2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #52087

STEM Identity and Support Structures: Student Perspectives from a Scholarship Program at an HBCU

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Chaunte White

STEM Identity and Support Structures: Student Perspectives from a Scholarship Program at an HBCU

Research Brief

Students from low-income backgrounds are underrepresented in engineering and face barriers to persistence and professional success. Historically Black Colleges and Universities (HBCUs) play a critical role in addressing these disparities, but institutional support often requires proactive student engagement [1]. This study examines how the Making to Advance Knowledge, Excellence, and Recognition in STEM (MAKERS) program—a multi-institutional initiative funded by the National Science Foundation—supports academically talented students at Tuskegee University. MAKERS aims to (a) boost the retention and graduation rates of low-income science, technology, engineering, and mathematics (STEM) undergraduates; (b) prepare students for STEM careers and graduate studies through academic support, skill development, and experiential learning; and (c) research the impact of its model on recruitment, retention, and graduation. To reach these goals, MAKERS offers collaborative, co-curricular interventions that complement coursework and develop STEM knowledge, research skills, professional abilities, and applied experience. We investigate how these interventions influence students' STEM identity, sense of belonging, and persistence in engineering.

Prior research, including motivation and background

HBCUs have long played a critical role in addressing disparities by providing access, support, and community for underrepresented groups in STEM. Prior research shows that institutional support structures, such as mentoring and financial aid, can positively influence student retention and success [2], [3], [4], [5]. However, these supports often require students to engage proactively, initiating contact and seeking opportunities. MAKERS was developed in response to these challenges and is structured around three core pillars—mentoring and community, professional development, and learning with purpose—with the aim of supporting academically talented students. This study seeks to understand how these pillars influence students' STEM identity, sense of belonging, and persistence in engineering, building on evidence that intentional, structured supports can foster equity and inclusion in STEM education [6], [7], [8].

Theoretical framework

The study is grounded in STEM identity development theory and sociocultural models of persistence, which are widely used in engineering education to explain how students develop belonging, engagement, and commitment to STEM pathways [1], [5], [6], [9], [10]. Prior research demonstrates that identity formation, mentoring relationships, and access to supportive communities are central to persistence, particularly for students navigating institutional and structural barriers [2], [3], [4], [7]. However, the existing literature calls for more empirical work examining how specific programmatic structures and institutional supports shape persistence-related outcomes [3], [8].

STEM identity development theory [6] guided qualitative analysis in this study by informing deductive coding and interpretive attention on how students described competence, recognition, and belonging in engineering contexts. Consistent with prior research, identity was examined as socially constructed through interactions with faculty, peers, and institutional structures [1], [9]. Sociocultural models of persistence [5], [10] further shaped the analysis by foregrounding the interplay between individual agency and institutional conditions, particularly how students navigate access to resources and sustain engagement through community membership. These frameworks also guided the integration of qualitative and quantitative findings, enabling the interpretation of group-level differences in relation to students' lived experiences.

The study contributes to the literature by applying these complementary frameworks within a mixed-methods design to offer a mechanism-focused account of how structured supports within a scholarship program (i.e., mentoring, professional development, and purposeful learning) operate in an HBCU context to shape STEM identity, belonging, and persistence.

Methods

This study was guided by three research questions focused on program influence, comparative experiences, and persistence outcomes:

1. How do MAKERS program components shape students' STEM identity and sense of belonging?
2. What differences exist between MAKERS participants and nonparticipants in resource use and faculty interaction?
3. How do institutional supports influence persistence for low-income students?

To address these questions, the study drew on a mixed dataset collected from engineering students at Tuskegee University, including students supported by MAKERS and students who were not affiliated with the program. Qualitative data were generated through virtual focus groups designed to elicit detailed accounts of students' academic and co-curricular experiences. Quantitative data were collected through surveys assessing engagement, faculty interaction, resource use, and sense of belonging. Integrating these methods strengthened interpretation by linking students' lived experiences with broader patterns of engagement and persistence across groups. All study procedures were conducted with informed consent and received approval from Tuskegee University's Institutional Review Board (IRB #00001137, approved October 2023).

The study used coding reliability thematic analysis following Braun and Clarke [11] to explore focus group data. Data were drawn from three 60-minute virtual focus groups conducted via Microsoft Teams in April 2023, March 2024, and February 2025, involving 14 participants (seven MAKERS students and seven non-MAKERS students). All sessions were audio recorded and transcribed by REV, an independent transcription service.

Three coders analyzed transcripts using NVivo 12, applying both inductive and deductive coding strategies [12]. Coders reviewed transcripts to develop familiarity then applied

protocol-informed codes aligned with the research questions, followed by deductive coding guided by the theoretical framework. Codes were organized into categories and refined into themes. Comparative analysis was used to examine similarities and differences between MAKERS participants and nonparticipants, particularly in access to resources, professional development opportunities, and engagement with faculty and peers.

Quantitative data were collected via electronic surveys distributed to eligible students through institutional email lists and administered using the Verint® Enterprise Feedback Management™ platform. In total, 79 engineering students completed the HBCU Student STEM Success Survey, which included validated scales measuring student engagement, resource use, and sense of belonging, along with demographic items [13]. Surveys were administered during the 2023–24 and 2024–25 academic years, with reminder emails sent to increase response rates.

Survey data were imported into Stata for data cleaning, screening, and analysis. Descriptive analyses were conducted to summarize sample characteristics and distributions of key constructs. Comparative analyses were used to examine differences between MAKERS participants and nonparticipants on variables aligned with the research questions, particularly faculty interaction, resource use, and sense of belonging. Quantitative analyses provided a basis for identifying patterns and group-level differences.

Results

Survey respondents were diverse and predominantly young. Thirty-seven percent were aged 18 and nearly 70% graduated from public high schools. The gender split was almost even (49% male, 47% female, 3% nonbinary, and 1% no response), and most respondents were full-time students (90%), with 42% in their first year and 23% in their second year. Thirty-six percent had a grade point average (GPA) of 3.5 or higher; 27% were just starting college and did not yet have a GPA. Family income varied widely, with the largest group (19%) unsure of their income and the remainder spread across annual income response options ranging from less than $30,000 to over $125,000. Overall, the cohort reflected a broad range of backgrounds and experiences.

Qualitative insights

Students acknowledged academic, financial, and professional resources but emphasized the need for proactive self-advocacy, such as initiating contact, following up, and independently seeking opportunities. Relationships with faculty, mentors, and peers were consistently cited as critical for navigating opportunities and sustaining motivation. MAKERS participation fostered confidence, leadership, and belonging, reinforcing persistence.

Theme 1: MAKERS provides faculty mentorship, which supports persistence

Multiple students mentioned mentorship as a primary support. Students described mentors and professors as accessible, encouraging, and deeply invested in their success.

- "*I primarily benefited from the relationship with my mentor and his practical advice*."

- "*[Faculty mentor] was so supportive… he has definitely made a huge impact on me graduating this upcoming May*."
- "*He doesn't want us to shy away… he wants to help. I can absolutely sense that*."

Theme 2: Financial support serves as a primary enabler of persistence

Students shared that financial resources such as scholarships, stipends, and other paid opportunities were essential to their ability to persist academically and engage in professional development.

- "*A lot of these different travel opportunities [to attend conferences], they come with stipends, you know, for food, living… almost 90% of all of them have stipends*."
- "*Financially I would rate [the institution] very highly…due to the opportunities… I'm sent emails weekly about opportunities, scholarships… or internships or co-ops*."
- "*[The institution] has definitely opened a lot of doors for me financially, so I'm eternally grateful for that*."

Theme 3: Experiential research and project-based learning provide transformative professional preparation

Hands-on experiential learning opportunities (including undergraduate research, project-based STEM work, conferences, and internships) enabled students to apply technical skills, develop professional identities, and further career aspirations.

- "*Last summer I also did a [research experience for undergraduates program]… it really got me out of my comfort zone and allowed me to build relationships*."
- "*The conferences for me have been what made my [institution] experience*."

Theme 4: Access to and awareness of co-curricular opportunities supports student development

Students reported similarities and differences in their experience based on program and initiative access. Several non-MAKERS students shared how other on-campus programs offered comparable opportunities to MAKERS students, while others noted more limited access to information and resources.

- *"The career fairs have been immensely helpful in allowing us as students to tailor our skills, correspond with industry professionals, as well as other organizations on campus such as NSBE, SWE, SME, all of the engineering-focused organizations here really seem to have a goal towards ensuring that the students that they are helping go on to help students that can come after them, to be in positions to continue this process and further the development of our people*."

- "*[The MAKERS Principal Investigator] immediately reached out and put me in contact with some people to give me advice about choosing schools, about how grad school would be like*."
- "*I was able to use the experience that I've seen from others presenting and how they prepare, and it helped me a lot to be more comfortable and I felt ready and prepared to do my presentation, and I feel like I did well on it…a big part of that is thanks to the LSAMP program and going to the conference and seeing how others present*."
- *"There was really nobody that guided me… I'm just now getting into research and volunteering."*

To assess whether patterns described in students' narratives were reflected at the group level, the following section presents quantitative comparisons between MAKERS and non-MAKERS students.

Quantitative results

Quantitative analyses addressed research questions examining differences between MAKERS students ($N = 31$) and non-MAKERS students ($N = 47$) in faculty interaction, sense of belonging, and STEM identity. Likert-type survey responses were compared using Welch's *t*-tests and Mann-Whitney U tests to assess group differences, accounting for unequal variances and sample sizes.

Of the 11 constructs examined (i.e., faculty approachability, encouragement to seek help, sensitivity to academic needs, faculty recommendations, sense of belonging, departmental commitment, STEM professional identity, STEM usefulness, STEM self-efficacy, STEM confidence, and STEM aspiration), two showed statistically significant differences between groups. Non-MAKERS students reported significantly higher STEM aspiration (M = 4.49 versus M = 3.90, p = .002, d = -0.75) and greater perceived faculty encouragement to seek help (M = 4.27 versus M = 3.74, p = .033, d = -0.54), both with medium effect sizes. The remaining nine constructs showed no statistically significant differences, though small effects favoring non-MAKERS students were observed for STEM professional identity (p = .057), sensitivity to academic needs, STEM confidence, and sense of belonging. Notably, MAKERS students reported greater access to faculty for recommendations (M = 4.16 vs. M = 3.96), though this difference was not statistically significant.

These patterns are consistent with the program's intended design and target population. MAKERS specifically recruits students who may face greater academic, financial, or social barriers to STEM persistence and, without structured intervention, may struggle to develop the faculty relationships, STEM identity, and sense of belonging that nonparticipating peers may have cultivated through alternative pathways. The finding that MAKERS students reported comparable levels of belonging and faculty interaction to non-MAKERS students, despite entering with potentially greater challenges, suggests the program may be narrowing gaps that would otherwise persist.

Discussion

Findings indicate that structured supports—particularly mentoring, professional development, and purposeful learning—are central to shaping STEM identity, sense of belonging, and persistence among engineering students at Tuskegee University. Qualitative results show that while students are aware of available academic, financial, and professional resources, effective use of these supports often depends on proactive self-advocacy and access to supportive relationships with faculty, mentors, and peers. These relationships are critical for navigating opportunities, sustaining motivation, and building confidence.

Quantitative results reveal a nuanced picture. While non-MAKERS students reported greater STEM aspiration and perceived faculty encouragement, this likely reflects selection effects. Students who do not seek structured support may already possess strong STEM identity and faculty relationships, and MAKERS intentionally recruits students who face greater barriers. The absence of significant differences on most constructs suggests MAKERS may be achieving its goal of elevating participants to levels of engagement and identity comparable to peers who already had these resources in place. Notably, MAKERS students reported greater access to faculty recommendations, supporting this interpretation. Together, the findings demonstrate that structured supports reduce disparities in student experiences, highlighting the program's success in serving students who need it most.

Implications

The findings underscore the importance of intentional program design targeting students who may lack pre-existing STEM identity and faculty connections. Rather than solely comparing the success of participants and nonparticipants, programs should be evaluated on their ability to support students who face greater barriers. The mixed-methods approach illustrates the value of combining student narratives with quantitative evidence to inform mentoring structures and institutional practices that promote equitable access to STEM support.

Conclusion

This study provides evidence that structured, programmatic supports can meaningfully influence STEM identity, sense of belonging, and persistence among engineering students at Tuskegee University. By examining student experiences and comparative patterns between program participants and nonparticipants, the study identifies key mechanisms that contribute to academic success, such as intentional mentoring, coordinated professional development, and purposeful learning.

Acknowledgements

This material is based on work supported by the National Science Foundation under Grant No. 2138273. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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