



Explaining Choice, Persistence, and Attrition of Black Students in Electrical, Computer, and Mechanical Engineering: Award# EEC-1734347 Grantee Poster Session - Year 4

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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. Our project builds on prior work that demonstrated the impacts of gender and race on academic trajectories in Electrical, Computer, and Mechanical Engineering (EE, CpE, and ME, respectively) to answer the following 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?

Major Activities for Year 4

During Year 4 (March 2021 – February 2022), the project team has continued to collaborate to accomplish the research goals. The research team has engaged in deeper analysis of our quantitative data from the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) and our qualitative data from 79 in-depth interviews of students in the three study majors at our four study institutions. We presented a summary of our work at the 2021 ASEE NSF Grantees' poster session and published a manuscript. In this section, we describe the main results from our ongoing work.

Paper # 1: “Who Tells Your Story? Qualitative Methods for Establishing Connections and Eliciting Narratives” was published in the *International Journal of Qualitative Methodology* in 2021 [1]. The paper includes a description of the development of the card-sorting activity that students completed to describe their reasons for choosing to major in engineering and an exploration of different ways to analyze the data. We contend that this technique is likely to be valuable to qualitative researchers in a variety of disciplines who find themselves not matched by race, ethnicity, gender, and other characteristics to the study participants. This technique enabled us to shift the focus away from the interviewer asking questions toward the students describing their own major choice process.

We used Social Cognitive Career Theory (SCCT) to better understand students' reasons for deciding to major in engineering [2, 3]. Lent and colleagues [4] utilized Bandura's [5] social cognitive theory to validate choices of Black students in engineering. SCCT's main components that shaped our analysis include (a) self-efficacy beliefs (beliefs about one's capacity to perform a task or take a course of action); (b) outcome expectations (beliefs about the consequences of taking certain actions); (c) personal goals (intentions to engage in specified activities or attain specified results); (d) personal interests; and (e) environmental influences (which include barriers imposed on students such as financial need or racial or gender bias and sources of support for overcoming the barriers). The basic premise that extends from these components is that

individuals pursue activities for which they have strong self-efficacy beliefs, positive outcome expectations, compatible personal goals and interests, fewer barriers, and supportive environmental influences.

Analysis of how frequently the factors influencing the major choice were chosen by interviewees has allowed us to identify those factors that carry the greatest importance for students and how they vary for persisters and switchers. The top five factors for all students were: good at math/science; job opportunities; salary; family influence; and prestige or challenge of major. The card-sort has allowed us to explore the nuance in student decision making, such as the differences between persisters and switchers. For example, our quantitative analysis of the card-sort results revealed that 24 persisters (43%) selected both “helping others/improving society” and “possibilities for invention” as important factors in their initial choice of a major, while only four switchers (17%) did so. In our poster, we will report early results on gender differences in major choice.

Paper # 2: “GPA Trends of Black Mechanical Engineering Students”: Our early qualitative work has led to questions about students who switch majors and those who leave the university. We are using MIDFIELD to better understand characteristics of students who switch majors and who leave the university. We are using functional cluster analysis to group the GPA trends to find clearly defined groups of students' GPAs. In particular, we examine trends based on four outcomes for students who have ever enrolled in ME: 1) they can persist for 12 semesters without graduating; 2) they can graduate in ME within 12 semesters; 3) they can switch to another major; or 4) they can leave school altogether. For our research question, we are interested in learning whether there is a relationship between distinct GPA patterns and whether a student persists in ME, graduates in ME, switches away from ME, or leaves the institution altogether.

Preliminary findings suggest that the students who switch majors have different GPA trends than the students who leave their institutions. This holds true for whether the student chooses to switch their major and stay within engineering or chooses to leave engineering altogether.

Paper # 3: “Pride and Prestige: Factors Influencing How and Why Black Students Choose to Attend a Predominantly White Institution or a Historically Black University”: In this paper, we explore the reasons that students in our study majors decided to attend either a HBCU or a PWI. In this paper, we describe the early results of our analysis.

Choosing an institution of higher learning is a complex process consisting of institutional and student factors, and several theories have emerged to explain this process [6]. We used Hossler and Gallagher's [7] framework as a starting point for understanding student choices. The stages are (1) aspiration (students developing a desire to attend college), (2) information (students pulling information on institutions and selecting institutions to apply to), and (3) finalization (selecting and enrolling in an institution from those they're admitted to).

Black students face a more difficult path to post-secondary education. Bergerson [8] describes several factors that discourage students of color from engaging in the college admissions process, including limited school resources, lack of student support, lack of access to college information,

and “tracking into non-academic high school courses” (p. 82). Choosing between an HBCU and a PWI is a crucial step in the college choice process of Black students, and according to Freeman [9] the racial make-up of an applicant’s high school influences whether a student chooses to attend an HBCU vs. a PWI. We will explore this theme further in our full article.

In this study, we selected 30 interviews, from our larger group of 79 interviews, to learn more about the college choice process of both persisters in engineering and switchers (those who left the engineering major for another major). We used a purposive sampling strategy to ensure an even distribution of students across institutions (HBCU vs. PWI), gender (male vs. female) and major (CpE, EE and ME). We have also provided information about the participants’ score on the Multidimensional Inventory of Black Identity (MIBI) [10]. As reported by Sellers and colleagues [11], the MIBI, a robust measure of Black identity, is derived from Sellers and colleagues’ [12] Multidimensional Model of Racial Identity (MMRI).

Our early analysis revealed that students had diverse reasons for college choice, including affordability, location, familiarity with the institution, family encouragement and connections, and prestige of the university. We will explore differences between HBCU and PWI students in their reasons for selecting a particular school and will examine whether their choices are related to MIBI scores.

Future Work

In Year 5, we will continue to explore how various institutional policies and practices shape student decisions and outcomes. This topic will be an integrative theme in all of our papers. To strengthen our discussion on institutional policies and practices, we will draw upon the recently published MIDFIELD policy analyses for our study institutions (<https://midfield.online/policy-summary/>).

Following further data analysis during Year 4, we have refined our research questions and intend to focus on specific groups, including Black ME students at all MIDFIELD institutions, Black women in PWIs and HBCUs in all majors, switchers in all majors, and Black men in CPE:

- Paper # 1—*Research Question # 1: Why do Black men and women choose and leave, EE, CpE, and ME?* Extending our current manuscript on the card sort activity, the conference paper reporting the results of the Student Experience of the Major survey, and the conference paper with preliminary results on why students switch their majors, we will more fully explore why students choose and leave EE, CPE, and ME by discipline. This paper will highlight key institutional policies and practices that shape student decisions to remain in the major or switch to another major.
- Paper # 2—*Research Question # 2: What are the academic trajectories of Black men and women in EE, CPE, and ME?* Many Black students who left one of these majors left the institution (as compared to changing majors). Black women were particularly persistent in ME. The full MIDFIELD dataset will be utilized to explore further the academic trajectories in our study majors. We will start with an ASEE paper focused on GPA trajectories in ME and then extend to the other study majors for a journal manuscript. We expect this analysis to produce implications about academic policies and advising practices, particularly around major changes, academic standing, and triggers for proactive advising.

- Paper # 3–*Research Question # 3: In what ways do these pathways vary by gender or institution?* 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 women attending an HBCU, analyzing for themes of intersectionality between gender and race and themes related to interviewees’ goals for entrepreneurship. We will explore and discuss themes pertaining to how institutional and departmental policies influence goals pertaining to entrepreneurship.
- Paper # 4–*Research Question # 4: Explaining the trajectories and performance of Black Men in CPE.* This paper will investigate the trajectories and experiences of Black men in computer engineering, the engineering discipline where Black men are least successful among the major engineering disciplines. Using MIDFIELD, we will explore the trajectories specifically of Black men in this discipline, using the analysis procedures developed in #2 and use our interview data with 10 persisters and 9 switchers to understand the personal, disciplinary, and policy factors that lead to persistence in or switching from the major.

Conclusion

Our mixed-method study is expanding understanding of the factors that promote retention and attrition in our ME, CpE and EE. In particular, our analysis will allow for rich and nuanced portrayals of Blacks that may be currently lacking in the literature. By amplifying the experiences and voices of Black students in engineering education, our research will help faculty and student services to understand how to create an environment where Black students can thrive.

Overall, the broader impacts to the field of engineering education will be evidenced by fuller participation of Black students in engineering, allowing for a more diverse engineering workforce. Ultimately, our work will help institutions understand how their policies and practices can contribute to the success of Black students in engineering. For example, our paper on college choice will be of value to university faculty and staff who are involved in decisions regarding acceptance to the university (i.e., whether to attend a PWI or an HBCU) and to the major of choice. The early analysis of the college search process of our interviewees suggests a relationship between college choice, major choice, and career choice. Additional influences on college choice include race-related variables, student perceptions of institutional commitment to diversity, and policies regarding financial aid and entry into major of choice. Such information can help institutions to tailor their recruiting messages and how they promote themselves to prospective students.

More details about our project and our presentations can be found here at this link:
<https://tinyurl.com/y992x237>

Acknowledgements

The authors thank the National Science Foundation for support of this research (Award # EEC-1734347). The views expressed herein are solely the authors’.

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