Abstract

Black and Latine students enrolled in science, technology, engineering, and mathematics (STEM) programs are switching majors and dropping out of college at higher rates than their white peers, highlighting systemic barriers and inequities that need to be addressed. The current study aimed to understand potential psychosocial pathways that contribute to poor retention of Black and Latine students in STEM relative to their white peers. Undergraduate students (N = 489, 55.60% women, 39.30% Black and/or Latine) in an introductory Biology course at a public American university completed a cross-sectional survey which assessed their academic experiences. Black and Latine students reported lower levels of sense of belonging, perceptions of diversity, and academic confidence than their white peers. Path analysis revealed that greater perceptions of diversity on campus predicted greater sense of belonging for both groups. For Black and Latine students, sense of belonging was negatively associated with intentions to leave the university and STEM, but positively associated with academic confidence. White students reported similar patterns except there was no significant association between sense of belonging and leaving their STEM major. We discuss how academic administrators and institutions can help retain Black and Latine students in STEM.

Keywords: sense of belonging, campus diversity, underrepresented students, retention in STEM

The Crucial Roles of Campus Representation and Sense of Belonging of Undergraduates in Science, Technology, Engineering, and Math

Although academic institutions aim to recruit Black and Latine students to Science, Technology, Engineering, and Mathematics fields, recruitment and retention remain significant issues (Hansen et al., 2023; NSF, 2019; Riegle-Crumb et al., 2019). For example, in the 2018-2019 academic year, 59% of STEM degrees were awarded to white students, but only 15% and 9% were granted to Black and Latine students, respectively (National Center for Education Statistics (NCES), 2018). These issues persist beyond undergraduate education, where white students earn 50.60% of graduate degrees compared to 10.30% and 9.60% of their Black and Latine peers, respectively (Kim et al., 2024). Notably, Black and Latine students in STEM are less likely to obtain their degree compared to their non-STEM peers (NCES, 2018), which warrants further attention to STEM-specific issues.

Efforts to increase representation of Black and Latine students both in general, and in STEM, specifically, is timely and critical, given the widespread legislative efforts to diminish and effectively eliminate diversity, equity, and inclusion (DEI) initiatives in public universities. These efforts will undoubtedly have serious impacts for historically underrepresented students, and particularly for those in STEM programs where representation is even more scarce. This is an ongoing issue, as 85 bills targeting DEI programs in colleges have been introduced since 2023, 14 of which have become law (Gretzinger et al., 2025). For example, in 2023, Florida passed legislation which banned public universities from spending money on DEI initiatives and put severe restrictions on how diversity could be discussed in courses, which effectively eliminated DEI offices, programs, careers, and centers designed to support diverse groups facing marginalizations such as students of color, women, and LGBTQ+ community members. In the

same year, the U.S. Supreme Court made an unprecedented decision to eliminate the use of affirmative action in college admissions, which will undoubtedly have long term consequences on Black and Latine applicants, their families, and society, in general (Hinger, 2023). In fact, in a study which analyzed data across 2,344 universities between 2012-2016, Mickey-Pabello (2024) found evidence that affirmative action bans did indeed cause a decline in the proportion of historically underrepresented students in STEM.

While much of the literature focuses on efforts to recruit prospective Black and Latine students in STEM, it is equally important to examine the pathways that enrolled students take within their intended STEM program. For example, students who swap their STEM majors for another STEM major warrant further attention, as the majority of the literature focuses on decisions to leave STEM altogether (Shaw & Barbuti, 2010). Switching from one STEM major to another can be beneficial to students whose career interests may be better suited to one major versus another, while nonetheless remaining in STEM (Liu et al., 2021). Further, understanding if Black and Latine students are choosing different STEM majors would help inform targeted interventions and strategies to retain these students in the field as a whole.

A comprehensive understanding of the factors driving these racial disparities in STEM will enable us to address these issues effectively and implement institutional interventions with the goal of improving retention rates. Research suggests that having a strong sense of belonging, which includes feeling represented and valued, is a critical aspect to pursuing and obtaining a professional or academic degree, and combating attrition in STEM (e.g., Dasgupta, 2011; Hussain & Jones, 2021; LaDue et al., 2024; Lin et al., 2019; Master & Meltzoff, 2020; McGee et al., 2022; O'Keeffe, 2013; Rainey et al., 2018). However, the majority of this literature has focused on sense of belonging to STEM, specifically, whereas we were interested in studying

students' broader sense of belonging to the university. How diversity at the university level relates to STEM outcomes remains underexplored and we argue that this line of inquiry can help inform broader efforts to recruit and retain Black and Latine students in STEM. In pursuit of achieving better representation and retention of underrepresented STEM scholars, Allen-Ramdial and Campbell (2014) argued that STEM training programs do not operate in a vacuum, but rather, are dependent on the systems and values (i.e., campus environment and climate) upheld by the institution itself. Thus, the current study explored how university-level sense of belonging as well as perceptions of campus diversity relate to STEM retention and academic confidence among students from a large Northeastern public university in the United States. We now review the relevant literature which has examined these psychosocial factors in relation to STEM pathways and outcomes among Black and Latine students.

Perceptions of Diversity and Sense of Belonging

Sense of belonging is the "psychological feeling of belonging or connectedness to a social, spatial, cultural, professional, or other type of group in a community" (Hurtado & Carter, 1997). There is theoretical precedence which points to the key role that sense of belonging, broadly, plays in student well-being and success; namely, according to Maslow's traditional hierarchy of needs (1948) and to Baumeister and Leary's (1995) belongingness hypothesis, humans have a fundamental need to belong which motivates them to seek community in order to preserve well-being and self-esteem.

In the context of higher education, sense of belonging can extend to feeling included, accepted, and valued across and within various university communities such as at the university level, within specific academic fields (e.g., STEM), and in cultural groups, to name a few (see Crawford et al., 2024 for a review). Sense of belonging is critical in fostering key psychosocial

aspects of the university experience which includes making meaningful connections with peers and faculty (Johnson et al., 2007; LaDue et al., 2024), and boosting academic confidence and performance (Hansen et al., 2023; Hussain & Jones, 2021; Kilgo et al., 2018; Master & Meltzoff, 2020). Indeed, an abundance of literature points to sense of belonging being positively associated with obtaining an undergraduate degree, as well as a STEM degree, specifically (Maghsoodi et al., 2023; Museus et al., 2017; Rainey et al., 2018; Raman, 2014; Xu & Laestrapes, 2022).

Campus-wide diversity can translate to the extent to which Black and Latine students identify with and feel a sense of belonging in their university community, broadly (Hurtado & Carter, 1997; Hussain & Jones, 2021; Johnson et al., 2007; Museus et al., 2017). However, more narrowly, we wanted to spotlight the impact that campus diversity has in the context of STEM where there is even lesser representation of Black and Latine students compared to other fields such as in humanities (Chang et al., 2014; Estrada et al., 2016). Research finds that STEM-specific sense of belonging predicts greater retention among underrepresented students (Hansen et al., 2023), but it is also possible that simultaneously, campus-wide diversity initiatives can have the potential to reach and extend to underrepresented students in STEM.

While having a strong sense of belonging at the university is essential for all students, it may be even more critical for Black and Latine students, and particularly for those in STEM fields where diversity is even more scarce than in other fields such as in humanities (Chang et al., 2014; Estrada et al., 2016). Black and Latine students remain vastly underrepresented in STEM, which in turn, can lead to downstream consequences (e.g., income equity gaps, achievement gaps, retention in college), making perceptions of diversity an essential variable which may set in motion the decision to remain in or depart from an intended STEM program. Indeed, Black and Latine students in STEM tend to report weaker sense of belonging and less

satisfaction with their education than white students, which puts them at greater risk of leaving STEM, leaving the university, and potentially stopping their education altogether (Crawford et al., 2024; Hansen et al., 2023; Lewis et al., 2017; Lin et al., 2019).

Traditional principles and theories of social psychology may in part explain why perceptions of diversity are so critical for the success of Black and Latine students in STEM. According to social identity theory (Tajfel & Turner, 1979), in order to fulfill psychological needs, individuals strive to maintain positive self-esteem with regard to their social identities, or the extent to which they perceive themselves with reference to a social group. Under this framework, group stereotypes, which derive from normative expectations of the most prototypical group members (Hogg et al., 1995), can arise, and in turn, lead to negative consequences for individuals with traditionally underrepresented identities within a group. Currently, the prototypical STEM student is stereotyped as white and male, with some students of Asian descent, making it challenging for individuals with other identities to feel as though they belong (e.g., Black and Latine students, women, and the intersection of these identities; McGee, 2016; Placa et al., 2024).

While the current study did not directly focus on or measure stereotypes, per se, we draw from the broader social identity theory framework to acknowledge the significant role(s) that stereotypes likely play with regard to retention issues in college, and in STEM, specifically. Evidence suggests that, compared to their white peers, Black and Latine students attribute their low sense of belonging in STEM and to the university to their racial identity being devalued (known as social identity threat; Johnson et al., 2019; Steele et al., 2002; Walton et al., 2015). Black and Latine students may encounter negative stereotypes (e.g., as unintelligent, being bad at math), which can in turn, lead to them experiencing anxiety, underperforming on academic tasks,

and perceiving their racial identities as not belonging at the university, or in STEM specifically, which could discourage them from pursuing STEM or from pursuing college in general (D'Anna-Hernandez et al., 2025; Johnson et al., 2019).

Both the perceived climate diversity of the campus and the lack of of identity-safety cues (i.e., cues signaling that historically underrepresented scholars' stigmatized identities will not lead to negative consequences; Pietri et al., 2019) may also have subsequent consequences for STEM, specifically (Lin et al., 2019; McGee et al., 2022; Winkle-Wagner & McCoy, 2018). For example, lack of campus diversity can be isolating for Black and Latine students, often leading them to feel as though they do not belong at college, and that they require additional preparation to combat negative stereotypes (Winkle-Wagner & McCoy, 2018) and feelings (e.g., as marginalized and undervalued, imposter syndrome; Jelks & McCain, 2020; McGee et al., 2022; Stone et al., 2018). Understanding the broad impacts institutional climate diversity has on the individuals and the institution is imperative to cultivate an environment where representation is easily attainable.

Academic Confidence

From a social identity perspective, when people feel that they do not fit in a social group, their ability to maintain a positive social identity may be hampered, which can lead to low self-efficacy and diminished confidence (Cheryan et al., 2015; Kim et al., 2018; Tajfel & Turner, 1979). Indeed, a strong STEM sense of identity and STEM community involvement are strong predictors of self-efficacy and academic confidence, making them critical for all STEM students to persist in their major (Syed et al., 2019). Academic confidence is another key variable which predicts whether or not students decide to pursue and persist in STEM (Hansen et al., 2023; Moakler & Kim, 2014). Black and Latine students tend to report having less academic

confidence compared to their white counterparts, which may be likely due to feeling little sense of belonging in STEM (Hansen et al., 2023). Academic confidence is also linked to sense of belonging; having little academic confidence has been shown to reinforce feeling unwelcome among Black and Latine students (Johnson, 2012) and conversely, having a strong sense of belonging predicts academic confidence and degree persistence (Hansen et al., 2023).

However, as part of core curricula, students in STEM are expected to take classes external to their major, and thus have many interactions with professors and peers in a broader university setting, making the overall campus climate important to pinpoint in predicting academic confidence and consequent academic career decisions. Both STEM faculty (Canning et al., 2019) and non-STEM faculty (Grier-Reid et al., 2015) report having low expectations of their Black and Latine students and may hold beliefs that ability is fixed, which in turn, diminishes students' motivation and academic confidence, thus posing another barrier for underrepresented students (Canning et al., 2019). Facing negative stereotypes from faculty and peers can lead to underperformance (i.e., stereotype threat), low academic confidence, and avoiding STEM fields (Rattan et al., 2018; Starr & Leaper, 2022).

Campus environments that are inclusive, supportive, and actively combat bias, however, have been shown to foster academic confidence and positive identity development among students from underrepresented groups (Johnson, 2012; Walton & Cohen, 2007). Strong academic confidence in turn strengthens self-efficacy, lowers levels of subject-specific anxiety (i.e., math anxiety), and predicts better grade performance and persistence in STEM overall (Lent et al., 1997; Moakler & Kim, 2014). By cultivating environments where Black and Latine scholars' academic confidence can thrive, institutions can thereby enhance their sense of belonging and resilience in STEM. This is of great importance as better academic outcomes and

the retention of Black and Latine scholars ultimately contributes to creating a more diverse and equitable STEM workforce.

The Current Study

The existing literature suggests that Black and Latine students are not persisting in fields and domains that may be perceived as unwelcoming for many historically excluded students, therefore causing them to leave STEM, and more broadly, post-secondary institutions at higher proportions than their white peers (e.g., Estrada et al., 2016; Hansen et al., 2023; Master & Meltzoff, 2020; Pietri et al., 2019; Riegle-Crumb et al., 2019). We focus on several psychosocial variables that have been linked to persistence in STEM across the education literature – perceptions of diversity, sense of belonging, and academic confidence.

To understand the interplay of these variables, we administered an online cross-sectional survey to undergraduate college students intending to major in STEM enrolled in an introductory Biology course at a public university in the Northeast part of the United States between Fall 2018 and Fall 2019. Our first research question, which was partially a replication of past literature, aimed to extend the literature by assessing whether Black and Latine students, compared to their white counterparts differed in our main variables of interest – perceptions of diversity, sense of belonging, academic confidence, intentions to leave STEM for another STEM major, intentions to leave STEM for a non-STEM major, and intentions to leave the university. In these comparisons, as part of Hypothesis 1, we predicted that, relative to their white peers, Black and Latine students would report (1a) lesser perceived diversity of the university student body (McGee, 2016), (1b) lower sense of belonging (Johnson et al., 2007), (1c) lesser academic confidence (Johnson, 2012), greater intentions to leave (1d) their STEM major for a non-STEM major (Liu et al., 2021), (1e) their STEM major for another STEM major (Liu et al., 2021), and

(1f) the university altogether (Shaw & Barbuti, 2010). Unique to our study, we wanted to paint a fuller picture of how these variables would compare in a university setting in which 62.8% of the undergraduate student population is non-white (https://www.stonybrook.edu/diversity/).

However, Black and Latine students remain underrepresented, comprising 9.30% and 14.90% of the student body, respectively, with even lesser representation in STEM. Given our focus on campus-wide diversity and sense of belonging, we hoped to contribute to the literature which largely draws from predominantly White institutions (PWIs). Faculty at this university, which includes 63.50% white, 7.30% Asian, 9.40% Latine, and 5.80% Black individuals, largely mirrors the national average (i.e., 70% of US faculty are white; Pham & Tsai, 2024). We consider faculty demographics relevant in understanding the cultural campus environment and broad perceptions of diversity.

As part of our second line of inquiry (Hypothesis 2), we explored the pathways in which perceived diversity leads to sense of belonging and ultimately academic confidence and key academic decisions (i.e., decisions to remain in STEM/the university) among historically underrepresented (Black and Latine) compared to white students. All our predictions were informed by supported psychosocial theories in the existing literature; however, we did not aim to test said theories. Drawing from a broad theoretical framework which links feeling represented and feeling welcome, (Dasgupta, 2011; Hurtado & Carter, 1997; Museus et al., 2017) we predicted that among all students, perceptions of diversity would be positively associated with sense of belonging (2a). We predicted that sense of belonging would then be positively associated with academic confidence (2b), but negatively associated with intentions of leaving STEM (2c), swapping STEM for non-STEM (2d), and leaving the university altogether (2e) given how feelings of belonging have been observed to be a buffer against attrition (e.g., Johnson

et al., 2019; Lin et al., 2019; McGee et al., 2022). It is unclear the degree to which these associations might differ based on the participants' identity and, therefore, we also consider whether the participants were underrepresented students or not in our models.

Method

Participants

Students enrolled in an introductory undergraduate Biology course at a large public university in the Northeast United States were recruited to participate in this survey study. Across three semesters, participants (N = 1,941; 52% juniors and seniors) completed a cross-sectional online survey at the end of the semester in which they were enrolled in the Biology course. We drew data from undergraduate students which resulted in a total of 489 students who self-identified as either African American/Black, Latine, and European American/Caucasian who intended on majoring in STEM at their university. Consistent with past research (Hansen et al., 2023), we included Black and Latine students, including those who identified as being multiracial (e.g., Black and Latine) given their historical lack of representation in STEM fields (Bauer-Wolf, 2019), whereas Asian students who are traditionally well-represented in STEM (i.e., 33 percent of STEM degrees; NCES; 2019) and at this institution (28.2%), were excluded. Participants self-reported demographics, with the majority of participants self-identifying as women (55.60%), white (60.70%), and intending to become Biology majors (47.03%). See Table 1 for additional participant demographics.

Procedure

This study was approved by the University Institutional Review Board. Participants were eligible to participate if they were 17 years or older, able to read and understand English, and enrolled in a Biology course. Participants were invited to participate via email sent by the

instructor. The consent form advised participants to complete the study in a private space and on a personal computer to maintain privacy and confidentiality. After survey completion, participants received debriefing information, and were compensated with course credit. Data were collected between May 2018 and December 2019.

Measures

The current study was part of a larger survey. We only report measures relevant to the aims of the current study below.

Sense of belonging was measured using three items that assessed perceptions of fit, comfort and welcome at the university (derived from Mendoza-Denton et al., 2002). Participants rated their level of agreement with statements such as, "As a member of your race/ethnic group, how comfortable/welcome do you feel at the University?" and "As a member of your race/ethnic group, do you feel that you fit in at the University?" on a one ("Definitely do not feel welcome at the University") to 10 ("Definitely feel welcome at the University") scale. Responses were summed to create a composite sense of belonging score with higher scores indicating greater sense of belonging. Internal reliability for the composite item, sense of belonging, was high (Hair et al., 2022) ($\alpha = .90$).

Perceptions of Diversity was measured using a single item that asked participants how racially/ethnically diverse they perceived the college student community to be at the University on a scale from one ("Not at all diverse at the University") to 10 ("Very much diverse at the University"), with higher scores reflecting higher perceptions of diversity (derived from Drape et al., 2017).

Academic Confidence was measured using a 19-item questionnaire that asked participants how confident they were that they could complete specific tasks (e.g., "How confident are you in

your ability to successfully manage/handle each of these tasks very well right now?") (Clark et al., 2021) on a scale from one ("Not at all confident") to six ("Extremely confident"). Example items included, "Study for classes and exams in my STEM courses" and "Manage both school and work". Items were summed such that higher scores reflect higher levels of academic confidence. Internal reliability for the 19-item scale was strong ($\alpha = .94$; Hair et al., 2022).

Intentions to leave STEM, switch majors, and leave the university were assessed using three separate subcategories in order to evaluate exactly where students are thinking of going when considering leaving their current STEM major (derived from Rosenthal et al., 2013 & Shin et al., 2016). Notably, these measures were kept separate in our analyses. Participants rated their intentions to leave their current STEM program, by indicating if they would leave their STEM major for a different STEM major: "I have recently considered leaving my current STEM major (e.g., biology) and switching to another STEM major (e.g., math)" on a scale ranging from one ("Strongly disagree") to seven ("Strongly agree") with higher scores indicating greater intent to leave one STEM major for another STEM major. Participants also indicated if they would leave their current STEM major for a non-STEM major: "I have recently considered leaving my current STEM major and switching to a non-STEM major (e.g., humanities)" on a scale ranging from one ("Strongly disagree") to seven ("Strongly agree") with higher scores reflecting greater intent to leave STEM for a non-STEM major. Participants also rated intentions to remain at the university (e.g., "I have recently considered leaving this university to enroll in another university"; "I have recently considered leaving this university to pursue a job opportunity") on a scale ranging from one ("Strongly disagree") to seven ("Strongly agree") with higher scores indicating greater intent to leave the university.

Demographics. Participants also completed self-reported demographic measures (e.g., age, race/ethnicity, gender).

Data Transparency and Openness

We follow the Journal Article Reporting Standards guidelines in the current work (Appelbaum et al., 2018) to report our sample size and to describe all data exclusions and manipulations. Analyses were conducted in R using the *lavaan* package (Rosseel, 2012) and the *rstatix* package (Kassambara, 2023). The path model visualization was created using the *lavaanPlot* package. As the research design is cross-sectional, this allowed for correlational or relational inferences, rather than causal inferences. The study design and analyses were not pre-registered. Processed data and code for the analyses are available on the Open Science Framework. Procedures were reviewed and approved by the university's Institutional Review Board (IRB2022-00241).

We tested a path analysis which allowed us to evaluate the extent to which patterns of association among observed variables (i.e., perceptions of diversity, intent to leave STEM, intent to leave the university) accurately reflected associations in our empirical data (see Figure 1). Path analysis is appropriate for this design as path analysis accommodates multiple correlated outcomes (i.e., sense of belonging and academic confidence), models complex theoretical structures, and avoids inflated measurement error such as multiple regression (Lleras, 2005). We outline our analytic procedure plan below. Model fit was assessed by the comparative fit index (CFI), the Tucker Lewis index (TLI), and the root-mean square error (RMSEA), with acceptable model fit indicated by a CFI and TLI > .90 and an RMSEA < .10 (Hu & Bentler, 1999; Kline, 2005). Notably, we handled missing data via listwise deletion.

Results

To test our first hypothesis, we conducted a one-way MANOVA comparing Black and Latine to white students in their perceptions of diversity, sense of belonging, academic confidence, intent to leave STEM for non-STEM, intent to leave their STEM major for another STEM major, and leave the university. We observed an overall significant effect between Black and Latine versus white students across our variables of interest, $F(6, 475) = 11.90$, $p < .001$, Pillai = .13, partial $\eta 2 = .12$. Compared to their white peers, Black and Latine students reported lesser perceptions of campus diversity, $t(311.85) = 6.74$, $p < .001$, $d = 0.65$, 95% CI [1.15, 2.09], lower sense of belonging, $t(349.48) = 6.68$, $p < .001$, $d = 0.63$, 95% CI [0.83, 1.53], as well as lower academic confidence, $t(400.21) = 3.44$, $p < .001$, $d = 0.32$, 95% CI [0.12, 0.45]. Black and Latine students reported that they were considering leaving their STEM major for a non-STEM major, $t(384.47) = -2.00$, $p = .046$, $d = -0.19$, 95% CI [-0.76, -0.01], and the university more than their white peers, $t(382.32) = -2.10$, $p = .036$, $d = -0.20$, 95% CI [-0.78, -0.03]. There was no statistical difference between Black and Latine students and white students in their intention to leave their STEM major for another STEM major, $t(404.15) = -1.68$, $p = .095$, $d = -0.16$, 95% CI [-.70, .06]. These findings overall are consistent with our hypotheses based on the previously discussed literature. Table 2 contains descriptive statistics on each of the measures. Table 3 contains correlations between the aforementioned variables of interest.

Path Analysis

To test our second hypothesis, we conducted a path analysis to determine whether perceptions of campus diversity predicted sense of belonging, academic confidence, intentions to leave their STEM program for both non-STEM and other STEM majors, and ultimately intentions to leave the university (see Figure 1). Racial identity was also included as a predictor for sense of belonging such that Black and Latine participants were coded as 1 and white

participants were coded as 0. Mean scores on sense of belonging as the dependent variable were assessed. We conducted this path analysis first including all participants then conducted two almost identical models – one model only included Black and Latine students whereas the second model included only white students. The models separating white students from Black and Latine students provided better model fit to our data and, therefore, we report those two models below (see our Supplemental Materials for the path analysis including all participants).

For the model including only Black and Latine students, model fit indices indicated that the model fit the data well (X^2 [15] = 273.45, $p < .001$; CFI = .90, TLI = .97; RMSEA = .05). Standardized model parameters are presented in Figure 1, Panel A. Greater perceptions of diversity significantly predicted greater sense of belonging ($b = .51$, $z = 11.27$, $p < .001$). Then, greater sense of belonging significantly predicted greater academic confidence ($b = .16$, $z = 5.83$, $p < .001$), lesser intentions to leave their STEM field for a non-STEM field ($b = -.18$, $z = -2.81$, $p = .005$), and lesser intentions to leave the university altogether ($b = -.41$, $z = -6.78$, $p < .001$). Sense of belonging did not predict intentions to leave STEM for another STEM major among Black and Latine participants ($b = -.11$, $z = -1.77$, $p = .08$).

For the model including only white students, model fit indicated the model fit the data well (X^2 [15] = 301.64, $p < .001$; CFI = .96, TLI = .85; RMSEA = .10). The standard model parameters are presented in Figure 1, Panel B. Once again, greater perceptions of diversity significantly predicted sense of belonging ($b = .29$, $z = 5.71$, $p < .001$). Additionally, much like the model for Black and Latine students, sense of belonging positively predicted academic confidence ($b = .10$, $z = 3.59$, $p < .001$), but negatively predicted intentions to leave the university ($b = -.21$, $z = -3.45$, $p < .001$). Much like the previous model, sense of belonging did not predict intentions to leave for another STEM major ($b = -.08$, $z = -1.27$, $p = .20$). Lastly,

unlike the model for Black and Latine students, sense of belonging did not predict intentions to leave for a non-STEM major (b = -.06, z = -0.94, p = .35).

Discussion

Given widespread legislation which diminishes and in some cases, eliminates DEI initiatives in public universities, there is an urgent need to recruit and retain historically underrepresented students, in general, and in STEM, specifically. We examined psychosocial pathways which predict Black and Latine students' retention in STEM and then compared these pathways to a sample of white students. We measured participants' perceptions of campus diversity, sense of belonging to the university, and academic confidence as well as their intentions to leave STEM (for non-STEM or switch to another STEM major) and the university, more broadly. In both samples, we found that perceptions of diversity positively predicted sense of belonging to the university, which then predicted greater academic confidence and lesser intentions to leave the university, highlighting the benefits that diversity has for all students. As a key finding, we found that sense of belonging among Black and Latine students was negatively associated with intentions to leave their STEM major for a non-STEM major but this association was non-significant amongst white students. Lastly, compared to their white peers, Black and Latine participants reported lower sense of belonging, perceptions of campus diversity, academic confidence, and higher intentions to depart from all STEM majors as well as the university which is consistent with previous literature (Johnson, 2012; Lewis et al., 2017; Lin et al., 2019; Liu et al., 2021; McGee, 2016).

Our results underscore the potentially far-reaching impact that campus diversity efforts can have for underrepresented STEM students. While race-conscious programs have increasingly become illegal, and coupled with the termination of affirmative action, we contend that federal

programs should continue to broaden participation in STEM, given how diversity can benefit all students, which our results point to. While there were some differences between the outcomes in our two models, which we review below, it is essential to note that higher perceived diversity, at the campus level, enhanced both samples' sense of belonging, which ultimately predicted higher academic confidence and intentions to remain at the university. Although our data were collected before the 2023 SCOTUS decision, we urge both researchers, as well as those with academic power at national and state levels, to consider how important it is that universities ensure a diverse and representative student body, which has positive benefits for both STEM students and society, as a whole. By ensuring better representation in the STEM workforce, there are ample benefits such as much-needed innovations in technology and medicine, to name a few. These results highlight that much like "the curb-cut effect" that "describes how addressing disadvantages or exclusions experienced by one group of people creates an environment that enables everyone to participate and contribute fully", having a diverse campus benefits all students in pursuit of academic success (Blackwell, 2016; National Cancer Institute, 2021).

However, in comparing the results from the two models, there are some important distinctions. First, while perceptions of campus diversity positively predicted sense of belonging in both models, when examining these associations separately, diversity seemed to play a more prominent role in driving a sense of belonging for Black and Latine students compared to their white peers. Thus, we recommend that institutional DEI initiatives should promote the benefits of diversity for all students while simultaneously acknowledging and confronting the unique challenges faced by Black and Latine students. Secondly, while having a low sense of belonging predicted greater intention to leave college in both samples, this variable significantly predicted intentions to leave STEM among Black and Latine students only. While the human need to fit in

is universal for all students (e.g., Baumeister & Leary, 1995; Maslow, 1948), our results suggest that lack of diversity, and subsequent diminished sense of belonging, is particularly salient for Black and Latine students in STEM, which warrants better diversity, equity, and inclusion initiatives. Developing an understanding of the experiences of Black and Latine students in an undergraduate STEM program is important for helping us to develop an environment within institutions aimed at retaining diverse STEM scholars. Accordingly, the results of the present study suggest that institutions should proactively address the lack of diversity within the broader campus community and within fields with low diversity (i.e., STEM). These fundamental changes may, in turn, have a positive impact on the persistence of Black and Latine students in STEM fields and at the institution.

We hope that our study encourages universities to make better efforts at increasing diversity at the student and faculty levels where there is an opportunity to make underrepresented students feel welcome and confident. While we focused on perceptions of diversity at the university, broadly, we hope that future research also investigates perceptions of diversity amongst faculty, as having better faculty diversity can buffer against the negative impact of experiencing marginalization that many Black and Latine students in STEM face (Hussain & Jones, 2021; Pham & Tsai, 2024). In accordance with Dasgupta's Stereotype Inoculation Model, in situations and environments where people's social identities are not adequately represented, the presence of a positive role model with shared social identities can serve as an identity-safety cue, which can buffer against negative outcomes (e.g., feeling unwelcome), and yield positive outcomes (e.g., better academic achievement) (Dasgupta, 2011). Thus, having positive role models such as Black and Latine professors in STEM may protect underrepresented students from feeling devalued, a key predictor of academic success and retention, buffer against feeling

devalued, a low sense of belonging, and experiencing stereotype threat, which are central to retention in STEM (Pietri et al., 2019; Ragland & Sommers, 2024). Having Black role models (i.e., identity-safety cue) is positively associated with sense of belonging to the institution among Black women, for example (Johnson et al., 2019), whereas we observe the opposite trend for Black and Latine students who feel alienated from their cultural communities (see Museus & Saelua, 2017 for a review). Black and Latine students often express concerns about limited campus diversity, and research indicates that experiencing negative racial encounters contributes to significant stress among these students, with considerable academic and health consequences (Kilgo et al., 2018).

While the literature highlights the critical need for Black and Latine representation at all levels—among students, faculty, and staff—this strategy for fostering inclusivity and equity within academic institutions presents challenges worth noting. For example, Black faculty often face an additional burden within their departments, as evidenced by the frequent use of terms like "father-figures" and "othermothering" to describe their mentor-mentee relationships with students (Guiffrida, 2005; Kendricks et al., 2013). Exploring alternative strategies to support underrepresented students and faculty could help address the challenges previously outlined. For example, implementing peer mentoring programs (Nuis et al., 2023) and involving Black and Latine alumni to alleviate the burden on faculty can be highly effective in fostering a sense of belonging among current students (Fan et al., 2021). Research indicates that a sense of belonging among alumni graduate students is associated with increased engagement and philanthropic contributions to their institution (Drezner & Pizmony-Levy, 2021). This connection between feeling welcomed and contributing to the institution is a valuable opportunity to leverage.

Taken together, we recommend that to improve retention rates, sense of belonging, and academic confidence, there are many opportunities for university-wide initiatives aimed at fostering DEI for Black and Latine students, which includes faculty and peer mentorship and networking opportunities, particularly with mentors and peers with shared social identities (Grier-Reid et al., 2016; Nuis et al., 2023). Lastly, there are serious financial implications of Black and Latine students being systematically excluded from the STEM workforce, given how STEM majors earn, typically, two and a half times what the non-STEM majors will earn (Hershbein & Kearney, 2014). Thus, retaining Black and Latine individuals in the STEM workforce is important in addressing historical and institutional racism.

Limitations and Future Directions

While results of this study offer important insight and support for interventions designed to increase retention for Black and Latine students in STEM, there are some limitations that should be noted. First, our results are based on a sample from one university; we recommend that future research employ samples from multiple institutions which may have differing campus climates and rates of diversity. For example, sense of belonging, perceived diversity, and academic confidence may differ between traditionally conservative versus liberal institutions or in rural versus urban settings. Relatedly, Black students at Historically Black Colleges and Universities often report greater sense of belonging compared to those at PWIs (Kumar et al., 2019). Despite only sampling from one institution, we believe that the results of this study are applicable to students from other universities. Black and Latine students from our sample, despite not attending a PWI, were uniquely underrepresented in their university and majors, which is comparable to Black and Latine students attending PWIs who similarly experience low numerical representation and can therefore lead to low perceptions of diversity and belonging.

Only a third (35.0%) of our sample identified as Black and Latine, and it would be fruitful to investigate issues of retention with samples of more Black and Latine representation. The number of Black and Latine students in our study who identified as women was even less, making intersectional analysis difficult. Women face a myriad of stereotypes (e.g., as being poor at math, as being better suited to caretaking) and prejudice (e.g., being disliked) which discourages them from STEM pathways and also face discrimination such as being passed over for STEM faculty positions at higher rates compared to men, with Black and Latine women being hired at even lesser rates (Casad et al., 2021). Only 36% of women are awarded bachelor's degrees in STEM, versus 64% of men, even though overall, women earn more bachelor's degrees than men (NCES, 2019). Likewise, women in STEM earn 74% of men's median earnings and only make up 14% percent of engineers and architects (Fry et al., 2021). In addition to facing gender-based discrimination, stereotyping, and prejudice, Black and Latine women in STEM also experience significant racism, thus making it even more important for research to understand their intersectional experiences and inform strategies to increase academic confidence, sense of belonging, and retention (McGee & Bentley, 2017; Placa et al., 2024; Pietri et al., 2019). For example, in 2016, white women earned 26% of all bachelor's degrees in STEM, while Black women only earned five percent (Nguyen et al., 2021). These issues permeate the STEM workforce as well, as only two percent of practicing engineers and scientists are Black women (NSF, 2015). Thus, we encourage future work to examine these variables among Black and Latine women as well as gender non-conforming students in STEM, who are studied even less.

Further, while we acknowledge that Black and Latine students in STEM face similar barriers (e.g., systemic racism) to obtain their degree, we recognize that these groups may have

some unique experiences that should be respected and explored in future research (Urdan & Bruchmann, 2018). For example, in a qualitative interview study of 38 high-achieving Black and Hispanic students in STEM, participants often reported embodying white practices and behaviors to minimize bias and stereotypes, but in slightly different ways (McGee, 2016). In some situations, Latine students concealed their cultural identities (e.g, as Puerto Rican) and identified as exclusively white, whereas Black students did not. Black students also sacrificed their cultural identities to avoid negative stereotypes; in the same study, one student reported that to exemplify the "Black and gifted" stereotype (a subtype of Black students), he lied to his professors that he had not studied for exams in which he scored in the high 90's. In these efforts, Black and Latine students often report feeling deflated and exhausted, which is a problem, as identity concealment can lead to psychological distress, which can in turn, predict academic outcomes (Quinn & Chaudoir, 2015). Further research is also needed to investigate the experiences of other students of color in STEM (e.g., Native American, Pacific Islander, Alaska Native, Southeast Asian), who may also have unique experiences of their social identities in STEM.

We did not find any significant differences between Black and Latine and white students intending to switch to another STEM major, which warrants further exploration. There is a growing line of research that finds that sense of belonging in STEM (which is typically lower among Black and Latine students) is a stronger predictor of career interests and persistence than general institutional belonging (Hansen et al., 2023; Xu & Lastrapes, 2022). Thus, future research should investigate Black and Latine students' reasons for (or against) STEM-swapping to further understand these complex decisions. In a similar vein, in order to understand student experiences over time, more longitudinal research would be fruitful, as our study was cross-sectional.

Moreover, the current study relied on self-reported measures to determine the degree to which students were considering, but had not yet left STEM and their university. We encourage future work to recruit students who do decide to leave to better understand what influenced their decision(s). Additionally, students leave STEM for a multitude of reasons which we may not have measured in the current study. As examples, students may become more interested in another major or may leave the institution due to other negative experiences at the university such as being too far from their family, not liking the university campus, or having negative interactions with peers and faculty (Ferrare & Lee, 2014; George-Jackson, 2011). Perhaps students categorize all STEM majors under the same conceptual umbrella, given common stereotypes that all STEM programs are too rigorous and thus be unwilling to consider the potential benefits of switching to another more fitting STEM pathway (Song et al., 2020). Further, by broadening the definition of STEM (e.g., including non-traditional majors with rigorous scientific research such as psychology), which we encourage future researchers to do, we observe higher retention rates of Black and Latine students in STEM, as many students choose to remain in the field, broadly, but swap majors for different reasons (George-Jackson, 2011). Understanding the potentially layered motivations behind students' decisions are complex. The choice to leave STEM and an institution may be a combination of both seeking an alternative better fitting university as well as feeling little to no sense of belonging. We again encourage future research to consider how these reasons may influence Black and Latine students differently than their white peers.

Lastly, while we focused on undergraduate students who had already decided to pursue STEM, it would be worthwhile to explore these decisions across the educational ladder, including STEM choices both before and after academia. We encourage future research to

investigate the longitudinal impact of these variables across the lifespan, as choosing to leave STEM or college altogether has critical outcomes which warrant further exploration such as emotional well-being and self-esteem, career opportunities, and lifetime income. There is evidence that Black and Latine students are discouraged from science and mathematics as early as preschool, which is in part due to negative stereotypes from faculty as well as lack of mentors with shared identities (Lee et al., 2024; McGee & Pearman, 2014). Further, there is limited research on how early education influences Black and Latine students' academic decisions; a recent meta-analysis of 20 studies which examined the effectiveness of STEM programs in middle school found a significant lack of studies on Black and Latine students (i.e., only one effect size reported for Black students and other minority groups) (Thomas & Larwin, 2023). To better encourage Black and Latine students to pursue STEM (as well as other career pathways of their choice), intervening earlier on is important. At the other end of the spectrum, undergraduate students who either decide to leave or stay in STEM will eventually enter the workforce where there is a great need for innovative science, medicine, engineering, and technology, and thus, it is critical to track the career decisions of Black and Latine students throughout their academic careers.

Conclusions

There is a clear need for institutions to create a more diverse and inclusive environment to boost sense of belonging and ultimately, increase retention among Black and Latine students, both generally, and in STEM, specifically. This is a pressing issue, as federal law now largely prohibits affirmative action, a historically critical strategy to increase representation of Black and Latine students. Further, at the state level, many public institutions are increasingly unable to foster programs aimed at recruiting and retaining historically underrepresented students, which

poses significant threats to the success and well-being of millions of prospective and current students. If Black and Latine students in STEM are exiting their majors at such high rates, especially in comparison to their white peers, administrators and universities should be questioning why and addressing the problems that are driving students away. Our study points to the urgency of institutions, teachers, and policy makers to attend to issues faced by Black and Latine students in the U.S., particularly those entering STEM fields.

One's sense of belonging as well as perceptions of diversity are points of potential intervention at an institutional level. We encourage universities to recognize and better attend to the needs of Black and Latine students, including providing mentorship opportunities, applying for and securing funding for programs designed to support historically underrepresented students in STEM, and creating safe and encouraging spaces for Black and Latine students to continue and thrive. Ensuring that students are adequately represented across the different departments on campus can encourage them to perform well academically, stay in their major, and stay at the institution. For instance, Black and Latine students in STEM programs often feel excluded at their institutions and have to form their own communities (Bauer-Wolf, 2019). At the classroom level, it is imperative that teachers consider the diverse experiences of their students and ensure that Black and Latine students' needs are met. Lastly, while we lament the U.S. Supreme Court decision to cease affirmative action as well as incoming state legislation which bans DEI initiatives, we urge that policy makers make progress in increasing Black and Latine representation and providing funding opportunities to ultimately foster a more diverse and inclusive educational landscape.

References

Allen-Ramdial, S. A. A., & Campbell, A. G. (2014). Reimagining the pipeline: Advancing STEM diversity, persistence, and success. *BioScience*, *64*(7), 612-618. https://doi.org/10.1093/biosci/biu076

Appelbaum, M., Cooper, H., Kline, R. B., Mayo-Wilson, E., Nezu, A. M., & Rao, S. M. (2018). Journal article reporting standards for quantitative research in psychology: The APA publications and communications board task force report. *The American Psychologist, 73*(1), 3–25. https://doi.org/10.1037/amp0000191

Bauer-Wolf, J. (2019, February 26). *Latinx, Black college students leave STEM majors more than White students.* Retrieved August 16, 2022, from https://www.insidehighered.com/news/2019/02/26/latinx-black-college-students-leave-stem-majors-more-white-students

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3)*,* 497-529. https://doi.org/10.1037//0033-2909.117.3.497

Blackwell, A. G. (2016). The curb-cut effect. *Stanford Social Innovation Review, 15*(1), 28-33. https://doi.org/10.48558/YVMS-CC96

Canning, E. A., Muenks, K., Green, D. J., & Murphy, M. C. (2019). STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. *Science Advances, 5*(2), eaau4734. https://doi.org/10.1126/sciadv.aau4734

Casad, B. J., Franks, J. E., Garasky, C. E., Kittleman, M. M., Roesler, A. C., Hall, D. Y., & Petzel, Z. W. (2021). Gender inequality in academia: Problems and solutions for women faculty in STEM. *Journal of Neuroscience Research, 99*(1), 13-23.

https://doi.org/10.1002/jnr.24631

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. *Journal of Research in Science Teaching, 51*(5), 555-580. https://doi.org/https://doi.org/10.1002/tea.21146

Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology*, *6*, 123074. https://doi.org/10.3389/fpsyg.2015.00049

Clark, S. L., Dyar, C., Inman, E. M., Maung, N., & London, B. (2021). Women's career confidence in a fixed, sexist STEM environment. *International Journal of STEM Education*, *8*(1), 1–10. https://doi.org/10.1186/s40594-021-00313-z

Crawford, J., Allen, K. A., Sanders, T., Baumeister, R., Parker, P., Saunders, C., & Tice, D. (2024). Sense of belonging in higher education students: An Australian longitudinal study from 2013 to 2019. *Studies in Higher Education*, *49*(3), 395-409. https://doi.org/10.1080/03075079.2023.2238006

D'Anna-Hernandez, K. L., Ruiz, E. L., Ermentrout, K., Guell, M., Velez, G., & Murray, A. K. (2025). The Relationship of Discrimination, Cultural Congruity, and Identity with Psychological Distress in Undergraduate STEM Students. *Journal for STEM Education Research*, 1-23. https://doi.org/10.1007/s41979-025-00145-4

Dasgupta, N. (2011). Ingroup experts and peers as social vaccines who inoculate the self-concept: The stereotype inoculation model. *Psychological Inquiry, 22*(4), 231–246. https://doi.org/10.1080/1047840X.2011.607313

Drape, T., Anderson, G., Church, A., Jain, S., Slabach, R., & Amaral, R. (2017). Is diversity on their minds? Perceptions of diversity in an undergraduate population using a mixed-methods design. *NACTA Journal*, *61*(3), 255-261.

Drezner, N. D., & Pizmony-Levy, O. (2021). I belong, therefore, I give? The impact of sense of belonging on graduate student alumni engagement. *Nonprofit and Voluntary Sector Quarterly*, *50*(4), 753–777. https://doi.org/10.1177/0899764020977687

Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John, G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., & Zavala, M. (2016). Improving Underrepresented Minority Student Persistence in STEM. *CBE Life Sciences Education, 15*(3), es5. https://doi.org/10.1187/cbe.16-01-0038

Fan, Y. K., Barany, A., & Foster, A. (2023). Possible future selves in STEM: an epistemic network analysis of identity exploration in minoritized students and alumni. *International Journal of STEM Education*, *10*(1), 22. https://doi.org/10.1186/s40594-023-00412-z

Ferrare, J. J., & Lee, Y. G. (2014). *Should We Still be Talking About Leaving? A Comparative Examination of Social Inequality in Undergraduates' Major Switching Patterns* (WCER Working Paper No. 2014-5). Retrieved from University of Wisconsin-Madison, Wisconsin Center for Education Research website: http://www.wcer.wisc.edu/publications/workingPapers/papers.php

Fry, R., Kennedy, B., & Funk, C. (2021, April 1). *STEM jobs see uneven progress in increasing gender, racial and ethnic diversity*. Pew Research Center. https://www.pewresearch.org/social-trends/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/https://www.pewresearch.org/social-

trends/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/

George-Jackson, C. (2011). STEM switching: Examining departures of undergraduate women in STEM fields. *Journal of Women and Minorities in Science and Engineering, 17*(2). https://doi.org/10.1615/jwomenminorscieneng.2011002912

Gretzinger, E., Hicks, M., Dutton, C., & Smith, J. (2025). Tracking Higher Ed's Dismantling of DEI. *Chronicle of Higher Education*, Retrieved from https://www.chronicle.com/article/tracking-higher-eds-dismantling-of-dei?emailConfirmed=true&supportSignUp=true&supportForgotPassword=true&email=cob2014%40med.cornell.edu&success=true&code=success&bc_nonce=2a1riu7e6klqknleh52il

Grier-Reed, T., Arcinue, F., & Inman, E. (2016). The African American student network: An intervention for retention. *Journal of College Student Retention: Research, Theory & Practice, 18*(2), 183-193. https://doi.org/10.1177/1521025115584747

Guiffrida, D. (2005) Othermothering as a Framework for Understanding African American Students' Definitions of Student-Centered Faculty, *The Journal of Higher Education*, *76,*(6), 701-723. https://doi.org/10.1353/jhe.2005.0041

Hair, J. F., Hult, G. M., Ringle, C. M., & Sarstedt, M. (2022). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) (2nd ed.). Thousand Oaks, CA: Sage Publications.

Hansen, M. J., Palakal, M. J., & White, L. J. (2023). The importance of STEM sense of belonging and academic hope in enhancing persistence for low-income, underrepresented

STEM students. *Journal for STEM Education Research*, 1-26. https://doi.org/10.1007/s41979-023-00096-8

Hershbein, B., & Kearney, M. S.. (2014, September 29). *Major Decisions: What Graduates Earn Over Their Lifetimes.* The Hamilton Project., Retrieved from www.hamiltonproject.org/papers/major_decisions_what_graduates_earn_over_their_lifetimes

Hinger, H. (2023). *Moving beyond the supreme court's affirmative action rulings. American Civil Liberties Union (ACLU)*. Retrieved July 7, 2024 from https://www.aclu.org/news/racial-justice/moving-beyond-the-supreme-courts-affirmative-action-rulings#:~:text=At%20the%20end%20of%20its,affirmative%20action%20in%20college%20admissions

Hogg, M. A., Terry, D. J., & White, K. M. (1995). A tale of two theories: A critical comparison of identity theory with social identity theory. *Social Psychology Quarterly*, 255-269. https://doi.org/10.2307/2787127

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hurtado, S., & Carter, D. F. (1997). Effects of college transition and perceptions of the campus racial climate on Latino college students' sense of belonging. *Sociology of Education, 70*(4), 324–345. https://doi.org/10.2307/2673270

Hussain, M., & Jones, J. M. (2021). Discrimination, diversity, and sense of belonging: Experiences of students of color. *Journal of Diversity in Higher Education*, *14*(1), 63.

https://doi.org/10.1037/dhe0000117

Jelks, S.M.R & Crain, A.M. (2020). Sticking with STEM: Understanding STEM career persistence among STEM bachelor's degree holders. *The Journal of Higher Education, 91*(5), 805-831. https://doi.org/10.1080/00221546.2019.1700477

Johnson, D. R. (2012). Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors. *Journal of College Student Development, 53*(2), 336-346. https://doi.org/10.1353/csd.2012.0028

Johnson, I. R., Pietri, E. S., Fullilove, F., & Mowrer, S. (2019). Exploring Identity-Safety Cues and Allyship Among Black Women Students in STEM Environments. *Psychology of Women Quarterly, 43*(2), 131–150. https://doi.org/10.1177/0361684319830926

Johnson, D.R., Soldner, M., Leonard, J.B., Alvarez, P., Inkelas, K.K., Rowan-Kenyon, H.T., & Longerbeam, S.D. (2007). Examining sense of belonging among first-year undergraduates from different racial/ethnic groups. *Journal of College Student Development 48*(5), 525-542. https://doi.org/10.1353/csd.2007.0054

Kassambara, A. (2023). *rstatix: Pipe-Friendly Framework for Basic Statistical Tests*. R package version 0.7.2, https://rpkgs.datanovia.com/rstatix/

Kendricks, K. D., Nedunuri, K. V., & Arment, A. R. (2013). Minority student perceptions of the impact on mentoring to enhance academic performance in STEM disciplines. *Journal of STEM Education: Innovations and Research, 14,* 38-46. Retrieved from https://eric.ed.gov/?id=EJ1006883

Kilgo, C. A., Linley, J. L., & Bennett, L. M. (2019). Critically examining the relationship between peer diversity interactions and psychological well-being. *Journal of Student*

Affairs Research and Practice, 56(1), 63-77. https://doi.org/10.1080/19496591.2018.1490305

Kim, A. Y., Sinatra, G. M., & Seyranian, V. (2018). Developing a STEM identity among young women: A social identity perspective. *Review of Educational Research*, *88*(4), 589-625. https://doi.org/10.3102/0034654318779957

Kim, J. H., Soler, M. C., Zhao, Z., and Swirsky, E. (2024). *Race and Ethnicity in Higher Education*: *2024. Status Report.* Washington, DC.: American Council on Education. Retrieved December 13, 2024 from https://www.equityinhighered.org/wp-content/uploads/2024/05/REHE2024_Full_Report.pdf

Kline, R. B. (2005). Principles and practice of structural equation modeling (2nd ed.). Guilford Press.

Kumar, R., McKether, W., & Adams, A. (2019, April). Belongingness uncertainty: A comparative study of African-American engineering students' experiences at PWI and HBCU. In Annual meeting program American Educational Research Association.

LaDue, N. D., Zocher, E., & Dugas, D. (2024). "It Just Makes It Feel Like You're Not Alone": A Qualitative Study of a Social Support Group for High-Achieving, Low-Income STEM Majors. *Journal for STEM Education Research*, *7*(2), 227-256. https://doi.org/10.1007/s41979-024-00116-1

Lee, A., Henderson, D. X., Corneille, M., Morton, T., Prince, K., Burnett, S., & Roberson, T. (2024). Lifting Black student voices to identify teaching practices that discourage and encourage STEM engagement: Why #Black teachers matter. *Urban Education, 59*(4), 979-1011. https://doi.org/10.1177/00420859211073898

Lent, R. W., Brown, S. D., & Gore, P. A. (1997). Discriminant and predictive validity of academic self-concept, academic self-efficacy, and mathematics-specific self-efficacy. *Journal of Counseling Psychology, 44*(3), 307–315. https://doi-org.stanford.idm.oclc.org/10.1037/0022-0167.44.3.307

Lewis, K. L., Stout, J. G., Finkelstein, N. D., Pollock, S. J., Miyake, A., Cohen, G. L., & Ito, T. A. (2017). Fitting in to move forward: Belonging, gender, and persistence in the physical sciences, technology, engineering, and mathematics (pSTEM). *Psychology of Women Quarterly*, *41*(4), 420–436. https://doi.org/10.1177/0361684317720186

Lleras, C. (2005). Path Analysis. In K. Kempf-Leonard (Ed.), *Encyclopedia of Social Measurement* (Vol. 3, pp. 25-30). Elsevier Inc. https://doi.org/10.1016/B0-12-369398-5/00483-7

Lin, S., Salazar, T. R., & Wu, S. (2019). Impact of academic experience and school climate of diversity on student satisfaction. *Learning Environments Research, 22*(1), 25-41. https://doi.org/10.1007/s10984-018-9265-1

Liu, V., Mishra, S., & Kopko, E. M. (2021). Major decision: The impact of major switching on academic outcomes in community colleges. *Research in Higher Education, 62*(4), 498-527. https://doi.org/10.1007/s11162-020-09608-6

Maghsoodi, A. H., Ruedas-Gracia, N., & Jiang, G. (2023). Measuring college belongingness: Structure and measurement of the sense of social fit scale. *Journal of Counseling Psychology*, *70*(4), 424. https://doi.org/10.1037/cou0000668

Master, A. H., & Meltzoff, A. N. (2020). Cultural stereotypes and sense of belonging contribute to gender gaps in STEM. *International Journal of Gender, Science, and Technology, 12*(1), 152-198. https://doi.org/10.3102/1570642

Maslow, A. (1948). “A Theory of Human Motivation.” *Psychological Review, 50*(4), 370. https://doi.org/10.1037/h0054346

McGee, E. O. (2016). Devalued Black and Latino racial identities: A by-product of STEM college culture?. *American Educational Research Journal, 53*(6), 1626-1662. https://doi.org/10.3102/0002831216676572

McGee, E. O., & Bentley, L. (2017). The troubled success of Black women in STEM. *Cognition and Instruction, 35*(4), 265-289. https://doi.org/10.1080/07370008.2017.1355211

McGee, E. O. Botchway, P.K., Naphan-Kingery, D.E., Brockman, A.J., Houston, S. & White, D.T. (2022). Racism camouflaged as impostorism and the impact on Black STEM doctoral students. *Race Ethnicity and Education, 25*(4), 487-507. https://doi.org/10.1080/13613324.2021.1924137

McGee, E. O., & Pearman, F. A. (2014). Risk and protective factors in mathematically talented Black male students: Snapshots from kindergarten through eighth grade. U*rban Education, 49*(4), 363-393. https://doi.org/10.1177/0042095914525791

Mendoza-Denton, R., Downey, G., Purdie, V. J., Davis, A., & Pietrzak, J. (2002). Sensitivity to status-based rejection: implications for African American students' college experience. *Journal of Personality and Social Psychology, 83*(4), 896–918. https://doi.org/10.1037//0022-3514.83.4.896

Mickey-Pabello, D. (2024). A STEM Penalty from Affirmative Action Bans?. *Research in Higher Education*, *65*(1), 92-123. https://doi.org/10.1007/s11162-023-09739-6

Moakler Jr, M. W., & Kim, M. M. (2014). College major choice in STEM: Revisiting confidence and demographic factors. *The Career Development Quarterly, 62*(2), 128-142.

Museus, S.D., Yi, V., & Saelua, N. (2017). The impact of culturally engaging campus environments on sense of belonging. *The Review of Higher Education, 40*(2), 187-215. https://doi.org/10.1353/rhe.2017.0001

National Cancer Institute. (2021, December 15). *The curb-cut effect*. https://dceg.cancer.gov/about/diversity-inclusion/inclusivity-minute/2021/curb-cut-effect

National Center for Education Statistics (NCES). (2018). Science and Engineering Degrees, by Race and Ethnicity of Recipients. https://www.nsf.gov/statistics/degreerecipients

National Center for Educational Statistics (NCES). (2019). Status and Trends in the Education of Racial and Ethnic Groups: Indicator 23: STEM Degrees. Postsecondary Graduation Rates. https://nces.ed.gov/programs/raceindicators/indicator_REG.asp

National Science Foundation (NSF), National Center for Science and Engineering Statistics. (2015). Science and engineering degrees, by race/ethnicity of recipients: 2002-2012. Arlington, VA: Author

National Science Foundation (NSF), National Center for Science and Engineering Statistics (2019). Women, minorities, and persons with disabilities in science and engineering: 2019. Special report NSF. 15–311. Retrieved from http://www.nsf.gov/statistics/wmpd/

Nguyen, T. H., Gasman, M., Washington Lockett, A., & Peña, V. (2021). Supporting Black women's pursuits in STEM. *Journal of Research in Science Teaching, 58*(6), 879-905. https://doi.org/10.1002/tea.21682

Nuis, W., Segers, M., & Beausaert, S. (2023). Conceptualizing mentoring in higher education: A systematic literature review. *Educational Research Review*, 100565. https://doi.org/10.1016/j.edurev.2023.100565

O'Keeffe, P. (2013). A sense of belonging: Improving student retention. *College Student Journal*, *47*(4), 605-613. Retrieved from https://eric.ed.gov/?id=EJ1029294

Pham, T., & Tsai, Y. Y. (2024). The Roles of Faculty Hiring and Retention in Shaping Diversity and Representation in US Higher Education Institutions: A Retrospective and Prospective Analysis from 2001 to 2035. *Research in Higher Education*, 1-41. https://doi.org/10.1007/s11162-024-09810-w

Pietri, E. S., Drawbaugh, M. L., Lewis, A. N., & Johnson, I. R. (2019). Who encourages Latina women to feel a sense of identity-safety in STEM environments? *Journal of Experimental Social Psychology*, *84*, 103827. https://doi.org/10.1016/j.jesp.2019.103827

Placa, N., Nick, C., & Lee, J. (2024). "I don't back away from a fight": Examining first year undergraduate Latinas' perseverance in STEM. *Journal for STEM Education Research*, *7*(2), 281-306. https://doi.org/10.1007/s41979-024-00120-5

Quinn, D. M., & Chaudoir, S. R. (2015). Living with a concealable stigmatized identity: the impact of anticipated stigma, centrality, salience, and cultural stigma on psychological distress and health. *Stigma and Health, 1*(S), 35–59. https://doi.org/10.1037/2376-6972.1.S.35

Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in STEM. *International Journal of STEM Education*, *5*, 1-14. https://doi.org/10.1186/s40594-018-0115- 6

Ragland, K. P., & Sommers, S. R. (2024). Can I see myself there? How Black potential applicants use diversity cues to learn about graduate program climate. *Journal of*

Experimental Psychology: General, *153*(11), 2742- 2750. https://doi.org/10.1037/xge0001571

Raman S. (2014) Sense of Belonging. In: Michalos A.C. (Eds.), *Encyclopedia of Quality of Life and Well-Being Research.* Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0753-5_2646

Rattan, A., Savani, K., Komarraju, M., Morrison, M. M., Boggs, C., & Ambady, N. (2018). Meta-lay theories of scientific potential drive underrepresented students' sense of belonging to science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology, 115*(1), 54. https://doi.org/10.1037/pspi0000130

Riegle-Crumb, C., King, B., & Irizarry, Y. (2019). Does STEM Stand Out? Examining Racial/Ethnic Gaps in Persistence Across Postsecondary Fields. *Educational Researcher, 48*(3), 133-144. https://doi.org/10.3102/0013189X19831006

Rosenthal, L., Levy, S. R., London, B., Lobel, M., & Bazile, C. (2013). In pursuit of the MD: The impact of role models, identity compatibility, and belonging among undergraduate women. *Sex Roles: A Journal of Research, 68*(7-8), 464–473. https://doi.org/10.1007/s11199-012-0257-9

Rosseel, Y. (2012) Lavaan: an R package for structural equation modeling. *Journal of Statistical Software, 48*, 1-36. https://doi.org/10.18637/jss.v048.i02

Shaw, E. J., & Barbuti, S. (2010). Patterns of persistence in intended college major with a focus on STEM majors. *NACADA Journal, 30*(2), 19-34. https://doi.org/10.12930/0271-9517-30.2.19

Shin, J. E. L., Levy, S. R., & London, B. (2016). Effects of role model exposure on STEM and non-STEM student engagement. *Journal of Applied Social Psychology*, *46*(7), 410-427.

https://doi.org/10.1111/jasp.12371

Song, Y., Kim, A. Y., Martin-Hansen, L. M., & Bernal, E. V. (2020). Switching lanes or exiting? STEM experiences, perceptions, and identity construction among college STEM switchers. *Critical Questions in STEM Education*, 227-249. https://doi.org/10.1007/978-3-030-57646-2_13

Starr, C. R., & Leaper, C. (2022). Undergraduates' pSTEM identity and motivation in relation to gender-and race-based perceived representation, stereotyped beliefs, and implicit associations. *Group Processes & Intergroup Relations*, *26*(8), 1774-1800. https://doi.org/10.1177/13684302221128235

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. *Advances in Experimental Social Psychology, 34*, 379–440. doi:10.1016/S0065-2601(02)80009-0

Stone, S., Saucer, C., Bailey, M., Garba, R., Hurst, A., Jackson, S. M., Krueger, N., & Cokley, K. (2018). Learning While Black: A Culturally Informed Model of the Impostor Phenomenon for Black Graduate Students. *Journal of Black Psychology, 44*(6), 491–531. https://doi.org/10.1177/0095798418786648

Syed, M., Zurbriggen, E. L., Chemers, M. M., Goza, B. K., Bearman, S., Crosby, F. J., Shaw, J. M., Hunter, L., & Morgan, E. M. (2019). The role of self-efficacy and identity in mediating the effects of STEM support experiences. *Analyses of Social Issues and Public Policy, 19*(1), 7-49. https://doi.org/10.1111/asap.12170

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin & S.Worchel (Eds.), *The social psychology of intergroup relations* (pp. 33–48). Monterey, CA: Brooks/Cole.

Thomas, D. R., & Larwin, K. H. (2023). A meta-analytic investigation of the impact of middle school STEM education: where are all the students of color?. *International Journal of STEM Education, 10*(1), 1-25. https://doi.org/10.1186/s40594-023-00425-8

Urdan, T., & Bruchmann, K. (2018). Examining the academic motivation of a diverse student population: A consideration of methodology. *Educational Psychologist, 53*(2), 114-130. https://doi.org/10.1080/00461520.2018.1440234

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: race, social fit, and achievement. *Journal of personality and social psychology*, *92*(1), 82. https://doi-org.stanford.idm.oclc.org/10.1037/0022-3514.92.1.82

Walton, G. M., Murphy, M. C., & Ryan, A. M. (2015). Stereotype threat in organizations: Implications for equity and performance. *Annual Review of Organizational Psychology and Organizational Behavior, 2*, 523–550. https://doi.org/10.1146/annurev-orgpsych-032414-111322

Winkle-Wagner, R., & McCoy, D. L. (2018). Feeling like an "Alien" or "Family"? Comparing students and faculty experiences of diversity in STEM disciplines at a PWI and an HBCU, *Race Ethnicity and Education, 21*(5), 593-606, https://doi.org/10.1080/13613324.2016.1248835

Xu, C., & Lastrapes, R. E. (2022). Impact of STEM sense of belonging on career interest: The role of STEM attitudes. *Journal of Career Development, 49*(6), 1215-1229. https://doi.org/10.1177/08948453211033025