Exploring Sense of Belonging Among Black and Latina Students in College Algebra and Precalculus: Insights From a Mixed Methods Study at a Minority-Serving Institution

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In this sequential explanatory mixed methods study, I examined Black and Latina female students' sense of belonging in gateway mathematics at a diverse, open-access minority-serving institution. Using frameworks of intersectionality, sense of belonging, and authorizing student perspectives, I explored how students' identities shaped their experiences in college algebra and precalculus. I surveyed 1,136 students (pre-survey) and 639 students (post-survey) using an adapted Math Sense of Belonging Scale and analyzed data using ANOVA and ANCOVA. Results showed that mathematics affinity and expected grades were stronger predictors of belonging than race or gender. From the qualitative data, I identified six positive and six negative factors influencing belonging, including professors' mathematical microaffirmations and microaggressions, perception of caring faculty, peer collaboration, peer connections, mathematics self-efficacy, and perceptions of class diversity. These findings highlight the importance of caring faculty, collaborative learning, and peer support in fostering belonging in racially diverse mathematics classrooms.

Keywords: Sense of Belonging, Intersectionality, Gateway Mathematics Classes, Minority-Serving Institutions, Authorizing Student Perspectives

Despite increasing diversity in higher education, Black and Latina women remain underrepresented in STEM and face persistent barriers in introductory mathematics courses (Ong et al., 2016; Hatfield et al., 2022). College Algebra and Precalculus at open-access institutions often serve as gatekeepers rather than gateways to STEM pathways, characterized by low pass rates and unwelcoming environments (Seymour & Hunter, 2019). These students navigate racialized and gendered challenges due to their intersecting identities (Leyva et al., 2020; McGee & Bentley, 2017). Moreover, minoritized female students are less likely to report feeling a sense of belonging in STEM although classroom-level belonging is critical to persistence and success (Wilson et al., 2015; Rainey et al., 2018). However, most studies overlook the intersection of race and gender and rarely focus on diverse, open-access minority-serving institutions.

In this study, I examined how Black and Latina female students' identities influence their sense of belonging in gateway mathematics classrooms at a racially and ethnically diverse open access minority-serving institution. The research questions are: (1) How do Black and Latina female students' sense of belonging in the college algebra and precalculus classrooms differ compared to students in other racial and gender groups? (2) How does Black and Latina female students' sense of belonging in college algebra and precalculus change from the beginning to the end of the semester? (3) How do Black and Latina female students describe their college algebra and precalculus learning environment, experiences, participation, persistence, support systems and challenges as it relates to their sense of belonging?

Theoretical Perspectives

To frame my study, I drew on three interconnected theoretical perspectives: college students' sense of belonging, intersectionality and authorizing student perspectives. Strayhorn (2019) argued that belonging is a fundamental human need that must be satisfied before students can

achieve higher-order outcomes such as confidence and creativity. Belonging is context-dependent and closely related to mattering, which is a feeling that one is valued by others. It influences academic behaviors and is associated with engagement, persistence, and achievement. Absence of belonging can lead to anxiety, low self-esteem, isolation, and poor performance.

Moreover, I used Collins and Bilge's (2020) framework of intersectionality, which explores how overlapping systems of power, such as race, gender, and class, mutually shape individual experiences. For Black and Latina women in mathematics, intersectionality reveals how marginalization occurs at the intersection of race and gender, often referred to as the "double bind" (Delgado & Stefancic, 2012). Finally, I use Cook Sather's (2006) concept of authorizing student perspectives to center students' voices and lived experiences. This framework positions students as experts in their own educational journeys and calls for creating spaces where their insights are valued and used to inform meaningful change in classroom practice.

Literature Review

Much of the extant research on sense of belonging focuses on minoritized students at the campus level, particularly within four-year PWIs or research universities (Hurtado et al., 2015; Zumbrunn et al., 2014). Belonging is positively associated with academic achievement, persistence, and mental health (Strayhorn, 2019), while its absence contributes to STEM attrition, especially among minoritized and female students. Although campus belonging is important, the classroom plays a central role in shaping students' daily experiences and decisions to persist in STEM (Wilson et al., 2015; Riegel-Crumb, 2019).

Recent studies have begun to examine belonging at the classroom-level in mathematics education. Griffin (2023), McGrane and Rasmussen (2023), and Lahdenpera and Nieminen (2020) found that interactive learning environments, mentorship, and instructor engagement significantly enhanced belonging. Griffin's study showed the majority of female calculus students identified group work or interactive lectures as key contributors. At Hispanic-Serving Institutions, McGrane and Rasmussen found calculus support courses improved belonging, while Cawley and Wilson (2024) documented that microaggressions undermined it. Urbieta (2022) highlighted how socioeconomic challenges, such as housing instability, lowered belonging among low-income students.

Su (2015) introduced the concept of mathematical microaggressions to describe subtle, often unintentional ways instructors signal that certain students do not belong in mathematics. These include dismissive phrases such as, "It's obvious" or "You should have learned this before," as well as behaviors such as ignoring questions or rushing through the material. On the other hand, mathematical microaffirmations, which are intentional, affirming practices that validate students' mathematical thinking help foster positive mathematics identities and reinforce belonging. As Cawley and Wilson (2024) observed, students often remember how they felt in mathematics class very vividly.

Classroom belonging is tied to motivation, engagement, and confidence (Freeman et al., 2007; Wilson et al., 2015). Students report stronger belonging when instructors are perceived as caring and when active learning is encouraged (Kirby & Thomas, 2022). Despite its importance, research on minoritized women's mathematics classroom belonging remains limited, underscoring the need for further study in diverse institutions.

Methods

I used a sequential explanatory mixed methods design, integrating both quantitative and qualitative data to examine Black and Latina female students' sense of belonging in college

algebra and precalculus classrooms. The quantitative phase was conducted first to identify patterns in belonging, followed by a qualitative phase to interpret and expand upon those findings (Creswell, 2015). The study site was an ethnically diverse, open-access, four-year public college near a major Southeastern city. Of its 11,000 students, 32% identified as Black, 27% Latinx, 24% White, and 12% Asian. Over half were eligible for Pell Grants and 40% were first-generation. The institution holds designations as both an Asian American Pacific Islander Serving Institution (AAPISI) and a Hispanic Serving Institution (HSI).

Quantitative Phase

Participants were enrolled in College Algebra and Precalculus during Fall 2023, in which semesters are 15 weeks long. I visited all sections to administer pre-surveys (weeks 1-3) and post-surveys (weeks 11-14). Surveys were distributed via Qualtrics using QR codes, and only students who completed both were included in the final analysis. The sample included seven sections of College Algebra with support, 37 of College Algebra, and 14 of Precalculus. Courses ranged from 25-30 students. A total of 1,136 students completed the pre-survey (31.0% Black, 30.3% Latinx, 20.7% White, 13.4% Asian, and 4.5% Other; 51.7% female and 48.3% male), and 639 students completed the post-survey (30.4% Latinx, 29.1% Black, 21.1% White, 14.2% Asian, and 5.2% Other; 50.4% female and 49.6% male). The faculty included 44 full-time instructors (47% White, 29% Asian, 18% Black, 4% Hispanic) and five part-time instructors.

Students completed a demographic questionnaire and an adapted Math Sense of Belonging Scale (Good et al., 2012) revised to reflect classroom context. The scale included 30 Likert items (1=Strongly Disagree to 6=Strongly Agree) and demonstrated high reliability (α=0.94). Composite scores were calculated for pre-, post-, and change in belonging. I analyzed the data using SPSS, using an alpha level of 0.05. Descriptive statistics and histograms were used to examine distributions. To address Research Question 1, I conducted a one-way ANOVA on pre-belonging scores across race-gender groups. For post-belonging scores, I used a multi-factor ANCOVA controlling for pre-scores, with race-gender, faculty, mathematics affinity, and expected grade as factors. To address Research Question 2, I conducted a multi-factor ANOVA on belonging change scores using the same variables.

Qualitative Phase

In the qualitative phase, I explored students' experiences to interpret and deepen understanding of the quantitative findings. This approach aligns with the study's theoretical perspectives, intersectionality and authorizing student perspectives, which center students' voices and experiences. I collected two types of qualitative data: mathematics autobiographies and individual interviews. Thirteen participants (five Black, six Latina, and two Black/Latina women) who completed both pre- and post-surveys were purposefully selected to represent a range of belonging scores. Eleven of these participants also submitted mathematical autobiographies reflecting on K-12 mathematics class experiences, which informed the interview protocols. Semi-structured interviews (average 59 minutes) were conducted in person or via Zoom at the end of the Fall 2023 semester. Interview prompts included questions such as, "In what ways did you feel that you belonged in your math classroom?" and "Can you think of a specific example of a time in this class when you felt like you didn't belong?" All interviews were professionally transcribed and I verified the transcripts for accuracy. I analyzed the data using Braun and Clarke's (2022) six-phase reflexive thematic analysis to identify patterns and themes related to students' sense of belonging.

Findings

Quantitative Results

Research Question 1: How do Black and Latina female students' sense of belonging in college algebra and precalculus classrooms differ compared to other racial and gender groups?

Quantitative analyses revealed that Black and Latina female students' mean belonging scores were comparable to other race-gender groups. At the beginning of the semester, only one statistically significant difference emerged: Latina female students reported lower pre-belonging scores than Black male students (p=0.026, Mean Difference=-0.24). Black female students' scores did not significantly differ from any other group. By the end of the semester, when controlling for pre-belonging scores, race-gender was not a significant predictor of post-belonging (p=0.740), indicating no meaningful differences between Black and Latina female students and their peers. Post-belonging mean score for Black female students was 4.5 and for Latina students was 4.4, while the overall mean score was 4.4.

Research Question 2: How does Black and Latina female students' sense of belonging change from the beginning to the end of the semester?

There were no significant differences in change scores based on race and gender (p=0.541). However, other factors were significantly associated with belonging change: faculty (p=0.034), mathematics affinity (p<0.001), and expected course grades (p=0.012). These findings suggest that students' perceptions of their instructors, enjoyment of mathematics, and confidence in their academic performance, played a more substantial role in shaping belonging than race and gender.

Overall, students maintained relatively stable and high belonging scores throughout the semester, with minimal average change. While race and gender did not significantly influence post-belonging or belonging change scores, mathematics affinity and expected grades were significant predictors of students' sense of belonging. Faculty did not significantly impact post-belonging scores, but did influence changes in belonging over time, highlighting the importance of instructors. These quantitative findings provided a foundation for the qualitative phase of the study, and in the next section, I expand on these results.

Qualitative Findings

Through thematic analysis of interviews and mathematics autobiographies, I identified six key factors that promote a sense of belonging in diverse introductory mathematics classrooms:

1. Professors' mathematical microaffirmations – Small validating interactions that affirm students' mathematical thinking and effort.
2. Perceptions of professors as caring, supportive and helpful – Students felt more connected when instructors were approachable and invested in their success.
3. Encouraged peer collaboration – Structured group work fostered academic and emotional support.
4. Peer connections – Positive interactions and relationships with classmates contributed to a sense of community and inclusion.
5. Positive mathematics self-efficacy – Confidence in math ability both supported and was reinforced by belonging.
6. Perception of classroom diversity – Seeing diversity in race and gender helped students feel represented and included.

These factors often worked together to enhance belonging. For example, students who received mathematical microaffirmations were more likely to perceive their professors as caring. Mathematics self-efficacy was both a contributor to and outcome of belonging, forming a positive loop. A conceptual model (Figure 1) illustrates these interconnections.

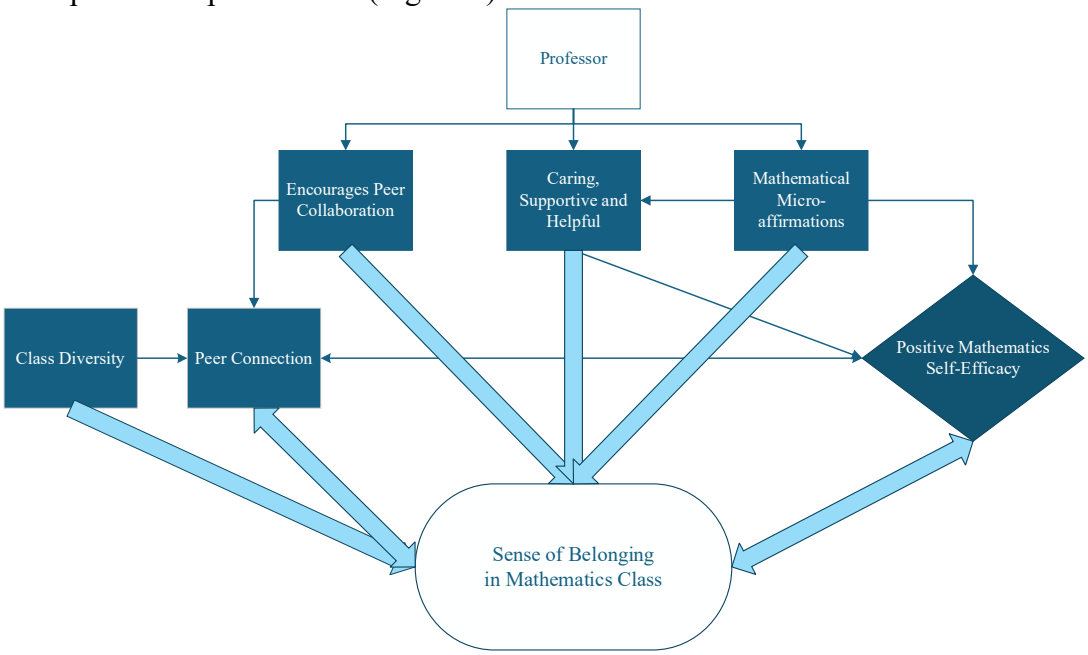

Figure 1. Six Factors that Promote Sense of Belonging in Mathematics Classrooms.

In contrast, students also described six factors that diminished their sense of belonging:

1. Professors' mathematical microaggressions – Subtle, dismissive comments that undermine students' mathematical confidence.
2. Perception of professors as uncaring or judgmental – Students avoided seeking help, fearing embarrassment or shame.
3. Limited peer collaboration – Lack of structured interaction hindered relationship-building.
4. Lack of peer connection – Isolation from classmates reduced feelings of inclusion.
5. Negative mathematics self-efficacy – Low confidence in mathematics ability weakened engagement with class activities and peers.
6. Past negative mathematics experiences – Previous struggles shaped current perceptions of belonging.

Students emphasized that when professors communicated, either explicitly or implicitly, that they were not valued, they became reluctant to be vulnerable about their mathematical challenges. This led to avoidance of interaction, increased frustration, and in some cases, disengagement. Similarly, lecture-only teaching approaches and lack of peer interaction reinforced feelings of isolation.

Notably, supportive professors and strong peer relationships served as protective factors, buffering students against negative experiences. Some students with low mathematics self-efficacy or prior negative mathematics experiences reported increased belonging when these support systems were present. As Britteny shared, "If you need help with something, [Dr. S.] is always there... [They were] easy to talk to so that made the course easier to get through because

when you're in a course for so long with a teacher, you have to get to know them, or it just has to be very easy to approach them. Like you bond over math."

Importantly, the qualitative findings reveal that students' sense of belonging is shaped more by relational dynamics, such as faculty support and peer interaction, than by the perceived difficulty of mathematics itself. Past negative experiences do not necessarily determine future belonging. When professors foster inclusive, affirming environments, students can develop a strong sense of belonging regardless of background or prior mathematics self-efficacy.

Discussion of the Integration of Quantitative and Qualitative Findings

The integration of quantitative and qualitative findings deepens our understanding of how a diverse institutional context influences Black and Latina female students' sense of belonging in mathematics classrooms. While the quantitative data showed no significant differences in belonging scores across race and gender groups, the qualitative findings revealed that diversity alone is not sufficient to foster strong belonging. As Hurtado and Guillermo-Wann (2013) suggested, representation matters, but it must be accompanied by relational and structural support. Students appreciated seeing peers who shared their racial or ethnic identity, but the ability to form supportive peer groups based on shared experiences played a more critical role in fostering belonging.

Racial and gender identity were not salient factors in shaping belonging for most participants in this diverse setting. Participants reported no experiences of racial or gender microaggressions, contrasting with studies at less diverse institutions. However, racial representation still mattered, and students valued being in classrooms where they felt seen and saw others who looked like them. The lack of significant differences in belonging scores across race and gender groups suggests that other factors, such as peer relationships and classroom dynamics, may be more influential in diverse classrooms.

Moreover, students' confidence in their mathematical abilities, shaped by prior educational experiences, influenced their engagement and sense of belonging. Students with negative K-12 mathematics experiences often started college with low mathematics self-efficacy, which impacted their classroom participation. However, when these students encountered supportive professors and collaborative environments, their sense of belonging improved. This suggests that mathematics self-efficacy may be more salient than racial or gender identity in shaping belonging, especially in diverse classrooms where students see others who look like them. It is important to note, that while race and gender did not directly affect belonging scores, students' past educational experiences are often shaped by systemic inequities, which are a direct influence of intersectional identity. This underscores the need to consider how historical and structural factors influence students' current sense of belonging.

Finally, while faculty was not a significant predictor of post-belonging scores, it was a significant factor in belonging change. Supportive faculty behaviors fostered belonging, while mathematical microaggressions and lack of support diminished it. Students did not explicitly connect these experiences to race or gender reinforcing the idea that relational dynamics were more salient in this context.

The integration of findings reveals that belonging is a complex, multifaceted construct shaped by students' prior experiences, classroom relationships, and institutional context. While diversity provides a necessary foundation, intentional pedagogical practices and relational support are essential for fostering belonging among minoritized students in mathematics classrooms.

Practical Implications for Gateway Mathematics Faculty

Creating a classroom where students feel they belong requires intentional, sustained effort throughout the semester. As Strayhorn (2019) emphasized, belonging must be actively nurtured and neglecting this need can contribute to students' academic and emotional struggles.

A strong link emerged between mathematics self-efficacy and students' sense of belonging. Faculty should adopt practices that build students' mathematical confidence, such as normalizing struggle, sharing personal educational experiences and journeys, and offering low-stakes assessments with revision opportunities. Creative assignments such as discussions, presentations and projects can also increase engagement and self-efficacy. Individualized support, especially early in the semester, is crucial for students with low-mathematics self-efficacy.

In addition, students shared that mathematical microaffirmations enhanced their sense of belonging, while mathematical microaggressions hurt it. Faculty development should include training on recognizing and using microaffirmations intentionally, while avoiding harmful language. Faculty peer observation groups can help instructors reflect on classroom communication patterns.

Moreover, clear and accessible office hours, both in person and virtual options, should be consistently communicated, especially to first-year students. Structured peer collaboration, with class norms co-constructed with students, and diverse groupings, can foster meaningful connections. Digital tools such as group chats may further support academic and emotional peer engagement.

Directions for Future Research

Future research should explore which faculty practices most effectively foster belonging by examining instructors whose students show significant changes in belonging over time. Classroom observations and interviews with faculty could reveal how instructor beliefs and behaviors shape belonging, especially through classroom norms. Additionally, studies should investigate the experiences of students who withdraw from or stop coming to mathematics classes, centering their perspectives to better understand attrition. Finally, expanding research to include students with disabilities, LGBTQ+ students, and varied learning environments (e.g., online, hybrid, elementary mathematics education and advanced courses) would offer a more comprehensive understanding of belonging in mathematics education).

Conclusion

This mixed methods study examined the sense of belonging among Black and Latina female students in gateway mathematics courses at a diverse, minority-serving institution. I identified that mathematics self-efficacy, faculty-student interactions, and peer relationships were more influential than race or gender in shaping students' sense of belonging in diverse mathematics classrooms. Faculty practices, such as using mathematical microaffirmations, demonstrating care, and fostering peer connections, played a critical role. Students also actively built peer relationships, even in classrooms lacking collaborative structures.

The study highlights the importance of centering student voices and identifying both positive and negative factors that shape belonging. Importantly, it shows that intentional faculty practices can buffer against negative mathematics experiences and foster inclusive learning environments. As Alexa shared about her belonging experiences, "You're not in it by yourself. You're going to have someone else to help you along the way… not just being there because you have to but being there because you feel like you're needed here." Mathematics classrooms can and should become spaces of belonging for all students.

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