE, 2020), thereby affecting who goes on to become future faculty members, leaders, and role models (Burt et al., 2019). Most research on broadening participation in engineering has focused on undergraduate education with relatively limited work on graduate populations (Burt et al., 2018). A recent systematic literature review on Black students in engineering identified 132 references situated in undergraduate education and only 5 in graduate education (Holloman et al., 2020). Holloman and colleagues' (2020) work synthesized scholarship related to recruitment and persistence, student identity, and graduate school perceptions and underscored the institutional and programmatic factors that help or hinder Black graduate students in engineering. Their research identified faculty advisor support as a crucial enabler while bias, discrimination, and power imbalance in the student-faculty relationship were deemed barriers to attaining a Ph.D. degree. Environmental and systemic factors could thus be key deterrents for their persistence in engineering.

Within educational ecosystems, hidden and unacknowledged messages of power surrounding many engineering programs communicate long-standing traditions that serve to sustain the *status quo*. Even amongst leaders and mentors within engineering graduate programs, given the statistics provided above, well-intentioned desires to change ecosystems and structures for the pursuit of equity have not significantly moved the needle for Black engineering students. These trends situate a need to move away from normative and self-focused approaches of professional formation that imprint in students' messages of exclusion, to a more *sense-making*

approach that considers adaptive, critically self-assessing, and open acknowledgement of students' visions of purpose and success. The latter requires the formation of ethical relationships between graduate students and their faculty (Gelles, Villanueva, & Di Stefano, 2019) so that institutional and programmatic factors that deter Ph.D. progression are mitigated, particularly those factors that contribute to racial inequities in STEM.

The authors situated the need for equal footing between Black engineering Ph.D. students and their mentors in where there is an intentional creation of safe and third spaces (Villanueva Alarcón & Sellers, 2023) by which ideas can be shared and differences that fall outside the traditional norms of engineering are reflected upon, discussed, and disrupted. Without an intentional breakdown of the *communicated (and often, uncommunicated)* power structures that systemically message exclusion to Black engineering students via its hidden curriculum (e.g., Villanueva et al., 2020), the liminal spaces that continue to sustain systemic racism remain intact, restricting students' agency in breaking down systemic barriers, and formation as engineering professionals.

For these barriers to break down, a use-inspired approach was deemed necessary by the authors in where the target population, Black engineering Ph.D. students and their faculty advisors, along with recent Black engineering Ph.D. alumni, can become *academic partners*. Given the realities of structural and systemic racism in the United States—colleges and universities notwithstanding—Black students' decisions and actions to (dis)engage in particular curricular or co-curricular related activities could be understood as agentic actions (Secules, et al., 2018). Creating a curriculum and repertoire of resources by which to understand and share the *where* and *when* Black Ph.D. students act agentially is critical to building inclusive and equitable engineering educational spaces, even when the environments are exclusionary and systemically inequitable in power.

This work-in-progress, stemming from a recently funded NSF project, will discuss the literature review, considerations, and significance for this topic and focus at improving the dire state of underrepresentation for this population in engineering. Future publications will include data collection and analysis details. We hope that future findings stemming from this work will inform the larger engineering landscape, and in particular, to augment the representation of Black Ph.D.s in engineering.

Literature Review and Statement of Problem

Graduate Student-Faculty Relationships in Engineering Graduate Programs

Race and ethnicity influence interactions between mentors and students. Same race relationships have been suggested to provide emotional and psychological support (Stolle-McAllister et al., 2011) and social and cultural capital for Black students (Museus, 2010). With a shared identity, Black faculty can also support their students in navigating issues related to race in academia, such as stereotypes (Singh & Stoloff, 2003) and feelings of representing their race (Shapiro & Williams, 2012). Thus, identity matching has been suggested to build comfort, trust, and holistic engagement in a mentoring relationship (National Academies, 2019). However, only 2.5% of engineering faculty members are Black and less than 2% of full professors in engineering are Black (ASEE, 2020; Rockquemore & Laszloffy, 2008).

Conversely, past research has pointed to reasons for strain between Black graduate engineering students and their majority faculty advisors. Racial microaggressions, verbal comments, and nonverbal behaviors that stigmatize and attack an individual and affect their well-being have been reported in advisor-advisee relationships involving Black engineering graduate

students (Burt et al., 2019). These microaggressions discourage students from communicating with their advisors when they need help (Burt et al., 2018) and have a cumulative effect on students' professional identity and persistence (Burt et al., 2019). Other research has indicated that White and Asian mentors ignoring race and identity issues creates challenges to their underrepresented students (National Academies, 2019). The latter point is of particular importance because an academic faculty advisor "is widely considered to be the primary agent of student socialization during graduate school" (Burt et al., 2018, p. 970).

The systemic inequalities and racialized experiences in higher education are perpetuated throughout the professional formation of Black academics. Structural and cultural issues that affect the experience and persistence of Black students are mirrored in the academe as "racial inequities have been implicated in the persistent problem of underrepresentation and low academic status among African American members of the U.S. higher education faculty" (Allen et al., 2000, p. 112). Black faculty members at predominantly White institutions (PWI) face isolation, tokenism, bias, and discrimination (Burt et al., 2018; Frazier, 2011). Notwithstanding, if faculty members (both from majority and minority groups) are not equipped to become racially literate to prepare their Black students for success, a systemic impasse is created, further narrowing the Ph.D. pathways for Black STEM graduate students. Thus, there is a need to both understand the dynamics created in these interactions and how agentic empowerment is formed through the mentor-mentee relationship. In turn, these relationships must be understood in the context of programmatic factors to uncover the hidden curriculum of their profession, engage in critical conversations, and distribute power in ways that individuals within the academic mentoring relationship can grow and support each other.

Conceptual Frameworks

While there may be several frameworks that can pertain to the issue at hand, the authors both elevated their expertise and knowledge to create a unique exposition of the factors that may influence this population the most, especially in the context of engineering. The frameworks (bolded) used along with their rationale are described below.

Agency is central to students' individual power over their own engagement, persistence through school, and ability to navigate systems of oppression (Secules et al., 2018). According to Ahearn (2001), agency is defined as the "socioculturally mediated capacity to act" (p. 112), which is fostered or inhibited by both individual power and the power enacted through social structures. In other words, mediation happens when social circles and groups form the experiences, identities, and aspirations of individuals, who through autonomous decisions and actions, participate in the political process of advocacy (Barnes, 2012; BIRTHA, 2014; Petri et al., 2020). An individual's agency precedes self- and collective advocacies and serves to challenge and dismantle systems of power across institutions.

It is important to define the context for **power**. Power is seen through the lens of Gelles and colleagues (2019), who explored the relationships between graduate students and faculty in science and engineering. According to the authors, power is shared amongst individuals when establishing, communicating, respecting personal/professional boundaries, and sharing information in the form of social capital to reveal the system's unwritten rules and expectations (i.e., hidden curriculum) (e.g., Gelles et al., 2019). The dismantling of information that is communicated via knowledge-sharing and social capital, in turn, empowers individuals to overcome the systemic barriers and challenges they face in their paths (e.g., Acker, 2001; Smith, 2014).

Communication is important for developing and sustaining relationships (Anvuur & Kumaraswamy, 2007; Wong et al., 2008) because it is bounded by the power relationships between a faculty advisor and a Ph.D. student (Lin & Hsu, 2013). Normally, information in these relationships occurs from the top-down (Lin & Hsu, 2013) but truly equitable relationships share information horizontally, leading to trust and power distribution (Das & Teng, 1998; Wong et al., 2008). Scholars have long argued that communication is an important skill for STEM students (Brownell et al., 2013; Graaff & Ravesteijn, 2001). However, most communication training programs in STEM focus on skill development from a deficit-approach (Dudo et al., 2020). According to Dudo and colleagues (2020) and Montgomery (2021), there is a need to move away from communicated forms of ‘imprinting’ where leaders and systems message to an individual to follow the behaviors and norms of the majority for the intent of acculturation and external validation. Dudo and colleagues (2020) further recommended that crafting messages to achieve a particular purpose, clarifying specific goals of communication, collaborating, connecting practices with “real-world” opportunities, and assessing outcomes can foster better mentorship and professional development in STEM fields (Hund et al., 2018).

Since agency is highly intertwined with communication, it is not too far-fetched to consider the sources, influences, and strategies that Black engineering Ph.D. students/alum develop in response to their surrounding **hidden curriculum** (e.g., Villanueva et al., 2020). Hidden curriculum, from a critical perspective, consists of the strategies and actions that follow an individual’s awareness of the unwritten, underexplored, and unintentional messages that cue exclusion to minoritized groups (Apple, 1980; Gelles, Youmans, & Villanueva, 2018; Sellers & Villanueva, 2021; Villanueva et al., 2020). Thus, hidden curriculum is not merely a ‘mirrored’ view of the communicated norms, behaviors, values, and attitudes of a majority group to a minoritized population, it also serves as an impetus to autonomy, resistance, and contradictions for the “possibility of educational action in the face of the power of the hidden curriculum” (Apple 1980, p. 47). In a recent study of 154 self-identified women in engineering, Sellers & Villanueva (2021) found that considering situational hidden curriculum (one that is contextual to their unique roles and identities of people in their learning/working environment), individuals either: (1) change their environment, (2) change themselves, or (3) perform no or minimal action. Particularly, majority women (White American) tended to perform the first two strategies more compared to women of color (Black American, Latinx, Native American) who took no or minimal action regarding their surrounding hidden curriculum. More recent unpublished research has also found similar findings among self-identified men and LGBTQIA+ individuals. The finding suggests that for situational hidden curriculum, the actions, and decisions one may take to face power is contextual and vary by different gender/racial/ethnic identities.

Method

The methods described below include the considerations needed to both address and provide information about how use-inspired approaches were ideated to further the representation of Black engineering Ph.D. students. As mentioned previously, the information shared is part of a NSF-funded study (#2140696) and this work-in-progress openly includes the proposal development ideas behind the work. We recognize that at this point in time, we don’t have results or limitations to share. Instead, the intent for sharing the main proposal ideas is to start conversations and inspire in others, a desire to become more transparent in their processes from the onset of a project. We also understand that some of these ideas may ignite other ideas and approaches amongst the readers for future proposals and projects. *As such, if using any of the*

shared information, we ask that this work is cited due to its novelty in advancing racial equity in STEM and the timeliness of the topic (Simmons, Villanueva Alarcón, & McNealy, 2022; Villanueva Alarcón, Simmons, & McNealy, this paper citation).

Use-Inspired Approach: Participatory Action Research

Use-inspired approaches (the origination and direction are driven by the end use; Stokes, 1997) for this work will involve that Black engineering Ph.D. students and their faculty advisors, along with recent Black engineering Ph.D. alumni, become academic partners in co-creating a professional development curriculum, procedures, and policies needed to equip individuals to be agents of change. This is timely and usable research as it also ensures its relevance, credibility, and legitimacy (Wall et al., 2017).

For this project, the team will use participatory action research (PAR). PAR is rooted in community partnership to facilitate change and is distinguished from traditional research in that “the researched cease to be objects and become partners in the whole research process” (Baum et al., 2006, p. 854). This approach shifts the research paradigm and power dynamic to involve the community instead of treating it as a passive subject. PAR “address[es] the structural and relational marginalization of groups of people whose voices tend to be unheard” (Pincock & Jones, 2020, p. 2), making it appropriate to fulfill the program aim of centering the voices and experiences of those who are impacted by racial inequity in STEM. Through a deepened understanding of the culture and context that is rooted in relationships and structures (Baum et al., 2006; Jacobs, 2016; Kingdon, Pain, & Kesby, 2007), PAR provides an approach for addressing such systemic issues.

At the forefront of PAR is the “responsible agency in the products of knowledge and the improvement of practice” (McTaggart, 1991, p. 171). Additionally, “power is a crucial underpinning concept to PAR” (Baum et al., 2006, p. 855), which provides methodological and theoretical alignment in the proposal and provides a framework that is methodologically and theoretically flexible (Case & Light, 2011). It also empowers Black engineering Ph.D. students and their accompanying faculty advisors and Black engineering Ph.D. alumni to be at the center for systemic change and barrier-breaking, whose assets in communication and educational action are elevated and supported.

During our recruitment and engagement with the academic partners, we will apply a critical and reflexive approach so that the “boundaries between subject and object disappear” (Davies, 2008, p. 5). This approach will be used to ensure trust between the research team and academic partners, whose activities require an extended time for interaction and co-creation activities that can equitably support their professional formation while empowering them to “disrupt the status quo and unsettle both neutrality and taken for granted assumptions by bringing to light underlying and obscure operations of power and control” (Silverman, 2013, p. 9). Through a deepened sense of responsibility and reflexivity, it is our expectation that participants (with our support, resource-sharing, and facilitation) will collectively change the status quo through praxis — “reflection and action upon the world in order to transform it” (Freire, 2011, p. 51).

Participants and Partners

For this work, Black engineering Ph.D. students and accompanying faculty advisors, and Black engineering Ph.D. alumni will co-create spaces where the voices of these academic partners are elevated on a systemic level, meaningful changes to existing programs (e.g., Graduate School, Tenure & Promotion Policies) can occur. Throughout the project consultants, advisory board

members, and senior personnel, will support curriculum development, community engagement, and documented exposition of the project outcomes. These individuals will work intimately with the research team to meet the stated goals of the project.

Results

While the items outlined below are not results per se, the literature review of the topic and the conceptual frameworks presented outlines primary considerations for the development of this project. While no data has been collected or analyzed yet, the authors consider this information to be useful in equipping other institutions and researchers to consider similar items in lieu of the challenges they may face at their institutions. Furthermore, the information is aimed to serve as a source of inspiration and not a verbatim approach that researchers can use as they think about systemically tackling issues of underrepresentation in engineering, particularly for Black and other marginalized graduate students. As stated earlier, if using any pieces of this work, please cite the origination points of this project (Simmons, Villanueva Alarcón, & McNealy, 2022; Villanueva Alarcón, Simmons, & McNealy, this paper citation).

Overview of Activities

Materials generated from the authors will be compiled and discussed to generate a set of guiding questions in the form of a short questionnaire to share with the academic partners. Since Black engineering Ph.D. students are *not Monolithic*, the guiding questions and corresponding responses will ensure that their rich cultures, voices, and experiences situate initiatives that systematically dismantle divergent aspects affecting their professional formation in engineering. All the partners and participants bring knowledge and experience (Pincock & James, 2020) in this process of questioning, answering, and co-creating.

Participants and their advisors will engage in additional conversations with members of an advisory board and accountability group primarily composed of experts in mentoring, administrators, educational researchers, and sociologists. These individuals will serve as a sounding board to ensure that all activities are done equitably. Throughout the project, these partners will engage in ideation meetings in-person and virtually. Talking points from these meetings will be collected as data. Soon following, a series of focus group meetings will occur to discuss the talking points and identify systemic barriers to focus on. All discussions and talking points will be assembled into a list of strategies and considerations for widespread dissemination, particularly to administrative leaders in the college of engineering. Furthermore, the research team will engage in critical conversations with the administrative leader and stakeholder group about their experiences around agency at the intersection of professional formation, communication, and hidden curriculum. In these meetings, actionable items for wider implementation into the college of engineering of study will be discussed.

Buy-In

In acknowledgement that buy-in may be a factor to consider the authors will leverage PAR such that all involved will be able to co-author and publicize project outcomes if they wish. The authors will work with them to co-develop dissemination materials; otherwise, they will be asked to serve as member-checkers or editors and their contributions will be acknowledged.

Also, for leadership and advisory board members, a series of webinar highlights will be conducted to make a stronger case to showcase meaningful mentorship practices and how these approaches support the mission of the university. With the lists and strategies develop to

accompany these highlights, the research team aims to equip all pertinent parties to agentically change the Ph.D. landscape for Black students in engineering.

Intended Outcomes

The intended outcomes for the project will leverage the materials developed to catalyze change in processes pertaining to the persistence and retention of Black engineering graduate students. These catalyzed changes will be synthesized into procedural or policy documents for onboarding, mentoring guidelines, communication, and awareness building. These artefacts will serve to internally and critically review existing procedures (or lack of) and fill systemic gaps in the process of onboarding, support and retention of Black engineering graduate students. At the same time, the other intended outcome is for their faculty advisors to become more racially literate and aware of the challenges that Black engineering graduate students face.

Evaluation

Due to the nature of the topic, the evaluation procedures will include both process and outcome evaluation. The process evaluation will answer questions regarding the implementation of the project to provide a portion of the formative feedback that will be needed to monitor the team's progress and foster continuous improvement, as well as summative feedback to determine the extent to which the project accomplishes its intended goals. This will include reviewing and providing feedback on research instruments/protocols, methods, dissemination, and data analysis, as well as monitoring the implementation of the project. Outcome evaluation will include and understanding the extent to which curriculum elements and other documents were viewed as useful, impactful, and accountable. Together, they will serve as an accurate measure to monitor and support the goals of this project.

Risk Considerations

Due to the nature of the topic, it is possible that the engagement of Ph.D. students and their faculty advisors. Given the relatively low number of Black Ph.D. engineering students, we may need to expand our invitation to other STEM disciplines outside of engineering. Furthermore, there may be instances where negative situations could arise in the faculty-advisor relationship that they may share with us as academic partners whose relationship of trust with us may increase over time. As authors, we recognize we do not have the expertise (e.g., counseling, psychology) to support these challenges but as part of our ethical and moral responsibility, lists of resources will be assembled and shared with the participants and partners. Also, participants and partners will be kept aware that their participation in the study is optional, and that they can withdraw at any time they feel is best for their academic program and interests.

Discussion

Since the project is anticipated to begin later in the year, the authors do not have data to collect and share at this point. These will be shared in later publications. However, the significance and impact of this work, when completed, will be enormous. As such, the authors opted to share some of these significances as others consider advocating for similar strategies at their campuses.

For example, upon completion of the project, there will be anticipated advancements in the knowledge within engineering and STEM education and across the broader field of higher education by: (1) contributing to an empirical understanding of structural and cultural barriers and supports to broadening participation in engineering, STEM, and higher education; (2) conducting an evidence-based examination of the ways in which Black student agency in engineering

education contributes to the dismantling of systemic racism in their fields; and (3) uncover the hidden curriculum that oftentimes deter systemic changes from occurring at the administrative level. As such, the findings of this project will inform a deep, contextual understanding of the interaction between the power of individual students and the power of social structures. This knowledge can inform institutional transformation and accountability by elucidating the socio-cultural barriers to and enablers of agency. Also, this project will lead to an amplification of Black student voices and agentic actions in their continuing work to achieve fair representation in engineering and STEM fields and in efforts by researchers, administrators, and educators to help students of color broaden their participation in the engineering workforce.

Conclusion

The information shared, although it is in the early stages, aims to agentially share what the authors developed in the Racial Equity in STEM grant to inspire others to do the same. By using a PAR approach, we are working alongside the target population to develop customized solutions for systemic change. Future publications will focus on the generated documents and outcomes of the work.

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