



Explaining Choice, Persistence, and Attrition of Black Students in Electrical, Computer, and Mechanical Engineering: Award# EEC-1734347 Grantee Poster Session - Year 2

Dr. Catherine Mobley, Clemson University

Catherine Mobley, Ph.D., is a Professor of Sociology at Clemson University. She has over 30 years experience in project and program evaluation and has worked for a variety of consulting firms, non-profit agencies, and government organizations, including the Rand Corporation, the American Association of Retired Persons, the U.S. Department of Education, and the Walter Reed Army Institute of Research. Since 2004, she has been a member of the NSF-funded MIDFIELD research project on engineering education; she has served as a Co-PI on three research projects, including one on transfer students and another on student veterans in engineering.

Dr. Marisa K. Orr, Clemson University

Marisa K. Orr is an Assistant Professor in Engineering and Science Education with a joint appointment in the Department of Mechanical Engineering at Clemson University. Her research interests include student persistence and pathways in engineering, gender equity, diversity, and academic policy. Dr. Orr is a recipient of the NSF CAREER Award for her research entitled, "Empowering Students to be Adaptive Decision-Makers."

Dr. Catherine E. Brawner, Research Triangle Educational Consultants

Catherine E. Brawner is President of Research Triangle Educational Consultants. She received her Ph.D. in Educational Research and Policy Analysis from NC State University in 1996. She also has an MBA from Indiana University (Bloomington) and a bachelor's degree from Duke University. She specializes in evaluation and research in engineering education, computer science education, and technology education. Dr. Brawner is a founding member and former treasurer of Research Triangle Park Evaluators, an American Evaluation Association affiliate organization and is a member of the American Educational Research Association and American Evaluation Association, in addition to ASEE. Dr. Brawner is also an Extension Services Consultant for the National Center for Women in Information Technology (NCWIT) and, in that role, advises computer science and engineering departments on diversifying their undergraduate student population. She remains an active researcher, including studying academic policies, gender and ethnicity issues, transfers, and matriculation models with MIDFIELD as well as student veterans in engineering. Her evaluation work includes evaluating teamwork models, broadening participation initiatives, and S-STEM and LSAMP programs.

Dr. Rebecca Brent, Education Designs, Inc

Rebecca Brent is President of Education Designs, Inc., a consulting firm located in Chapel Hill, N.C. She is a certified program evaluator and a faculty development consultant. Brent received her B.A. from Millsaps College in Jackson, Miss., her M.Ed. from Mississippi State University, and her Ed.D. from Auburn University. She was an Associate Professor of education at East Carolina University before starting her consulting firm in 1996.

**Explaining Choice, Persistence, and Attrition of Black Students
in Electrical, Computer, and Mechanical Engineering
Award# EEC-1734347
(Year 2)**

Abstract

Our project aims to enhance understanding of the policies and practices that promote persistence and graduation as well as attrition for Black students in Electrical Engineering (EE), Computer Engineering (CpE), and Mechanical Engineering (ME). The qualitative portion of our study seeks to explore in depth the causes of the observed differences while our quantitative study explores whether the findings of the earlier research are consistent over time and with a broader set of institutions. Our transformative mixed-methods project responds to calls for more cross-institutional qualitative and longitudinal studies of minorities in engineering education. Our study is 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?

To explore our research questions, our mixed-methods approach capitalizes on the quantitative power of large sample sizes available from the Multi-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) and the qualitative richness of 80 in-depth interviews with students at predominantly white institutions (PWIs) and a historically black college and university (HBCU); key informant interviews; and detailed content analysis of institutional policies and contexts at four institutions. Our work advances prior research by interviewing both persisters and switchers in EE CpE, and ME to better understand the nuanced and complex nature of retention and attrition among these students.

Project Goals

The objective of this project is to identify policies and practices that lead to increased persistence and graduation as well as attrition for Black students in EE, CpE and ME and to make actionable recommendations for policy makers regarding best practices. Our approach combines the quantitative power of large sample sizes available from the Multi-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) and the qualitative richness of 100 in-depth interviews and detailed content analysis of institutional policies and contexts at five institutions. 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).

Building on prior work that demonstrated the impacts of gender and race on academic trajectories for engineering as a whole and electrical/computer engineering (ECE) and ME in particular, we will use a transformative mixed methods design [1] to respond to calls for more

cross-institutional qualitative and longitudinal studies of minorities in engineering education [2]. The study will investigate the following overarching research questions:

Our transformative mixed-methods project responds to calls for more cross-institutional qualitative and longitudinal studies of minorities in engineering education. Our study is 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?

Major Activities for Year 2

During Year 2 (March 2019 – February 2020), the project team has collaborated to accomplish the research goals.

Project Team Meetings

Our research team has been on a regular basis via telephone conference to plan, coordinate, and discuss the project elements.

Data Collection

- During Year 2, the research team completed the in-depth student interviews at our four study institutions. As depicted below, overall, the team completed a total of 79 interviews, including 56 current CpE, EE and ME majors and 23 students who switched out of these majors. Switchers are categorized by their former major and are those students who either switched to another engineering major or out of engineering altogether.

Study Major	Stay	Switch	Grand Total
CpE	16	10	26
ECE	2	2	4
EE	13	3	16
ME	25	8	33
Grand Total	56	23	79

As a part of our mixed-methods approach, we used the following data collection strategies for these in-depth interviews:

- Student interview protocol
- Qualification survey (to get scheduling information and basic demographics from interested students)
- Pre-interview survey (for those selected to be interviewed)
- Card-sorting exercise (to learn more about reasons for selecting major)
- Identity circle
- Multi-Dimensional Inventory of Black Identity (MIBI)

The research team also engaged in the following research activities:

- Conducted additional key informant interviews at our study institutions to learn more about the institutional context of student experiences. These interviews helped us to refine our student interview protocol.
- Continued to engage in in-depth analysis of our interview transcripts and interview notes from key informant interviews, school profiles, and university policies.
- Continued to engage in in-depth analysis of MIDFIELD database, using our mixed method approach to investigate questions that have already arisen based on key informant interviews and from the qualitative analysis of student interviews.
- We continued to conduct an in-depth literature review on a variety of topics related to our research, particularly including research on Black students in engineering and STEM.

Dissemination

In Year 2, in addition to our NSF Grantees paper and poster for Year 1, we wrote and presented an additional three conference papers and two research posters.

We presented a paper about the preliminary findings from our website analysis of institutional websites at the second annual Collaborative Network for Engineering and Computing Diversity (CoNECD) conference in April 2019:

C. Brawner, C. Mobley, R. Brent, M. Orr, M. Rucks, and C. Waters. 2019. "Overview of Policies and Programs for Black Students in Engineering."

We developed and presented a poster, summarizing our qualitative interview techniques, at the annual meeting of the Southern Sociological Society in April 2019. The conference theme, *The Challenge of Intersectionality: Who or What are Missing?*, aligned with our project:

C. Mobley, C. Brawner, M. Orr, R. Brent, and C. Waters. 2019. "The Challenges and Rewards of Researching Intersectionality: Qualitative Approaches for Investigating Educational Experiences."

We presented a paper, describing the results from our MIDFIELD analysis, at the ASEE annual meeting in June 2019:

M. Orr, C. Brawner, C. Mobley, R. Brent, and R. Layton. 2019. "Academic Trajectories of Black Men and Women in Electrical, Computer, and Mechanical Engineering."

We presented a paper and poster, summarizing the preliminary results from students who left computer, electrical, and mechanical engineering, highlighting the factors leading to their attrition from these majors. This paper was presented at the 2019 Annual Meeting of the IEEE/FIE conference:

R. Brent, C. Mobley, C. Brawner, and M. Orr. 2019. "Work-in-Progress: "I Feel Like I've Found Where I Belong": Interviews with Black Engineering Students Who Change Majors."

We developed and presented a poster at the NSF Grantees Conference in October 2019:

C. Mobley, C. Brawner, M. Orr, and R. Brent. 2019. "Bridging Qualitative and Quantitative Methods: Explaining Choice, Persistence, and Attrition of Black Students in Electrical, Computer, and Mechanical Engineering."

Highlights of Significant Results

Below we highlight some of the key findings from several of our papers, published in the proceedings of the conferences noted.

From the CoNECD 2019 Paper

C. Brawner, C. Mobley, R. Brent, M. Orr, M. Rucks, and C. Waters. 2019. "Overview of Policies and Programs for Black Students in Engineering." *Proceedings of the 2019 Collaborative Network for Engineering and Computing Diversity (CoNECD) Conference*, April.

In this work in progress, we use Lee and Matusovich's model of co-curricular support (MCCS) and the recruitment aspect of the Building Engineering and Science Talent (BEST) framework to investigate the policies, programs, and activities for, and recruitment and retention of, underrepresented students at four institutions. These four colleges of engineering are in the top 15 nationally in engineering bachelors' degrees conferred on Black students. This information will provide background for a mixed-methods study on the choice, persistence, and attrition of Black students in computer, electrical, and mechanical engineering and is a critical first step to contextualize the student experiences to be revealed in individual interviews. We use publicly available information from web-based and other resources as well as interviews with key informants on each campus to ascertain the programs that are available on each campus and categorize them using the MCCS and BEST frameworks. This study lays the groundwork for future institutional data analysis and interviews with Black students currently or formerly enrolled in computer, electrical or mechanical engineering to uncover what causes them to enroll and persist in or leave these majors.

In this paper, we have described the inputs at four colleges of engineering related to the MCCS model for student success. This paper is not meant to represent an assessment of any of these programs, but to document the presence of programs, services, and activities that may influence Black student persistence in mechanical, electrical, and computer engineering. We described some services and activities that were also part of larger programs for completeness. We found that all of the universities contained significant elements of the framework. None of them offered all elements, which is to be expected as each institution and engineering student support center must make decisions on what is most needed for their student body within budget and personnel constraints. Some programs (e.g., LLCs) are limited in how many people they can serve while others (e.g., EE tutoring) serve all students, not just underrepresented ones. We were expansive in what we included in our search to ensure that we captured as many programs as possible that would benefit Black students in engineering, whether or not the programs or services were designed for them. We believe that such support programs, both targeted and otherwise, are necessary, but not sufficient, for fully addressing issues related to diversity in higher education.

As one of our informants noted, in spite of decades of offering programs and activities to help Black and other underrepresented students live and learn in the predominantly White culture on his campus, the lived experience of Black students there has not changed much over that time. Rather, he hopes that these programs have empowered these students to cope better in the environment as it is.

From the ASEE 2019 Paper

M. Orr, C. Brawner, C. Mobley, R. Brent, and R. Layton. 2019. "Academic Pathways of Black Men and Women in Electrical, Computer, and Mechanical Engineering." *Proceedings of the 2019 Annual Conference of the American Society for Engineering Education*.

In this paper, we present a visual, quantitative analysis of the academic pathways of Black men and women who enroll in EE or ME at any point during their undergraduate experience (N=4816). Our research provides evidence that more Black students choose EE than ME, in contrast to national data for all races that show that more students major in ME than EE. While more Black students initially enroll in EE overall, ME attracts a larger proportion of its Black students from other majors and retains a larger fraction. Black women are particularly persistent in ME (58%). Seventy-eight percent of Black men and 65% of Black women who leave ME leave the institution without a degree. Of those leaving EE, 74% of Black men and 64% of Black women leave the institution without a degree. This examination of quantitative differences between disciplines lays a foundation for qualitative study through in-depth student interviews of Black students in these majors.

From the FIE 2019 Paper

R. Brent, C. Mobley, C. Brawner, and M. Orr. 2019. "Work-in-Progress: "I Feel Like I've Found Where I Belong": Interviews with Black Engineering Students Who Change Majors." *Proceedings of the 2019 Frontiers in Education/IEEE Conference*. October.

This Research Work in Progress paper reports on Year 1 of a three-year mixed-methods study to identify institutional factors that promote increased retention of Black students in engineering curricula and to determine causes of their attrition. The paper outlines preliminary findings from interviews of students who left computer, electrical, or mechanical engineering curricula. The students cited poor advising, academic challenges for which they were unprepared, lack of knowledge about their chosen major, financial and personal difficulties, perceived poor fit in the major, and issues around being a first-generation college student as important factors in deciding to change their major. They identified their race as an important factor in their selection of a university and in their sense of belonging at the institution, but not in their choice of a major or their decision to change majors.

Additional Major Findings

In the second year, we report preliminary results from our quantitative MIDFIELD analysis and qualitative student interviews. Some highlights include the following findings:

- This year we integrated the centrality measure from the Multidimensional Inventory of Black Identity (MIBI) to better understand the importance of Black identity to the

students' educational experiences. Early results indicate that students attending the HBCU had higher MIBI averages than students who attended the PWI, indicating that racial identity was more important to the HBCU students.

Future Work

For the remainder of Year 2 and during Year 3, the research team will also work on several additional conference papers and journal manuscripts. Our primary efforts will focus on addressing the four research questions outlined in the original proposal. Tentative topics and journals include the following:

- C. Brawner, et al. 2021. "The effect of institution policies on Black enrollment and persistence in selected engineering majors." To be submitted to *Journal of Engineering Education* or similar.
- C. Brawner, et al. 2020. "Classroom experiences of Black students in ECE and ME [based on findings of pre-interview survey and qualification survey] To be submitted to FIE 2020.
- R. Brent, et al. 2020. "A Deeper Dive into Stories of Switchers."

Some additional topics have emerged and we will work on these papers as we are able:

- M. Orr, et al. 2020. "Historically Black or Predominately White? How high school racial composition influences Black students' choice of institution." To be submitted to a journal [TBD – possibly *Journal of Women and Minorities in Science and Engineering*].
- C. Mobley, et al. 2020. "Community Cultural Wealth and First-Generation in College Black Students in Engineering." To be submitted to a journal [TBD].
- C. Mobley, et al. 2020. "Mixed-Method Approaches for Exploring the Education Experiences of Underrepresented Minorities." To be submitted to the *Journal of Mixed Methods Research* or a similar methods journal.

Upcoming Dissemination Activities

A paper about the preliminary findings from our student interviews, focusing on what we learned about Black identity and intersectionality, has been accepted for presentation at the third annual Collaborative Network for Engineering and Computing Diversity (CoNECD) conference in April 2020:

C. Mobley, C. Brawner, M. Orr, and R. Brent. 2019. "The Centrality of Black Identity for Black Students in Engineering."

A paper describing the results from our qualitative interviews was accepted for the ASEE annual meeting in June 2020.

R. Brent, C. Brawner, C. Mobley, and M. Orr. 2020. "Why do Black Students Choose to Major in Computer, Electrical and Mechanical Engineering?"

ACKNOWLEDGMENTS

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

REFERENCES

- [1] J. W. Creswell, *Research design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th ed.*, Thousand Oaks, CA: Sage, 2013.
- [2] G. Lichtenstein, H. L. Chen, K. A. Smith and T. A. Maldonado, “Retention and persistence of women and minorities along the engineering pathway in the United States,” in *Cambridge Handbook of Engineering Education Research*, A. Johri and B. M. Olds, Eds., New York, NY: Cambridge University Press, 2014, pp. 311-334.