Board 418: Understanding why some African American Students Chose Engineering Technology over Engineering and the Implications of this Choice

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A. Introduction

According to data from the American Society for Engineering Education (ASEE) [1], the enrollment in both bachelor's and master's programs in Engineering Technology (ET) have been increasing over the past ten years. Despite this growth, many in academia, K-12 education, and industry are still not familiar with ET and the differences and similarities between 4-year bachelor's degree programs in ET and engineering.

Table 1. Proportion of Black Students in ET and Engineering Programs at Top 10 Institutions for number of ET Graduates

	ET	EN
University of Houston	11.9%	5.0%
Arizona State University	7.2%	3.4%
Purdue University	3.7%	1.8%
Farmingdale State University	8.8%	-
Texas A&M University	2.9%	2.6%
Ferris State University	3.1%	0.0%
Eastern Michigan University	14.4%	11.7%
East Carolina University	14.0%	8.1%
University of Toledo	7.5%	3.0%
Indiana University - Purdue University Indianapolis	11.1%	6.0%

The 2017 report "Engineering Technology Education in the United States" published by the National Academies of Engineering documented the findings of a two year study of many aspects of the status, role, and needs of Engineering Technology (ET) education in this country [2]. The study sought to shed light on the field and to present the differences and similarities between graduates of 4-year bachelors programs in ET (referred to hereafter as ET graduates), engineers, and technicians (graduates of 2-year associate's degree programs in engineering technology). One finding of the study that the authors noted as striking was that "ET (bachelor's) degree earners are almost three times more likely to be Black as those who receive a 4-year degree in engineering," based on the IPEDS data the share of degrees awarded to African Americans in engineering and ET in 2014 was 3.8% and 10.7% respectively. This finding is not surprising to those familiar with ET programs. Table 1 shows the number of Black students as a percentage of the total enrollment in ET and engineering (EN) at the top 10 schools for ET enrollment in 2019 as reported by the American Society of Engineering Education (ASEE) [1]. For all of the institutions on the list that offer accredited bachelor's degree programs in both engineering and ET, the proportion of Black students in ET is higher than the proportion of Black students in engineering, and for most the ET number is more than double that of engineering.

The NAE report went on to recommend that agencies consider funding research aimed at better understanding the reasons for "the preference for engineering technology over engineering of African American students" and they conjectured that understanding this trend might help inform strategies to attract and retain a diverse student population in both types of programs [2]. This recommendation implies (or assumes) that Black students have equal access and opportunity to pursue both engineering and ET majors and overwhelmingly choose ET. In reality, inequities largely rooted in systemic racism, as well as institutional, academic, economic, and psychological barriers make ET the more feasible option for many Black students.

The disproportionately high percentage of Black students in ET compared to engineering would be less of a cause for concern if the tagline "The degree is Engineering Technology, the career is Engineering" trademarked by the American Society for Engineering Education reflected the typical experience of ET graduates. However, despite these and other efforts to assert that ET is a separate but equal, less mathematically rigorous, more practical pathway to a traditional engineering career, this messaging is often inconsistent with the reality of opportunities and advancement in college and after graduation. Many employers do not hire ET graduates for engineering positions for a variety of reasons, including a lack of familiarity with the preparation

and qualifications of ET graduates, and the tendency for many employers to still associate ET with a two-year associates degree program. In fact, ET graduates often do not realize until they begin their job search that many employers do not consider holders of Bachelors of Science in ET (BSET) degrees for engineering positions [3]. Further, while some industries and employers give ET and engineering graduates equal consideration for entry-level engineering positions, the gaps between the salaries, potential for career advancement, and management opportunities often widen as they approach mid-career [4]. There are also very few graduate programs in ET, and most engineering masters and Ph.D. programs require a degree in engineering and not ET for admission. In addition, the path to professional engineering licensure is considerably more difficult in some states and impossible in others for ET graduates, including those who graduate from accredited ET degree programs [5]. ET graduates are also often not included in discussions of engineering workforce development. For example, the 2018 Status Report on Engineering Education: A Snapshot of Diversity in Degrees Conferred in Engineering cited a national shortage of engineers and did not count ET degree holders as engineers [6]. At the college level, ET students are ineligible for scholarships from the National Action Council for Minorities in Engineering (NACME), and some chapters of the National Society of Black Engineers (NSBE) are not always welcoming to ET students. Large-scale efforts to broaden participation in engineering (including the 50K Coalition that aims to graduate 50,000 diverse engineers annually by 2025) also overlook ET. In short, the differences between engineering and ET, the experiences of students in engineering and ET, and how engineers and ET graduates are perceived are far more complex than the simplistic 'more mathematical' versus 'less mathematical' model that is often used to compare engineering and ET.

The low number of African Americans who go on to graduate engineering degrees, the engineering professoriate, engineering research careers, and leadership positions in industry is impacted by the disproportionate number of Black students pursuing undergraduate ET degrees compared to engineering and the barriers to academic and career advancement that technologists face. ET is thus an important but overlooked consideration in the broadening participation in engineering discussion. The need for greater insight into the reasons Black students choose ET and the implications of this choice frame our current study.

B. Background

The Report of the Committee on Evaluation of Engineering Education (also known as the "Grinter Report") published in 1955 recommended more scientifically oriented engineering curricula as being essential to the development of competent engineers equipped to handle difficult engineering problems [7]. This report still informs the design and organization of engineering curricula. The Grinter Report included a reference to a preliminary report that suggested a bifurcation of engineering curricula into two types of programs: a general professional category and a scientific professional category. The former would focus on more practical applications to meet the needs of industry and the latter would be centered on math and science geared towards careers in design, research, and development. The engineering faculty who reviewed the preliminary report rejected this proposal, and the consensus was that all engineering curricula should incorporate strengthened basic science content. Despite the rejection of this proposed bifurcation by the engineering community, many universities began expanding their existing two-year technology programs into four year engineering technology degree programs in the mid-1950's in response to a need for more practically trained graduates who would be able to enter the workforce without the need for specialized on the job training. However, these four-year engineering technology degrees were not universally viewed as another type of engineering program as the Grinter report had envisioned. Today, more than fifty years later many engineering employers prioritize the calculus based engineering curricula over the specialized hands-on training of ET programs, and ET graduates encounter barriers to career advancements and limitations based on their choice of degree.

Inequities in funding for public schools and the impacts of redlining and other historically oppressive and racist policies result in a disproportionate number of Black students who do not receive adequate mathematics preparation at the elementary and middle school levels and who have limited access to Advanced Placement (AP) and other higher-level mathematics classes in high school. The higher proportion of Black students in ET programs as compared to engineering is thus unsurprising given that mathematics is the gateway to the pursuit of STEM careers in general, and engineering in particular, and is a barrier for many Black students interested in engineering. In general, engineering curricula include calculus and calculus-based science courses, while ET programs focus on application and implementation with coursework based on algebra, trigonometry, and applied calculus. The high school GPA and mathematics scores in standardized tests (e.g. ACT and SAT) required for admission to ET programs are thus generally lower than those required for engineering. High school counselors and college recruiters generally describe the ET degree as a more practical, hands-on, less mathematical pathway that leads to essentially the same engineering career opportunities as (more academically rigorous) engineering programs and often suggests that an ET degree provides the qualifications for all careers on the engineering spectrum except 'mathematically complex' design and analysis, and research.

Dempsey's 2018 dissertation titled "The Role of Engineering Technology as a Pathway for African Americans into the Field of Engineering" used Critical Race Theory as a framework to explore ET's role as a separate and unequal pathway to the engineering workforce for African Americans [8]. The study used faculty and alumni surveys and alumni interviews from two institutions, as well as the national data set. The racial stratification of the engineering field was examined within historical and social contexts. Dempsey identified several barriers to full participation in engineering careers that ET professionals of all races encounter both in college and after graduation [8]. These 'mechanisms of control and closure' include educational credentials, institutional discrimination, financial considerations, and licensing. Dempsey's recommendation is to rebrand engineering technology as applied engineering with some curriculum changes. This recommendation is consistent with the bifurcation suggested in the Grinter Report. The rationale for this recommendation includes a 'flattening of the engineering hierarchy' and the development of a 'legitimized and equal pathway to engineering careers for many African Americans' [8].

Rebranding ET as applied engineering in an attempt to 'elevate' its position in the engineering hierarchy does not address the systemic issues and racial inequities that contribute to the racial stratification of the engineering profession. In this project, we aim to not only understand the reasons Black students choose ET in college and the potential ramifications of this choice on the attainment of their career goals, but also to contribute to the dismantling of the racial inequities that exist in engineering education and the engineering profession.

C. Preliminary Data

As part of a prior NSF-funded project (award #1640553), Berhan and Kumar interviewed Black students in both engineering and ET at the University of Toledo. ET students in that study cited the desire for a less mathematical, more hands-on curriculum and not meeting the mathematics admissions requirements as reasons why they chose to enroll (or were automatically enrolled) in ET versus engineering. Below are excerpts from interviews with two different students.

Male Speaker 1: "I learned engineering (science) is more the math where you sit and do calculations, which I never got up to learn and find exciting. I am more of a practical guy. I like hands-on experiences which is why I switched to technology. You work with stuff you want to make."

Male Speaker 2: “I wish I would have known about the prerequisites to get into mechanical engineering before. I didn't know what classes you needed. If I knew what classes, I probably could have sped up the process to get to mechanical engineering. That way I could get done with my major with less time.”

While it is true that mathematics is a primary reason why many students choose ET, there are students, including Black students, who completed calculus and AP mathematics coursework in high school and still choose ET. In an online survey conducted by Berhan and Lucietto in 2018 of ET students primarily at Purdue University and the University of Toledo aimed at identifying the reasons why they chose ET, 56% of the 652 respondents and 14 of the 26 black respondents agreed or strongly agreed that high school had prepared them for their first college mathematics courses. Although the survey was not limited to Black students, it does provide insight into some of the other reasons students choose ET. Tables 2 and 3 below show some of the written responses students gave to the survey questions “Why did you chose your current major?” and “What has been the most challenging aspect of your educational experience?”, respectively.

The interviews and survey responses confirm that the factors influencing the choice of ET over engineering include mathematics and science preparation, career counseling received (or not received) in high school and college, a preference for a more ’hands-on’ curriculum, as well as socioeconomic, institutional, and psychological factors. They also point to institutional barriers that students experience that make engineering less accessible than ET.

Table 2. Select Responses to ET Survey Question “Why did you chose your current major?”

“I was referred (to it) after not getting into first year engineering.”
“In Engineering, I was getting lost in big lectures and was treated as a number. In the Polytechnic, I get to work more in teams, with hands-on activities, and I get treated like a person by professors and advisors alike.”
“At the time I started it was an online program, so was able to work on my degree and work full time in order to provide for my family.”
“My engineering mentor at work advised me that the MET program was more practical for engineering jobs in the area and that the program helps give you a better understanding of how the concepts are applied.”
“I am an I.T. Professional, and this major benefits/bolsters my career choice.”
“I wanted to major in something that would apply to my current job position/duties and have a chance at finally finishing my degree in something (anything).”
“Originally it was the electrical choice where most of the classes were offered in the evening, but that isn’t the case any more.”
“I thought that electrical engineering technology was the same as electrical engineering. I didn’t know of the difference till last year.”
“I thought engineering and engineering technology was the same thing.”

Table 3. Select Responses to ET Survey Question “What has been the most challenging aspect of your educational experience?”

“The most challenging aspect has been overcoming the obstacle of getting jobs. I would consider myself academically sufficient based on GPA and involvement, however, it seems like it's harder to compete with engineering majors when finding jobs. It seems like many companies value an engineering degree more than an engineering technology degree.”
“Having people look down on my major. I didn't switch because of calculus, I'm going to get my minor in mathematics. I switched because no one was interested in understanding applications and I felt like I would be useless in industry.”

"The most challenging aspect has been competing with 'traditional engineering students.' I feel that a lot of companies do not value a degree in MET as they do with a degree in ME. It has been difficult to obtain internships/jobs due to this."
"Being looked down on by some industry people when looking for an internship because I am a female MET. Not even an ME."
"People telling me I chose engineering technology because I'm a woman and am not intelligent enough to do 'real engineering'."
"Transitioning to technology from Bioengineering since I really wanted the get my BIOE degree."
"People think less of me because i am a Technology student."
"Switching majors, because I felt that I was stepping down, however now that i am in my current major, I feel that it is an improvement"
"Being compared to engineering students."

D. Interdisciplinary Research Approach to Examine Black ET Students' Experiences

Our research centers on the voices, experiences, and knowledge of Black ET students and graduates through interviews and surveys in order to gain insight into the experiences of Black students and professionals in ET. The ultimate goal of this work is to contribute to the removal of systemic barriers and racial inequities in ET education and the ET workforce through interventions and policy changes informed by the research.
When marginalized students are required to assimilate to the dominant institutional culture, it reflects a deficit perspective, devalues students' cultural distinctiveness [9] and silences their voice [10]. We propose to adopt theoretical frameworks and race-reimaged constructs and empirical approaches [11] to reflect the asset-based approach that undergirds this project.
In this project we will examine the reasons why Black ET students and graduates pursuing engineering careers may not be as successful as engineering students in realizing their educational and professional goals within the engineering field. The complexity of this issue calls for a conceptual model based on interdisciplinary theoretical perspectives. The theoretical lenses informing this project include: (1) Critical Race Theory (CRT) to examine the systemic barriers such as advisor and faculty biases and expectations of Black students' success and their impact on students' experiences and academic choices; (2) Expectancy Value Theory to examine the additive, mediated, and interactive effect of antecedent and mediating factors on Black students' expectations of success, and enrollment and graduation from Engineering Technology vs. Engineering and (3) Belongingness Theory to understand both general and race-reimaged aspects of belonging among ET students.

The following reseach questions will be investigated in this project.

1. What role do high school counselors, college counselors/recruiters, and faculty play in Black students' choice of ET versus engineering?
    a) How do faculty/advisor perceptions and expectations of Black students determine Black students' placement in Engineering vs. Engineering Technology?
    b) What is the relationship between explicit stereotype beliefs and implicit attitudes of administrators, faculty and staff and recruitment practices for engineering technology programs?
2. What are the academic and structural barriers that restrict Black students' admittance to engineering?
    a) What is the relationship between Black students' academic preparedness and high school coursework and Black students' placement in Engineering Technology?
    b) To what extent do program requirements (entry requirements and required coursework) and structural differences between engineering and engineering technology programs (e.g., length of program, flexibility of programs, part-time and

online options, ease of transfer from community colleges, acceptance of HS/college dual credit, etc.) influence selection of and persistence in chosen major?

3. What are the structural barriers and affordances that prevent or enable Black students to transfer from ET to engineering (and vice versa) from the first to the second and third year in the program?
    a) To what extent is the transfer from ET to Engineering (or vice versa) related to contextual salience of stereotype threat and belongingness to the program?
4. How do Black ET students perceive their future career opportunities? Are these opportunities realized upon graduating from ET?
5. To what extent do Black students identify with the ET domain and how is this related to contextual salience of stereotype threat and belongingness to the program?
6. How do students' perceptions of their experiences in ET and the interpretation of these experiences relate to their self-schemas including their expectations of success, personal, cultural, and professional identities, and their career goals?
7. To what extent are ET students' original career intentions and expectations met by their chosen major? Do students believe that the information they received in high school/freshman year of college that informed their choice of major was well aligned with their perception (and experience?) of their career prospects as seniors/college graduates?

This is a Work In Progress. We will present the results to date of individual interviews and focus group interviews that are currently ongoing and scheduled to continue through April 2024.

Researchers from the University of Toledo and Purdue University conducted a study that involved individual interviews and small group focus group discussions. However, the original plan for the project design was altered when only a few students showed up for the initial focus group interaction. Therefore, the researchers made modifications to enable data gathering in this format. Combining individual interviews and focus groups allows researchers to triangulate qualitative data in a manner that enhances data richness and depth of inquiry while contributing to knowledge production and synthesis [12].

The research team from the University of Toledo and Purdue University conducted a study that involved individual interviews only due to the low turnout of students for the initial focus group interaction. The thus researchers had to modify the project design to facilitate data gathering in this format. This change in the anticipated interview format allowed for more flexibility and ensured that the study was successfully completed.

The data collected will be further analyzed in the summer of 2024, and additional papers will be written based on the findings. However, those who participated in the interviews had some anecdotal observations about the small focus groups and individual interviews.

During the group interviews at Purdue University, two groups of two individuals were observed. It was noted that once they began responding to questions, they became more open and began to discuss their responses in greater depth. As they shared more common experiences, they became more engaged and animated in the process.
Anecdotal observations from the individual interviews that occurred at the University of Toledo highlight important personal and contextual circumstances that students encounter while majoring in ET.

E. Conclusion

Understanding the role of race in racialized students' educational pursuits will improve how policies and practices are created to mediate the impact of race. By documenting, analyzing, and triangulating the data of the perceptions and experiences of current and recent Engineering

Technology graduates, we will uncover the reasons Black students choose ET, the implications of the choice on future opportunities, and its implications for the Engineering profession. By ignoring the need for research on the disproportionately high percentage of Black students in ET compared to engineering, we will also be ignoring the complex social terrain that Black students must navigate to combat the structural barriers in education to achieve a college degree generally and an Engineering degree specifically, with all of the professional benefits it confers. By examining the complexities and suggesting solutions to lessen their impact, Black students' opportunities in all areas of the Engineering profession will improve. Thereby developing a more diverse STEM workforce.

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