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Sense of Belonging of Black Students in STEM Majors: A Mixed Methods Study

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Abstract

Using an explanatory sequential mixed methods design, we explored Black STEM students' sense of belonging as it pertained to the university and within their academic majors. Participants recruited from a large, urban university (N=89) were administered a revised Psychological Sense of School Membership (PSSM) survey. From that, participants (N=8) were purposively selected to participate in one-on-one follow-up interviews. Seven themes emerged during the qualitative phase of the study: (a) student perceptions of the university; (b) student perceptions of their STEM programs; (c) individual attributes; (d) family ties, interactions, and support; (e) faculty interaction and support; (f) peer interaction and support; and (g) student-generated recommendations.

Introduction

A sense of belonging plays a critical role in individuals' psychological well-being and motivation. When the need to belong is satisfied, individuals report higher levels of well-being, engagement, and both mental and physical health [1]. Within higher education, a large body of research has demonstrated a positive association between students' sense of belonging and academic achievement [2], engagement [3-5], self-efficacy [6,7], satisfaction with the university [4,8], persistence in college [3,9], and positive self-perceptions [10]. As students transition into college, developing a sense of belonging is a central component of academic and social integration [10]. When students are unable to establish this sense of connection early in their university experience, they may experience disengagement, psychological distress, and an increased likelihood of departure [11].

For Black students attending Predominantly White Institutions (PWIs), this process of integration is often compounded by institutional and cultural barriers [12]. Prior research has documented challenges Black students face in navigating college campuses [12]. These challenges are further intensified within Science, Technology, Engineering, And Mathematics (STEM) fields, where Black students are frequently underrepresented [13,14]. National data indicate that Black students continue to have some of the lowest six-year graduation rates among racial groups pursuing four-year degrees 40%, [15]. Given the established links between belonging and key academic outcomes, examining how Black STEM students experience and make meaning of belonging remains critical. The present study explored Black students' perceptions of belonging, with particular attention to their experiences within STEM majors and programs at a Predominantly White Institution (PWI).

Theoretical Framework

The present study was grounded in Vincent Tinto's theory of student integration and departure, which conceptualizes student persistence as a function of academic and social integration within the university environment [16,17]. Drawing on Durkheim's theory of social integration, Tinto argued that students who fail to develop meaningful connections to the institutional culture and peer networks are more likely to disengage and eventually withdraw from higher education. Central to this framework is the idea that relationships with peers, faculty, and the campus community foster commitment to the institution and degree attainment.

Building on Tinto's work, [18] advanced a theory of sense of belonging that integrates elements of [19] hierarchy of needs and emphasizes belonging as a fundamental human motive. In this framework, sense of belonging is defined as student's perceived social support, connectedness, and mattering within a given context. [18] identified belonging as particularly impactful for students from historically marginalized groups and noted that belonging is dynamic, context-dependent, and continually shaped by social interactions and institutional conditions.

Sense of Belonging in Higher Education

Research has demonstrated that sense of belonging is closely tied to academic, psychological, and social outcomes in higher education. Students with stronger belonging report higher levels of engagement, self-efficacy, satisfaction, and persistence, as well as lower levels of anxiety and depression [3,7,20-23]. More importantly, belonging is fostered not simply through social contact, but through frequent, positive, and affirming interactions [20,24]. In contrast, environments characterized by exclusion, marginalization, or negative interpersonal experiences may undermine students' sense of belonging and well-being [25,26]. Research has also shown that early development of a sense of belonging to the university is particularly important for student adjustment. [10] found that students who reported stronger university belonging early in their academic careers experienced greater academic confidence, social acceptance, and emotional well-being. These findings emphasize the importance of examining how institutional contexts and relationships shape students' belonging.



Black Students in STEM

For Black students attending PWIs, developing a sense of belonging can be especially challenging, particularly within STEM fields where they are often vastly underrepresented. Prior research has documented that Black STEM students frequently experience academic and social isolation, which may contribute to attrition from both STEM majors and higher education more broadly [27,28]. Qualitative and mixed-methods studies have highlighted the central role of peer support and structured programs in fostering belonging and success among Black STEM students. Palmer et al. [29] found that positive peer relationships, study groups, and shared academic goals were critical to students' academic persistence and emotional support in rigorous STEM programs. Similarly, Maton et al. [12] examined the Meyerhoff Scholars Program and found that intentional academic and social integration - through summer bridge programs and cohort-based collaboration - enhanced students' sense of belonging and academic achievement.

More recently, Hansen and colleagues [30] reported that participation in a curricular and co-curricular program designed to provide community, mentorship, and financial support significantly predicted greater STEM degree persistence among Black and Brown students. Importantly, they also found that a sense of STEM-specific belonging more strongly predicted degree persistence among program participants, suggesting that targeted, structured STEM programs may be especially impactful for Black students. Collectively, these studies suggest that belonging among Black STEM students is closely tied to access to supportive peer networks, opportunities for meaningful engagement, and institutional efforts to counter isolation. However, much of the existing literature has focused on programmatic interventions or outcome measures, with less attention to students' own interpretations of belonging and exclusion within everyday university contexts.

Current Study

The current study builds on existing theoretical and empirical work by examining Black STEM students' perceptions of belonging at a PWI, with particular attention to the relational factors that enhance or hinder belonging. By centering students' narratives and integrating qualitative interview findings with quantitative belonging scale scores, this study seeks to address gaps in the literature related to how belonging is experienced, negotiated, and understood by Black students within STEM environments. The following research questions guided this work:

- How do Black students describe their perceptions of belonging at the university and in their STEM programs?
- In what ways do Black students believe their sense of belonging has been enhanced or hindered while at the university and in their program?

- How do the experiences of Black STEM students support or contradict the results of students' perceived sense of belonging scale scores?

This study employed a participant-selection variant of an explanatory sequential mixed-methods design. In this design, quantitative data are collected and analyzed first, followed by a qualitative phase that is informed by the quantitative results [31,32]. The purpose of the first quantitative phase was to gauge students' belonging beliefs. Quantitative findings from the initial phase were used to identify and select participants for follow-up interviews, allowing for a more in-depth examination of students' perceptions of belonging at the university and within their STEM majors.

Data collection occurred during a period of heightened national attention to issues of racism, discrimination, and lack of representation in higher education, as students across the nation engaged in protests addressing campus climate. While these events may have influenced students' perspectives and belonging-related concerns, they also reflect broader institutional issues shaping the student experience. Rather than disqualifying participants' accounts, these events provide important context for understanding their experiences.

Quantitative Methods

Quantitative sample

Participants were drawn from a large, urban university (LUU; pseudonym) in the Mid-Atlantic United States. To be eligible for the study, students had to meet each of the following criteria: (a) declaration of an academic major in a STEM related field; (b) enrollment in the university as a full-time student; (c) between the age of 18 and 24; and (d) identification as Black or African-American. Students in their first-year, first semester were excluded from the study because of the time that is generally needed to form a sense of their experiences in the university [5]. Of the participants in the quantitative phase (N=89), ages ranged from 18-23, 64 (72%) identified as female, 23 (26%) identified as male, and 2 (2%) did not provide gender information. Participants belonged to 17 different majors: Biochemistry (2%), Bioinformatics (1%), Biology (40%), Biomedical Engineering (3%), Chemical Engineering (3%), Clinical Lab Sciences (2%), Computer Science (3%), Environmental Science (2%), Forensic Science Health (10%), Physical education and Exercise science (HPEX; 9%), Information Systems (2%), Interdisciplinary Science (1%), Mathematics (6%), Mechanical Engineering (7%), Physics (1%), and Science (2%). Approximately 32% indicated that they were freshmen in their second-semester, and others identified as sophomores (21%), juniors (25%), or seniors (23%). Approximately 31% (n=28) of the participants in the quantitative phase were involved or previously involved in either a living learning community or summer bridge program (see Table 1 for program descriptions). All programs were cohort-based.

Table 1: Program Descriptions.

Program Name	Components	Target Students	University Specific/Nation Wide	Program Goal
Advancement	Summer session Living learning community	Freshman interested in pre-health concentrations	University specific	Provide exposure to health professions
Edge	Living learning community	Students focused on professional leadership	University specific	Prepare students who can successfully lead professional organizations
LSAMP	Summer-bridge	Underrepresented groups in STEM	National program (held at several universities)	Increase the success and quantity of underrepresented students who successfully completing STEM degree programs, and to increase the number of students qualified for and matriculating into STEM graduate programs
Orb	Living learning community	Students interested in globalization	University specific	Expand knowledge and impact of globalization and enhance leadership skills in global education
Pre-College Program	Summer-bridge	Underrepresented groups in STEM	National program (all students can apply)	Provides students from underrepresented backgrounds with the foundation of engineering through problem solving
Strive	Living learning community	Students interested in community engagement	University specific	Enrich students' understanding of how to create positive change in communities

Note: Each program was assigned a pseudonym to maintain confidentiality.



Quantitative data collection and analysis

For the quantitative phase of the study, participants completed a demographic questionnaire and a scale measuring their sense of belonging. Students were provided with approximately 25 minutes to complete the survey, and all participants finished within the allotted time.

Demographic Questionnaire

Students provided demographic and academic information, including their age, gender, ethnicity, academic standing, academic major, and participation in a living-learning community or summer bridge program they participated in. Participants were also asked to indicate their willingness to participate in a follow-up interview.

Sense of Belonging

To measure students' sense of belonging, we modified the Psychological Sense of School Membership Scale (PSSM; [33,34] initially created the PSSM to measure school membership perceptions and belonging of middle school aged children. Zumbrunn et al. [7] later modified the scale to target college-aged students ($\alpha=0.90$). Although the adapted scale that was used for the current study is aligned to the same population, Zumbrunn and her colleagues [7] were specifically interested in measuring belonging at the classroom level. All items used in Zumbrunn et al. [7] were used for the current study; however, wording was adapted to focus on a more general sense of belonging to the university and major, instead of the classroom. Participants rated 15 items on a 5-point Likert-type scale ranging from "Not at all true" to "Extremely true." Scores for students' sense of belonging were created by taking the mean of all items.

Quantitative Results

Participants' quantitative sense of belonging scores were used to select participants for the qualitative phase. Following the procedures outlined by [7], students were categorized into low- and high-belonging groups based on the mean ($M=3.59$) and standard deviation ($SD=0.54$) of their PSSM scores. Students whose scores were one standard deviation below the mean or lower (≤ 3.05) were classified as low-belonging ($n=18$), whereas students whose scores were one standard deviation above the mean or higher (≥ 4.13) were classified as high-belonging ($n=11$).

Qualitative Methods

Qualitative Sample

In total, 29 students were identified for membership in the low- and high-belonging groups. Of these students, 16 provided contact information and indicated willingness to participate in the qualitative phase. All 16 eligible participants were contacted, and eight agreed to participate in follow-up interviews. Table 2 provides descriptive information and quantitative belonging mean scale scores for each participant in the qualitative phase. Among these participants, three (37%) were biology majors, with the remaining five representing five different STEM disciplines. The qualitative sample included one male participant and seven female participants. Four participants were second-semester freshmen, two were juniors, one was a sophomore, and one was a senior. Half of the participants had participated or were currently participating in a living learning community or summer bridge cohort-based program.

Qualitative data collection and analysis

Qualitative data were collected via semi-structured interviews focused on students' perceptions of belonging and their experiences at the university and in their STEM programs. Interviews were conducted individually, lasted approximately 60 minutes, and participants selected pseudonyms for themselves to ensure confidentiality. All interviews were tape-recorded and transcribed verbatim. Prior to analyzing the qualitative data, we emailed each participant a copy of their transcripts for member checking. Participants were informed that they could add, change, or remove any portion of their dialogue they saw fit.

Table 2: Qualitative Participants.

Pseudonym (belonging group)	PSSM Score	Gender	Major	Academic Standing	Cohort
Kristina (low)	2.4	Female	Clinical lab sciences	Second-semester freshman	Yes
Kierra (low)	2.65	Female	Biomedical engineering	Second-semester freshman	Yes
Bre (low)	2.7	Female	Exercise science	Junior	No
Selena (low)	3	Female	Biology	Junior	No
Mary (high)	4.15	Female	Forensic science	Senior	No
Jason (high)	4.15	Male	Biochemistry	Second-semester freshman	No
Star (high)	4.3	Female	Biology	Sophomore	Yes
Brenda (high)	4.45	Female	Biology	Second-semester freshman	Yes

Note: Participant names are represented using pseudonyms; PSSM=Psychological Sense of School Membership; PSSM Scores could range from 1-5.

To explore students' belonging experiences at the university, data analysis was an iterative process using structural [35] and hypothesis [36] coding, whereby interviews were coded using both data- and theory-driven approaches. Interviews were first organized into segments of text, and then coded by labeling and categorizing individual phrases or sentences. Using constant comparative analysis [31], we explored connections, contrasts, and comparisons between codes to help ensure that codes covered all data and were mutually exclusive. Codes were then grouped into categories and subcategories to meaningfully organize the data [37]. As a final step, side-by-side comparison [31] was used to organize data from both the quantitative and qualitative phases and show how responses from student interviews explain, confirm, or disconfirm their PSSM scale scores.

Qualitative Findings

We first examined alignment between the quantitative and qualitative data. Table 3 presents each participant's PSSM scale score aligned with an exemplar quote of what was expressed by each of the student's perceptions of belonging. Some qualitative findings converged with students' PSSM scores, whereas others diverged from or complicated the quantitative results. The qualitative analysis yielded seven themes: (1) student perceptions of the university, (2) student perceptions of their STEM programs, (3) individual attributes, (4) family ties, interactions, and support, (5) faculty interaction and support, (6) peer interaction and support, and (7) student-generated recommendations **Table 3 (cont.)**.

Table 3: Comparison of Data from PSSM Survey and Student Interviews.

Participant (belonging Group)	PSSM Score	Exemplar Quotes
Kristina (low)	2.4	"I would say [my belonging is] in between because it wasn't good or bad but I feel like I would want it to be a lot better especially for incoming Black students. If I could get on an [executive] board of one of the [student organizations], I would try to have a lot more of a presence at [LUU] to help other Black students feel welcomed."
Kierra (low)	2.65	"I think [LUU puts forth] a lot of effort to try to ensure the students are comfortable. I think [LUU is] pretty contradictory, because despite it being very diverse in the student population, it's not diverse in the actual faculty."
Bre (low)	2.7	"I really do enjoy [LUU]. [LUU], just like every other predominantly white institution-don't get me wrong but-I feel safer here."
Selena (low)	3	"So far at [LUU] it's been really good actually, as a Black student, because we have a strong 'wokeness'-we're a very liberal school so I've never really stayed around people that made me feel uncomfortable for my race ... it was easy for me to find people who celebrated Blackness and celebrated who they were, and different cultures and POCness. ... I enjoy the diversity that we have on our campus and it does make me feel very comfortable to go here rather than go to like [other state university] or like [other state university] or something like that."
Jason (high)	4.15	"I think I have had an overall good experience when it comes down to just my race. But I mean, I have felt a little disconnected, but not because I'm Black, but maybe because I am a guy, or maybe because of how I look, like, maybe like my physical attributes."
Mary (high)	4.15	"I pretty much enjoy the diversity and the different backgrounds that I saw here on campus. It made me happy to be here. ... With [LUU] branding diversity and with it still being segregated, it's hard to [bring everyone together for homecoming]. We tried our best and if we saw a good mixture [of ethnicities] at an event it made us even happier because we all know we put forth the effort to make that happen."
Star (high)	4.3	"I came [to LUU] because I knew it was very diverse so I knew I wouldn't feel left out."
Brenda (high)	4.45	"When I first got [to LUU], I was actually shocked that [there were] as many white people as there are. I know that sounds bad, but I was shocked because I didn't think-I thought that, I mean I guess-when I first got here I was expecting a huge, like a massive amount of diversity and then I got more used to [LUU] and there actually is a lot of diversity here."

Note: Participant names are represented using pseudonyms; PSSM = Psychological Sense of School Membership Scale.

Student Perceptions of the University

Participants described aspects of the university they appreciated, challenges they experienced, and areas for improvement. Students highlighted programming and organizations for Black students as sources of support. Mary mentioned the meaningfulness of the special graduation LUU held for Black students, "I believe this year was the first year that they had a [separate] graduation for Black students and I was happy to hear that." Bre commented on the role student organizations played in her belonging experiences on campus, "I just feel like they really do cater to us and I feel like they do everything they can to make sure we feel like this is our community." Some students identified diversity across the university as a strength. Star shared, "I came here because I knew it was very diverse so I knew I wouldn't feel left out." However, others noted limited diversity among faculty and student organizations representing Black students as areas for improvement. For example, Kierra noted, "Despite it being very diverse in the student population, it's not diverse in the actual faculty." Related, several students noted disappointment in the recognition of racial issues. Bre described the situation as "cosmetic diversity," while Kristina added, "My experiences as a Black student...from day one...was kind of disappointing to not see that representation or unity." Brenda shared, "When I first got here I was actually shocked that there were as many white people as there are ... I guess I was expecting a massive amount of diversity."

Student Perceptions of their STEM Programs

Students' perceptions of belonging in their STEM programs was a prominent topic of discussion during the interviews. All students expressed that their experiences in STEM were unlike the experiences that they had university-wide. When asked how they would describe their belonging in STEM, many participants indicated that this differed from their broader sense of belonging at the university. Several responded with comments such as, "That's a little different." Surprisingly, students who were in programs and communities that were created to increase students' sense of community and prepare them for the STEM field did not perceive the STEM field as positively as those who had not been in cohort programs. Star, the student with the highest quantitative belonging score, admitted, "there aren't many Black students in STEM," as the reason underlying her lower sense of belonging within her major. Participants also noted their desire to have additional faculty that were Black, noting "everybody should have professors that [are] relatable or looks like them, of some regard." Mary, who was a graduating senior, noted that since joining the university, she had not yet had "any Black professors in any of [her] core curriculum, like science classes or forensic science classes."

Individual Attributes

Students identified personal traits, future outlook, and upbringing as influencing their experiences. High-belonging students often attributed persistence and positive engagement to these characteristics. For example, Brenda noted that the feelings of exclusion were a "personal thing," referring to her own agency of excluding herself from certain groups. Others attributed some of their positive experiences to their own. Mary stated: It probably all came from me being who I am and coming from the background that I come from and just always seeing the bright side of things and always appreciating diversity... I came in with an open mind no matter what. Mary's sentiments seemed to allude to the reasons why she was able to remain at the university and in her major, while many of her other friends either changed their major or went to or wished they had gone to a Historically Black College or University (HBCU).

Students in the low-belonging group cited personal attributes, such as shyness or self-exclusion, and not surprisingly, shared less positive experiences. When discussing peer relationships with Selena, she expressed that over the three years that she had been attending the university that she was unable to find a close group of friends to study with. When probed about the reasons for this, she identified herself as the potential problem saying, "[it] may be a personal issue... it may just be me being me, being too shy to step out, or too shy to be like, 'hey guys, let's all study together,' or feeling a weird barrier of closeness."

Family Ties, Interactions, and Support

Participants' discussions of their families varied across the high- and low-belonging groups. A few talked about their family backgrounds, while others discussed the support they have received from family members. Some students who spoke of parental support discussed the importance of their involvement to their success and belonging, and many of these students belonged to the high-belonging group. Kierra was the only member of the low-belonging group to discuss her family in the interview, but noted that the support she received was somewhat limited because her "parents didn't complete or didn't attend college." On the other hand, three of the four students in the high-belonging group shared about the positive role their families played in their college experience and belonging. Despite being busy completing her degree, Mary shared, "My parents... I'm not really good with communication... I get so busy with school... but I knew through it all they were always there for me, if I needed." Brenda's experiences with her family were more mixed. She explained:



I think my family is really supportive, as supportive as they can be because no one in my immediate family on my moms' side has gone to college. And then my dad, they [went to college], but they didn't [study] biology so they don't understand. They know it's hard—that's why they didn't [study] it, but that's it. That's why they're always like 'you got it, you can do it!' That's so annoying to hear, because what if I can't. I feel like they have this high expectation like, 'we know you can do it,' [and] I'm like 'I'm trying!' She admitted that she felt like her friends with parents who attended and graduated from college with STEM degrees might have a different experience. Students who were part of summer bridge or living learning cohort communities were less likely to discuss their families in a positive manner as compared to their peers not in those programs. Three of the four students in the cohort group discussed the ways that their family influenced and/or supported them; however only Star reported positive experiences. When discussing the support she received from her family, Star shared, "They're really good. They really support me and being out of state, I pay a lot more, but my family - they, they literally take out a million loans just to make sure I can come here [and] get my education." Although only half of the students in the non-cohort community group discussed family support during the interview, those who did all shared positive experiences and felt supported by their families.

Faculty Interaction and Support

All participants, across groups, at some point in their interviews, talked about their interactions with faculty and staff members across the university and within their majors, and most interactions referenced seemed to be positive experiences. Students in the high-belonging group consistently talked about the need to get to know their professors outside of the classroom, and were more likely to have more frequent interactions with faculty than the low-belonging group. Indeed, many students in the low-belonging group described viewing professors primarily as instructors and saw little reason to interact with them outside of class.

When discussing their interactions with faculty, many participants commented about their relationships with their advisors. Most students in the high-belonging group seemed to have positive advising experiences. For example, Star noted that her advisor was helpful not only in selecting courses, but also in guiding her toward opportunities aligned with her career aspirations. However, some students across both belonging groups shared mixed perceptions of their advisors. Bre shared that she thought the faculty cared about her a lot, especially her advisor who had worked diligently to ensure that she graduated on time. She also explained that her general advisor was not as supportive as her academic advisor within her major. Bre was a transfer student, and discussed how she was surprised to be so supported at a predominantly White institution due to her past negative experiences with advising at a different institution.

Not all participants had positive experiences with advising, however. Selena talked about having "trouble for a while with advising and there were some semesters that [she] didn't even have an advisor so [she] didn't even know what [she] was doing for a while." Mary shared similar thoughts, expressing her frustration with the fluctuation of advising through the years, "being tossed around, it made things not inconsistent but kind of like wonky ... because I didn't have that direct contact person."

Although students seemed to have differing opinions about their advising situations, most were able to identify a professor, staff member, or teaching assistant whom they were able to connect and have a positive experience with. For two of the four participants in cohort communities, faculty and staff within their cohort programs were especially meaningful, and students attributed their feelings of inclusion and belonging to these relationships. For example, Brenda talked about her experience with a program at the university, where on occasion the staff that ran the program allowed students to express frustrations they may have felt throughout the semester, including personal issues. She also discussed how her mentors made her feel "more comfortable" and better at LUU. Specifically, Brenda named a professor and a teaching assistant in the program whom she felt were two of her biggest supporters during her time at the university. She mentioned their relatability and their ability to understand her issues as a Black woman in STEM. Star also discussed her relationship with her success coach in a different living learning community at the university. Similar to Brenda, Star noted that her success coach was very influential and helpful when it came to ensuring she was successful in her academics.

Peer Interaction and Support

In addition to faculty and staff, participants also discussed the important role their peers played in their belonging and success at the university. In fact, peer interactions and support was the most prominent theme across all participant interviews. Discussions about peer-group interactions centered on both academic and social dimensions, including the presence or absence of academic support and the positive and negative social experiences students had with peers in their majors and across the university. Overall, students across the groups appeared to have positive relationships with their peers both university-wide and major-specific.

All students in the high-belonging group discussed the support that they received from their peers in regards to their academics. Jason noted that he has "a lot of friends who [he] likes to study with" and has "found that the people that [he] stud [ies] with have become ... closer friends." Star attributed many of her positive peer relationships to her involvement with several student organizations. She said, "Some people in the [program] that I'm in, I met them and I found out they're part of my major and we take some of the same classes, and so now we form study groups and we go out and do different things."

Kristina shared that she made most of her friends, and eventually her study group, through her living learning community. She explained that many of her friends were "minority pre-health ... doing similar things," which she believed contributed to a stronger sense of belonging through her involvement in the program. The majority of the low-belonging group reported similar positive experiences. The one exception, Selena, struggled to find community within her major; however, her experiences did not appear to be completely negative. Selena attributed the lack of a close group of friends and a lack of a study group to not having many students in her major that "looked like [her]." Bre shared that despite the lack of Black students in her major, she has been able to make close relationships with peers across the university. She explained that her group is "diverse ... which makes [her] feel a little better because... [she doesn't] feel like another little Black girl walking around campus." A few students spoke about their experiences with discrimination and racially charged remarks, though they emphasized that these incidents were infrequent and not representative of their broader university experience.

Student-Generated Recommendations

Throughout the interviews, students offered recommendations for how the university could better support Black STEM students' sense of belonging. We believe these recommendations provide insight into the factors students viewed as shaping, enhancing, or hindering or enhancing their perceived belonging. Five of the students provided recommendations related to their concern with the lack of Black faculty at the University. Selena stated that additional Black faculty "would help ... Black students feel more comfortable." Brenda believed that increasing the number of Black faculty could "make things easier if [faculty] under[stood]" and might help Black students "feel more comfortable." Another student recommended that there should be "more celebration of [Black] culture" at the university.

Student recommendations also pointed to a need for additional organizations that are inclusive of STEM students and focused on providing academic support, assistance, and a stronger sense of camaraderie among students. Mary suggested: "An organization that combined any Black student that's a STEM major from the beginning [could] build more of a strong foundation and more of community with Black STEM majors. And [the university wouldn't] get the dropout or the people who kind of like, switch their majors over to something else ... because if you have someone going through the same thing with you, you also have that extra push, you have this brother over here, this sister over here. When you feel like you're gonna give up, you won't because you have that sense of community to back you up."

Discussion

The purpose of this study was to understand Black STEM students' perceptions and experiences of belonging at the university and within their STEM programs. Specifically, we explored how Black students described their sense of belonging, as well as the factors they perceived as enhancing or hindering their belonging beliefs. Many



participants discussed encounters ranging from appreciation of cultural diversity to experiences of discrimination, highlighting the complex ways that social interactions shape belonging. Findings from this work provide insights that extend prior research by centering Black students' experiences.

The consensus among all interviewees was that their experiences in STEM programs were less positive than their experiences university-wide. Unexpectedly, this pattern was especially pronounced among students in cohort communities, who perceived the STEM field less positively than students who were not in such programs. These findings were particularly interesting, as we presumed that participation in smaller programs would feel more inclusive and welcoming to students. However, and similar to [38], lack of diversity across both peers and faculty in their programs seemed to contribute a great deal to students' low-belonging experiences in their STEM programs. The supportive cohort community programs may have increased students' expectations for inclusion, belonging, and equity in STEM contexts. Others have found that culturally relevant and responsive college environments and counterspaces can foster belonging for Students of Color, as well as help them identify and navigate institutional exclusion [39]. Cohort programs may have functioned as affirming spaces for students, making the contrast between their experiences in these programs and their experiences in broader STEM environments more visible [40]. These findings illuminate important aspects of students' experiences that contribute to their belonging beliefs within racialized STEM contexts.

While not all students discussed their individual attributes in relation to their sense of belonging, many who did noted that particular aspects of their personalities contributed to their coping more effectively and enhanced their overall sense of belonging. These findings were largely consistent across students in both the high- and low-belonging groups. Students in both groups were more likely to attribute their individual characteristics as influences that shaped how they respond to situations at the University and in their STEM majors. Individual attributes, such as a tendency to focus on the positive or to identify as shy, can shape students' sense of belonging and interactions within the university [41]. Speaking positively of oneself may signal a greater sense of belonging for students [42].

Family background and support emerged as an important factor in many students' belonging beliefs and experiences. Students involved in summer bridge or living learning community cohorts discussed their families about as often as those not engaged in community cohorts. However, half of the students participating in cohort communities reported lower levels of support from their family members than those not in a community cohort, and these experiences were often tied to their families' limited understanding of college life [24,43]. We found that students in the low-belonging group seldom spoke of their parents. This is an important finding and could possibly signal a potential significant factor related to student belonging beliefs. Aligned with [17], family background and support can be a significant mediator between students' belonging beliefs and their goal and institutional commitment. Although existing research has focused extensively on peer and faculty interactions, parental interactions are less frequently included in analyses [5,44]. Our findings extend the research conducted by [45], who found that students with high levels of parental attachment demonstrated stronger functioning in the university than those with lower or differing levels of attachment. Future research should more closely examine how interactions with family members influence students' academic decisions and overall success.

Faculty interactions were also identified in the social system of [17] model of institutional departure. In this study, students were asked to describe their interactions with faculty and staff as they related to their sense of belonging. Most students spoke positively about advisors, professors, and other staff within the university, and several students attributed their academic success to these close relationships. Many students expressed a desire to develop relationships with faculty members, but reported difficulty doing so. Some participants also reported frustrating or disappointing faculty interactions, particularly with their advisors. Half of the students who belonged to cohort communities discussed forming meaningful relationships with cohort faculty members; we expected more students in the cohort communities to report similarly positive experiences, but this was not the case. These findings were unexpected, given that many living learning communities and summer enhancement programs are designed to facilitate relationship-building between students and faculty within their fields [46,47]. One possible explanation is that students who had not formed meaningful relationships with faculty may not have been enrolled at the university long enough to recognize the importance of such connections or to feel comfortable initiating them. Overall, our findings underscore the central role of faculty interactions in students' experiences of belonging.

Peer interactions emerged as the most prominent aspect of students' experiences discussed by participants in the current study. Consistent with [17] model, peer and group interactions were central to students' social integration and goal commitment, as well as to the development of their self-efficacy beliefs [48]. Regardless of their level of belonging, students described both academic and social peer support aligning with prior research that identifies peers as critical sources of belonging [5,7]. These interactions appeared to shape students' sense of belonging, sense of community, academic experiences, and desire to remain at the university.

Although some students reported having few peers within their STEM fields, there were minimal differences in how peer interactions were discussed across low- and high-belonging or cohort and non-cohort groups. Overall, the majority of students spoke positively of their peer networks and reported generally feeling supported by their friends. All students who belonged to cohort communities shared very positive experiences and perceptions regarding their peers. The majority of students not participating in such communities felt similarly, with one exception. One student who did not belong to a cohort community explained that her lack of support stemmed from those peers specifically within her major; it may have been beneficial for her to participate in a cohort program that could expose her to individuals with possible shared interests, backgrounds, and goals.

This study extends existing literature by centering Black students' peer interactions. Without prompting, many participants described interactions that ranged from cultural appreciation to explicit discrimination. Nearly all students recalled specific instances of racial profiling, discrimination based on race or gender, feelings of exclusion, and the ways these experiences strongly shaped their perceptions of the university and academic major. Though others have found peer interactions to be a significant predictor of belonging and academic achievement [7,18,49], our findings suggest that peer interactions across racial groups may be particularly influential in Black students' sense of belonging. It should be noted that data collection occurred during a period of prominent anti-racism activism both locally and nationally, including Black student activism on campus, and protests related to police violence, Confederate symbols, and public monuments. This historical context may have shaped how participants made sense of their belonging, perhaps heightening their attention to institutional inequities or, conversely, increasing their sense of possibility for change within the university and their STEM programs.

To gain further insight into students' perceptions of the university and their major, participants were asked to offer recommendations for how the institution could better support Black STEM students' sense of belonging. One common recommendation was to increase the presence of Black faculty across the university, particularly within STEM departments. Several students noted that although Black faculty were present in other disciplines, they were largely absent from STEM fields. This recommendation aligns with prior research emphasizing the importance of faculty interactions for student success [5], as students expressed a desire for faculty who "look like me" or who could more readily relate to their experiences. Additional recommendations included mandatory diversity and sensitivity training for faculty and staff, as well as more structured networking and programming opportunities for Black STEM students.

These recommendations were grounded in participants' personal experiences and reflected their perspectives on what would most effectively support Black STEM students' belonging. For example, students highlighted the importance of cultural awareness in fostering a more inclusive campus climate and emphasized the importance of networking and peer engagement as important sources of belonging. Collectively, these findings extend the existing literature by centering student recommendations, an area that has received limited attention in prior research. As primary stakeholders within the university system, students offer critical insights into the institutional practices and conditions that shape their experiences. Their recommendations underscore the value of incorporating student perspectives into efforts to advance equity, inclusion, and belonging in higher education, particularly within STEM fields.

Implications for Research and Practice

These findings offer actionable insights for universities seeking to support Black students' persistence and success in STEM. Across interviews, participants emphasized that belonging was not peripheral to their academic experience; rather, it was central to their engagement, persistence, and sense of possibility within STEM fields. As one



participant asked, “Will [the university] actually take this and [use this] as factors or recommendations [for] consideration [for change]?” This question emphasizes the importance of not only gathering student perspectives, but also using them to inform institutional change.

For university administrators, policy makers, and program planners, these findings highlight the need to center student voices in the design, implementation, and evaluation of support initiatives. Participants identified several practices that could strengthen Black STEM students’ belonging, including increased networking opportunities, peer mentoring, culturally affirming spaces, and academic and social support that begins at the point of application and continues through graduation. Rather than treating belonging as an individual student responsibility, institutions should intentionally structure programs, policies, and campus climates to foster connection, community, and support across students’ academic pathways.

Although financial barriers and academic preparation gaps are often emphasized as primary contributors to attrition, the present findings suggest that belonging is also a critical and sometimes overlooked factor contributing to student persistence and achievement [50,51]. Universities therefore have a responsibility to invest in sustained, systemic supports that address not only students’ academic needs, but also their need to feel seen, valued, and connected within their programs and institutions.

Future research should continue to examine how social and institutional support systems contribute to Black STEM students’ sense of belonging and persistence in higher education. Additional research is also needed to explore how belonging is experienced across intersecting identities, including gender identity, first-generation status, disability, sexual orientation, and other marginalized social positions. Such work can inform more nuanced and responsive approaches to supporting students whose experiences may be shaped by multiple forms of exclusion or marginalization. Taken together, these findings position belonging as both a psychological experience and an institutional responsibility. Attending to student belonging as a strategic component of equity and student success can help universities create STEM environments where Black students can persist, thrive, and envision themselves as full members of their academic and professional communities.

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References

- Dost G, Mazzoli Smith L (2023) Understanding higher education students’ sense of belonging: A qualitative meta-ethnographic analysis. *Journal of Further and Higher Education* 47(6): 822-849.
- Womble CC (2018) Investigating black male intersectionality: Counternarratives of high-achieving black male engineering undergraduates at a predominantly white institution.
- Gopalan M, Brady ST (2020) College students’ sense of belonging: A national perspective. *Educational Researcher* 49(2):134-137.
- Strayhorn TL (2008) The role of supportive relationships in facilitating African American males’ success in college. *Naspa Journal* 45(1): 26-48.
- Strayhorn T (2015) Factors influencing Black males’ preparation for college and success in STEM majors: A mixed methods study. *The Western Journal of Black Studies* 39(1): 45-63.
- Yi S, Zhang Y, Lu Y, Shadiev R (2024) Sense of belonging, academic self-efficacy and hardiness: Their impacts on student engagement in distance learning courses. *British Journal of Educational Technology* 55(4): 1703-1727.
- Zumbrunn S, McKim C, Buhs E, Hawley LR (2014) Support, belonging, motivation, and engagement in the college classroom: A mixed method study. *Instructional Science* 42(5): 661-684.
- Tian J, Zhang M, Zhou H, Wu J (2021) College satisfaction, sense of achievement, student happiness and sense of belonging of freshmen in Chinese private colleges: Mediation effect of emotion regulation. *International Journal of Environmental Research and Public Health* 18(22): 11736.
- Hausmann LRM, Schofield JW, Woods RL (2007) Sense of belonging as a predictor of intentions to persist among African American and White first-year college students. *Research in Higher Education* 48(7): 803-839.
- Pittman LD, Richmond A (2008) University belonging, friendship quality, and psychological adjustment during the transition to college. *The Journal of Experimental Education* 76(4): 343-362.
- Pedler ML, Willis R, Nieuwoudt JE (2022) A sense of belonging at university: Student retention, motivation and enjoyment. *Journal of Further and Higher Education* 46(3): 397-408.
- Maton KI, Hrabowski III FA, Schmitt CL (2000) African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching* 37(7): 629-654.
- Fry R, Kennedy B, Funk C (2021) STEM jobs see uneven progress in increasing gender, racial and ethnic diversity. *Pew Research Center*, pp. 1-28.
- Kena G, Hussar W, McFarland J, de Brey C, Musu-Gillette L, et al. (2016) The condition of education 2016 (NCES 2016-144). U.S. Department of Education, National Center for Education Statistics.
- Irwin V, Zhang J, Wang X, Hein S, Wang K, et al. (2021) Report on the condition of education 2021 (NCES 2021-144). US Department of Education. Washington DC: National Center for Education Statistics.
- Tinto V (1975) Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research* 45(1): 89-125.
- Tinto V (1993) Leaving college: Rethinking the causes and cures of student attrition. The University of Chicago Press, USA.
- Strayhorn TL (2012) Satisfaction and retention among African American men at two-year community colleges. *Community College Journal of Research and Practice* 36(5): 358-375.
- Maslow AH (1954) Motivation and personality. Harper and Row, pp. 1-394.
- Allen KA, Kern ML, Rozek CS, McInerney D, Slavich GM (2021) Belonging: A review of conceptual issues, an integrative framework, and directions for future research. *Australian Journal of Psychology* 73(1): 87-102.
- Faircloth BS, Hamm JV (2005) Sense of belonging among high school students representing 4 ethnic groups. *Journal of Youth and Adolescence* 34(4): 293-309.
- Hoffman M, Richmond J, Morrow J, Salomone K (2002) Investigating sense of belonging in first-year college students. *Journal of College Student Retention: Research, Theory & Practice* 4(3): 227-256.
- Stebbleton MJ, Soria KM, Huesman Jr RL (2014) First-generation students’ sense of belonging, mental health and use of counseling services at public research universities. *Journal of College Counseling* 17(1): 6-20.
- Baumeister RF, Leary MR (1995) The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin* 117(3): 497-529.
- Gray DL, Hope EC, Matthews JS (2018) Black and belonging at school: A case for interpersonal, instructional, and institutional opportunity structures. *Educational Psychologist* 53(2): 97-113.
- Strayhorn TL (2018) College students’ sense of belonging: A key to educational success. (2nd edn.) Routledge Publishers, UK, pp. 1-160.
- Dortch D, Patel C (2017) Black undergraduate women and their sense of belonging in STEM at predominantly White institutions. *NASPA Journal About Women in Higher Education* 10(2): 202-215.
- Seymour E, Hewitt NM (1997) Talking about leaving. Volume 34, Westview Press, USA.
- Palmer RT, Maramba DC, Dancy II TE (2011) A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *Journal of Negro Education* 80(4): 491-504.
- Hansen MJ, Palakal MJ, White LJ (2024) The importance of STEM sense of belonging and academic hope in enhancing persistence for low-income, underrepresented STEM students. *Journal for STEM Education Research* 7(2): 155-180.
- Corbin J, Strauss A (2008) Basics of qualitative research. SAGE Publications Inc.
- Creswell JW, Plano Clark VL (2018) Designing and conducting mixed methods research.



32. Ivankoa NK, Creswell JW, Stick SL (2006) Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods* 18(1): 3-20.
33. Goodenow C (1993a) Classroom belonging among early adolescent students: Relationship to motivation and achievement. *The Journal of Early Adolescence* 13(1): 21-43.
34. Goodenow C (1993b) The psychological sense of school membership among adolescents: Scale development and educational correlates. *Psychology in the Schools* 30: 79-90.
35. Saldaña JM (2013) *The coding manual for qualitative researchers* (2nd edn.), Sage Publications, USA.
36. Bernard HR (2011) *Research methods in anthropology: Qualitative and quantitative approaches*. (5th edn.), Altamira Press, USA, pp. 1-821.
37. Patton MQ (2002) *Qualitative research and evaluation methods*. (4th edn.), Sage Publications, USA.
38. Killpack TL, Melón LC (2017) Toward inclusive STEM classrooms: What personal role do faculty play? *CBE Life Sciences Education* 15(3).
39. Museus SD, Yi V, Saelua N (2018) How culturally engaging campus environments influence sense of belonging in college: An examination of differences between White students and students of color. *Journal of Diversity in Higher Education* 11(4): 467-483.
40. McGee EO (2016) Devalued black and latino racial identities: A by-product of STEM college culture? *American Educational Research Journal* 53(6): 1626-1662.
41. Bohndick C, Breetzke J, Klingsieck KB, Buhl H (2025) Students' personality impacts sense of belonging of students in different ways. *Social Psychology of Education* 28(98).
42. Escobar-Soler C, Berrios R, Peñaloza-Díaz G, Melis-Rivera C, Caqueo-Urizar A, et al. (2023) Effectiveness of self-affirmation interventions in educational settings: A meta-analysis. In *Healthcare* 12(1): 3.
43. Schuyler SW, Childs JR, Poynton TA (2021) Promoting success for first-generation students of color: The importance of academic, transitional adjustment, and mental health supports. *Journal of College Access* 6(1): 12-25.
44. Freeman TM, Anderman LH, Jensen JM (2007) Sense of belonging in college freshmen at the classroom and campus levels. *The Journal of Experimental Education* 75(3): 203-220.
45. Fass ME, Tubman JG (2002) The influence of parental and peer attachment on college students' academic achievement. *Psychology in the Schools* 39(5): 561-573.
46. Johnson DR (2011) Examining sense of belonging and campus racial diversity experiences among women of color in STEM living-learning programs. *Journal of Women and Minorities in Science and Engineering* 17(3).
47. Lee-Paul SN (2023) Impact of a STEM living learning community on first-year science and technology students' success at a historically Black college and university. *Journal of Learning Spaces* 12(1): 13-22.
48. Bean J, Eaton SB (2001) The psychology underlying successful practices. *Journal of College Student Retention* 3(1): 73-89.
49. Hausmann LR, Ye F, Schofield JW, Woods RL (2009) Sense of belonging and persistence in White and African American first-year students. *Research in Higher Education* 50(7): 649-669.
50. Apumayta RQ, Cayllahua JC, Pari AC, Choque VI, Valverde JCC, et al. (2024) University dropout: A systematic review of the main determinant factors (2020-2024). *F1000Research* 13: 942.
51. Symonds WC, Schwartz R, Ferguson R (2011) Pathways to prosperity: Meeting the challenge of preparing young Americans for the 21st century.