2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023

The Harbor of Engineering
Education for 130 Years

ASEE

Paper ID #38826

Attracting Black Students to Undergraduate Engineering Programs: A Rapid Review for Broadening Participation

Micaha Dean Hughes, North Carolina State University, Raleigh

Micaha Dean Hughes is a doctoral student in the Educational Psychology program in the Teacher Education and Learning Sciences department at North Carolina State University. Her research interests include community-engaged approaches to educational equity and access in STEM education, college recruitment and K-12 outreach practices for minoritized groups in STEM, mathematical identity development for rural adolescents and young adults, and culturally sustaining STEM outreach assessment and evaluation.

Micaha received her Master of Science in STEM (Science, Technology, Engineering and Mathematics) Education degree from the University of Kentucky College of Education, and her Bachelor of Science in Integrated Strategic Communication (Public Relations) from the University of Kentucky College of Communication and Information Studies.

John Roberts, UK College of Engineering

John is pursuing a Doctorate of Philosophy in Educational Policy and Evaluation at the University of Kentucky. One of his main research interests are college choice and student enrollment in higher education. Over in the past ten years, he has been fortunate to progress in the field of admissions and enrollment by working for two large public universities and one small private college. In these roles, he managed territories within Kentucky and in various states across the country. Moreover, he has had his hand in marketing and content creation as it relates to admissions and enrollment. Lastly, and most importantly, he has been able to work with amazing students across the country from all walks of life to help them enroll in an institution of higher education and pursue their dreams.

Attracting Black students to undergraduate engineering programs: A rapid review for broadening participation

Introduction

Much of existing research in science, technology, engineering and mathematics (STEM) fields demonstrates two trends: 1) the demand for STEM jobs has outpaced the current supply of STEM workers in the United States; and 2) the demand for STEM jobs has outpaced the future supply of STEM workers, i.e. current degree-seeking college students [6], [7], [8], [9]. The lack of representation of Black students in undergraduate engineering programs is particularly pronounced. Black Americans make up approximately 13% of the population but less than 5% of engineering graduates year-over-year [10]. In recent years, engineering education literature acknowledges the fact that Black students and other minoritized groups have been systemically excluded from engineering over time through structural racism, which has significantly contributed to the deficit of diversity in undergraduate engineering programs today [11], [12], [13].

In order to encourage minoritized students to enter college engineering programs, many Institutions of Higher Education (IHEs) have developed college recruitment and student engagement initiatives to garner interest from K-12 students. However, IHE programs with a goal of broadening participation for minoritized groups in engineering tend to take a deficit lens on Black student readiness, choosing to find ways to integrate Black students into current engineering culture, rather than investigating and addressing the ways the field excludes students of color. McGee [11] contends that IHEs develop "interventions that center predominately on equipping, changing, and fixing the student, rather than on doing the more challenging work of assessing the ways institutions and departments are perpetrating racism and other "isms" in STEM, which leaves these structures under- or unexplained" (p. 634). For example, summer bridge programs are commonly hosted by predominantly white institutions (PWIs) to "prepare" students for integration into the engineering curriculum, usually focusing on academic and social improvement, offering workshops like math tutoring sessions or interview panels with current engineers [14], [15], [16]. In developing programs that focus on "fixing" the student to fit the current and historical engineering culture, we foster problematic conversations around what type of student should be allowed entry to engineering rather than fixing existing structures that keep students out. Within the walls of these structures, students can and do exact agency and in deciding to participate or not participate in the culture of engineering [17]. We posit that there are two major components of a student's decision to enroll that are ignored: choice and belonging.

For high school students, there are several variables that contribute to the decision to enroll at a specific college or university. Generally, college choice begins with predisposition – having the desire to pursue a college degree. Next is gathering information about college options. Last comes the actual decision, taking in consideration predisposition and the information gathered during the search. This three-step college decision model, posited by Hossler and Gallagher (1987), is a commonly cited college choice model in higher education literature [18], [19], [20], [21], [22]. While this framework simplifies the sequencing and timing of the college decision process, other college choice theories expanded upon this initial understanding. In the mid-1960s, Holland and Richards [23] posited four influential factors on college choice: 1)

intellectual emphasis of the prospective campus; 2) practical concerns; 3) advice of others; and 4) perceived social climate of the campus. Litten's [24] (1982) five-stage model included: 1) college aspirations; 2) beginning the search process; 3) gathering information; 4) sending applications; and 5) enrolling. Later, Kotler and Fox [25] developed a seven-stage college choice model: 1) discovery of a desire to attend college; 2) research about college options; 3) application to college; 4) acceptance into college; 5) enrollment; 6) persistence; and 7) graduation.

However, the choice of which college to attend is only half the battle – the student must also decide their college major or discipline. What motivates a student to decide on a career path? This is where existing academic literature on "broadening participation" in engineering splits into two segments – into *student outreach* and *student recruitment* – which is a significant finding of this study that is discussed later in this paper. Just like college choice, there are several criteria that contribute to a student's decision to pursue a specific college major or career. Social cognitive career theory (SCCT) is a popular model that is operationalized to understand student career choice through the lens of socio-cognitive constructs [26]. SCCT focuses on three core tenets to understand student career choice and working opportunities: "self-efficacy beliefs, outcome expectations, and goal representations" [27], [28]. What do students believe they are good at? What can they achieve if they select a certain career? And how, if at all, can they reach their professional and career goals despite any systemic barriers? These principles are at the core of student motivation to select a career in which they feel they can be successful, based on their perceptions given available information and resources from IHEs.

Interestingly, as college and career choice models have expanded and changed over time, we note that there has been a consistency in the lack of emphasis on student "fit," or belonging, on a college campus or in a college academic program. However, if you were to pick up college marketing materials or visit any university website, the message is clear: you, a student, can *belong* here. "Sense of belonging" is a term rooted in social psychological concepts and, in higher education in recent years, has been operationalized as a way to evaluate student integration in the college environment and as a way to anticipate student success and retention [29], [30]. According to Murphy & Zinkel [31], "a "sense of belonging" in school is a complex construct that relies heavily on students' perceptions of the educational environment, especially their relationships with other students" (p. 2). When prospective students interact with college recruiters and recruitment programs, students create perceptions of the college environment, the climate for current students, and opportunities to build a sense of belonging if they chose to enroll there [32], [33].

Thornburg [34] offered groundbreaking direction in college and career choice research by conducting a comprehensive qualitative study with first and second-year college students who identified as Black/African American, Black/African, or Black/Multiracial. Thornburg found that "participants developed assumptions of overall fit based on how they perceived their general well-being, whether they would integrate into the campus culture, and if the culture resonated with their personalities, values, beliefs, and desired college experience" (p. 105). These findings are a clear extension of existing college choice models regarding the "desired college experience," and support our suggestion that student identity and anticipated sense of belonging is missing from college and career choice literature. Thornburg [34] goes on to say:

"The most significant influences [to college choice] included the level of importance to the participant; preconceived notions or beliefs about the institution and the environment; first-hand experiences with the institution, such as those that eliminated or created a false narrative about the reality of Black student experiences on campus; previous experience or current mindset navigating potentially challenging or different environments; level of awareness of impression of the institution's position, stance, and offerings; information from individuals or trusted sources, such as second-hand experiences, advice, opinions, and so on" (p. 110).

Minoritized students may approach the concept of belonging in college differently than non-minority students in response to systemic racism, stereotypes about Black students in STEM fields, and existing perceptions around systems of inclusion or exclusion in the environment of the field or college itself. Students of color are particularly vulnerable to stereotyping or exclusion in undergraduate engineering programs at PWIs, where they are severely underrepresented [35]. Further, Steele et al. [36] postulated that underrepresented groups are at heightened susceptibility for "social identity threat, or the threat that one's social group may be devalued in a particular setting" (p. 251). For the students in Thornburg's study, just the *anticipation* of a negative experience based on preconceived notions about the IHE and its social climate was enough to shape student expectation of belonging on campus before deciding to enroll [34]. Stereotyping and social group threat are a significant barrier to belonging, and yet school climate nor current or historical patterns of exclusion are incorporated into college and career choice models as depicted in the academic literature.

Purpose of the Study

The purpose of this rapid review is to conduct an investigation of the academic literature on existing initiatives and models for attracting Black high school students to undergraduate engineering programs, which may also be referred to as "broadening participation" in engineering. This work is part of a larger project to understand the lived experiences of Black high school students during the engineering admissions process and how those experiences align with the programs, practices and systems that are enacted within higher education today. For the purposes of this review, we sought to answer the following research questions:

1) How, if at all, does the definition of "broadening participation" in engineering differ between "student outreach" and "student recruitment" in the literature?
2) What are the major themes found in the engineering education research literature as it pertains to interest, inclusion and belonging for attracting Black students to undergraduate engineering programs?

Methodology

To understand the current landscape of theory and practice on recruiting Black students into undergraduate engineering programs, we conducted a literature review using a rapid review approach. The rapid review method is a format of data analysis that requires a systematic review of literature but is constrained by time. Rapid reviews "aim to be rigorous and explicit in method

and thus systematic but make concessions to the breadth or depth of the process by limiting particular aspects of the systematic review process" [37]. We chose to conduct a rapid review for this work because we agree that the continued low enrollment of Black students in undergraduate engineering programs is pressing and dire. Moreover, in this time of hyperpoliticized educational environments, we concur that the issues presented here are problems of exclusion within the field that should be given immediate attention.

Data Selection

We compiled literature using (1) the Education Resources Information Center (ERIC) database, (2) the American Society of Engineering Education (ASEE) Peer Document Repository database, and (3) the ProQuest Education Database. We started our literature search using the search query (recruit* OR college choice AND Black or minorit* AND undergraduate students or college students AND engineer*) or near equivalent queries. We used the asterisk wildcard (*) on recruit*, minorit* and engineer* to pick up words like "recruitment" or "recruiting," "minority" or "minoritized," and "engineers" or "engineering". It quickly became apparent that many peer-reviewed sources with the content we needed were under the keyphrase of "broadening participation in engineering," and so we chose to include that search term as well, but still only selected articles that focused specifically on direct recruitment initiatives and programs. These keywords and phrases combined yielded a total of 70 peer-reviewed articles in ERIC and ProQuest. The ASEE PEER database search depended greatly on two changes: first, a historical search showed a significant upswing after 2003; papers on the topic in the ASEE PEER database before 2003 yielded just 203 results, but papers on the topic after 2003 yielded 1,782 results. Second, search using the three terms recruit (or college choice) + black + undergraduate students yielded 1,782 results, but the search terms recruit (or college choice) + minority + undergraduate students yielded 3,765 results, more than twice the results. To further search for relevant literature, we also conducted (4) referential backtracking from the reference lists of our highly relevant articles and (5) a final search on Google Scholar, which added articles that were admissible but not found in the initial search.

Inclusion and Exclusion Criteria

We carefully selected articles that met our inclusion criteria:
1. Published in the year range 2003 to 2023
2. Focus on *direct recruitment practices* (i.e. recruitment programs, strategies, or initiatives)
3. Focus on minoritized students who were about to enter, were actively in, or just completed the college admissions process (high school junior to first-year college students)
4. Contain data related to practices for minority-focused undergraduate college recruitment
5. Published as a peer-reviewed journal article or refereed conference proceedings

Studies that focused on graduate students, centered on other areas of study that were not engineering education, papers that were published before 2003, or studies that occurred outside of the United States were excluded. We did not include every article found during the data collection portion of this study. To accelerate the review process, one author conducted an abstract screening of the top 200 results from ERIC and the ASEE PEER Repository databases.

Approximately 30 articles were identified as relevant to the study after a screening of the abstracts, specifically confirming all sections of our inclusion criteria. Following this abstract screening, the second author conducted an abstract screening from a random sample of papers from the referential backtracking list and the Google Scholar database. Less than 10 additional papers were added following the second screening.

Data Analysis

Once the articles for review were selected, the authors each reviewed half of the papers in detail using thematic analysis procedures. Inductive coding was used to ensure that researcher biases did not interfere with data analysis, and we allowed the themes to emerge as we analyzed the documents. Following the identification of primary codes, we chose to synthesize the findings using narrative description, in order to tell the story of existing practices in the field in a comprehensive and cohesive manner [38].

Author Positionality

The first author identifies as a multiracial woman (she/her) and is a first-generation college graduate from rural Appalachia. While working for several years in college recruitment and community-engaged K-12 STEM outreach within a PWI research university setting, she also earned a master's degree in STEM education and is now a doctoral student in educational psychology. The second author identifies himself as a white male (he/him) and is a multi-generation college graduate from a rural southeastern state. He is a doctoral candidate in higher education policy and is focusing his research on college choice. Additionally, he has served multiple PWIs over the last decade as an admissions counselor/college recruiter serving high school and undergraduate students across the U.S.

Here, we offer insights into our individual positionalities to demonstrate how our work experiences contribute to this study. Notably, our shared positionality also has a significant influence on our motivation to conduct this work and contributes to our interpretation, understanding and analysis of our findings. We have collectively worked as higher education recruitment and admissions professionals for more than ten years, including working together for some time in complementary, outreach-to-recruitment "pipeline" roles. Our positionality as engineering enrollment management professionals – also referred to as "engineering recruiters" – gives us a unique lens as academic researchers in engineering education, one that is grounded in practicality. Knowing that our past experiences have provided us with perspective that impacts the way we think about engineering recruitment and outreach, we approach this work reflexively and with thoughtful caution. Guillemin & Gillam [39] states:

> "the reflexive researcher does not merely report the "facts" of the research but also actively constructs interpretations ("What do I know?"), while at the same time questioning how those interpretations came about ("How do I know what I know?")" (p. 274).

The iterative process of researcher reflexivity is intentionally shared in this review, not only to ensure rigor, but also to demonstrate our construction of knowledge throughout the research process [39]. Because of our professional experiences, we challenge that there is a lack of

opportunity for collaboration between enrollment management practitioners and academic researchers. This paper is as much a reporting of our findings from academic, peer-reviewed literature as it is our interpretation of the findings within the pragmatic lens of "boots-on-the-ground" work in engineering K-12 outreach and undergraduate recruitment.

Findings

This review revealed several themes in the literature that IHEs use to attract minoritized students to undergraduate engineering programs. For this paper, we have selected the three most salient recruitment themes within a psychologically-driven college and career choice framework centered on student interest, representation and belonging: (1) untangling "broadening participation" in engineering, (2) identity matching and engagement opportunities, and (3) marketing and communications.

Theme 1: Untangling "Broadening Participation" in Engineering

In the last two decades, there has been a significant increase in strategies intended to "broaden participation" of underrepresented students in undergraduate engineering programs [2], [40], [41]. We have found the limited academic literature on best practices for recruiting Black students into undergraduate engineering programs concerning. Most articles we found target "underrepresented racial minorities," which includes African Americans, American Indians including Native Alaskans, Hispanics and Native Pacific Islanders, but generally does not specify approaches for sociocultural attunement toward individual groups [42]. Among the targeted strategies developed to increase the number of minority students in engineering programs is the nationwide growth of outreach programs like summer camps, weekend family events and other informal education opportunities in which students can engage. In general, many researchers consider educational "outreach" to be informal, out-of-school experiences for students [43].

One possible reason for the lack of easy-to-locate research in minority engineering recruitment is the loose, poorly defined use of the terms "outreach" and "recruitment" in engineering education research. For the purposes of this discussion, we utilize "outreach" to mean informal interactions with K-12 students that are generally geared toward increasing awareness or interest in engineering and "recruitment" to indicate interactions with upper age high school students (grades 11-12) that are specifically targeted with a short-term goal of getting students to enroll in an undergraduate engineering program. Given our decided focus on psychological factors within the college and career choice process, this may appear as a confusing way to define the differences between college outreach and college recruitment. However, we emphasize the problem therein: K-12 outreach is important, but once students have entered the recruitment phase, there is more attention given to cognitive criteria such as test scores and grade point averages (GPA) rather than non-cognitive factors such as career interest, and this discrepancy is further reflected during the college application process. This mismatch cultivates a system of exclusion for minoritized students: students are led to think they can succeed during *outreach*, only to be told they are not allowed in during *recruitment*.

Holloway et al. [44] listed 11 major factors used to admit or deny students during the college application review process by IHEs in the years 2006-2010: (1) "subject matter expectations (the

number of semesters of math, science, English, social studies, and foreign language that each student is required to have taken in high school), (2) overall high school grade point average (GPA) (3) core high school GPA (English, math, science, foreign language, and social studies classes), (4) high school class rank scores from U.S.-based national standardized tests for college readiness (SAT or ACT), (5) overall grades in academic coursework grades related to intended major, (6) strength of student's overall high school curriculum, (7) trends in achievement, (8) ability to be successful in intended major, (9) personal background and experiences, (10) time of year the application is received, and (11) space availability in intended program" (p. 279). Of the eleven listed criteria for admission, 64% are directly related to quantitative, cognitive factors that require students to have completed rigorous coursework, as well as have average or above average grade point averages, standardized test scores and academic achievement. Another 18% of factors (time of year of application and program space availability) are due to administrative and organizational criteria, leaving just 18% of the criteria for admission to include non-cognitive factors like anticipation of belonging and other components of student identity. This list of criteria also skirts over the process of a "holistic application review," indicating that IHEs might be reviewing non-cognitive criteria but do not explain the way that sense of belonging or anticipated "fit" might be evaluated.

On the other hand, most literature on outreach assessment for minority students revolves around social identity and self-efficacy development [45], [46], [47]. These programs are most commonly developed and evaluated with an aim for students to gain "comfort and sense of agency in domain; engagement; long-term interest and persistence vs. obstacles and frustration" in the setting of engineering education [48] (p. 8). Much of the existing literature on engineering outreach (or as commonly written, STEM outreach) focuses on engineering identity development, with the assumption that stronger identity alignment with engineering results in higher interest in pursuing engineering as a degree and career. These presumptions look much like what we offer as a depiction in Figure 1.

Figure 1
Perceptions of Outreach-to-Recruitment-to-Enrollment Pipeline
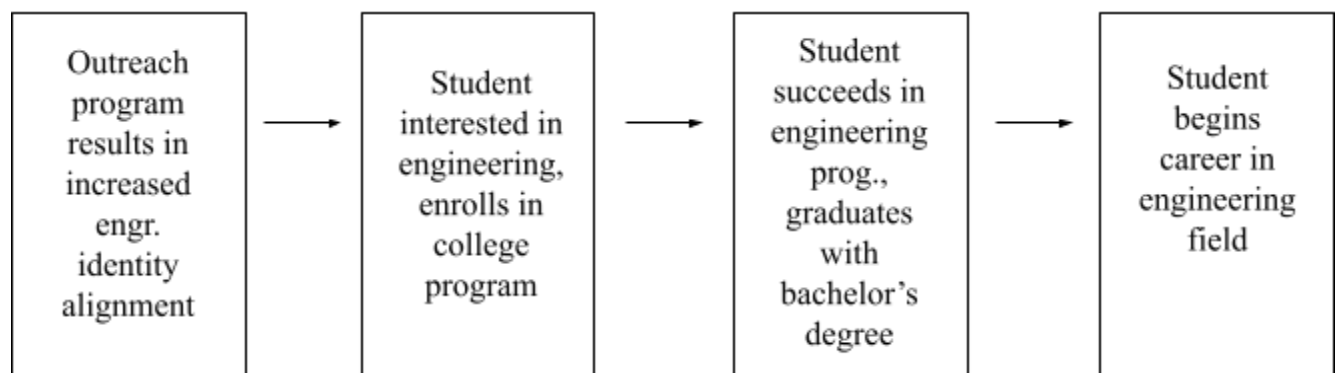
While Figure 1 seems like an oversimplification – and it is – this is the general disposition of the existing literature on broadening participation strategies for engineering education. And despite the widespread insistence that the process for growing minority enrollment in engineering programs is as linear as the chart in Figure 1, our practitioner lens allows us to confidently say

that this is not an accurate depiction of the student experience from outreach to undergraduate enrollment. In the literature, there is a remarkable emphasis placed on the importance of the "engineering pipeline," and at the same time, there is equal emphasis placed on how "leaky" the pipeline is [49]. It is therefore worthwhile to consider that the "leak" may be from leading students to interest in engineering degrees through programs under the scope of "broadening participation," only to lock them out of the programs upon application due to a mismatch between belonging and identity alignment, and required cognitive skill for admission. In a study of a Midwestern university, Holloway et al. [44] found that the average SAT math score for admitted engineering students at that university was 680, a full 165 points above the national average in those same years. Notably, Smith and Reeves [45] found that "the average scores for Black (454) and Latino or Hispanic students (478) [were] significantly lower than those of white (547) and Asian students (632)" in the class of 2020.

Theme 2: Identity-Matching and Engagement Opportunities

Once students are in the recruitment phase, they move into the "information gathering" and "application submission" stages of the college choice process. During these stages, students will engage in campus visits or college tours, website scouring, attending college events, and later deciding to apply or not to apply to certain IHEs depending on a variety of factors as mentioned in the introduction to this paper. The campus visit is widely considered to be one of the most influential components of the college choice process [50].

There is a general absence of scholarship that explores how campus visits impact the recruitment of minoritized students, but part of this may be the aforementioned lack of definition between outreach and recruitment. One excellent example of this is an annual summer program at the University of Texas at Austin, called "My Introduction to Engineering," or MITE. According to a 2005 paper by Ogilvie [51], the MITE program serves the following purpose (note that this program is now called the "My Introduction to Engineering" program but is titled differently in Ogilvie's article, written 15 years ago):
> "The Minority Introduction to Engineering (MITE) program at The University of Texas at Austin (UT Austin) is a five-day summer residential program designed to spark students' interest in engineering as an exciting career choice. MITE offers 100 high school juniors and seniors the opportunity to discover engineering through hands-on experience and interaction with engineering students, faculty, staff, and practicing engineers. While residing on the UT campus, MITE participants attend interactive workshops that highlight: engineering disciplines; the college admissions process; and financial aid/scholarships. In addition, student teams participate in a week-long design competition where they are required to design, build, and test a working model to meet given specifications within a budget. MITE provides high school students with an understanding of the personal commitment required to obtain a degree in engineering" (p. 1).

Ogilvie also states that MITE "serves as our most effective recruitment program," which acknowledges that one of the main goals of MITE is to increase enrollment of minority students, but MITE is listed on the UT Austin website as a K-12 outreach event [52] (p. 1). Discrepancies in definition such as this one can lead to – and did, for us – difficulty in locating relevant literature and also in navigating administrator expectations surrounding program assessment.

That said, programs like MITE exhibit a unique student experience for minoritized students attending campus events – identity matching, or affinity grouping. The MITE program website states that the program is hosted in partnership between the Equal Opportunity in Engineering Program at UT Austin's Cockrell School of Engineering and members of the student groups Pi Sigma Pi Academic Engineering Society, National Society of Black Engineers (NSBE) and Society of Hispanic Professional Engineers (SHPE). The National Society of Black Engineers (NSBE) boasts more than 300 collegiate chapters, which includes more than 13,000 NSBE college student members [53]. All over the country, not just at UT Austin, NSBE student chapters collaborate with recruitment professionals to host events in order to encourage more Black K-12 students to pursue engineering as a college major choice. Twale et al. [54] found that the universities who recruited minority students most effectively were those institutions that engaged in early outreach efforts to socialize minority students before matriculation. They also concluded that having more diversity in faculty is key to recruitment as well. Opp [55] concluded similar findings regarding early intervention by connecting students of color with identity-matched faculty or administrators.

Some offices of admissions, especially in larger IHEs, have dedicated admissions professionals who primarily focus on recruiting underrepresented students, however we were unable to find peer-reviewed academic literature that discussed these positions. Such professionals are typically charged with hosting "diversity recruitment events," which are on-campus or off-campus events used to recruit underrepresented populations. Such events may be off-campus receptions, on-campus open houses, or on-campus information sessions and tours. Whether dedicated to minority recruitment or not, college recruitment professionals also frequently engage in strategies to meet prospective students off-campus (e.g., off-campus events, high school visits, college fairs, etc.). However, these visits are often economically strategized, targeting "high-achieving" students with top test scores. In their study, Salazar et al. [56] concluded that a number of large public research universities spend their time recruiting in more affluent areas (areas where the median household income was $121,000), causing schools with larger populations of Black, Hispanic, and Native American students to receive no visits from the public research universities.

Theme 3: Marketing and Communications

Just as important as the campus visit is, websites and digital communication have become irreplaceable to the college recruitment process within the last two decades. With the proliferation of the internet, admissions offices have utilized social media, websites, texting, email, blogs, IP targeting, retargeting, and more to market and recruit students. Chapman [57] was the first to integrate institutional communication into his model of college choice, and Johnston [58] highlighted the importance of *peer-to-peer* communication in recruiting diverse students to enroll. Digital advertising has a powerful impact because, if done correctly, can be segmented to reach "target audiences." This is the idea behind market automation and behavioral intelligence – both of which use machine learning to automate messaging based on the data points of each individual student. Segmenting communication based on racial, cultural, or gender lines can create challenges, because it can give way to social fissures, ethnic tensions, and fragmentation [59]. Digital segmentation can also minimize knowledge and exposure of other

groups in our society [60]. This is particularly important to pay attention to, because as engineering colleges seek to advance diversity in their student population, their websites, advertising, and communication efforts will need to both show their commitment to diversity while also not furthering stereotypes [59][61][62].

It is banal for enrollment management offices to invest in marketing initiatives to appeal to underrepresented populations. Such initiatives include, but are not limited to literature (e.g., campus viewbooks, brochures, and mailers) and digital advertising. All of these initiatives serve two purposes: 1) sharing information about the university or college (e.g., values, community, programs, services, etc.); and, 2) building relationships with prospective students (e.g., face-to-face interactions with admissions counselors, faculty, alumni, current students, or administration). College viewbooks are defined as "promotional admissions brochures created by marketing professionals to 'sell' institutions to prospective students and their families" [63], [64]. (p. 386). Osei-Kofi and Torres [65] provided a thorough analysis of college admissions viewbooks, in which their conclusion was that viewbooks, or literature used to highlight the strengths of an IHE while minimizing weaknesses, tell narratives that are hyper-gendered and hyper-racialized [66].

A study by Pippert, Essenberg & Matchett [67] found through content analysis of images from college marketing materials from the year 2011, from 165 IHEs, that "diversity was typically symbolized by portraying African American students at higher rates rather than presenting a more representative student body" (p. 258). They found that photographs of African American students in college viewbooks overrepresented the actual mean of the student body by 7.7%. While Pippert et al. found that college viewbooks overrepresented all underrepresented minority groups, the differences between Black and White students was most pronounced, stating that "the mean difference of 7.7% between actual and photographic portrayals of African American students corresponded to an over-representation of 104% (percent change) compared to an over-representation of whites by just 4.8% (percent change)" (p. 271). While this seems to be, and arguably is, problematic, as Pippert and colleagues point out, this could potentially be a result of the *aspirations* of IHEs – by depicting greater diversity, more diverse students may want to enroll, which will create more diverse campuses. To that notion, Gibbs [68] argues – and we agree – that "persuasive marketing" by IHEs is unethical, and that colleges should resist employing such strategies.

This concept of disingenuous marketing was reproduced in Henslee et al.'s 2017 mixed methods study examining undergraduate, first-year student perceptions of the college viewbook at Indiana University-Purdue University Indianapolis (IUPUI) [64]. Because Henslee used the viewbook from the year prior, it was likely that students participating in the study had seen the viewbook during their college choice process and utilized it to gather information and make a decision on enrollment at IUPUI. Henslee and colleagues found that a small subset of students of color felt that because the college viewbook demonstrated more diversity than what they saw or experienced on campus, that the institution was tokenizing diverse students "for institutional gain" (p. 74). Additionally, they found that students within their study did not "identify culture as one of the top three values promoted in the IUPUI viewbook" (p. 75). Specifically, the research team in the IUPUI study noted that the surveyed students remarked on the lack of viewbook mention of identity-matched student organizations to which they belonged, which they found to

be "culturally invalidating." This theme further validates our finding in theme 2, that belonging matters to minoritized students, prospective or current, and students who see themselves reflected in student groups or in campus communications have a strengthened sense of belonging and "feelings of cultural validation on campus" even prior to enrolling [64] (p. 74).

Discussion and Implications

In this paper, we discussed three major themes found in the literature that support new ways of thinking on the development of recruitment initiatives for minoritized students in engineering.

First, we believe that it is important to discuss the implications of using the term "broadening participation" together with "underrepresented minorities." Using this terminology, it is simple to ignore or dismiss the systemic racism that underlies low minoritized student enrollment in engineering. Minoritized students are not simply underrepresented. Instead, they have historically and intentionally been excluded from participation in the engineering field. Moreover, literature on "broadening participation" heavily focuses on implementing new outreach and recruitment programs – student engagement strategies – rather than addressing the systemic barriers that students of color face when attempting to enter the undergraduate engineering space. Both are important. Youngman and Egelhoff [69] state that "successful schools [in recruiting minority students] experienced a readiness for diversity and recognized that diversity requires systemic change and the systemic change must precede diversification" (p. 6). By focusing on the system involved in recruiting minoritized students, the door is open to use a critical and honest approach toward increasing undergraduate enrollment. An example where IHEs need to recognize the systemic barriers to admission versus simply engaging with students to garner interest is the common engineering admission criteria of "math readiness." There are minoritized prospective students who are inspired to be engineers, engaging in tasks like taking engineering courses in high school or attending engineering summer camps, but do not have the qualifications as outlined by IHEs (e.g., math readiness scores) to pursue an engineering degree. Students must then adapt or troubleshoot as they acquire new information during recruitment and make realizations about their available pathways to an engineering degree. Such a realization might be that they will not qualify for admission in their desired field of study, given that most colleges of engineering have selective admissions.

Second, college and career choice models are an important framework when discussing how students think about choosing a college or major, but there are several distinct instances that can occur when minoritized students enter the information gathering and social-interactional phases of the college choice process. We propound that there are a significant number of *recruitment programs* for high school juniors and seniors that are categorized as *outreach programs*, which can lead to difficulty in (1) locating and understanding academic literature and (2) determining appropriate assessment for programs. Nevertheless, the literature supports that students who engage in STEM identity-affirming recruitment and outreach programs are more likely to anticipate a positive sense of belonging in STEM majors, but event programming, marketing and communication must be genuine. It is not enough for IHEs to just tell a message of belonging for diverse students. Engineering colleges should reflect accurate depictions of cultures of inclusion or exclusion within their institutions, or risk incongruity between prospective student perceptions

and current student experiences, which could result in lower enrollment *and* retention rates of diverse students.

Third, we offer that there is a significant disconnect between practitioners of college recruitment and academic literature. There was difficulty in finding literature that discussed any actual part of the recruitment process itself, and research on recruitment *strategies* was particularly scant. One significant hypothesis we have for this challenge is that recruitment strategies might be viewed as "secret," or even as non-generalizable. We do not agree with these sentiments. From the data presented at the start of this paper, it is clear that the dearth of Black students seeking engineering degrees is a challenge that all stakeholders – researchers, recruiters, administrators, etc. – should collaborate to address. We suggest that the relationship between these stakeholders can be improved. While we limited our literature search to peer-reviewed journal articles for this paper, we hypothesize that many college recruitment professionals do not turn to academic literature when searching for new ideas for recruitment strategies. Instead, for example, organizations like Ruffalo Noel Levitz, an educational consulting organization, creates and distributes an "Enrollment Toolkit" that recruiters can openly access [70]. This lack of research-practice partnership between academics and recruiters likely decreases the amount of available information about recruitment practices and strategies that work to recruit more minority students into undergraduate engineering programs, and it damages the field as a whole.

If a student engages with an IHE in some way, such as visiting a college website or making a campus visit, recruitment professionals assume the student is interested in that college or program. We suggest that what happens next is more important than their initial interest: do the students see themselves represented in the college or program? Will they be organically included in the academic space? Do they anticipate being able to belong? Will they belong? The problem of low minority enrollment in undergraduate engineering programs is complex, and there are currently no clear-cut paths or frameworks in the literature for incentivizing students to join. We do not pretend to have a magic solution. However, we argue that while recruiters, university administrators and education researchers clamor to broaden participation in engineering, the field must acknowledge and address the possibility that one-off recruitment and outreach programs are not sufficient by themselves to largely increase the number of underrepresented minority students in undergraduate engineering programs. These programs are important to garner interest, but these efforts must be preceded by and coupled with structural change toward broader systems of inclusion, where all students can belong, in order to diversity the field.

Summary

This paper described the findings of a rapid literature review exploring the ways existing research describes past and current initiatives for attracting Black students to undergraduate engineering programs. Using a critical lens, we used college and career choice models to frame our investigation into how Institutions of Higher Education (IHEs) recruit minoritized students. We presented thematic findings from our data analysis: (1) the idea of "broadening participation" in engineering as a conflicting definition between outreach and recruitment, (2) the significance of identity matching in recruitment events and programs, and (3) the importance of culturally responsive but honest marketing and communications materials.

The aim of this paper was to serve as a critical reflection on current trends for higher education professionals in college recruitment practices as it pertains to Black and other minoritized students in engineering. Future work should explore existing college choice models to investigate the inclusion of student sense of belonging and identity alignment. Future studies should also explore student emotions and perceptions when presented with minority-focused recruitment strategies and programs (e.g. do students feel a culture of inclusion or exclusion when presented with targeted events and communication?). Finally, we hypothesize that there is a consequential disconnect between recruitment professionals and academic researchers that has resulted in a lack of actionable college choice models for encouraging minoritized students to enter engineering programs. Finally, future research should investigate where college enrollment management professionals obtain their information when developing recruitment strategies, as well as exploring the similarities and differences between recruiter and researcher perspectives on what factors are valuable to consider for students in the midst of the college selection process.

References
[1] T. Holloman, W. C. Lee, J. London, A. Halkiyo, G. Jew and B. Watford, "A historical and policy perspective on broadening participation in STEM: Insights from national reports (1974-2016)." In *2018 CoNECD-The Collaborative Network for Engineering and Computing Diversity Conference*, April 2018.
[2] S. M. James and S. R. Singer, from "NSF: The National Science Foundation's investments in broadening participation in science, technology, engineering, and mathematics education through research and capacity building," in CBE—Life Sciences Education, 15(3), 2016.
[3] Z. Wilson-Kennedy, Z., G. S. Byrd, E. Kennedy, and H. T. Frierson, (Eds.). "Broadening participation in STEM: Effective methods, practices, and programs." Emerald Group Publishing. 2019.
[4] F. A. Hrabowski III, "*Broadening participation in American higher education—A special focus on the underrepresentation of African Americans in STEM disciplines*," The Journal of Negro Education, 87(2), 99-109, 2018.
[5] American Society for Engineering Education, "Engineering and Engineering Technology by the Numbers 2019". Washington, DC.
[6] L. M. Jackson and T. Rudin, "Minority-serving institutions: America's overlooked STEM asset," *Issues in Science and Technology,* vol. 35, no. 2, pp. 53-55, Winter 2019.
[7] T. J. Kennedy and L. M. Odell, "Engaging students in STEM education, "*Science Education International,* vol. 25, pp. 246-258, 2014. [Online]. Available: http://icaseonline.net.
[8] T. J. Oyana, S. J. Garcia, J. A. Haegele, T. L. Hawthorne, J. Morgan and N. J. Young, "Nurturing diversity in STEM fields through geography: The past, the present, and the future," *Journal of STEM Education: Innovations & Research,* vol. 16, no. 2, pp. 20-29, 2015. [Online]. Available at: https://www.learntechlib.org/.
[9] D. Peggy, C. Bahrim, J. Daniel, J. Kruger, J. Mann and C. Martin, "Closing the gaps and filling the STEM pipeline: A multidisciplinary approach," *Journal of Science Education and Technology,* vol. 25, no. 4, pp. 682-695, 2016.
[10] M. Loftus, "Untapped potential," *ASEE Prism*, vol. 18, no. 2, pp. 52, 2008.
[11] E. O. McGee, "Interrogating structural racism in STEM higher education," *Educational Researcher*, vol. 49, no. 9, pp. 633-644, 2020.

[12] B. Coley and J. Holly, "Starting with the promises: moving from inspirational words to institutional action in addressing systemic racism," In *2021 IEEE Frontiers in Education Conference (FIE)*. IEEE, October, 2021, pp. 1-4.

[13] C. A. Berry, A. Bowden, M. F. Cox, T. N. Reid, and L. L. Long, "Black in Engineering: How the Social Justice Efforts of Black Academics Affect Change," In *2021 ASEE Virtual Annual Conference Content Access*, July 2021.

[14] M. R. Anderson-Rowland, "The effect of course sequence on the retention of freshmen engineering students: When should the intro engineering course be offered?" Cat. No. 98CH3621 in FIE '98. *28th Annual Frontiers in Education Conference.* Moving from Teacher-Centered to Learner-Centered Education. Conference Proceedings, November 1998, (4) (Vol. 1, pp. 252-257). IEEE.

[15] M. Ashley, K. M. Cooper, J. M. Cala and S. E. Brownell, "Building better bridges into STEM: A synthesis of 25 years of literature on STEM summer bridge programs," *CBE—Life Sciences Education*, vol. 16, no. 4, es3, 2017.

[16] D. Dickerson, F. Solis, V. B. Womack, T. Zephirin and C. S. Stwalley, "Can an engineering summer bridge program effectively transition underrepresented minority students leading to increased student success?," In 2014 *ASEE Annual Conference & Exposition*, June 2014, pp. 24-251.

[17] S. Secules, A. Gupta, A. Elby, and E. Tanu, "Supporting the narrative agency of a marginalized engineering student" in *Journal of Engineering Education*, 107(2), 186-218. 2018.

[18] A. F. Cabrera and S. M. La Nasa,"Understanding the college-choice process," in *Understanding the college choice of disadvantaged students: New directions for institutional research*. San Francisco: Jossey-Bass, 2000, pp. 5-22.

[19] K. Freeman and G. E. Thomas, "Black colleges and college choice: Characteristics of students who choose HBCU's," *Review of Higher Education*, vol. 25, no. 3, pp. 349-358, 2002.

[20] D. Hossler and K. S. Gallagher, "Studying student college choice: A three-phase model and the implications for policymakers," *College and University*, vol. 62, no. 3, pp. 207–221, 1987.

[21] D. L. Stewart, "Black collegians' experiences in US northern private colleges: A narrative history, 1945-1965." New York: Palgrave MacMillan, 2017.

[22] C. Iloh, "Toward a new model of college "choice" for the twenty-first-century context," *Harvard Educational Review*, vol. 88, no. 2, pp. 227-256, 2018.

[23] J. L. Holland and J. M. Richards, Jr. "A Factor Analysis of Student Explanations of their Choice of a College". 1965. [Online]. Available at: https://files.eric.ed.gov/fulltext/ED016994.pdf

[24] L. H. Litten, "Different strokes in the applicant pool: Some refinements in a model of student college choice," *Journal of Higher Education*, vol. 53, no. 4, pp. 383-402, 2014.

[25] P. Kotler and K. F. Fox, "Strategic marketing for educational institutions." *Prentice Hall.* 1995.

[26] R. W. Lent, S. D. Brown, and G. Hackett, "Social cognitive career theory," *Career choice and development*, 4(1), 255-311. 2002.

[27] S. R. Ali and E. H. McWhirter, "Rural Appalachian youth's vocational/educational postsecondary aspirations: Applying social cognitive career theory." *Journal of career development*, 33(2), 87-111, 2006.

[28] M. M. Gibbons and M. F. Shoffner, "Prospective first-generation college students: Meeting their needs through social cognitive career theory," *Professional School Counseling*, 91-97, 2004.

[29] S. P. Farruggia, C. W. Han, L. Watson, T. P. Moss, and B. L. Bottoms, "Noncognitive factors and college student success," in *Journal of College Student Retention: Research, Theory & Practice*, vol. 20, no. 3, pp. 308-327, 2018.

[30] M. Gopalan, M and S. T. Brady, "College students' sense of belonging: A national perspective," *Educational Researcher*, vol. 49, no. 2, pp. 134-137, 2020.

[31] M. C. Murphy and S. Zirkel, "Race and belonging in school: How anticipated and experienced belonging affect choice, persistence, and performance," *Teachers College Record,* vol. 117, no. 12, pp. 1-40. 2015.

[32] A. L. Stephenson, A. Heckert, and D. B. Yerger, "College choice and the university brand: exploring the consumer decision framewor*k*," *Higher Education,* vol. 71, pp. 489-503, 2016.

[33] A. M. Locks, S. Hurtado, N. A. Bowman and L. Oseguera, L., "Extending notions of campus climate and diversity to students' transition to college," in *The Review of Higher Education*, vol. 31, no. 3, pp. 257-285, 2008.

[34] K. R. K. Thornburg, "Black student voices: exploring the expectations and lived experiences of belonging as recruited and enrolled students at two flagship institutions." Doctoral dissertation at the University of Texas at Austin. 2020. [Online]. Available at: https://repositories.lib.utexas.edu/handle/2152/86473

[35] R. Campbell‑Montalvo, G. Kersaint, C. A. Smith, E. Puccia, J. Skvoretz, H. Wao, and R. Lee, "How stereotypes and relationships influence women and underrepresented minority students' fit in engineering," *Journal of Research in Science Teaching*, 59(4), 656-692, 2022.

[36] C. M. Steele, S. J. Spencer, and J. Aronson, J, "Contending with group image: The psychology of stereotype and social identity threat," in *Advances in experimental social psychology*, vol. 34, pp. 379-440. Academic Press, 2002.

[37] M. J. Grant and A. Booth, "A typology of reviews: an analysis of 14 review types and associated methodologies," in *Health information & libraries journal*, vol. 26, no. 2, pp. 91-108, 2009.

[38] S. Wollscheid and J. Tripney, "Rapid Reviews as an Emerging Approach to Evidence Synthesis in Education," *London Review of Education,* 19(1), n1. 2021.

[39] M. Guillemin, and L. Gillam, L., "Ethics, reflexivity, and "ethically important moments" in research," in *Qualitative inquiry*, vol. 10, no. 2, pp. 261-280, 2004.

[40] T. K. Holloman, W. C. Lee, J. S. London, C.D. Hawkins Ash, and B. A. Watford, "The assessment cycle: Insights from a systematic literature review on broadening participation in engineering and computer science," in *Journal of Engineering Education,* vol. 110, no. 4, pp. 1027-1048, 2021.

[41] J. S. London, W.C. Lee, C. Phillips, C., A. S. Van Epps, and B. A. Watford, "A systematic mapping of scholarship on broadening participation of African Americans in engineering and computer science," in *Journal of Women and Minorities in Science and Engineering,* vol. 26, no. 3, 2020.

[42] National Science Foundation, "Where Discoveries Begin. US NSF - MPS - DMR - Broadening Participation." Retrieved August 1, 2022, from [Online]. Available at:

https://www.nsf.gov/mps/dmr/diversity.jsp#:~:text=Groups%20underrepresented%20in%20materials%20research,)%2C%20and%20persons%20with%20disabilities.

[43] C. Maiorca, T. Roberts, C. Jackson, S. Bush, A. Delaney, M. J. Mohr-Schroeder and S. Y. Soledad, "Informal learning environments and impact on interest in STEM careers," in *International Journal of Science and Mathematics Education,* vol. 19, no. 1, pp. 45-64, 2021.

[44] B. M. Holloway, T. Reed, P. K. Imbrie, and K. Reid, "Research-informed policy change: A retrospective on engineering admissions," in *Journal of Engineering Education*, vol. 103, no. 2, pp. 274-301, 2014.

[45] E. Smith and R. V. Reeves, "SAT math scores mirror and maintain racial inequity", Brookings. 2022. Retrieved April 29, 2022. [Online]. Available at: https://www.brookings.edu/blog/up-front/2020/12/01/sat-math-scores-mirror-and-maintain-racial-inequity/

[46] C. D. Denson and R. B. Hill, "Impact of an engineering mentorship program on African-American male high school students' perceptions and self-efficacy," in *Journal of STEM Teacher Education*, vol. 47, no. 1, 2020.

[47] M. J. Mohr-Schroeder, M. Cavalcanti, and K. Blyman, "STEM education: Understanding the changing landscape. A practice-based model of STEM teaching." 2015.

[48] J. Lemke, R. Lecusay, M. Cole, and V. Michalchik, "Documenting and assessing learning in informal and media-rich environments." The MIT Press, 2015.

[49] S. Appelhans, T. De Pree, J. Thompson, J. Aviles, A. Cheville, D. Riley, and A. Akera, "From" Leaky Pipelines" to" Diversity of Thought": What Does" Diversity" Mean in Engineering Education?" in *ASEE annual conference & exposition 2019.*

[50] S. Secore, "The significance of campus visitations to college choice and strategic enrollment management," in *Strategic Enrollment Management Quarterly*, vol. 5, no. 4, pp. 150-158, 2018.

[51] A. Ogilvie, "Capturing Young Minds With Mite–A Pre College Residential Program Generating Results," *n ASEE 2005 Annual Conference.* 2005.

[52] MITE Program. [Online]. Available at: https://cockrell.utexas.edu/connect/k-12-outreach/mite

[53] National Society of Black Engineers. [Online]. Available at: https://www.nsbe.org/K-12#:~:text=The%20students%20in%20our%20170,and%20professionals%20in%20our%20network.

[54] D. J. Twale, C. J. Douvanis, C. J. and F. J. Sekula, "Affirmative action strategies and professional schools: Case illustrations of exemplary programs," *Higher Education*, vol. 24, pp. 177-191, 1992.

[55] R. D. Opp, "Enhancing recruitment success for two-year college students of color," *Community College Journal of Research and Practic*e, no. 25, pp. 71-86, 2001.

[56] K. G. Salazar, O. Jaquette and C. Han, "Coming soon to a neighborhood near you? Off-campus recruiting by public research universities," *American Educational Research Journal,* vol. 58, no. 6, pp. 1270-1314, 2021.

[57] D. W. Chapman, "A model of student college choice," *The Journal of Higher Education*, vol. 52, no. 5, pp. 490-505, 1981.

[58] T. C. Johnston, "Who and what influences choice of university: Student and university perceptions," *American Journal of Business Education, vol. 3, no.* 10, 15-24, 2010.

[59] A. J. Cortese, "Provocateur: Images of women and minorities in advertising." Lanham, MD: Rowan & Littlefield, 1999.

[60] D. W. Schumann, *The transmission of prejudice: What do our marketing strategies really reinforce* in *J. D. Williams, W. Lee, & C. P. Haugtvedt "Diversity in advertising: Broadening the scope of research directions."* Mahwah, NJ: Lawrence Erlbaum Associates, 2004, pp. 121-131.

[61] E. Goffman, *Gender advertisements*. New York, NY: Harper Colophon, 1979.

[62] V. Singh and S. Point, "(Re)presentations of gender and ethnicity in diversity statements on European company websites," *Journal of Business Ethics*, vol. 68, pp. 363-379, 2006.

[63] N. Osei-Kofi, L. E. Torres, and J. Lui, "Practices of whiteness: Racialization in college admissions viewbooks," in *Race Ethnicity and Education,* vol. 16, no. 3, pp. 385-405, 2013.

[64] C. Henslee, M. Leao, K. Miller, L. Wendling, and S. Whittington, "Do you see what I see?: Undergraduate students' perceptions of IUPUI campus viewbooks and experiences," in *Journal of the Student Personnel Association at Indiana University*, vol. 48, pp. 64-82, 2017.

[65] N. Osei-Kofi, and L. E. Torres, "College admissions viewbooks and the grammar of gender, race, and STEM," in *Cultural Studies of Science Education*, vol. 10, pp. 527-544, 2015.

[66] R. Hite and A. Yearwood, "A content analysis of college and university viewbooks," *College & University*, vol. 76, no. 3, pp. 17–21, 2001.

[67] T. D. Pippert, L. J. Essenburg, and E. J. Matchett, "We've got minorities, yes we do: Visual representations of racial and ethnic diversity in college recruitment materials," in *Journal of Marketing for Higher Education,* vol. 23, no. 2, pp. 258-282, 2013.

[68] P. Gibbs, "Does advertising pervert higher education? Is there a cause for resistance?" In *Journal of Marketing for Higher Education*, vol. 17, no. 1, pp. 3– 11, 2007.

[69] J. A. Youngman and C. J. Egelhoff, "Best practices in recruiting and persistence of underrepresented minorities in engineering: a 2002 snapshot." *In 33rd Annual Frontiers in Education, 2003. FIE 2003.* Vol. 2, pp. F2D-11. IEEE. 2003.

[70] Ruffalo Noel Levitz. [Online]. Available at: https://www.ruffalonl.com/