

Female Minoritized Students' Sense of Belonging in College Algebra and Precalculus Classrooms at a Diverse Minority Serving Institution

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Sense of belonging is an essential factor in supporting student success in undergraduate STEM courses. Female minoritized students, in particular, are less likely to report feeling a sense of belonging due to experiences of isolation, bias, racial and gender microaggressions, and stereotype threat. Although researchers have investigated sense of belonging at the campus or department level at PWIs, HBCUs, and research institutions, less is known about students' mathematics classroom belonging at open-access, racially diverse institutions. In this report, I present the preliminary qualitative results from a mixed methods study regarding the aspects of classroom experiences that foster sense of belonging for Black and Latina female students in college algebra and precalculus classrooms at a Minority Serving Institution. My qualitative findings indicate that sense of belonging is influenced by mathematical microaffirmations, mathematical microaggressions and mathematics self-efficacy.

Keywords: Belonging, Intersectionality, Gender, Race, Minority-Serving Institution

Sense of belonging at the classroom level has been identified as a key factor in supporting student's engagement, persistence, academic confidence, and achievement in college (Wilson et al., 2015). However, minoritized female STEM students are more likely than any other demographic group to feel a lack of sense of belonging to their campus (Johnson, 2012) and to their STEM major (Rainey et al., 2018). Researchers argue that minoritized female students face an additional burden in STEM introductory courses, as they navigate both gendered and racialized experiences due to the "double bind," i.e., their intersecting racial and gender identities (Leyva et al., 2020; Museus et al., 2011). Intersectional work that investigates minoritized women's experiences in STEM exist (Borum & Walker, 2012; Leyva, 2016; McGee & Bentley, 2017), but literature addressing minoritized women's sense of belonging remains underdeveloped especially in diverse introductory mathematics classrooms.

Introductory mathematics courses such as college algebra and precalculus can serve a gatekeeping function, as it is one of the places where students decide whether to stay or leave STEM, especially in open-access institutions (Seymour & Hunter, 2019). There are limited studies on mathematics classroom-belonging that consider race or gender, and even fewer that address the intersection of these dimensions in diverse mathematics classrooms, particularly for female minoritized students. Understanding female minoritized students' sense of belonging, therefore, is a key aspect in better understanding their academic experiences in gateway mathematics classrooms, and by extension, understanding how to better support their persistence and achievement through classroom structures and pedagogies that foster rather than hinder students' sense of belonging (Hurtado & Alvarado, 2015; Museus et al., 2017; Strayhorn, 2018).

Consequently, I examined how minoritized female students with intersecting racial and gender identities experience belonging, in gateway mathematics classrooms in a minority-serving, open-access institution with a racially and socioeconomically diverse student population, a context seldom considered in belonging studies. The following research question guided this study: What aspects and experiences in college algebra and precalculus classrooms

support or hinder Black and Latina female students' sense of belonging at a racially and ethnically diverse open access institution?

Theoretical Perspectives

To explore female minoritized students' sense of belonging and experiences in gateway mathematics classrooms, I framed my study using the two conceptual frameworks: (a) sense of belonging and (b) intersectionality. The importance of *sense of belonging* as a conceptual framework has been well established in the literature (Ostrove & Long, 2007; Strayhorn, 2018). Researchers have connected sense of belonging to student's identity, types of institution, interaction with peers, relationship with faculty, campus climate, engagement, and positive student outcomes (Bollen & Hoyle, 1990; Hurtado et al., 2015; Strayhorn, 2013; Wilson et al., 2015; Zumbrunn et al., 2014). For this study, I used Strayhorn's (2018) definition of sense of belonging: "Students' perceived social support on campus, a feeling or sensation of connectedness, and the experience of mattering or feeling cared about, accepted, respected, valued by, and important to the campus community or others on campus" (p.4).

My second framework, *intersectionality*, is related to one of the core elements of Strayhorn's (2018) theoretical model of belonging: social identities intersect and affect students' sense of belonging, and students experience belonging in different ways. Crenshaw (1989, 1991) is credited with introducing the term "intersectionality," in order to explore how Black women experience double-discrimination on the basis of race and sex. For my study, I used Collins and Bilge's (2020) working definition of intersectionality: "Intersectionality investigates how intersecting power relations influence social relations across diverse societies as well as individual experiences in everyday life. As an analytic tool, intersectionality views categories of race, class, gender – among others – as interrelated and mutually shaping one another" (p. 2).

Background Literature

Research has indicated that sense of belonging is correlated with positive outcomes such as academic achievement, retention, persistence and mental health (Strayhorn, 2018; Gopalan & Brady, 2020). Conversely, a lack of sense of belonging is the primary cause of student opting out from their STEM major, particularly among minoritized and female students, even when achievement is high (Strayhorn, 2018; Good et al., 2012). Frequent validating interactions with supportive faculty, engaging pedagogies, positive interactions with diverse peers, a welcoming campus culture/climate, racial/gender diversity, living on campus, and positive perception of one's cultural identity positively contribute to minoritized students' sense of belonging (Strayhorn, 2008; Hurtado et al., 2015; Gasman & Nguyen, 2016; Hurtado & Carter, 1997; Johnson, 2007; Lee & Davis, 2000; Locks et al., 2008; Museus et al., 2017; Nguyen et al., 2021; Velasquez, 1999). Moreover, when students feel a sense of belonging in their educational environment, they are willing to take risks, challenge themselves, and commit to their major (Booker, 2016).

Although most belonging studies are situated at the campus level, because the classroom is the primary context where student and faculty interactions take place, it serves a critical role in promoting sense of belonging and may even determine which students decide to remain in STEM majors (Riegle-Crumb et al., 2019; Seymour & Hunter, 2019). Studies have linked classroom belonging to self-efficacy, academic motivation, engagement, confidence, achievement, and persistence (Freeman et al., 2007; Kirby & Thomas, 2022; Wilson et al., 2015; Zumbrunn et al., 2014). Moreover, students feel more connected in classes with instructors who are perceived as caring, open, supportive, competent and incorporate active learning pedagogies

that encourage peer collaboration (Wilson et al., 2015; Kirby & Thomas, 2022; Booker, 2007). Despite the importance of sense of belonging, the research remains underexplored for female minoritized students in diverse settings (Booker, 2016; Johnson, 2012; Rainey et al., 2018; Strayhorn, 2018), particularly in the mathematics classroom context.

Recent research point to faculty microaffirmations as a positive factor in students' sense of belonging in STEM (Demetriou et al., 2023; Estrada et al., 2019). Cawley and Wilson (2023) defined *mathematical microaffirmations* as subtle actions or statements that can support students' positive mathematics identity by affirming that they belong in mathematics. Mathematical microaffirmations are more significant when they come from faculty or others who have influence in a learning context and are most powerful when they are specific to the individual student. In contrast, mathematical microaggressions are subtle ways in which instructors convey the message that students don't belong in mathematics which can have profound negative effects (Su, 2015).

Methods

This study was conducted at an open-access, four-year, public college in the Southeast region with an ethnically diverse population of about 12,000 students (12% Asian/American, 32% Black, 27% Latinx, 24% White/ 59% Female and 41% Male). Approximately 40% of the entering freshman class are first-generation students and over 50% are eligible for a Pell-grant. The college has also earned two specific designations under the Minority Serving Institutions Program: Asian American and Pacific Islander Serving Institution and Hispanic Serving Institution. College algebra or precalculus is usually the first math course which STEM first-year students take at the institution.

This report is part of a larger mixed-methods study which integrated both quantitative (pre- and post- sense of belonging surveys) and qualitative methods (mathematics autobiography and semi-structured individual interviews). In the first quantitative phase, 1,135 students completed the presurvey at the beginning, and 639 students completed the post-survey at the end of the Fall 2023 semester in 44 sections of college algebra and 14 sections of precalculus. This paper reports on the second qualitative phase, in which I interviewed 13 students (two Black-Latina students, five Black students, and six Latina students) at the end of the Fall 2023 semester. Of the 13 interview participants, 11 also completed mathematics autobiographies. Each hour long semi-structured interview was audio recorded and transcribed; all students names are pseudonyms.

I analyzed the transcripts and mathematics biographies using Braun and Clarke's (2006, 2021) six-phases of thematic analysis using MAXQDA. I began the coding process using a deductive approach using my two theoretical perspectives, sense of belonging and intersectionality. I then shifted to an inductive state of coding (Esposito & Evans-Winters, 2022) in which I: (a) read through the transcripts, (b) engaged in descriptive coding by assigning one word or short phrase to key moments, and (c) engaged in in vivo coding with the participants' words/phrases. Through this process I constructed themes from combining or rearranging codes. I also kept a research journal to write down reflections, emergent ideas, questions and research progress.

Findings

In examining how Black and Latina female students described their experiences, two major themes emerged as pivotal in affecting their sense of belonging: mathematical microaffirmations/ mathematical microaggressions, and mathematics self-efficacy. Quantitative results indicated

that five students' sense of belonging to their mathematics class increased, four students' belonging stayed relatively the same, and four students belonging' decreased.

Mathematical Microaffirmations and Microaggressions

Three of the four students whose sense of belonging increased, discussed feeling uncertain of their sense of belonging at the beginning of the semester, but felt encouraged by their mathematics professor which helped them believe that they could do the mathematics. Alexa said, "I was just like, I don't know what I'm doing but, she came over and she was like, you're on the right track...you're doing this perfectly...I know what I'm doing and I'm doing this correctly. So, all of this is doable." Marlina also credited her professor for making her believe that she was capable of being successful in her precalculus class:

He would ask a question and he would look straight at me and be like, Marlina, you're on the right track. And I'd be like, I don't know. And he'd be like, "Okay, well, what are you thinking? And then I'd tell him what I'm thinking. He'd be like, "Yes, that's exactly you are-- you're on the right track. And I always felt encouraged. And then it also made me feel good to go up on the board and do it. I didn't feel like I was bad at math anymore. I felt like if I applied myself, then I could accomplish things... I felt I didn't want to hide and disappear into the back of that wall.

Mathematical microaffirmations also involves listening to acknowledging and validating students' mathematical questions and concerns (Cawley & Wilson, 2024). Tyanna shared how she struggled with mathematics test anxiety and her professor pulled her aside after class to encourage her and give her strategies to deal with it. Tyanna stated, "I felt seen because I didn't know it was a thing. I thought it was just based, like, anxiety about anything because I always have a little bit, but it just felt like, oh, other people experience it, and it's not like I'm being dramatic." Moreover, Tyanna appreciated how her professor was patient and understanding when someone asked a question on a problem even it was "easy."

On the other hand, examples of discouraging mathematical microaggression phrases that students shared which made them feel that they didn't belong in the class were, "Everyone should know this," "This is high school," "This is easy," "You should already know this, so we're just going to skip this step". Participants shared that they felt "stupid," or not as smart as other people in the class, and not wanting to ask any more questions. Anela described how she felt discouraged after experiencing a mathematical microaggression.

I mean, like, if somebody is telling you over and over in an aggressive tone, this is review, I feel let down because maybe I should know this, but even though everybody in this class is struggling with review topics, it's not something that you should keep calling out we should know this. How about, let's practice this or let's go over this real quick since I see that majority of you are having a problem with it... I felt like maybe I wasn't smart enough because she kept over saying like, oh, you don't get this. Well, maybe you should drop out of the class right now. I take it seriously when it's coming from a professor because I'd rather do the smart thing, you know? So, I did feel a little academically insecure.

Mathematics Self-Efficacy

During the interviews, seven students (three students whose belonging decreased, all four students whose belonging was constant, and one student whose belonging increased) shared that they felt behind, did not feel prepared for their mathematics course, or felt helpless even though they tried their best. For instance, Jess explained that she did not learn key mathematical

concepts in elementary school, which made her feel as if she was getting judged in her college algebra class for struggling. Therefore, Jess did not feel belonging in the class explaining, “everybody would get a question down. I’m still trying to figure out how do you even go about it. It made me feel left behind. I would just slowly move on from the question and going on to the next, so it won’t seem like I’m stuck on this question forever during groupwork. If I don’t understand it, I’ll let someone else take over.” Similarly, Faith also shared that everyone else seemed to understand, which made her refrain from engaging in class activities with her classmates. Likewise, Britteny also felt discouraged when she just could not understand a problem: “It wasn’t more like anyone made me discouraged. It was like an internal thing. Like wow, how come I don’t understand this? You just feel a little bit down, the way he explained it is so easy, but I’m just not getting it, you know?” By the end of the semester, Ana had given up on her college algebra course: “the more that I knew that I couldn’t get it, I couldn’t do it, it’s kind of just discouraging, to where one gives up.”

In contrast, all four students whose belonging increased, viewed themselves as capable of doing well in their mathematics class. When asked what made her feel belonging in her precalculus class, Alexa, pointed to “the validation that I can do the work and understand it as much anyone else.” Another student, Leslie, described herself as “really good at math,” found her professor easy to understand and shared, “I felt like I belonged.” For Marlina, at the beginning of the semester it was dreadful going to class, but that slowly changed for her. “I think my sense of belonging increasing definitely made me do better, because if I had continued to feel like, I hate this, I don’t want to go to class, and if I continue to have that shadow on myself, I wouldn’t have done well in the class. But because I felt like I can do this, like other people are encouraging me, and then I was able to do a lot better in the class, and I enjoyed it, ultimately. I was proud of myself in the end.”

Discussion

My study differs from past studies, as Black and Latina female students did not discuss experiencing racial or gender microaggressions explicitly; rather, the participants expressed appreciation of seeing diversity in their classrooms. They did however raise mathematical microaffirmations/microaggressions and mathematics self-efficacy as key to their sense of belonging. Therefore, to increase students’ belonging in the classroom, mathematics faculty should consciously include mathematical microaffirmations in their interactions with their students, by noticing and encouraging their efforts, and creating space for students to make mistakes, present their work in small groups, and discuss their thinking out loud with peers during class. They should also avoid unintentionally discouraging students with mathematical microaggressions as it decreases students’ sense of belonging.

Although mathematical microaffirmations is critical in increasing students’ sense of belonging, it is not sufficient. Students’ mathematics self-efficacy is also related to students’ sense of belonging, although the directionality between self-efficacy and belonging is less clear. However, preliminary analysis suggests that faculty can influence students’ self-efficacy which can support or hinder belonging and vice versa. Participants discussed the following ways in which their professors can help students develop mathematics self-efficacy: (a) frequent informal feedback aside from assessment, (b) approachability and availability of professors outside of class, (c) engaging activities that include peer-collaboration, (d) a classroom environment where questions are encouraged, and (e) opportunities for students to experience small successes in the classroom. These findings provide evidence of the significance of faculty’s role in fostering students’ belonging through mathematical microaffirmations and mathematics self-efficacy.

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