Persistence in the Margins: An Autoethnographic Study of a First-Generation, Low-Income Mathematics Major

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Although research on persistence and attrition in the undergraduate mathematics major remains limited, existing studies point to structural, curricular, and identity-related barriers that shape student trajectories. This autoethnographic study extends that conversation by exploring the lived experience of a first-generation, low-income undergraduate math major in the United States, using digital journaling to explore persistence, barriers, and systems of support. Guided by Tinto's theory of student departure, the study highlights the impacts of financial uncertainty, faculty interactions, and institutional and social demands on students' academic integration, sense of belonging, and self-image as a mathematician. Persistence emerges as an act of resistance. This study contributes to the literature on equity in undergraduate mathematics education by highlighting the complex interaction between identity and institutional structures. In doing so, the study offers insights for the creation of inclusive advising and pathways that support the success of students from disadvantaged backgrounds in mathematics.

Keywords: Persistence, First-Generation, Low-Income, Mathematics, Autoethnography

Introduction and Relevant Literature

Research in undergraduate mathematics education has long emphasized the gatekeeping role of mathematics courses in science, technology, and engineering (STE) pathways (Olson & Riordan, 2012; Seymour et al., 2019; Seymour & Hewitt, 1997). This emphasis has led to a plethora of research on the topic of how mathematics courses serve as barriers to persistence and retention of a wide range of STEM majors (Enderson & Ritz, 2016; Leyva et al., 2022; Olson & Riordan, 2012; Seymour et al., 2019; Seymour & Hewitt, 1997; Whalen & Shelley, 2010). Because of this dominant narrative, there has been a large focus on Calculus 1 (D. Bressoud et al., 2015; Johnson, 2016; Rasmussen et al., 2014). While this focus has been crucial in reimagining undergraduate mathematics instruction, it positions mathematics as a service discipline. This focus risks misrepresenting the experiences of mathematics majors, who differ significantly from other STE students. Only 2% of students enrolled in Calculus 1 intended to major in mathematical sciences (D. M. Bressoud, 2021), and unlike some STE majors (e.g., biological science, engineering) who declare during year 1, most math majors (64%) declare after (Chen, 2013). This misalignment suggests that while research on calculus 1 has generated valuable insights for STEM persistence broadly, it does not adequately capture the distinct pathways, challenges, and experiences of students intending to major in mathematics in the United States. These statistics underscore the need to look beyond calculus 1 to understand the persistence and attrition of undergraduate mathematics majors.

Although research specifically centered on undergraduate math majors in the US remains scarce, a small body of researchers has begun the exploration within this population. First, Ellington and Frederick (2010) focused their work on Black, high-achieving mathematics majors, finding that family support, program resources, and prior math experiences shaped persistence and identity as high-achieving. Later, Bahi et al. (2015) employed a time-series analysis to estimate a 23% probability of switching by the end of the first semester, noting no differences among genders. Zhuhadar et al. (2019) used survival analysis techniques with n=272,

showing that attrition risk increases later in the major and indicates that 3000-level courses better predict dropout as opposed to introductory calculus. And, more recently, Hubbard (2023) made an attempt at 'dispelling the myth' that there is a specific course that deters students from completing a math major and instead investigated persistence in between math courses within a specific institution. The author found that while median pass rates were 73%, persistence varied across demographics. Of worthy note, females are passing at higher rates but persisting less than males, and Black students are passing at lower rates but maintaining a higher persistence rate. Collectively, the present literature underscores the complexity of persistence and attrition of the undergraduate mathematics major. This literature supports the assumption that the factors that support a student's persistence (or lack thereof) are equally complex. What has not been investigated are factors such as structural, curricular, and programmatic barriers alongside identity, external factors, motivation, and holistic experiences in the major. The current study aims to fill these gaps.

Given these gaps, my socioeconomic identity (first-generation and low-income), and the call-to-action previously mentioned, an autoethnographic approach seemed fitting to investigate the complexities and the whole undergraduate journey of a mathematics major. Understanding the factors that influence persistence and attrition of the mathematics major is critical for the RUME and the larger mathematics community as we seek to address equity, access, and the definition of success in mathematics. By centering the lived experience of a mathematics major, this autoethnographic project aims to contribute a more nuanced understanding of how disciplinary identity, institutional structures, and personal identity interact to shape persistence. I seek to reopen dialogue and expand conversations within RUME beyond mathematics as a gatekeeper and towards mathematics as a discipline whose majors deserve focused scholarly attention.

Theoretical Framework

To answer this call-to-action, a theoretical framework is needed that considers the complex natures of equity, access, and the definition of success in mathematics. This study is grounded in Tinto's Theory of Student Departure (Engle & Tinto, 2008; Tinto, 1975, 1988). Tinto theorizes student attrition as the result of the interplay between characteristics of the individual (the student) and the institutional environment. His framework categorizes departure factors into three dimensions: academic and social integration, commitment, and external influences.

Academic and Social Integration

Persistence is shaped by the extent to which students engage with academic structures, achieve in coursework, and the degree to which students develop meaningful social connections with peers, faculty, and the broader campus/institution community.

Commitment

A student's commitment to educational goals and the institution is a key predictor of persistence. Higher levels of commitment correspond with greater likelihood of degree completion.

External Factors

Persistence is also mediated by factors beyond the institution. These factors include, but are not limited to, socioeconomic status, familial responsibilities, and aspects of personal identity.

While Tinto's framework serves as the foundation for this study, my application of it is situated within a constructivist epistemology and informed by a critical theoretical lens. From this perspective, knowledge is understood as socially constructed, and research is positioned as a means of interrogating systemic inequities in education. Thus, I extend Tinto's model by considering how inequities (tied to identity, access, and belonging) shape students' opportunities to persist in the undergraduate mathematics major. Consequently, external factors are more accurately conceptualized as factors beyond the locus of control of the student, not beyond the institution.

The decision to use the autoethnography aligns with this theoretical framing and understanding. Autoethnography situates lived experiences as a valid and rigorous form of knowledge (Bochner & Ellis, 2022; Creswell & Poth, 2016). In doing so, the autoethnographic methodology allows for the disruption of dominant narratives about success in mathematics. Within this study, the method also serves as a form of healing, allowing for critical reflection on the ways my lived experiences as a first-generation, low-income mathematics major interacted within the broader community to impact persistence. Therefore, healing is not conceptualized as separate from inquiry but as integral to the process of making sense of persistence in undergraduate mathematics. This framework informed the design, including the research questions and interpretation of this study.

This study is guided by the following research questions.

1. What personal and systemic factors influence my persistence as a first-generation, low-income undergraduate mathematics major?
2. What barriers did I encounter during my undergraduate journey, and how did they impact my academic and personal development?
3. What types of programmatic and institutional support could have better supported my persistence and success within the mathematics major?

Methodology

As stated by Bochner and Ellis (2022), evocative autoethnography emphasizes the personal narrative as a means of creating resonance and connectedness for readers. In alignment with this approach, I engaged in structured, digital journaling over a period of seven days, writing for approximately twenty minutes each day. These writing sessions were guided by prompts developed with both the literature and theoretical framework in mind. The aim was to elicit memories and reflections on persistence, barriers, institutional support, and self-identity changes. The use of digital journaling provided a space to revisit and reconstruct my undergraduate journey while connecting my experiences to systemic patterns identified in prior research.

Data analysis occurred through iterative, open coding (Creswell & Poth, 2016) of the journal entries, with attention to both emergent themes and connections to the theoretical framework. I sought to highlight how individual agency, social and institutional constraints, and factors outside my locus of control interacted to shape my trajectory through the mathematics major.

Validity was addressed through transparency and reflexivity. Throughout the journaling process, I documented my decisions, acknowledged my positionality, and considered the ways my interpretations were shaped. Autoethnography does not aim for generalizability in the traditional academic sense. But it does offer transferability through resonance and connectedness, inviting readers to draw connections between my lived experiences and broader patterns in undergraduate mathematics education.

Preliminary Findings

In this section, I present the preliminary findings from the analysis of this autoethnographic study. The purpose of this autoethnographic study is to explore and gain a better understanding of the nuances of the factors that led to my persistence and shaped my navigation through the undergraduate math major here in the United States. I wrote, *"I had to finish this degree. But I didn't want to be in math spaces anymore. I gave up on my dreams of medical school or an advanced degree in math. I believed what I was told that I did not belong in this community… that I did not know enough math… that I guess I will just teach instead… I could not go back to poverty. This sentiment stays with me even to this day, but I'm healing."* This reflection highlights the treacherous navigation of my academic journey and its impact on my sense of belonging. Through open coding of the digital journals, four major themes emerged: (1) persistence as resistance, (2) navigation of higher education, (3) identity and belonging in math spaces, and (4) external factors. At the time of this submission, my analysis has focused on theme four, external factors.

Financial Uncertainty and Institutional Constraints

Financial uncertainty, which led to institutional constraints, significantly shaped both my academic choices and relationship to the institution. I write, *"I had acceptances at many places... Yet, I felt like I had no actual choice… Without financial support, I was not going to be able to go to college."* These institutions varied by location (both in- and out-of-state) and level of institution (private, public, liberal arts, state schools, new-ivy, and ivy leagues). Yet, it became internally apparent that the decision of a specific institution was not mine to make. Instead, it was my lack of financial security that was going to make the decision. Ultimately, the institution that was chosen was a small, liberal arts college, located in the Appalachian region of the country. I wrote, *"For better, for worse, I don't know. I am giving up a lot of resources and access to a larger world with this decision. But I also have no other real option."* This exemplifies a critical point in Tinto's (1993) theory, where he argues that external obligations, lack of institutional integration, and decreased resource level increase the likelihood of departure. The implications of this forced decision limited my access to robust faculty options and resources.

Faculty Gatekeeping and Limited Academic Support

The institution had only two faculty during my undergraduate timeline, one of whom was my primary advisor, and the sole instructor for any course beyond calculus, limiting my academic experience to their problematic approach. This faculty member questioned my belonging and ability in mathematics. I recalled, "*You just don't get it... Someone like you doesn't belong in math."* These were common occurrences, according to the journal entries, and "*were confirmation of insecurities I had worked to overcome."* Tinto (1993) emphasizes that academic integration is essential for student persistence. I understand academic integration to be the meaningful and validating relationships with faculty and institutional academia at large. In direct contrast, I experienced integration as a gatekeeper. I wrote, *"I was made to feel minuscule and disposable."* Any option to request another advisor was not available. I wrote *"No path to escape [their] authority."* Efforts were made to report the pattern of mistreatment. However, those efforts were met with indifference and redirection. I recalled the frequent, *"Maybe you should just change your major."* But this did not exonerate my feelings. These experiences created a climate in which seeking support felt dangerous or risky, while fostering doubt about my ability to learn mathematics, turning persistence into an act of endurance rather than growth.

Overworked and Social Demands

Tied directly to financial constraints and a desire to be involved in campus activities, affairs, and institutional structures, I navigated undergraduate life dominated by work, constant social demands, and mathematics. I held a federal work-study position every semester. I worked, yearly, as a campus (math, chemistry, physics) tutor and peer mentor. I was a collegiate athlete. I was elected Vice President for the student government association. I even held off-campus work at a local department store and as a server at a local restaurant. I wrote, *"I had to. I wanted to feel like part of the college, like I was making it better for those like me. I also had to pay for school. I had to pay to live."* Balancing these responsibilities left little room for recovery from setbacks. Tinto (1993) argues that external demands that reduce time and academic engagement can lead to attrition. Though I chose to persist, I found that my identity as a first-generation, low-income student was pushed aside by the institution's lack of mechanisms to reduce these external and social demands. *I wrote, "This was saddening, infuriating, considering the institution prided itself on its large (about 50%) portion of first-generation and low-income students 'success."* Internally, I understood this to reinforce that the institution of academia was not built for students like me. Tinto (1993) suggests that departures often occur due to insufficient institutional integration, rather than lack of motivation; my experience affirms this and illustrates how persistence can function as an act of resistance.

Discussion and Conclusion

This study highlights the ways institutional structures, financial pressures, and faculty dynamics shaped the persistence of a first-generation, low-income mathematics major. My experience underscores that support structures, or the absence of, directly impacts students' academic engagement, sense of belonging, and ultimately their identity as mathematicians.

The current findings align with prior research emphasizing the importance of institutional agents and structures shaping outcomes for first-generation students (Burnett, 2017; Engle & Tinto, 2008; Jehangir, 2010; McCain et al., 2024). However, my findings add nuance by showing how unchecked faculty authority and institutional rigidity can transform structures of support into barriers. This connects to survivor narratives among low-income students, suggesting that persistence often requires enduring trauma rather than accessing support (Cota, 2024; Hahn, 2023; Wallace, 2018). Furthermore, my analysis contributes an additional layer to the complexity of persistence by showing how deeply power dynamics (faculty-to-student and lack of options of teaching faculty) can function as a structural condition that limits students' capacity to learn and enhances harm.

I am interested in thoughts from the audience about the following: (a) feedback on my analysis that would inform my exploration of the other three themes, (b) possibly expanding this work through a larger quantitative or mixed methods study to examine systemic factors across mathematics courses and majors, or (c) employing a duoethnographic methodology (Burleigh & Burm, 2022) with another first-generation, low-income mathematics (or STE) student. The latter two studies could explore the variance among institutions, regions, and the complexity of self-identity and mathematical identity formation. These studies could further illuminate the intersection and interplay of identity, systemic (academic and social) constraints, and persistence.

Lastly, this work makes clear the importance of inclusive advising, support structures, and pathways that reflect the realities of students from disadvantaged backgrounds (*Disadvantaged Background*, n.d.). Not only recognizing but addressing these systemic and academic barriers is critical to fostering persistence and furthering the conversation of equity in undergraduate mathematics education.

References

Bahi, S., Higgins, D., & Staley, P. (2015). A time hazard analysis of student persistence: A US university undergraduate mathematics major experience. *International Journal of Science and Mathematics Education*, *13*(5), 1139–1160. https://doi.org/10.1007/s10763-014-9538-9

Bochner, A. P., & Ellis, C. (2022). Why autoethnography? *Social Work and Social Sciences Review*, *23*(2), 8–18.

Bressoud, D., Johnston, E., Murphy, C., Rhea, K., Williams, J., & Zorn, P. (2015). The calculus sequence. *Mathematical Assocation of America*.

Bressoud, D. M. (2021). The strange role of calculus in the United States. *ZDM – Mathematics Education*, *53*(3), 521–533. https://doi.org/10.1007/s11858-020-01188-0

Burleigh, D., & Burm, S. (2022). Doing duoethnography: Addressing essential methodological questions. *International Journal of Qualitative Methods*, *21*, 16094069221140876. https://doi.org/10.1177/16094069221140876

Burnett, L. L. (2017). *Characteristics of persistence and retention among first-generation college students majoring in science, technology, engineering, or math* [PhD Thesis, University of Alabama Libraries]. https://ir.ua.edu/bitstream/handle/123456789/3581/file_1.pdf?sequence=1

Cota, S. (2024). *Storytelling to succeed: Exploring resiliency among culturally diverse first-generation college students in doctoral programs*. University of California, San Diego. https://search.proquest.com/openview/bd0ff4d0fe0f40b3cb01569ffe6f1e5f/1?pq-origsite=gscholar&cbl=18750&diss=y

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications. https://books.google.com/books?hl=en&lr=&id=DLbBDQAAQBAJ&oi=fnd&pg=PP1&dq=qualitative+inquiry+and+research+design+choosing+among+five+approaches&ots=-iq08cHWOs&sig=GB1AZt28X68hcDLGSLiiXVcHO20

Disadvantaged Background. (n.d.). National Institutes of Health. Retrieved August 22, 2025, from https://www.era.nih.gov/commons/disadvantaged_def.htm

Ellington, R. M., & Frederick, R. (2010). Black high achieving undergraduate mathematics majors discuss success and persistence in mathematics. *Negro Educational Review*, *61*. https://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=05481457&AN=56536361&h=fTyhGWnOtSW7LR4W4OvST3zTTGym3SGqoUQZeYrBv2qN%2BVK478BGLt5WgRk7BDMtP%2Fpf%2F%2FJel6x7%2F4bRd2OhSw%3D%3D&crl=c

Enderson, M. C., & Ritz, J. (2016). STEM in general education: Does mathematics competence influence course selection. *Journal of Technology Studies*, *42*(1), 30–41.

Engle, J., & Tinto, V. (2008). Moving beyond access: College success for low-income, first-generation students. *Pell Institute for the Study of Opportunity in Higher Education*. https://eric.ed.gov/?id=ED504448

Hahn, M. L. (2023). *Academic help seeking, cultural mismatch, and first-generation college students: A narrative inquiry* [PhD Thesis, Grand Canyon University]. https://search.proquest.com/openview/4c3900312cb54530487c493334364336/1?pq-origsite=gscholar&cbl=18750&diss=y

Hubbard, K. E. (2023). The leaky math major pipeline. *PRIMUS*, *33*(1), 51–64. https://doi.org/10.1080/10511970.2021.2023242

Jehangir, R. (2010). Stories as knowledge: Bringing the lived experience of first-generation college students into the academy. *Urban Education*, *45*(4), 533–553. https://doi.org/10.1177/0042085910372352

Johnson, E. (2016). What is in Calculus I? *MAA Focus*, *36*(2), 17–20.

Leyva, E., Walkington, C., Perera, H., & Bernacki, M. (2022). Making mathematics relevant: An examination of student interest in mathematics, interest in STEM careers, and perceived relevance. *International Journal of Research in Undergraduate Mathematics Education*, *8*(3), 612–641. https://doi.org/10.1007/s40753-021-00159-4

McCain, J., Roksa, J., & Breen, S. (2024). Support without status: Inequities in student–advisor relational dynamics between first-generation and continuing-generation doctoral students. *Education Sciences*, *14*(5), 441.

Olson, S., & Riordan, D. G. (2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. Report to the president. *Executive Office of the President*. https://eric.ed.gov/?id=ed541511

Rasmussen, C., Marrongelle, K., & Borba, M. C. (2014). Research on calculus: What do we know and where do we need to go? *ZDM*, *46*(4), 507–515. https://doi.org/10.1007/s11858-014-0615-x

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving* (Vol. 34). Westview Press, Boulder, CO. http://www-personal.umich.edu/~glarose/dept/teaching/resources/talkingAboutLeavingSeymourHewittOverview.pdf

Seymour, E., Hunter, A.-B., & Harper, R. P. (2019). Talking about leaving revisited. *Talking About Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education*. https://www.ams.org/journals/notices/202009/rnoti-p1375.pdf?trk=2145&cat=education

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research*, *45*(1), 89–125. https://doi.org/10.3102/00346543045001089

Tinto, V. (1988). Stages of student departure: Reflections on the longitudinal character of student leaving. *The Journal of Higher Education*, *59*(4), 438–455. https://doi.org/10.1080/00221546.1988.11780199

Wallace, J. D. (2018). *The exploration of first generation low income students experiencing survivor guilt and how college leaders can help* [PhD Thesis, St. Thomas University]. https://search.proquest.com/openview/7426bda8a73880ec0d1db5ef21293d27/1?pq-origsite=gscholar&cbl=18750

Whalen, D. F., & Shelley, M. C. (2010). Academic success for STEM and non-STEM majors. *Journal of STEM Education: Innovations and Research*, *11*(1). https://www.jstem.org/jstem/index.php/JSTEM/article/view/1470

Zhuhadar, L., Daday, J., Marklin, S., Kessler, B., & Helbig, T. (2019). Using survival analysis to discovering pathways to success in mathematics. *Computers in Human Behavior*, *92*, 487–495.