

**Explaining Choice, Persistence, and Attrition of Black Students
in Electrical, Computer, and Mechanical Engineering:
Award# EEC-1734347 - Year 3
Grantee Poster Session**

Our transformative mixed-methods project, funded by the Division of Engineering Education and Centers, responds to calls for more cross-institutional qualitative and longitudinal studies of minorities in engineering education. We seek to identify the factors that promote persistence and graduation as well as attrition for Black students in Electrical Engineering (EE), Computer Engineering (CpE), and Mechanical Engineering (ME). Our work combines quantitative exploration and qualitative interviews to better understand the nuanced and complex nature of retention and attrition in these fields. We are investigating the following overarching research questions:

1. Why do Black men and women choose and persist in, or leave, EE, CpE, and ME?
2. What are the academic trajectories of Black men and women in EE, CpE, and ME?
3. In what ways do these pathways vary by gender or institution?
4. What institutional policies and practices promote greater retention of Black engineering students?

Project Goals

Our project aims to highlight the policies and practices that contribute to increased persistence and graduation as well as attrition for Black students in EE, CpE and ME. In the end, we hope to make actionable recommendations for a variety of stakeholders regarding best practices for ensuring retention of Black students in these majors. We employ a mixed-method approach to explore our research questions.

The quantitative dimension of our project employs the power of large population sizes available in the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD), which includes 10,929 Black students (8072 men and 2857 women) who have ever majored in one of the study disciplines, allowing us to study trajectories and outcomes. We have also employed several qualitative research strategies, including in-depth interviews with campus stakeholders and Black students in our study majors and a detailed content analysis of institutional policies and contexts at our institutions. The student interviews also included a pre-interview survey about classroom experiences and a post-survey about racial identity. This mixed-methods approach will allow for the development of the thematic rigor necessary to advance theoretical understanding of engineering education for underrepresented minorities (URMs).

Major Activities for Year 3

During Year 3 (March 2020 – February 2021), the project team has continued to collaborate to accomplish the research goals by analyzing research and identifying significant results to guide year 4's activities.

Dissemination

In line with our original dissemination plan, the research team has made presentations to several communities of interest, including researchers interested more broadly in engineering education (presenting our Year 2 grantees' poster at the ASEE conference) and engineering education in an international context (at the Frontiers In Education conference), as well as more specifically those researchers interested in diversity in engineering education (presented at the CoNECD conference). In Summer 2020, one of our undergraduate researchers disseminated research findings by presenting a poster to a group of undergraduate researchers and their advisors from multiple disciplines.

Highlights of Significant Results

In this section, we describe the main results from the CoNECD and FIE papers and the poster.

From the CoNECD 2020/2021 Paper:

Mobley, Catherine; Brawner, Catherine; Brent, Rebecca; Orr, Marisa. (2021). "*The Centrality of Black Identity for Black Students in Engineering.*" Paper presented at the 2021 Collaborative Network for Engineering and Computing Diversity (CoNECD) Virtual Conference, January 2021. <https://peer.asee.org/36127>

Our study draws upon several theoretical foundations to investigate and explain the educational experiences of Black students majoring in ME, CpE, and EE: intersectionality, critical race theory, and community cultural wealth theory. Intersectionality explains how gender operates together with race, not independently, to produce multiple, overlapping forms of discrimination and social inequality[1]. Critical race theory recognizes the unique experiences of marginalized groups and strives to identify the micro- and macro-institutional sources of discrimination and prejudice [2]. Community cultural wealth integrates an asset-based perspective to our analysis of engineering education to assist in the identification of factors that contribute to the success of engineering students [3].

We also drew upon racial identity theory, which expands understanding about the significance and meaning associated with students' sense of group membership. Sellers and colleagues [4] introduced the Multidimensional Model of Racial Identity (MMRI). According to this theory, racial identity refers to the "significance and meaning that African Americans place on race in defining themselves" (p. 19). This model recognizes that individuals differ in the extent to which they attach meaning to being a member of the Black racial group. Sellers and his colleagues developed a 51-item inventory, the Multidimensional Inventory of Black Identity (MIBI), which provides a robust measure of Black identity that can be used across multiple contexts [5]. We used the racial centrality portion of this inventory; the authors define racial centrality as "the extent to which a person normatively defines himself or herself with regard to race" [4, p. 25]. This paper reports on initial results from in-depth interviews at one HBCU and one PWI. We asked students about a variety of topics, including their sense of belonging on campus and in the major, experiences with discrimination, the impact of race on their experiences, and experiences with microaggressions. We utilized several qualitative research strategies to encourage

participants to share their stories. In this paper we present the identity circle as a tool that allows researchers the flexibility to elicit such stories. The identity circle exercise uncovered valuable information about the influence of various identities on participants' sense of self and on their engineering education. For example, the identity circle revealed that participants had different perceptions about the centrality of their Black identity and mixed feelings about enacting this identity while attending school. That is, although all participants were Black students, they placed race in different places of the identity circle (or, not at all), reflecting the relative salience of the identity for each of them.

From the FIE 2020 Paper:

Brawner, Catherine, Marisa Orr, Rebecca Brent, and Catherine Mobley. 2020.
“Experiences of Black Persisters and Switchers in Computer, Electrical and Mechanical Engineering in the USA.” *Proceedings of the IEEE/FIE Conference*, October.

In this paper, we begin to provide information about institutional policies that may influence student persistence and attrition, thus responding to requests last year from our External Advisory Board and Program Officer to provide such information. In this paper, we examine the reported experiences of Black students who are majoring in or switched from electrical (EE), computer (CpE), or mechanical (ME) engineering. Prior work has shown different persistence trajectories for Black students in these majors relative to White students, as well as differences between Black men and Black women. We surveyed 79 students at four institutions in the USA, three Predominantly White Institutions and one Historically Black University. In all, 33 students who had ever majored in ME, 27 in CpE, and 19 in EE completed a pre-interview survey that asked about aspects of the learning environment, faculty and peer relationships, and perception of belonging. This survey was adapted from the Student Experience of the Major (SEM) survey developed by the National Center for Women and Information Technology (NCWIT) for use with undergraduate students in computing majors and extended for use in engineering departments [6].

Fifty-six students persisted in these majors while 23 switched to other majors. Compared to switchers, persisters are more likely to feel that the quality of instruction is higher, feel more encouraged by professors and peers to continue, and feel a greater sense of belonging in their departments. ME students are much more likely to experience group learning in their classes than either EE or CpE students and their ME peers are more likely to encourage them to persist. The difference in persistence between EE and CpE may be explained in part by the attraction of the computer science major as an alternative option for computer engineering majors; half of our CpE switchers switched to computer science. However, teaching quality may be an additional factor as CpE students perceived teaching quality to be lower than EE students did. Future research will explore these findings in the context of our in-depth interviews with these students.

From the Clemson University Creative Inquiry Poster:

Sayster, Aimée. 2020. "Community Cultural Wealth in African American Students with an International Background." Digital poster presented at the 2020 Clemson Creative Inquiry and Undergraduate Research Summer Showcase, August.
Available: <http://ci.clemson.edu/blogs/summershowcase/1581-20/>

The case study authored by an undergraduate student and reported in this poster focuses on how students with international experience make sense of racism in the US. Students with this specific background are either children of immigrants, immigrants themselves, and have studied or lived overseas before beginning their engineering degree in the US. The author applied a mixed methods approach, though it is heavily driven by qualitative research. The author drew upon Community Cultural Wealth (CCW) theory as a framework to better understand how these students comprehend racism and sexism [3]. CCW is an asset-based framework that includes aspirational, navigational and resistance capital as resources that students bring from their familial and community background.

The two interviews for this case study were chosen based on students' discussions of their background. Many students briefly mentioned their parents having immigrated to the United States; few, however, elaborated on how their family's immigration status influenced their views relating to sexism and racism. Since there were not any questions in the original interview protocol that directly addressed a student's immigration status or background, beyond them identifying as Black or African American, the researcher for this case study was tasked with determining which students were first or second-generation immigrants. During this process, she found that several students had an additional international experience that gave them a unique perspective on racism in the US.

The author ultimately selected two participants' interview transcripts, supplemented by survey data and data from participants' responses to an identity circle exercise, to better understand the student experiences. The first student participant mainly relied on linguistic capital to endure the bias that existed against him, while the second student participant mainly relied on navigational capital to understand the differences in Canadian and American cultures. Both men, however, utilized resistance capital and aspirational capital to ensure their success in engineering. The results of this research and poster presentation will inform our future analysis of interview transcripts, especially in terms of community cultural wealth and Black identity.

Future Work

During Year 4 (a no-cost extension year), the research team will focus its energy on writing manuscripts for submission to peer-reviewed journals, with a particular emphasis on addressing the four research questions outlined in the original proposal. Our work to date has generated over 2500 pages of transcripts resulting from our 79 student interviews and interviews with key informants; we have also conducted a preliminary analysis of MIDFIELD data regarding trajectories of Black men and women in EE and ME. Our early analysis suggests that our approach has generated rich stories and themes and multiple opportunities for exciting mixed-methods analysis. Some tentative projects are described below.

- One of our manuscripts, “Who Tells Your Story? Qualitative Methods for Establishing Connections and Eliciting Narratives,” includes a description of the development of the card-sorting activity that students completed to describe their reasons for choosing to major in engineering. This manuscript also includes an exploration of different ways to analyze the data. Analysis of the top three factors influencing the major choice has allowed us to identify those factors that carry the greatest importance for students and eliminate some of the noise created by the fact that some students select many factors. We also describe how strategies like the card-sorting activity can take the focus off of the researcher and shift it to the interviewees so interviewees can more freely share their narratives.
- One paper, which is fundamental to our overarching research objectives, will summarize the policies and practices that contribute to the success of Black students attending two PWIs. We will utilize a mixed-method approach, integrating the analysis of key informant and student interviews with data in MIDFIELD or publicly available data from the institutions to investigate the relationship between various policies and practices and student persistence.
- Our early analysis of the student interviews has revealed interesting patterns pertaining to the demographic make-up of the high schools that our interviewees attended and these students’ perceptions of their engineering education experiences. We will further explore this theme by investigating the outcomes of students at both HBCUs and PWIs, using high school demographics as the independent variable.
- The interviews have resulted in rich data about racial identity and intersectionality, garnered through our use of identity circles and the MIBI. Themes related to identity were also revealed during other sections of the interview. This paper will focus on a comparison of women attending a PWI and an HBCU, analyzing for themes of intersectionality between gender and race.
- Extending our current manuscript on the card-sorting activity and the conference paper reporting the results of the SEM, we will more fully explore why students choose, persist in and leave EE, CpE, and ME by discipline.
- The early qualitative work has led to questions about students who switch majors and those who leave the university. These questions will be investigated more fully using MIDFIELD to better understand characteristics of students who switch majors and who leave the university.
- We hope to secure funding to develop workshops for wider dissemination of findings to our partner institutions and to the larger engineering community and to further investigate themes uncovered during our initial analyses. The workshops were a part of our original proposal, but were eliminated during budget negotiations.

More details about our project and our presentations can be found here at this link:

<https://tinyurl.com/y992x237>

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