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RESEARCH ARTICLE

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Expanding conceptualizations of engineering persistence: Examining four undergraduate Black men's dual-degree experiences

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Abstract

Background: There have been many efforts designed to broaden the participation of racially minoritized groups in engineering fields, including Black men. One pathway to attaining an undergraduate engineering degree is the dual-degree program, which has been in existence for several decades. However, much remains unknown about students' experiences in these programs. This study contributes new knowledge by studying four Black male college students who are matriculating through a dual-degree program and expanding conceptualizations of engineering persistence.

Purpose: The purpose of this article is to examine the experiences of four Black male dual-degree engineering majors using the transfer-receiving framework. In so doing, this article also explores their pre-college interests that catapulted their engineering aspirations.

Methods: This study employs the case study methodological approach to understand the four Black men's experiences. More specifically, the study uses multiple cases to build descriptions and explanations, offer different viewpoints, and produce compelling interpretations across the cases.

Findings: The data revealed three overarching themes. The participants (i) had different, yet meaningful pre-college experiences that ignited their engineering interests; (ii) took advantage of the support mechanisms at the engineering-granting institution; and (iii) navigated various challenges as dual-degree students.

Conclusion: The study provides recommendations for practice, policy, and future research about ways to study and acquire more knowledge of dual-degree engineering programs, improve the transfer process, and cultivate future Black male engineers.

KEYWORDS

Black mentoring tax, dual-degree program, engineering education, engineering persistence, transfer students, transfer-receiving framework, undergraduate Black men

1 | INTRODUCTION

Black students have been excluded—historically and to the present day—from engineering majors and career fields (Holly Jr. & Quigley, 2022; McGee, 2020a). Consequently, there have been national, state, and local efforts to increase the representation of Black scholars in engineering fields (National Science Board, National Science Foundation, 2024; Slaughter et al., 2015). Undoubtedly, there is a great demand for Black engineers given the racialized intelligence and innovative ideas they bring to the profession (McGee, 2020a). Over the last several decades, there has been an increase of Black students who are enrolling in higher education institutions; however, the number of Black engineering graduates remains painstakingly low (Atwaters et al., 2015; U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, 2024). That is, Black students are disproportionately represented among engineering degree recipients even though they have the interests, aptitudes, and creative talents to succeed in engineering fields (A. R. Brown et al., 2005; Slaughter et al., 2015). And while it is true that men dominate the field, Black men only account for approximately 2.8% of bachelor's engineering degree recipients (American Society for Engineering Education, 2022).

Engineering persistence represents individuals' resolve to persist in engineering degree programs and careers despite any challenges; this phenomenon has been studied by several researchers (Burt et al., 2018; McGee et al., 2016, 2022; Samuelson & Litzler, 2016). These studies have included Black engineering students, postdoctoral scholars, faculty members, and administrators. The current study places a laser focus on engineering persistence at the undergraduate level. To operationalize this concept in this study, engineering persistence is defined as persistence of those who started their engineering education coursework at a non-engineering degree-granting institution and then transferred to an engineering institution (I expound upon dual-degree programs and related literature in the next section). Dual-degree engineering students represent a slice of the transfer pie and are a missing variable from the persistence equation. As researchers and scholars, we must expand our conceptualizations of engineering persistence to account for this understudied group.

The dual-degree program is designed to broaden the participation of racially minoritized groups in engineering (Pierre, 2015). Although dual-degree programs are a well-established pathway to earning an undergraduate engineering degree, little research has explored students' experiences in these programs. As a result, valuable opportunities are missed to better understand these programs' strengths and areas for improvement. Of importance with respect to this study, misunderstandings can occur regarding how Black male students navigate and persist in these programs. Undergraduate Black men deserve scholarly attention given their extraordinary potential to major, excel, and thrive in engineering fields. To contribute empirical work in the aforementioned areas, the following research questions are addressed:

- What are the pre-college interests, experiences, and backgrounds of four undergraduate Black men enrolled in a dual-degree engineering program?
- What support mechanisms and/or challenges are revealed in their narratives that impact their persistence in the dual-degree program?
- What insights does the transfer-receiving framework provide to better understand the support mechanisms and/or challenges of these dual-degree students?

2 | REVIEW OF THE LITERATURE

To situate this study in the engineering education literature, I explore three areas of scholarship: (i) pre-college engineering efforts, (ii) engineering persistence among undergraduate Black men, and (iii) dual-degree engineering programs. Throughout the remainder of this article, note that STEM (science, technology, engineering, and mathematics) is used instead of engineering where the cited authors have used the broader term.

2.1 | Cultivating engineering interests via pre-college efforts

Engineering learning experiences at the early childhood level shape school-aged learners' perceptions of what they can do and achieve in the field. Prior work has stressed that early engineering experiences are vitally important for Black

children who have not been equitably served in this domain (Anderson & Littlejohn, 2024; Burt & Johnson, 2018; London et al., 2021). Correspondingly, engineering activities, standards, and curricula have been infused in formal and informal spaces (Fletcher Jr. et al., 2023; Newton et al., 2020; Wright et al., 2018). For Black boys, this exposure to engineering and broader STEM ideals has come in the form of playing with computers and video games, visiting scientific laboratories and museums, learning from industry professionals, and discussing engineering careers with their families (Burt & Johnson, 2018; DiSalvo et al., 2014; Flowers, 2015; Hrabowski et al., 1998; Jett, 2023; Rogers & Johnson, 2025; Strayhorn, 2015).

After-school programs and summer camps provide interaction with potential engineering majors with opportunities to explore related coursework, enhance their engineering preparation, and build community with peers who have engineering interests (Long III & Elam, 2023; Pleasants et al., 2025; Taylor Jr. et al., 2023). For example, Henderson et al. (2021) studied an after-school engineering program in three elementary settings with 60 Black and Brown boys. Recognizing that the elementary years are critical for engineering identity formation and development, the researchers examined how the two program components—engineering design activities and mentors (primarily consisting of college engineering majors)—enhanced the fourth- and fifth-grade boys' engineering identities. The boys expressed that the mentors had similar interests in video games and television shows and understood their references to popular culture, which deepened the mentor–mentee relationship and allowed them to envision engineering as a desirable career.

In another example, an engineering summer bridge program provided 24 minoritized students with opportunities to better understand what it means to "do engineering" and incorporate socially engaged perspectives in the field (Pleasants et al., 2025). Funded by local and regional employers, the program supported students who had a knack for public good. Although many had limited prior knowledge about engineering, it motivated these students to study engineering in college. Other programs have equipped racially minoritized pre-college students with the ammunition to persist in engineering and STEM (Edouard, 2024; Hill, 1990; King & Pringle, 2019; Newton et al., 2020; Sims, 2018; Taylor Jr. et al., 2023).

2.2 | Examining engineering persistence among undergraduate Black men

Researchers have explored Black students' persistence and success in undergraduate engineering programs (Brawner et al., 2024; Henderson et al., 2023; May & Chubin, 2003; Moore III et al., 2003; Stitt & Happel-Parkins, 2019). They have shown that engineering environments are racially hostile for academically successful Black students (McGee & Martin, 2011). More contemporary work has called out the anti-Black racism in engineering, which is fueled by White supremacist logics, ideologies, and epistemologies, and has advocated for anti-racist engineering classrooms (Holly Jr. & Quigley, 2022; Long III, 2020; McGee, 2020a, 2020b). The attacks and bans on diversity, equity, and inclusion (DEI) programs, efforts, and initiatives add to the significance of this research (McGowan et al., 2025; Sayman, 2025).

Given that collegiate Black men persist despite myriad challenges, researchers have devoted specific attention to exploring what works to support their persistence in engineering (Brown et al., 2005; Moore III, 2006; Tolbert Smith, 2022). Large-scale studies with undergraduate engineering students make a major impact on the literature, but their lack of, or miniscule, number of Black men leads to inconclusive findings resonant to this group (e.g., Faber et al., 2020; Litzler & Young, 2012). Thus, there is a need to conduct research exclusively with Black men who persist in undergraduate engineering programs and amplify their stories in the literature.

There is an emergent body of work regarding Black men's experiences in engineering (Benjamin & Henderson, 2024; Brown et al., 2024; Burt et al., 2018; Cross & Paretti, 2020; Holly Jr., 2020; Sellers et al., 2022; Williams et al., 2025). These scholars have advocated for on-ramps to propel Black men into engineering fields and have argued for more welcoming, supportive, and inclusive engineering spaces for this group. This work is done in solidarity with scholars who have explored ways to increase Black women's retention and persistence in undergraduate engineering degree programs in light of the racialized, gendered, and other oppressive systems thrust upon them (Blosser, 2020; Fletcher, Jefferson, et al., 2023; Hailu et al., 2025; Sidbury et al., 2015; Stitt & Happel-Parkins, 2019; also see Leggon et al., 2011).

In the transfer arena, Berhane (2017) studied five high-performing Black male students who transferred from a community college into a 4-year engineering institution in the Mid-Atlantic region. He used demographic questions and interviews to explore differences between Black African and Black American students. In his qualitative study, he found that the participants benefited from peer groups and that their community college created an "ethos that supported their transfer aspirations" (p. 67). Flowers (2015) conducted a study in the Southern region that examined the perceptions of eight Black male engineering majors at two highly selective universities. Six of his eight participants

were from single-parent homes. He found the family factor to be a critical component to the participants' academic development. Stated differently, "high parental expectations, firmness, encouragement, support, and continuous follow-up" (p. 64) were valuable in these Black male students' academic lives. Ash et al.'s (2023) study explored nine Black male engineering majors' experiences with academic advisors at a Hispanic-Serving Institution (HSI). They found that their participants had limited access to their advisors, rejected the prescriptive approach to advising, and built their own advising teams. Despite their limited access to quality academic advising, the nine participants persisted in the engineering major.

As these studies show, Black men persist in undergraduate engineering programs. Berhane's (2017) study with community college students demonstrated that Black men transfer and persist once enrolled at 4-year granting institutions, while Flowers's (2015) study highlighted the importance of family regarding engineering persistence. The majority of higher education studies highlight how Black men have successfully matriculated through traditional engineering programs (Ash et al., 2023; Burt et al., 2020; Flowers, 2015). Studies with Black men who have pursued the dual-degree engineering pathway are largely missing in the literature. The current study extends prior work in engineering education by focusing on four Black male students who pursued this pathway to engineering degree attainment.

2.3 | Exploring dual-degree engineering programs

The dual-degree engineering program was designed to increase participation in engineering programs for students at liberal arts institutions that did not offer engineering majors (Pierre, 2015). Now, dual-degree students also hail from community colleges, traditionally single-gender colleges (especially women's colleges), minority serving institutions (MSIs, although that language has been critiqued), and regional comprehensive universities. In the dual-degree engineering program, students typically declare two majors while earning a degree in a scientific field and an engineering degree (although other dual-degree disciplinary options have surfaced, such as the engineering and business one, e.g., Calvert, 2022). The first major is typically completed at the originating or transfer-sending institution; the second major (i.e., the engineering-focused major) is subsequently completed at the engineering-granting or transfer-receiving institution. This pathway often leads to two bachelor's degrees; hence the term *dual degree*. Of note, the dual-degree program is a critical pathway for engineering degree attainment at the undergraduate level.

Often referred to as the "3 + 2" option, the dual-degree program is designed for students to complete the requirements for the first degree in 3 years (Pierre, 2015). Then, they complete the engineering requirements at the second institution in the final 2 years. Dual-degree students are either vertical transfers (from a 2-year to a 4-year institution) or lateral transfers (from one 4-year institution to another). Related scholarship purports that Black engineering majors are more likely to transfer from 4-year institutions as opposed to 2-year institutions (Cosentino et al., 2014). As an example, Newman and Jackson (2013) stressed the pivotal role of historically Black colleges and universities (HBCUs) in supplying lateral transfers, which sustains dual-degree programs and expands opportunities for Black students to attain engineering degrees.

Like any program, the dual-degree engineering program has its advantages and disadvantages, which shape its reputation and inform Black students' decision making about pursuing this option. One benefit is that students have a much broader academic preparation because they complete advanced coursework in two disciplines (Newman & Jackson, 2013). Another benefit is that students have access to two institutional networks with varying engineering-related opportunities (Newman & Jackson, 2013; Pierre, 2015). Regarding disadvantages, dual-degree students have to start over, in many respects, because they often experience transfer shock (the difficulty encountered when transferring institutions), isolation, and alienation (Lakin & Elliott, 2016; Newman & Jackson, 2013). Considering the anti-Black racism present at many engineering-granting institutions, this issue is compounded for Black students (Holly Jr. & Quigley, 2022; McGee, 2020b). Also, dual-degree students do not get to graduate with their entering college classmates (Dinin et al., 2017). Furthermore, the dual-degree program involves at least 5 years, whereas a bachelor's degree is usually a 4-year commitment.

There are several dual-degree partnerships between institutions. As a result, dual-degree students have numerous experiences in these distinctive programs. To date, there exists relatively little research about the experiences of dual-degree engineering students in comparison to their peers who started at the university as traditional first-year engineering majors. The current study provides insights about how four Black male students navigated the dual-degree program.

3 | TRANSFER-RECEIVING FRAMEWORK

Thiry et al.'s (2023) transfer-receiving framework is used to guide this study. The transfer-receiving framework explores vertical transfer with goals to maximize the potential of transfer students, diversify STEM fields, and expand access to STEM careers for students from underrepresented groups. As STEM majors, the transfer process can be more cumbersome given that prerequisite course requirements and course sequencing "present extra navigational obstacles that cost students time, money, and credits" (p. 13). In short, this framework is designed to help transfer students succeed at their transfer-receiving institution, is STEM-specific, and builds upon prior race-related theoretical work regarding the transfer process (Jain et al., 2011).

The transfer-receiving framework has three stages (i.e., pre-transfer, post-transfer adjustment, and post-college planning) that provide transfer students with navigational, academic, and social/cultural support (Thiry et al., 2023). At the pre-transfer stage, students, advisors, and administrators explore STEM major options, plan the transfer process, partner with institutional stakeholders regarding course alignment, and take advantage of STEM pre-professional opportunities. During the post-transfer adjustment stage, stakeholders orient students to the institution and major department, create strategic action items to facilitate transfer student progress, and encourage participation in support structures. The post-college planning stage assists with career preparation, promotes research experiences and internships responsive to STEM transfer students' needs, and provides discipline-specific mentorship.

Prior work has shown that researchers examining engineering persistence of transfer students overwhelmingly focus on community college students via vertical transfers (Smith & Van Aken, 2020). To align with the bulk of the transfer published literature, Thiry et al.'s (2023) framework focuses on transfer from community college to a university. In this study, I extend the transfer-receiving framework to a different type of transfer students—dual-degree engineering students who are lateral transfers. Lateral transfers have received scant attention in the engineering education literature. The current study's population of four Black male lateral transfers in a dual-degree program, paired with the transfer-receiving framework, adds to the growing corpus of work regarding engineering persistence.

4 | RESEARCH METHODS

This section includes information about the qualitative approach used to design the study. I begin with a positionality statement. Then I describe the case study approach, institutional context, and participant selection process. Following that, the data collection and analysis plans are shared.

4.1 | Researcher's positionality

I am a Black man and proud HBCU graduate who champions these institutions in my work (Jett, 2013, 2022b; Jett & Jones Williams, 2025). I was encouraged to pursue an engineering major because of my mathematical proficiency, especially in Calculus 2 and Differential Equations—the gateway courses to engineering at my HBCU. My personal passions, however, led me to major in mathematics and pursue a career as a mathematics education researcher (see Jett, 2019b). My research agenda employs race-based frameworks to examine mathematical persistence and success among Black men (e.g., Jett, 2019a, 2022a, 2022c). The current study adds to my scholarly work by focusing specifically on four undergraduate Black men enrolled in a dual-degree engineering program.

I have taught mathematics in community settings (i.e., summer camps, enrichment programs, and churches) and at different higher education institutions (i.e., community college, HBCU, regional comprehensive university, and research university). Across these learning spaces, I have encountered students who desire to become engineers, with many of them being required to transfer to an engineering-granting institution to reach their goal. Additionally, I have been intimately involved with teaching, advising, and mentoring aspiring Black male engineers. Put simply, my personal and professional experiences have prepared me to undertake this study.

4.2 | Case study approach

This study was qualitative in nature. In qualitative studies, researchers seek to understand context and people's perspectives, illuminate meanings, and make comparisons to unearth important themes (Bogdan & Biklen, 2007;

Patton, 2015). Qualitative studies are transferable, allowing other researchers to explore and extend findings in different contexts (Patton, 2015). Under the qualitative research umbrella, I employed the case study approach (Merriam, 1998; Yin, 2013). Case study research "is an empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context" (Yin, 2013, p. 16). Case study researchers use multiple forms of data to understand, describe, and raise awareness about them. Cases can be empirical units or theoretical constructs, and case studies can stand alone as a detailed story about an individual, institution, or program (Patton, 2015). Case study researchers have a lot of autonomy to state what constitutes a case within their area of inquiry. For the purposes of this study, the cases represent four collegiate Black men who were enrolled in a dual-degree program.

Because there were four participants, this study was a multiple case study (Merriam, 1998; Yin, 2013). Anchored in real-life experiences, multiple cases build rich and descriptive explanations, consist of multiple variables, and provide different points of view regarding the phenomenon. Multiple cases provide greater variation, which yields a more compelling interpretation of the cases (Merriam, 1998). Multiple cases also strengthen the validity of the findings (Yin, 2013). Given these considerations, case studies advance the knowledge base in a field. This case study advances knowledge in engineering education by examining engineering persistence among four Black male dual-degree students using the transfer-receiving framework.

4.3 | Institutional context

The institution from which this study is derived is a public university in the Southeast that has a dual-degree program option. It graduates a diverse set of engineers annually and is a top producer of Black undergraduate engineering students (Malcom-Piqueux & Malcom, 2015). The institution has an active National Society of Black Engineers (NSBE) chapter. Through NSBE, Black undergraduates get to know and interact with other Black engineering majors and practicing engineers (Ross & McGrade, 2016). The institution also has a thriving cultural center, which is a space where many Black students congregate and form peer networks naturally. Cultural centers serve as counterspaces and have played a prominent role in fostering a home-like environment for Black students at historically White institutions (Brooms et al., 2021; Newman, 2016; Patton, 2006), especially Black engineering majors (Carter Andrews, 2019).

4.4 | Participant recruitment

This analysis comes from a larger qualitative study that examined the collegiate experiences of Black male STEM majors. I recruited the participants by sending emails to program leaders, talking with students about the study in communal areas, and posting flyers in the cultural center. Study participants met the following criteria: (i) self-identify as an African American or Black man; (ii) are a STEM major; (iii) have a grade point average (GPA) of 3.0 or higher; and (iv) have successfully completed the Calculus sequence. Foundational work indicates that students who have at least a 3.0 GPA and have successfully completed the Calculus sequence persist in STEM majors at a higher rate than those who do not (Seymour & Hewitt, 1997; also see Seymour & Hunter, 2019). I recruited 10 participants for this case study. Eight of them were engineering majors. Half of them were dual-degree engineering students. The participants self-selected pseudonyms to assist with anonymity.

4.5 | Data collection

Data collection methods included a demographic survey, artifacts, and a semi-structured interview (Merriam, 1998; Patton, 2015). First, the four participants completed a demographic survey. The demographic survey requested information about their family, K-12 schooling, college experience, post/undergraduate plans, and aspirations. Participants were advised to bring two to three artifacts related to their STEM experience to the interview (Patton, 2015). Presenting the artifacts allowed participants to share their reality in a personalized manner. The semi-structured interview was conducted in person at the institution and lasted roughly an hour. The interview was designed for the participants to respond freely about their experiences as STEM majors. Examples of interview questions included "When did you first notice your interest in STEM?" "Why did you select your specific major?" and "What are your short- and long-term

career goals?" These questions allowed me to gather descriptive and explanatory data (Yin, 2013). These questions were later mapped onto the transfer-receiving framework (Thiry et al., 2023).

The three sources were used to triangulate the data, as espoused in case study research (Yin, 2013). With triangle—a foundational geometric shape—as a root word, triangulation borrows from this mathematical idea to symbolize a way qualitative researchers use multiple data sources to mitigate bias or errors from a single data source (Patton, 2015). Furthermore, triangulation strengthens a study by including a variety of data collection sources to cross-check data for validity and consistency. This illuminative process aids in data analysis.

4.6 | Data analysis

For effective data analysis, I wrote memos for each case to paint a picture of the individual participant. Importantly, the case study methodological approach involves within-case and cross-case analyses (Merriam, 1998). The within-case analysis consisted of coding and analyzing each individual case (Merriam, 1998; Saldaña, 2016). The cross-case analysis entailed searching for, identifying, and strengthening common themes across the four individual cases (Merriam, 1998). Taken together, these two data analysis stages allowed me to develop deeper understandings across the four cases. In addition, I engaged in triangulation by comparing the data across the three sources of each within-case description as well as analyzing the data among the cross-cases to test for consistency (Patton, 2015).

Deductive and inductive coding was employed in this study (Saldaña, 2016). Codes were derived from the engineering, STEM, and higher education literature (Berhane, 2017; Burt & Johnson, 2018; Ross & McGrade, 2016; Spencer, 2024; Watkins & McGowan, 2022). Example deductive codes included summer camps, NSBE, peer support, real-world applications, and transfer shock. Inductive codes came from the data. Sample inductive codes included business, group dynamics, timeline, and mentoring burden. These codes were mapped onto the transfer-receiving framework to enhance understanding of the data and make explicit links to the three stages outlined in the framework (Thiry et al., 2023). With that, deductive and inductive coding assisted with placing the data into overarching themes.

The data analysis process provided the evidentiary base for the overarching themes, as multiple cases bring about stronger arguments to support them (Borman et al., 2006; Yin, 2013). The three stages of the transfer-receiving framework were also employed to produce careful presentation and considerations of my thinking, interpretations, and thematic offerings of the data (Thiry et al., 2023). Because the transfer-receiving framework is relatively new, it has not been applied extensively in engineering education research. In any event, the theoretical framework offered three stages to reflect continuously on the analytic process, make adjustments over time, and present the data. Not only that, but I also engaged in peer debriefing by sharing my interpretations and receiving critical feedback. This extra layer supported the validity of my cross-case findings.

5 | THE PARTICIPANTS

Four Black male dual-degree engineering students participated in the study. They were persisting in the program as graduating college seniors. They had valuable insights about the dual-degree program given their real-time enrollment as undergraduate students. Table 1 includes relevant contextual information.

Interestingly, all four participants attended high school in the same state, with three of them being from the city where the engineering-granting institution is located. Only one participant, however, knew that he would pursue the dual-degree engineering pathway in high school. The transfer-sending institutions were also within the state system. These four baccalaureate institutions provide broad access to higher education in different regions of the state. The N/A for Maxwell under the major column in Table 1 means that he was on the pre-engineering track at his originating institution, so he did not declare a major there. All four participants had graduate school aspirations.

5.1 | Individual cases

This section includes a brief narrative about each case—Brandon, Maxwell, Rasmus, and William. Brandon's parents earned undergraduate degrees at HBCUs and are both employed in STEM fields. He mentioned that they were his role models and a huge influence on his decision to pursue a computer engineering degree. He has always had a desire to

TABLE 1 Participants' information.

Name	Age	State high school	High school racial composition	Dual-degree program decision	Transfer-sending institution	In-state	First major	Second major	GPA	Grad school	Anticipated area of study
Brandon	22	Yes	Predominately White	During the first year of college	Public HBCU 1	Yes	Mathematics	Computer engineering	3.50	Yes	Electrical engineering, computer engineering, or computer science
Maxwell	22	Yes	Predominately Black	After the first year of college	Public HBCU 2	Yes	N/A	Industrial engineering	3.20	Yes	Master of Business Administration (MBA)
Rasmus	23	Yes	Predominately Black	During the second semester of college	Regional Comprehensive University 1	Yes	Chemistry	Chemical and biomolecular engineering	3.82	Yes	MBA or Chemical engineering
William	24	Yes	Predominately Black	During a high school college fair	Regional Comprehensive University 2	Yes	Computer science	Aerospace engineering	3.30	Yes	Aerospace engineering

understand how computers work. Prior to his matriculation in this engineering program, he attended an HBCU where he successfully completed the requirements to earn a mathematics degree. In his free time, he completes programming challenges online given that he had to program on the spot in a recent interview. He is a member of a Black Greek-Letter Organization (BGLO) and participates in other community-based organizations that promote Black male success.

As an industrial engineering major with a concentration in supply chain engineering, Maxwell is a conscientious student and plans to pursue a career in engineering as well as start his own business. In middle school, he received the Road Less Traveled Award. Ironically, his dad always used those exact words regarding him. Maxwell woke up at 5:00 a.m. to take two buses to get to his high school, which was approximately 40 min away from his home. Although he wanted to pursue engineering, he started out at an HBCU because of a baseball scholarship. Playing on the baseball team caused him to miss class and instructional time often due to the heavy travel schedule. Co-ops were not encouraged to the extent that he desired at his transfer-sending institution, and group projects were his biggest challenge at the transfer-receiving institution.

Hereto, Rasmus was born in Ghana, but his family moved to the United States when he was nine years old. He shared that he attended an underfunded middle school characterized by a dilapidated building with crummy books. His high school environment was much better; he and his high school peers attended field trips, which exposed him to STEM ideas. Rasmus is a chemical and biomolecular engineering major with a material sciences minor. At the time of the study, he, along with his teammates, advanced to the next round in an engineering competition. Their project was centered on providing economically challenged households with affordable energy. Rasmus is the president of the Transfer Student Association (TSA) and serves as a mentor to his engineering peers.

In addition to earning a dual degree in computer science and aerospace engineering, William is also a double minor, pursuing minors in mathematics and physics. He works as a full-time engineer, is a full-time student, and is an active member of a BGLO. He was exposed to STEM ideas in grade school, took an engineering course in high school, and was a member of the Robotics Team. He was also part of a collegiate design team to launch a satellite and worked on wind tunnel research, which was subsequently contracted by a STEM-based company. William noted his perseverance and strong work ethic as being instrumental to his collegiate success.

6 | FINDINGS

Via data analysis that included triangulation to strengthen credibility and confidence across the data sources (Patton, 2015), three themes were generated from the cross-case analysis—(i) igniting engineering interests before college, (ii) taking advantage of institutional support structures, and (iii) navigating challenges associated with being in the dual-degree program. In this section, data are shared to support the three overarching themes.

6.1 | Igniting engineering interests before college

The first theme was centered on the participants' exposure to engineering-related ideas at the pre-college level. These pre-transfer experiences occurred during their childhood and not as college students, as outlined in the transfer-receiving framework's pre-transfer stage (Thiry et al., 2023). These early childhood experiences occurred across multiple settings and eventually landed them in the dual-degree program. William shared how he would always help his mother set up the internet and fix the family's computer-related issues. Reflecting on his childhood, he stated:

> I was always into cars and stuff, but I always liked military aircraft, like I had posters of Fokker and the V-22 Osprey and the SR-71 Blackbird like that was on my wall next to Kobe Bryant and LeBron James. So, I was always interested in aviation.

William's childhood posters included Black male professional basketball players who serve as role models for Black boys given their hypervisibility in the media (May, 2009). Yet, he led with his fascination with military aircraft, as his childhood posters included Bell Boeing's V-22 Osprey and Lockheed's SR-71 Blackbird. These specialized military aircraft are known for their initial climb during takeoff, high-speed cruise, and landing capabilities. Importantly, they piqued his interest in flight science and propelled him to pursue a major in aerospace engineering.

In his home, Brandon played video games during his spare time, which prompted his early interest in computers and engineering. He commented:

> I was a little kid playing video games because I grew up watching systems improve over time... graphics would improve. You could do more in the game... and that's what really got my attention.

Video games often provide different types of innovative animations and are a dynamic resource to expose Black boys to STEM ideas, especially considering that many Black male youths are staunch consumers of video games (DiSalvo et al., 2014).

In addition to home-based experiences, the participants had other experiences that impelled them to major in engineering. For Maxwell, who grew up in the same city where he is completing his dual-degree engineering program, this came in the form of a summer camp. He noted:

> There were people like [redacted] students, they would come and volunteer just to show us little robots, activities, and some different little science experiments... that kind of upped my interest in STEM-related fields.

Summer camps, as well as other informal learning spaces and activities, serve as powerful mechanisms to expose Black boys to STEM-related concepts (Strayhorn, 2015; Washington et al., 2020). The fact that the college students came from Maxwell's subsequent transfer-receiving institution had personal meaning for him.

Oftentimes, students have a natural curiosity about engineering and other STEM-related principles. Rasmus provided background information to describe his thinking about how things work and how that thought process related to his interests.

> My very first experience was just like seeing the cool stuff around me. Like I guess a lot of people don't wonder about how things work you know. Okay like I have this iPhone that works or whatever, I don't care as long as it works. But me, I've always been like, do you ever wonder how this is made? How do they get this into this shape? How do they make so many of them at the same time? How am I seeing the screen right now? Things like that, it's always been in my head. I feel like science is the only way to answer those questions.

Rasmus's series of questions about how the iPhone works demonstrates his curiosity about scientific and engineering processes. As shown, the four participants' collective pre-college experiences occurred in formal and informal settings, and they sparked the fire for these Black men to major in engineering via the dual-degree pathway.

6.2 | Taking advantage of institutional support structures

The second theme acknowledged that these Black male dual-degree students took advantage of the support mechanisms at the engineering-based institution, which adhered to the post-transfer adjustment stage in the transfer-receiving framework (Thiry et al., 2023). The support structures included peers, professors, teaching assistants (TAs), and student organizations. These support mechanisms make up the institutional community. In his interview, Maxwell pointed out:

> The community here is always together like you may be going through three, four, five tests a week.... There's so many resources... Everybody's here to build each other up.... There's always some type of community that welcomes you in. Just to try and see you be your best self, so that's why I joined some of these organizations. It's just a really well-knit community.

His narrative about community is inclusive of the peer support, networks, and resources to ensure his academic success. His reference to student organizations includes the institution's NSBE chapter; later in the interview, he referenced NSBE's responsiveness to the Black experience.

The participants made the most of the institutional support structures. For example, help-seeking behaviors result in greater support among undergraduate engineering students (Wirtz et al., 2018). The Black men in this study exhibited help-seeking behaviors. Brandon acknowledged:

> I always go to office hours. I probably go to office hours at least twice every week to be honest... talking to TAs who've taken the class before; they often give tips that can help me do much better... because that shows a different outlook on how you can approach a problem. That's why I love to speak to other people in general, because you may have one way [to solve a problem].

As Brandon's narrative indicates, he values multiple stakeholders' (i.e., professors, TAs, and peers) perspectives or approaches to solving a problem, which allows engineering students to better understand disciplinary issues. The main point here is how he takes advantage of office hours to learn from the professor. Rasmus also makes good use of office hours. His conversations go beyond engineering concepts. He expressed:

> There's a professor, he's the only Black professor in the [redacted] department, so I go to him a lot to ask for advice when I feel weird sometimes about this or that. Or why did you choose to go to grad school or something like that. I talk to him a lot. Sometimes I stop by to say hello and hang out. He's always very approachable. He's always very nice.

Rasmus shared that he had previously enrolled in this professor's class and that he is one of the "good" professors at the institution. Rasmus's conversations with him also include personal matters, and it is important to note that his professor is a Black man. Rasmus's connection with his Black male professor is not surprising given prior research indicating that Black male students seek academic and career guidance as well as personal direction from professors who share their racial and gender identities (Fries-Britt & White-Lewis, 2020; Jett, 2022a; Jett & Jones Williams, 2025).

At the transfer-receiving institution, there is not a critical mass of Black engineering professors. Although there are some Black engineering majors present, the number dwindles when broken down into engineering specializations. William disclosed:

> There aren't a lot of Black people in AE, you know, so going to the NSBE meetings, I'm a member of that as well. ...I think that if I never joined the chapter here, I never would have been exposed to any of that so that really helped me as well.

Student organizations such as NSBE take up some slack because they offer an opportunity for engineering majors to come together and learn from Black professors, practicing engineers, and students with a broad range of expertise. In this way, engagement with other Black engineering majors through NSBE serves as a form of support for these four collegiate Black men.

In another case, Brandon received support from his peers who came from his transfer-sending institution through a mentoring program, "From my program, there were two more people that got here before I did... They're providing me with tips and a little more resources that helped me out over time." For Brandon, having dual-degree students from his previous institution, an HBCU, worked in his favor because they were providing him with strategies to navigate the engineering landscape in this institutional space. Furthermore, his narrative indicates that dual-degree engineering students offer advice to other transfer students to promote persistence in the major.

One final support structure came in the form of an award. Rasmus received an academic accolade, which positively influenced his self-confidence in the major as a dual-degree student. He stated:

> An award I got when I first got here, it was for getting a 4.0 for my first year here as a transfer student, which doesn't happen for transfer students, so they wanted to give me honors for that. And it gave me hope that I could actually be successful here like everyone else, so I was very proud of that.

Rasmus's experience gives a new meaning to transfer shock, which can result in a decrease in GPA or even a change of major for STEM majors (Lakin & Elliott, 2016). Instead, his transfer shock was associated with receiving an award for his 4.0 GPA. Even though he received the award early on as a dual-degree student, it did not exempt him from the challenges that are associated with matriculating through the institution and dual-degree engineering program. The third theme highlights the participants' challenges in doing so.

6.3 | Navigating challenges as dual-degree students

The third theme was about navigating challenges uniquely ascribed to dual-degree students. The shared challenges encompass both the post-transfer adjustment and post-college planning stages in the transfer-receiving framework (Thiry et al., 2023). William described his initial challenge as culture shock:

> I did have culture shock. That was a thing that I had to mentally work with and develop, you know, a comfortability in that environment and then also the courses, the coursework, you know, it was a lot harder here than it was at my old school.

What William described is akin to transfer shock, which often necessitates that transfer students take some time to develop comfort in the new institutional space, learn the pace of coursework, and develop the mental fortitude to persist in the program (Lakin & Elliott, 2016). In another case, Brandon mentioned:

> Finding an internship is difficult when you don't have a GPA here. When I first got here, that was the most difficult problem.... Even at job fairs they were wondering about that, so most (engineering companies) were hesitant [to make internship offers]... so just being here didn't count for as much.

Brandon's shock was rooted in the fact that he did not have an institutional GPA. The institution hosts engineering career fairs, so not having a GPA at the transfer-receiving institution is a challenge. This issue could impact eligibility for internships and research experiences and cause some professors to not provide recommendation letters for these career-advancing disciplinary opportunities.

The four undergraduate Black men in this study had very few pre-existing relationships, if any at all, with their peers at the transfer-receiving institution. As a result, they had some challenges with navigating group dynamics. Typically, study groups and teams form through acquaintances, but this presents a challenge for dual-degree students. Maxwell spoke at length about this issue.

> When it comes to group projects in certain classes and the professor says to make your group, so like automatically all the friends and the people who have known each other over the years, they automatically clique up and get in their own little groups, and you're left wondering "so what group am I going to be in?"...The senior project... a lot of people already have their groups together. They know who they're going to work with. They know who they're going to ride out that struggle with. It's just like you're always kind of on the tail end of things, trying to catch up, and hoping that you're going to be accepted by all these groups that have already been made, so I will say that the group projects are the hardest thing.

Maxwell's quote is representative of dual-degree students' plight from arrival up to the senior project. Many engineering course projects require students to work as a team, and the exclusion from groups is compounded by issues of race and gender. As an example, previous work with eight Black male engineering students on multiracial teams at a predominately White institution (PWI) found that although students reported positive team experiences, they were also keenly aware of stereotypes, lacked opportunities to develop deeper friendships with teammates, and navigated conflicts surrounding unmet expectations (Cross & Paretti, 2020). Although this study's participants chalked up this challenge to being in the dual-degree program, prior work suggests that the salience of race and gender bears mention.

The timeline to degree completion was another challenge for the dual-degree students. Brandon talked about this challenge:

> For me, it's two and a half years because you have to take certain prereqs, so you can't graduate, at least for the Computer Engineering program. You can't graduate in two years, so the scholarship even has leeway for that because they know as a whole the prerequisites might hinder you from graduating at a specific time.

Here, he focuses on prerequisite coursework. Missing a prerequisite course can add a semester or year to the collegiate timeline; this is distressing because it delays graduation, among other things. In Brandon's case, it will take him 2½ years to complete the coursework at the transfer-receiving institution. For the other three participants, it will take

3 years. In fact, Rasmus asserted that the dual-degree program "should be advertised as 3 + 3" instead of the "3 + 2" program. He likened it to a lack of communication about the timeline between advisors at the transfer-sending and transfer-receiving institutions, "I don't think they know that it's six semesters guaranteed. And they don't know that you can't take certain classes in the summer... so I think there's a lack of communication."

One additional challenge was a *mentoring tax*—a price paid to be seen as academically astute within the context of engineering. While peer mentoring is a worthwhile endeavor, it can be overwhelming when the mentor has several mentees. Brandon had an exorbitant number of mentees.

> You're given a certain number of students... Since I was a transfer, I was assigned 27 different transfer students of different majors, and that's also a struggle because of the various majors I don't know all that they do, but I also have some computer engineers, so I can at least give them more resources than others. But it's more than just me giving them information, trying to get them different opportunities. Pretty much help them overall, in general basically if they need any help, it's my job to go and help them, if they need advice or anything else that they need.

Because of his transfer status, Brandon could relate to some of the transfer-related challenges. However, he was still learning about the resources and opportunities associated with all the engineering specializations and STEM majors offered at the institution. Maxwell conveyed similar sentiments about the sizable number of mentees.

> I am a mentor right now to about 20 or so kids... they don't always respond, but I mean you're given a list of people... I have all transfer students... And then there's an Engineering Office...so I am a mentee through that program right now, so it's like I have a mentor as well.

Notably, Maxwell's mentoring is bi-directional given that he serves as a mentor and a mentee. Nonetheless, challenges remain around the logistical coordination of these mentoring relationships with such a considerable number of mentees.

7 | DISCUSSION

The purpose of this section is to discuss the findings from the current study. In the overarching discussion, I review the three research questions, unpack the study's three themes in light of the research questions, and make connections to the transfer-receiving framework. After that, I discuss the study's limitations.

7.1 | Overarching discussion

The three themes from the cross-case analysis map explicitly onto the three research questions. To recap, the research questions were centered on (i) uncovering the pre-college interests, experiences, and backgrounds that led these four Black men to pursue an engineering degree in a dual-degree program; (ii) identifying the support mechanisms and/or challenges that impacted their persistence in a dual-degree engineering program; and (iii) exploring how the transfer-receiving framework helped to understand these issues.

Regarding the first research question, the four Black male dual-degree college students had some early exposure to engineering. In other words, their STEM interests were formed before they entered college. As such, they did not arrive on their transfer-sending college campus without any initial inclinations to pursue an engineering pathway. These pre-college experiences included fixing computers, playing video games, attending STEM summer camps, and tapping into their natural STEM curiosity. This finding, spurred by their individual interests, aligns with other published research that purports that Black children's—namely Black boys'—vicarious experiences inspire interest in STEM careers (Burt & Johnson, 2018; DiSalvo et al., 2014; Jett, 2023), fuel their passion for the field (McGee et al., 2016), and foster *potential engineers* (London et al., 2021).

The second research question revealed that participants drew from their institutional community and support structures to persist in their engineering programs, which included their peers, Black faculty, and the NSBE chapter. Other research has emphasized the crucial role of peers and Black faculty toward improving STEM retention, persistence, and

graduation among Black male students (Fries-Britt & White-Lewis, 2020; Jett, 2022c). The participants in this study also benefited from the institutional NSBE chapter. Black professors and engineering professionals in NSBE provide opportunities for Black male students to envision themselves in similar roles (Ross & McGrade, 2016) or as *possible selves* (Markus & Nurius, 1986). Further, institutional mentorship across these support mechanisms is imperative with respect to exposing Black students to graduate programs in engineering (McGee et al., 2016), as three of the participants aspired to attend graduate school for engineering.

In one last example of institutional support, Rasmus received an award for the 4.0 GPA he earned during his first year at the transfer-receiving institution. This accomplishment is commendable given the many adjustments that come along with transferring institutions, especially as a Black male engineering major. Previous work has substantiated that awards are a powerful way to publicly recognize Black students' academic accomplishments, boost their self-confidence in STEM fields, and motivate them to persist with their studies (Heggins et al., 2001; Jett, 2022a, 2022c).

The second research question also revealed that the four Black men experienced challenges while navigating the dual-degree engineering program. Unlike other studies where Black male transfer students dealt with a convoluted process characterized by erroneous admissions decisions, inadequate advising, and confusing course sequences (Berhane et al., 2024; Qaqish et al., 2020), the participants in this study benefited from taking courses in the same statewide system, which prompted a rather seamless transfer process course-wise. For these undergraduate Black men who were further along in their degree program, the group dynamics were felt immediately and exacerbated feelings associated with transfer shock. Having left friends at their transfer-sending institution—and in contrast to students who already know the ins and outs of the engineering institution—dual-degree students have a short window of time to build relationships with peers and faculty as well as learn a new institutional and programmatic culture (Newman & Jackson, 2013). Another significant challenge voiced by the participants was the timeline to degree completion. The intensive program of study, which prolongs the collegiate timeline, has been noted as a dual-degree barrier (Jett, 2022a; Newman & Jackson, 2013). In my previous study, quite a few Black male dual-degree engineering majors opted out of the program when they deeply considered the additional time for a bachelor's degree and changed their majors to mathematics (Jett, 2022a).

One additional participant-professed challenge was the *mentoring tax*. Burrows (2016) wrote about a "Black tax," defined as a toll paid for Black scholars to participate in White institutions. "At the heart of the Black tax is the notion that if African Americans work hard and rise above their situation without complaining about racism, they will gain privileges that Whites already have" (p. 15). Similarly, if Black college men mentor other engineering majors, then they will be viewed as exemplary scholars in this space, hence a mentoring tax. This construct is troublesome because Black male students' pathways to undergraduate engineering degree attainment are already multifaceted, laced with racial stereotypes, and difficult to balance given their many commitments and challenges (Holly Jr., 2020; Long III & Elam, 2023). Along those lines, McGee (2020b) posits that mentoring programs, by and large, fail to acknowledge "the structural racism that is so pervasive in STEM academic and industry contexts" (p. 634).

In another related study about how Black male engineering majors experience advising, Ash et al. (2023) found that advisors maintained large caseloads making it nearly impossible to "consistently deliver high-quality advising, including building meaningful interpersonal relationships with students, responding to inquiries promptly, and customizing the student experience to tailor it to their needs and goals" (p. 309). Comparably, the participants' assigned mentees stretched them too thin because there was such a large number of them. As a result, this mentoring tax prevented them from meaningfully engaging with their mentees and took considerable time away from their own engineering studies. Altogether, these four Black men's challenges could have negatively impacted their persistence in the major or caused their engineering aspirations to wane; fortunately, that was not the case for the dual-degree students in this study.

As it pertains to the transfer-receiving framework, data analysis revealed very little about the pre-transfer stage (Thiry et al., 2023). The transfer-receiving institution provided minimal guidance and no documented pre-professional opportunities; however, the transfer-sending institution provided information about the transfer process and STEM course alignment. Data analysis revealed the most about the post-transfer adjustment stage, and this makes sense given that the participants had recently completed this stage in their educational journeys. As college seniors, they had become acclimated to the transfer-receiving institution, were knowledgeable about their degree program, and had taken advantage of institutional support structures. Consequently, they were able to readily identify support structures and challenges to engineering persistence tied to the dual-degree program.

The transfer-receiving framework's third stage, post-college planning, had some confirming evidence (Thiry et al., 2023). The participants were able to participate in discipline-specific internships and career fairs to assist with

career preparation. Moreover, they received mentoring from Black faculty and NSBE members and were able to serve in a mentoring role to transfer students, which was inclusive of dual-degree students. It is worth noting that two of the four participants plan to earn an MBA. Benjamin and Henderson (2024) highlighted the relationship between engineering and commercial enterprise and found in their study with 20 undergraduate Black male engineering majors that many of them had entrepreneurial aspirations. Given the rising number of dual-degree engineering and business models (Calvert, 2022), this could be a rewarding pathway for undergraduate Black men whose post-college goals include entrepreneurial engineering.

7.2 | Limitations

This study has some limitations that warrant discussion. First, I recruited 10 Black male STEM majors for this study and ended up with four dual-degree engineering majors. The protocol was tailored to the current engineering-granting institution. This caused me to miss valuable information about the transfer-sending institutions, as espoused in the transfer-receiving framework's pre-transfer stage (Thiry et al., 2023). A second limitation is that this sample was limited to collegiate Black men who were excelling in the dual-degree program; this was evidenced by their GPA and persistence at the engineering-granting institution. Studying Black men who opted not to continue in the dual-degree program before transferring or those who discontinued their studies after enrolling in the transfer-receiving institution would have offered different insights.

Another limitation is that I did not parse out the intricacies of the participants' engineering specializations. Because I am a mathematics education researcher, I likely passed over opportunities to prompt for further details about any engineering specialty areas. Posing questions about major-specific subcultures could have unearthed varying interpretations about disciplinary specializations to help potential engineering majors navigate the complexities surrounding major choice (Main et al., 2022). A final limitation pertained to the transfer-receiving framework (Thiry et al., 2023). While useful, the framework was designed to examine the vertical transfer process from the community college to a 4-year university. Despite these noted limitations, the study adds new knowledge to the engineering education research canon.

8 | IMPLICATIONS

In this section, I provide implications for practice, policy, and future research. I also emphasize the scholarly contributions of this study germane to engineering education research.

8.1 | Implications for practice

The first implication pertains to the participants' pre-college experiences as Black boys. Their childhood interests provide some background information about their engineering journeys. As noted earlier, research shows that Black children's early exposure and interest in engineering strongly influences decisions about college majors and career trajectories (London et al., 2021); that was the case for the participants in this study. William's mention of his childhood posters of professional basketball players reminds us that other Black male role models, such as professional engineers, should receive heightened visibility and be equally positioned as exemplars of success to generate interest among Black boys. A promising practice is to pay close attention to the things Black boys have a vested interest in as well as their personal hobbies vis-à-vis formal and informal settings to make explicit connections to engineering (Holly Jr., 2020; Main et al., 2022). Along with that, practitioners should let Black male students know that their engineering aspirations are within reach and infuse action items to validate, cultivate, and nurture their discipline-specific interests.

Another implication is focused on mentoring. The current study found that the participants were mentored in this institutional context. Now that they are seniors and the tables have turned, they serve as mentors for dual-degree and other transfer students. Leaders of mentoring programs should be mindful of and decrease, where necessary, the number of assigned mentees given the proportion of time necessary for effective mentoring (Packard, 2016). Mentoring transfer students adds an additional layer because these students are not fully integrated into the campus community. Added to that, the racialized experiences that Black men endure in the engineering space (Burt et al., 2018;

Holly Jr., 2020) intensify the mentoring tax, so practitioners should carefully consider mentoring efforts as they think about the feasibility and sustainability of mentoring programs for dual-degree engineering students, especially those from racially minoritized groups.

8.2 | Implications for policy

This study points to a need for more government funding and policy to be directed to early childhood engineering programs for Black boys. The participants' early experiences and other published work, in the aggregate, emphasize the central role that early childhood learning across home, school, and community-based settings plays in strengthening Black boys' engineering and STEM identities (Henderson et al., 2021; Holly Jr., 2020; Kane, 2016; Rogers & Johnson, 2025; Washington et al., 2020). On a different note, one interesting finding in this study was that the collegiate Black men (although with diverse backgrounds) completed their public high school education in the same state, started college at a public institution within the statewide system, and had in-state status at the transfer-receiving institution. Based on this finding, researchers and practitioners should more closely investigate how different state-level policies enact dual-degree programs and determine to what extent geographical accessibility matters for dual-degree students. Additionally, scholars could determine whether what is articulated by participants is congruent with institutional policies for dual-degree students and programs.

The transfer-receiving framework, as echoed in this study, advances that the transfer-receiving institution needs to be more involved in the pre-transfer stage (Thiry et al., 2023). Dual-degree programs are a collaborative arrangement, not a one-sided partnership. In this study, some participants were still fuzzy about their GPA at the transfer-receiving institution and voiced concerns about the lack of communication across institutions. Established policies should be in place to ensure more frequent communication between both institutions. Committed advisors who are not saddled with unmanageable caseloads are needed to make this a reality (Ash et al., 2023). Related to this point, Smith and Van Aken (2020) recommend that institutions have a transfer center and transfer-focused advisors to assist with developing more equitable transfer processes and policies for students transferring into engineering institutions. Further, Jain et al. (2011) suggest that transfer processes not be relegated to a few offices on campus but that they become institutionalized policies. Based on the findings from this study as well as other research, policies should be enacted to make certain that communication efforts are also attuned to facilitating and improving peer-based group dynamics to include Black engineering students, given that peer interactions are more convoluted and stressful when race is added in the mix (Blosser, 2020; Cross & Paretti, 2020).

8.3 | Implications for future research

Future work should acknowledge and explore the role of HBCUs and regional comprehensive universities in the production of Black engineers. Transfer-receiving institutions often get the credit and accolades via national rankings for producing Black engineers, but this study shows that there is more to the story. Previous scholarship has alluded to the "hidden" contributions of HBCUs relative to the number of Black engineers; hence, continued studies of HBCUs can provide research directions to support Black male engineers (Addae et al., 2014; Burrell et al., 2015; Ransom, 2015). More impressive is that HBCUs and regional comprehensive universities (and even community colleges for that matter) cultivate Black engineering majors with meager resources—equipment, facilities, personnel, research, endowments, and other financial assets—in comparison to doctoral-granting engineering institutions (Malcom-Piqueux & Malcom, 2015). Completion data often do not take into account the graduates who earned engineering degrees by way of dual-degree programs (Malcom-Piqueux & Malcom, 2015), and "transfer success metrics that incentivize and reward both ends are yet to be developed" (Wang, 2020, p. 153). Researchers and analysts should disaggregate data by transfer pathway to address this shortcoming in the literature (Cosentino et al., 2014).

The study's four Black men are considered lateral transfers, as are several other Black engineering transfer students (Cosentino et al., 2014). Frameworks are needed to guide research studies and construct knowledge about lateral transfers. A framework specific to dual-degree engineering students would allow engineering education researchers to better understand the nuances of collegiate Black men's dual-degree experiences. Because dual-degree students have successfully transferred, they can lend insider knowledge about what supports and hinders the lateral transfer process, which

engineering specializations are more palatable for transferability, and how different transfer factors impact persistence among racially minoritized groups.

More research is needed concerning dual-degree engineering programs. Case studies should be employed to include students' perspectives given that they are on the receiving end of the dual-degree pathway (Yin, 2013). The Black men in this study had GPAs higher than 3.0; other dual-degree students with less strong GPAs might have a different story. To advance work in the field and simultaneously improve the dual-degree pathway, researchers should investigate critical points for dual-degree students, determine why students switch out of the dual-degree track before or after transitioning to the transfer-receiving institution, and pinpoint the disciplinary success factors that boost persistence. Merging the transfer-receiving framework with the case study approach could prompt researchers to examine Black male students' experiences in other contexts to extrapolate geographical, institutional, and programmatic support structures and barriers. Furthermore, the broader dual-degree research agenda should examine the experiences of racially minoritized students given efforts to revolutionize engineering departments (RED), improve persistence, and broaden participation in engineering.

8.4 | Contributions to engineering education

Researchers have studied engineering persistence among undergraduate students, but an understudied group is dual-degree students. This study expands conceptualizations of engineering persistence by adding dual-degree students and programs into the persistence equation. In particular, this study examined four Black male students' dual-degree experiences using the transfer-receiving framework (Thiry et al., 2023). In the engineering education literature, there is more transfer work with Black men who were community college students (e.g., Berhane et al., 2020; Qaqish et al., 2020) than with Black men who transfer from one 4-year university to another. Therefore, another contribution of this study is the application of this framework to the lateral transfer process.

In their systematic review of engineering persistence, Smith and Van Aken (2020) found that few studies explored engineering transfer student pathways and their subsequent success. A contribution is that this study presented cases of undergraduate Black men that are inclusive of their post-transfer success. Case studies are useful because they provide practitioners, policymakers, and researchers with real data to make evidence-based decisions (Yin, 2013). On another note, the study's finding and offering of a Black mentoring tax is a contribution to the knowledge base. In all, the current study, combined with future work, could appreciably enhance dual-degree programs, foster persistence in the major, and lead to long-term engineering success for Black men. In these ways, this study contributes new knowledge and adds to the expansive work being done in engineering education.

9 | CONCLUSION

This case study expands conceptualizations of engineering persistence by reporting on four undergraduate Black men enrolled in a dual-degree program using the transfer-receiving framework (Thiry et al., 2023). The findings, which address the research questions, center on unearthing the participants' pre-college interests, identifying collegiate support mechanisms and/or challenges with a dual-degree program, and applying the transfer-receiving framework to better understand these issues. The implications provided herein offer substantive guidance for practice, policy, and future research to support Black men in dual-degree programs. My hope is that the culture, climate, perception, and inner workings of these programs are greatly improved to truly affirm the Black male engineering talent pool and broaden the participation of racially minoritized individuals in engineering fields.

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