

Navigating Belonging, Competence, and Career Aspirations in Mathematics: Experiences of First-Generation, Low SES Women

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This study investigates the academic journeys of first-generation, low socioeconomic status (SES) women in mathematics, focusing on their sense of belonging, perceptions of competence, and career aspirations. Using narrative inquiry, the research draws on interviews and reflections to illuminate how isolation, identification as “rule followers,” and a lack of mentorship shape their experiences. The study adopts Wenger’s (1998) mode of belonging framework—engagement, alignment, and imagination—to analyze how these students interact with their mathematics community and envision their roles within it. Findings highlight the urgent need for mentorship and career guidance tailored to underrepresented students in STEM. This research provides insight into institutional strategies for supporting the success of first-generation, low SES women in mathematics.

Keywords: belonging, career guidance and mentorship, competence, first-generation

The underrepresentation of women and racially/ethnically minoritized students in Science, Technology, Engineering, and Mathematics (STEM), particularly in mathematics, is a persistent issue in higher education (Beasley & Fisher, 2012; Master & Meltzoff, 2020). For first-generation, economically disadvantaged students, these challenges are further compounded by a lack of institutional knowledge, resources, and mentorship (Kim & Sax, 2018; Mishra, 2020). These students often navigate the academic landscape without the familial or social networks that their more privileged peers rely on, facing significant barriers in accessing the support necessary for academic success and career development (Choy, 2001; Mishra, 2020). As a result, many of these students experience feelings of isolation and uncertainty, particularly within the competitive and exclusive environments of STEM fields (Good et al., 2012).

Mentorship plays a crucial role in fostering student success, providing both academic and emotional support, yet first-generation, low-income students often find themselves without this vital resource (Piatek-Jimenez, 2008). The absence of consistent mentorship can limit students’ career aspirations, leading them to pursue more practical, though uninspired, options that do not fully align with their academic strengths or passions (Piatek-Jimenez, 2015). Furthermore, implicit biases and stereotypes can exacerbate these issues, reinforcing feelings of non-belonging and limiting opportunities for underrepresented students in STEM (McGee & Martin, 2011; Good et al., 2012; Rainey et al., 2018).

Through Wenger’s (1998) framework of modes of belonging—engagement, alignment, and imagination—this study explores how gender, race, first-generation status, and socioeconomic disadvantage intersect to shape the academic experiences of women in mathematics. Thus, the study aims to answer the following research question: How do women of low socioeconomic status experience their mathematics major, particularly in relation to their sense of belonging within their mathematics community? The study highlights the role of mentorship, the challenges of belonging, and the importance of career guidance in supporting the academic and professional development of these students.

Theoretical Framework

The theoretical framework guiding this study is based on Wenger's (1998) concept of "modes of belonging," which include engagement, alignment, and imagination. These modes provide a lens for understanding how individuals negotiate their identities and find belonging within a community of practice, such as an academic or professional field. Each mode offers a distinct yet interrelated perspective on the processes through which individuals experience inclusion or exclusion, and how these experiences impact their participation and development of mathematical competence.

Engagement refers to the active participation in a community through the ongoing negotiation of meaning, where individuals interact with others and the environment to co-construct knowledge and develop their sense of belonging. Engagement is key to identity formation as it integrates doing, thinking, feeling, and belonging (Wenger, 1998). However, engagement is not always guaranteed; individuals may face barriers to full participation due to social dynamics, unequal power relations, or institutional structures. When engagement is limited, it can lead to feelings of marginalization and prevent individuals from fully developing their competence within the community.

Alignment involves coordinating one's actions and efforts with the broader structures, goals, and expectations of the community. It requires individuals to adapt to the norms, values, and practices that define what is considered competent or valuable within the community. Alignment, however, can also be disempowering if it involves blind adherence to prescriptive norms without room for individual agency. For individuals who have historically been excluded from dominant communities, alignment may be particularly challenging, as their identities and experiences may not fit neatly within the established culture of the institution. This tension can result in a disconnection between personal goals and the broader expectations of the community.

Imagination is the ability to envision future possibilities and create new ways of being within the community. It allows individuals to transcend immediate circumstances, think creatively, and imagine their potential trajectory within the community. Imagination plays a crucial role in helping individuals see themselves as capable of growth and achievement. However, when access to role models, mentors, or opportunities for exploration is limited, imagination can be stifled, restricting an individual's ability to envision a broad range of future possibilities. This limitation can hinder one's long-term engagement and commitment to the field.

Together, these three modes of belonging—engagement, alignment, and imagination—offer a comprehensive framework for examining how individuals navigate their participation in academic or professional communities. They highlight the dynamic and often complex nature of belonging, showing how barriers in any one mode can impact an individual's overall sense of identity, competence, and future aspirations within a community of practice.

Method

Background and Participants

This study employs a narrative inquiry approach to explore the academic journeys of two first-generation, low socioeconomic status women pursuing mathematics degrees at a research-intensive large university (Clandinin, 2006). Nia, a biracial (Black and White) student, and Bethany, a White student, were selected due to their shared characteristics as first-generation students and double majors in Pure Mathematics and Secondary Mathematics Teaching (SMT). Nia had switched majors twice—first in Chemistry and then Psychology—before finding satisfaction in mathematics. Bethany, on the other hand, identified more strongly with the SMT

community and managed her studies alongside work to maintain financial independence. Both participants faced challenges related to belonging, competence, and mentorship, which shaped their academic paths and career aspirations.

Data Collection

Data were collected during the spring 2022 semester through semi-structured, in-depth interviews and weekly video reflections. Three interviews were conducted with each participant via Zoom, focusing on their sense of belonging, competence, and their future in mathematics. In addition, weekly video reflections collected throughout the semester, which allowed the participants to share real-time updates on their academic and social experiences. Throughout the process, field notes were taken to document key observations and reflections, helping the researcher triangulating the data and capturing a fuller picture of the participants' experiences.

Data Analysis

The narrative inquiry approach was used to examine the participants' experiences in depth, with Wenger's (1998) mode of belonging framework serving as a lens for data analysis. In this study, narrative is defined as a way of understanding and representing the participants' lived experiences as storied phenomena that unfold over time and within specific social and cultural contexts. Drawing on Clandinin and Connelly's (2000) perspective, narratives are conceptualized as both the means of inquiry and the objects of study, reflecting how individuals make sense of their identities and experiences through the stories they tell. By centering on the interviews and weekly video reflections as the primary sources of narrative data, the study captures authentic evidence of the participants' everyday experiences—experiences that are often overlooked or devalued by institutions, instructors, and peers within the mathematics community. These narratives provide a lens into how the participants navigate the intersecting challenges of belonging, competence, and career aspirations, revealing the subtle and overt ways in which systemic barriers shape their journeys.

Open, axial, and selective coding processes were followed to systematically analyze these narratives while remaining grounded in Wenger's (1998) framework. First, open coding was employed to identify initial categories from the interview and reflection transcripts, focusing on broader patterns related to the modes of belonging, conceptualized through *engagement*, *alignment*, and *imagination* components. Next, axial coding was used to connect related themes, integrating these patterns with Wenger's (1998) framework to explore how the participants' sense of belonging within the mathematics community was shaped and negotiated. Finally, selective coding was applied to distill the core themes reflecting the participants' evolving modes of belonging, specifically in relation to participatory actions, mathematical competence, career aspirations, and the influence of mentorship (or the lack thereof).

Wenger's (1998) framework provided a theoretical anchor, enabling the analysis to explore the dynamic interplay between the participants' identities as first-generation, low SES women and their experiences within the mathematics community. This iterative approach ensured that the findings honored the richness of the participants' narratives while being theoretically informed by the mode of belonging framework, ultimately illuminating how their identities and experiences were shaped by their interactions within their academic and social contexts.

Findings

The findings from the narratives of Bethany and Nia reveal key insights into how first-generation, low SES women navigate the mathematics community. This section explores three

central themes that emerged from their stories: (a) their sense of belonging and feelings of isolation in academic spaces, (b) their perceptions of competence and identity as learners of mathematics, and (c) the role of mentorship and guidance in shaping their career aspirations. While both women share common struggles tied to their socioeconomic and gender identities, Nia's biracial identity adds an additional layer of complexity to her experiences, creating both shared and distinct challenges in how they perceive and engage with their academic environment. Nia and Bethany's experiences reveal the interconnectedness of belonging, competence, and mentorship in their mathematics journeys, each influencing the others in profound ways. Through Wenger's (1998) modes of belonging—engagement, alignment, and imagination—both participants grappled with feelings of isolation and uncertainty about their place in the mathematics community, compounded by perceptions of competence and the absence of mentorship.

Belonging and Isolation in the Mathematics Community

Both Nia and Bethany struggled with a sense of belonging within their academic community, particularly in group settings where they often felt marginalized by more confident or prepared peers. Bethany's feelings of exclusion were exacerbated by her perception that others were more capable, leading her to disengage from group work. She reflected, "I just assume people like Troy¹ know more than me, so they must be doing it right, even if it doesn't make sense to me" (Bethany, Reflection 2). This assumption hindered her ability to fully engage, aligning herself only passively within the group, which deepened her isolation.

Similarly, Nia's experience of exclusion was tied to her peers' faster pace and greater mathematical background. She remarked, "Sometimes, especially in group work, I'm just the person watching others solve problems. It's hard when others move faster, and I can't keep up" (Nia, Reflection 4). The sense of being sidelined diminished her engagement and made her feel like an outsider in a space where she struggled to align her academic identity with the expectations of the mathematics community. For both participants, their first-generation status may have contributed to their challenges, as they lacked access to social and familial networks that could have supported them in navigating college.

Perceptions of Competence: Rule-Following vs. Rule-Making

Both Bethany and Nia saw themselves as "rule followers," a mindset that limited their perception of competence and ownership over mathematical knowledge. This tendency to follow prescribed methods without feeling a deep connection to the material undercuts their confidence. Bethany reflected on this in saying, "I'm just a rule follower, really. I do what the professors tell me to do, and that's how I know I've done it right" (Bethany, Reflection 7). For her, mathematical success was defined by adherence to the rules set by her instructors, rather than by personal exploration or critical thinking.

Nia echoed this sentiment, expressing frustration that her learning experience was mechanical and devoid of intellectual autonomy. "I don't feel like I have ownership over the math I'm doing. It's just a bunch of methods I follow, and it feels like I'm not really the one making decisions" (Nia, Interview 1). This rule-following approach led both women to feel disconnected from the deeper, creative aspects of mathematics, reinforcing their position on the

¹ Troy was one of Bethany's peers who often dismissed her contributions during group work, reinforcing her feelings of inadequacy and furthering her sense of isolation. Bethany frequently referred to him in her reflections, highlighting the impact of his actions on her confidence and participation.

periphery of the mathematics community. The shift from rule-following to rule-making—an essential transition in higher-level mathematics—remained out of reach for them, thus further impacting their engagement and alignment.

Mentorship and Career Guidance

The absence of mentorship played a crucial role in shaping both participants' academic trajectories and their ability to imagine broader career possibilities. Without a mentor to help her explore the landscape of opportunities, Bethany felt confined to practical career choices, such as teaching. While she saw it as a viable and straightforward path, she expressed uncertainty about whether it was the most fulfilling option available to her. "I really wish I had someone to guide me more. I don't think I've explored all the possibilities with a math degree, but there's no one really pointing me in a different direction" (Bethany, Interview 2). This lack of guidance diminished her alignment with the larger goals of the mathematics community and limited her ability to imagine herself in a more diverse array of mathematical roles.

For Nia, the mentorship she received in high school did not continue into her university life, leaving her to independently navigate her academic and career goals. She reflected: "My high school teacher pushed me toward math, but in college, it feels more like I'm on my own" (Nia, Interview 1). This lack of consistent support left her uncertain about pursuing more ambitious career paths like data analytics, reinforcing feelings of isolation and non-belonging.

Nia also revealed that her academic advising lacked direction, particularly in relation to STEM fields. She explained: "When I was looking for different careers, there wasn't much suggestion for the STEM field... I wasn't looking at STEM. I was looking at everything but STEM" (Nia, Interview 2). This gap in guidance may reflect systemic implicit biases that can affect the opportunities and support available to students from underrepresented groups, including Black women, in STEM fields, potentially reinforcing stereotypes about who is deemed capable of pursuing scientific careers. Without tailored mentorship to counter these biases and explore broader career options beyond teaching, Nia may have experienced a sense of disconnection from the academic community. This might hinder her confidence in pursuing other fields, such as data analytics, which she saw as a more challenging and fulfilling path, but one she did not feel equipped to follow due to the lack of encouragement and support.

Discussion

The experiences of Nia and Bethany reveal the profound impact of gaps in engagement, alignment, and imagination on their academic trajectories, career choices, and perceptions of competence. These themes highlight how the absence of meaningful support structures can hinder the success and persistence of women and racially/ethnically minoritized students in mathematics.

Belonging and isolation emerged as critical issues, directly linked to the students' engagement with their mathematics community. Both participants felt sidelined in group settings, a dynamic that undermined their engagement and reinforced their sense of isolation (Wenger, 1998). For Bethany, group work often left her feeling less competent compared to her peers: "I just assume people like Troy know more than me" (Bethany, Reflection 2), highlighting how perceived disparities in competence contribute to disengagement (Good et al., 2012). Nia faced similar challenges, remarking that she often felt like "the person watching others solve problems" in group settings, further underscoring the exclusion she felt within the mathematics community (Nia, Reflection 4). These feelings of isolation were magnified by their first-

generation status, as both lacked the social capital necessary to navigate academic spaces more effectively (Choy, 2001; Mishra, 2020).

Rule-following vs. rule-making also played a significant role in the participants' academic journeys related to their perceived competence. Both Nia and Bethany saw themselves as "rule followers," a perspective that limited their sense of ownership over mathematical knowledge and stifled their ability to engage in creative problem-solving (Di Martino & Zan, 2010). Bethany reflected on this in saying, "I'm just a rule follower" (Bethany, Reflection 7), while Nia described her frustration at being unable to make decisions independently in her mathematical work (Nia, Interview 1). This internalization of prescriptive learning models prevented them from fully aligning with the broader goals of their academic community, diminishing their confidence and reinforcing their feelings of being outsiders (Wenger, 1998).

The absence of mentorship and career guidance was particularly detrimental to the students' ability to imagine broader career possibilities in mathematics. Bethany expressed regret over not having someone to guide her career exploration, stating that she wished she had more opportunities to learn about the "possibilities with a math degree" (Bethany, Interview 2). Nia echoed this sentiment, noting that while her high school teacher encouraged her toward mathematics, she felt isolated and unsupported at the university level (Nia, Interview 1). McGee and Martin (2011) argued that marginalized students may navigate academic spaces while managing or rejecting imposed stereotypes, which could explain why Nia did not initially seek support. This lack of mentorship, coupled with implicit biases that may have shaped the career advice they received, further limited their ability to align their academic goals with ambitious career paths (Beasley & Fisher, 2012; Cribbs et al., 2021; Piatek-Jimenez, 2008, 2015).

These findings suggest that the combined effects of disengagement, misalignment, and limited imagination create a cycle of self-doubt and marginalization for first-generation, low SES women in mathematics. Addressing these issues requires a comprehensive support system that fosters engagement through meaningful participation, aligns personal goals with community expectations, and encourages the imagination of broader career possibilities through targeted mentorship that is free of stereotypes and biases (Wenger, 1998; McGee & Martin, 2011; Piatek-Jimenez, 2008b).

Concluding Remarks

An exploration of Nia and Bethany's experiences revealed critical gaps in institutional support for first-generation, low SES women in mathematics. These students struggled to fully integrate into their mathematics communities, often feeling isolated and unable to align their personal goals with the academic expectations placed upon them. Their perception of themselves as rule-followers, rather than independent thinkers, compounded their lack of confidence and diminished their potential for success. Furthermore, the absence of mentorship played a crucial role in shaping their career aspirations, which were more influenced by financial necessity than by a true exploration of the field's possibilities. Importantly, this study also highlights the need to further investigate how racial identity intersects with first-generation and low SES status to impact students' experiences in STEM, particularly regarding access to support and mentorship. This study emphasizes the urgent need for targeted institutional interventions, including mentorship, career counseling, and exploratory learning opportunities, that foster a sense of belonging and competence among underrepresented students in STEM. Addressing these barriers is essential for enhancing their academic outcomes, and future research should explore how mentorship and peer networks can be effectively leveraged to support their success.

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