Daily Affirmations: Strengthening Marginalized Student Identity in First Year College Calculus Courses

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This study investigates how marginalized students experienced affirmation of their mathematical identities in first-year calculus. Thematic analysis revealed thirteen forms of identity affirmation, clustered into internal (understanding and utility) and external (peer instruction, community, instructor recognition) categories. While understanding and utility were universally affirming, most affirmations were socially mediated. Findings highlight the critical role of community and instructional practices in shaping identity, suggesting that affirming environments are essential for supporting persistence in STEM.

Keywords: mathematical identity, identity affirmation, calculus

Introductory courses disproportionately drive minoritized students out of STEM pathways (Ellis et al., 2016; Hatfield, 2022). This attrition is especially troubling given the persistent underrepresentation of these students in postsecondary mathematics and STEM fields more broadly (Greene et al., 2008; Riegle-Crumb et al., 2019). Understanding the mechanisms by which early mathematics courses contribute to inequitable outcomes remains a critical concern for both researchers and practitioners.

One promising lens for examining this issue is that of student identity. Identity shapes how students perceive themselves and their relationship with mathematics and is increasingly recognized as a central construct in mathematics education research (Darragh, 2016; Fellus, 2019; Li et al., 2020; Radović et al., 2018; Rodriguez et al., 2018). How students come to see themselves—such as whether or not they identify as "math people"—has been shown to strongly influence their success, persistence, and long-term engagement in mathematics (Miller-Cotto & Lewis, 2020). As these authors argued, this self-perception is not merely internal but is deeply intertwined with the social and cultural contexts of learning, shaping how students engage with mathematical tasks, how they respond to challenges, and how motivated they feel to continue in mathematics.

At the same time, research has highlighted how mathematics learning environments can marginalize students. Solomon (2007), for instance, documented how students often experience disconnection from the mathematical community even when they retain confidence in their abilities. Such findings, along with results about the impact of mathematics learning environments on learning and community (Leyva et al, 2020; Oppland-Cordell & Martin, 2015) suggest that affirming and supporting students' mathematical identities is essential, particularly for those who are under-represented or marginalized in STEM.

This paper reports on an investigation into what was specifically affirming to marginalized students' identities in first-year college calculus courses. By centering student perspectives, we aim to illuminate practices and experiences that strengthen students' sense of belonging and mathematical identity, offering insight into how introductory courses might be reimagined as spaces of affirmation rather than exclusion.

Literature Review & Research Questions

An extensive body of research has examined identity in mathematics and STEM education, and consequently, the conceptual and methodological foundations of this work are varied. Simpson and Bouhafa (2020), in their synthesis of empirical research on identity across STEM published between 2000–2018, highlighted both the increasing prominence of identity as a construct and the persistent challenges in defining and operationalizing it. They note that while identity has been shown to be a powerful lens for understanding persistence and participation in STEM, the literature is fragmented in how it conceptualizes identity and how its dimensions are applied in research.

Radović et al. (2018) further emphasize this complexity, identifying five main categories through which the literature has operationalized identity. The most prominent approach conceptualizes identity as narratives, drawing on Sfard and Prusak's (2005) framework of identity as a collection of stories told by the individual and by others about them. This narrative lens has been especially influential in studies that seek to capture the lived experiences of students navigating mathematics learning. However, as Radović et al. argue, a persistent challenge lies in the relationship between the defining features of identity (e.g., recognition, positioning, affect, agency) and their operationalization. Identity research often combines multiple dimensions, but the lack of clarity about how these interact leaves the field with conceptual fuzziness and limited cumulative insight.

Another pattern in the existing literature is a tendency to emphasize the negative aspects of identity—how deficit narratives, marginalization, and exclusionary practices undermine students' sense of belonging and persistence in mathematics (Nasir & Cobb, 2007; Solomon, 2008). *While this body of work is critical in highlighting systemic inequities, it also creates a gap*: less attention has been paid to the affirming aspects of identity, or to the pedagogical practices that can strengthen students' mathematical identities in positive and sustaining ways.

Taken together, the gaps in the literature suggest an urgent need for research that attends to affirming aspects of identity in mathematics and connects pedagogical practice directly to identity formation. *This study seeks to address these absences by examining the specific ways marginalized students experience affirmation of their identities in first-year college calculus courses.* The study is guided by the research questions: (1) What experiences do minoritized students say are affirming to their identities? and (2) How have experiences in first year mathematics courses affirmed minoritized students' identities relative to mathematics?

Theoretical Framework

While most people have an intuitive sense of identity, defining it rigorously has proven challenging (Wetherell, 2010). In mathematics education, this has led to a proliferation of approaches and definitions, often inconsistent with one another, that has made the field of mathematics identity research difficult to synthesize (Darragh, 2016).

To bring clarity to this project, I draw on two complementary perspectives: Gee's conception of identity as Discourse and Sfard and Prusak's framework of identity as narrative. Radović et al. (2018) define five categories of how identity has been operationalized all align with James Paul Gee's (2000) notion of identity as being recognized as "a certain type of person." For Gee, identities are situated within Discourses—socially and culturally patterned ways of speaking, thinking, acting, and interacting. A Discourse is more than language: it encompasses values, beliefs, practices, gestures, and assumptions that convey belonging to a community. From this perspective, identity formation is not merely an individual psychological process but a fundamentally social one, emerging in relation to cultural norms and institutional structures. This

emphasis on the cultural and social contexts of learning mathematics makes Gee's framing particularly relevant to studying marginalized students in college calculus courses, where recognition and belonging play crucial roles.

To make this theoretical perspective analytically useful for qualitative research, I follow Radović et al.'s (2018) recommendation to be explicit about operationalization. I adopt Sfard and Prusak's (2005) conception of identity as a collection of stories about a person, told by themselves or others. For a story to be part of identity, it must be (1) reifying—transforming a fleeting behavior into a stable trait; (2) significant—meaningful in a person's social or cultural life; and (3) endorsable—validated or accepted by the person as at least partially true. This framework emphasizes how particular narratives come to matter for students, both those they claim for themselves ("I'm the kind of person who struggles in math") and those assigned to them by others ("She's the kind of student who always gets it right").

Identity as narrative is especially useful in connecting learning with its sociocultural context. Narratives like "only certain people are good at math" can be seen not just as individual beliefs but as socially circulating stories that shape students' opportunities to belong in mathematics. By attending to the stories marginalized students tell about themselves and those told about them in classroom contexts, this framework enables me to examine how classroom practices, teacher feedback, and peer interactions contribute to affirming—or undermining—mathematical identities. In this way, the framework provides both a broad sociocultural grounding (via Gee) and a concrete operationalization for analysis (via Sfard & Prusak).

Methods

The population for this study consisted of undergraduate students enrolled in either Calculus I or Calculus III, first and second year mathematics courses with the highest equity gaps in terms of DFW rates at the research site. A list of eligible students was generated by the Mathematics Department. From this list, fifteen students were recruited at the beginning of the semester via email invitation. All participants consented to take part in the study, which focused on their experiences navigating their calculus courses.

To capture students' evolving perspectives over time, each participant completed three semi-structured interviews (Kvale & Brinkmann, 2009), conducted at evenly spaced intervals throughout the semester. Interviews ranged from thirty to sixty minutes and invited students to reflect on their experiences in the course, their perceptions of themselves as learners of mathematics, and the personal and institutional factors shaping those experiences. This design allowed us to explore both immediate challenges and longer-term shifts in students' mathematical identity.

All interviews were transcribed and analyzed through an iterative process of thematic coding (Braun & Clarke, 2006) Each transcript went through systematic reading, with passages flagged when they were broadly relevant to the research questions. The first cycle of coding (Saldaña, 2016) identified broad, overarching categories related to students' academic and identity-related experiences. Particular attention was paid to structural, instructional, and relational factors.The second round refined these initial codes, shifting the focus from individual cases to cross-case analysis (Miles et al., 2014). This involved comparing codes across participants to identify recurring patterns, as well as attending to variations and unexpected insights. Holistic themes resulted that reflected commonalities in students' experiences while also preserving the complexity of individual narratives. These themes provided the foundation for interpreting how institutional and classroom practices affirmed students' mathematical identities in introductory calculus courses.

Results

Analysis of the interview data revealed thirteen distinct experiences that students described as affirming their mathematical identities. These experiences clustered into two broad categories: internal/intrinsic affirmations and external/social affirmations. While internal affirmations, such as achieving understanding and perceiving the utility of the material, were important, the vast majority of identity-affirming influences were grounded in social interactions. For brevity, a detailed illustration will only be provided for the theme of social affirmation here; more illustrations will be provided in the presentation.

Dominating Prevalence of Social Interaction

Students' mathematical identities were shaped most prominently through their relationships with peers, instructors, and broader classroom communities. Peer instruction emerged as a particularly powerful source of affirmation. Several students described how helping classmates not only reinforced their own understanding but also disrupted internalized narratives of deficiency. In the language of Sfard and Prusak (2005), these interactions actively challenged previously "endorsable" aspects of negative identity. As one student explained:

> "I'll have friends who are actually wanting to be math teachers, and they'll turn to me like, how do we do this again, and I'll be like oh, I'm the one that's supposed to know this… because I look like I know what I'm doing… oh, I do know what I'm doing."

Beyond peer instruction, opportunities to engage in community, such as through recitation sessions, study groups, and academic support offices such as CAST, were consistently described as affirming. Even experiences students framed as "internal," such as achieving understanding or recognizing utility, were often facilitated through these external supports.

Understanding and Utility

Although fewer in number, internal affirmations were universally present in students' narratives. Two themes dominated: understanding the material and recognizing its utility. Utility was described as transforming mathematics from an abstract requirement into something meaningful. One student put it succinctly: "I like [math] a lot more now I can actually understand the use."

Understanding was even more prevalent. Many students directly tied their enjoyment of the course to whether they could make sense of the material: "Once I understand it, I will enjoy it… [t]he only reason I'm feeling positive right now is just because I'm understanding it a lot better." These narratives suggest that comprehension and relevance remain central to identity affirmation, though they are often scaffolded by external supports.

Influence of Instructor

Instructors played a moderating role in shaping students' mathematical identities, either affirming or disaffirming students' identities. Positive interactions with professors were frequently reported as affirming, boosting confidence and cultivating a sense of belonging. One Calculus I student reflected: "[He] just makes you like… Oh, I feel seen in this class. So we just want to put more effort in, and at least really kind of enjoy math." In contrast, negative experiences with lecturers undermined students' sense of themselves as capable mathematical learners. Unlike other affirming experiences, the instructor's influence was notably volatile, with the potential to either strengthen or erode mathematical identity. In this study, positive

interactions with instructors were only reported by Calculus I students. There may be a variety of explanations for this, including particular instructors or subject matter, but these comparative factors were not made explicit by any students.

Overall Trends

Taken together, these findings highlight the centrality of social interaction in affirming students' mathematical identities in first-year calculus. While understanding and utility served as universal affirmations, they were frequently mediated by external supports and relationships. For some students, experiences in these courses reinforced pre-existing self-perceptions, while for others, the classroom environment catalyzed meaningful shifts in how they saw themselves as mathematical learners.

Although mathematics is often imagined as a solitary pursuit, this study underscores the essential role of community, interaction, and recognition in shaping marginalized students' mathematical identities. Affirming practices within peer groups, support structures, and classroom communities appear to be crucial levers for fostering persistence and belonging in STEM pathways.

Preliminary Nature of Report

At the time of writing, data collection and initial cycles of coding are complete, and emerging themes have been identified. The primary area of the project still under development is the articulation of the theoretical framework. While the analysis draws on Sfard and Prusak's (2005) conception of identity as narratives, further alignment with broader frameworks (e.g., Radović et al., 2018; Simpson & Bouhafa, 2020) is needed to clarify how different dimensions of identity are being operationalized in this context.

We seek feedback from the RUME community on the following questions:

1. How might we better connect our themes with existing theoretical lenses on identity?
2. What cautions or affordances should we consider in interpreting identity through both internal (understanding, utility) and external (peer interaction, instructor influence) dimensions?
3. Are there underutilized frameworks in the mathematics education literature that might strengthen the positioning of this study?

This feedback will help refine the theoretical framing and situate our analysis within the larger body of work on mathematics identity.

Conclusions

This study sought to identify what affirms marginalized students' mathematical identities in first-year calculus courses. The results suggest that while intrinsic factors such as understanding and utility consistently affirmed identity, the vast majority of affirming experiences were social in nature. Peer instruction, opportunities for community, and supportive instructors emerged as especially powerful drivers of affirmation, capable of disrupting deficit narratives and creating space for students to see themselves as "certain types of people" in mathematics.

In short, this work shows that affirmation is possible and impactful, but not yet systemic. Understanding how to reliably cultivate identity-affirming practices in introductory mathematics remains an area for future research and instructional design.

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