

Empowering STEM Pathways: Social and Institutional Support for Hispanic/Latine Students in Higher Education

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While Latine/Hispanic higher education enrollment rates have increased over time, enrollment in STEM, and mathematics in particular, has been slower to change. As part of a larger study, our team interrogates the experiences of those who have successfully navigated the mathematics pathway. Specifically, we look to understand how our research participants leveraged the support of both social (familial, peer, etc.) and institutional (mentors, faculty, administrators) along their academic pathways. We investigate primarily using in-depth qualitative interviews of five individuals who hold bachelor's degrees in mathematics and STEM PhDs, to ascertain both positive and negative influences on their education, utilizing the community cultural wealth framework. While the Latine PhD population is, of course, not monolithic, our findings suggest that social, familial, and navigational capital were instrumental in their ultimately successful navigation of both graduate and undergraduate education.

Keywords: community cultural wealth, mentorship, social networks, student experiences,

The increasing number of Latine students enrolling in higher education institutions has led to an increase in Hispanic Serving Institutions (HSIs) in the United States (Lane et al., 2024; Pawley, 2017). While certainly an increase in Latine/Hispanic student enrollment is an achievement to be celebrated, research on HSIs (Garcia, 2020, 2023) indicates that these institutions are still grappling with what it means to hold the HSI label and often struggle to serve their Latine student populations adequately. It is no secret that US higher education institutions have significant issues supporting, retaining, and graduating students from marginalized backgrounds in STEM and, specifically, in mathematics. According to the National Center for Education Statistics (2023), even with an increase in Latine/Hispanic student enrollment in colleges and universities, only 14.6% graduate with a STEM bachelor's degree, 11.4% obtain a STEM master's degree, and 9.2% are awarded a doctoral degree in STEM.

All stakeholders in the higher education space must understand the current educational landscape better in the context of Latine education if their goal is to truly serve and support Latine/Hispanic students. As part of this imperative, our research team investigates the experiences of those who have successfully navigated the math PhD pathway, focusing specifically on how they leveraged the support of both social (e.g., familial, peer, etc.) and institutional (e.g., mentors, advisors) actors in their academic endeavors. We aim to address the following research question: *What types of resources did Latine mathematics teaching-focused faculty draw from that helped them navigate and persist in the higher education space?*

Theoretical Background

Drawing from Critical Race Theory (CRT), Yosso (2005) developed the *Community Cultural Wealth* (CCW) framework, which takes an asset-based approach by recognizing the cultural wealth held by students who identify as underrepresented minorities (URMs) as valuable forms of knowledge in the education space. The CCW framework is composed of six forms of non-

dominant capital, which include (1) aspirational, (2) familial, (3) linguistic, (4) navigational, (5) resistant, and (6) social. Aspirational capital refers to maintaining hopes and dreams despite educational barriers. Familial capital relies on kinship and family ties that individuals can draw from as they navigate higher education. Linguistic capital refers to the multiple languages and communication styles that URM students can utilize from context to context. Resistant capital can be characterized by the knowledge, skills, and resources individuals can utilize to challenge systems built with dominant cultures in mind. Social capital encompasses the resources that individuals gain as they develop relationships and social networks. The CCW framework reorients cultural capital to a more dynamic model (Sablan & Tierney, 2014), providing an anti-deficit approach to the resources that URM students possess and leverage in their pursuit of a successful education.

In mathematics education, previous research studies have used the CCW framework as a guide for analysis to explore student and educator experiences at varying stages. This framework has been applied to investigate teaching practices (Holbrook, 2021) as well as the experiences of multilingual learners (Pelaez et al., 2023), teaching assistants (Poulsen Stringer, 2023), and others. For this paper, we center our analysis around what forms of capital were attained and when they were leveraged at the undergraduate and graduate levels by current Latine mathematics faculty who have successfully navigated a pathway through STEM. Herzig's (2004) exploration of the experiences of women of color in doctoral mathematics programs and Ong's (2011) study on the challenges and mitigations involved in the transition from undergraduate to graduate education highlighted the pivotal role that supportive environments play in helping these students achieve success in graduate mathematics education. Furthermore, research emphasizes the detriment of chilly and exclusionary climates in STEM departments (Camacho & Lord, 2013), particularly in mathematics departments (Herzig, 2002).

Methods

Emerging from a more extensive study focused on generating equitable hiring procedures for the hiring of Latine teaching-focused faculty (TFF) in STEM departments (Funded by NSF Award #2113355), our project centers on a subset of five TFFs across multiple institutions who completed at least a bachelor's degree in mathematics. We categorize each faculty member as "teaching-focused" if they devote at least 50% of their time to teaching. Four of our participants attained PhDs in mathematics and/or statistics. Of these, three hold faculty roles in mathematics departments, while one participant is a TFF in a digital and computational studies department. The final participant received a PhD in biology and is in a TFF position in a biology department.

We conducted five semi-structured interviews (Bernard, 1988; Zazkis & Hazzan, 1999) that were approximately one to two hours in length. These interviews were held via Zoom, audio recorded and transcribed using Otter.ai, and analyzed with the ATLAS.ti platform. All of our participants were compensated for their time. The interviews hinged on enabling our participants to reflect on their academic journeys and were divided into two parts: (1) experiences leading up to the faculty role and (2) TFF experiences in their current position. For this paper, we focus on the first section of the interviews.

We analyzed the data using a deductive and inductive approach (Corbin & Strauss, 1990; Miles & Huberman, 1994). Our analysis implemented a deductive approach to test the CCW framework using the six constructs of non-dominant capital as a priori codes. Next, we used an inductive approach to generate overarching themes from the data. Researchers collectively coded multiple transcripts until they reached a suitable level of inter-rater reliability (*Krippendorff's alpha* = .68), then coded the remaining transcripts separately.

Results

The nuances in participant experiences allowed us to have a rich dataset that we use to tell their stories and give them a voice. We found that our participants drew from multiple forms of support to navigate their higher education journeys, including peer support, mentorship, and familial support, comprising all the CCW constructs, particularly aspirational, familial, navigational, and social capital. In the subsequent sections, we will explore participants' motivations to pursue mathematics careers and their various forms of support along the pathway.

Familial Support

Familial capital has the potential to serve as a cornerstone for motivating students to seek a STEM career and supporting them along the mathematics trajectory. Our research participants often described family education and expectations as influencing factors in their decisions to pursue higher education. Consider Maria, an Argentine American TFF at an R1 institution whose guardians had varying levels of education. Maria's mother had an accounting degree, her father did not finish high school, and her grandmother did not experience any formal schooling:

I have an older brother [attending college] that was, you know, four years ahead of me or five years. So, it [was] clear [that] I was going to go to college...Also, [my family and friends] value [a] faster way to change [social] classes...So [this was] kind of a way of changing and getting a good life so that's really important... – Maria

For Maria, her family values were an essential factor in her decision to pursue higher education, demonstrating evidence of familial capital. Specifically, Maria expressed that her love for mathematics at a young age encouraged her to pursue the mathematics field.

During our interview with Brian, a TFF at an R1 institution who was a first-generation (FG) college student, he expressed that his parents provided immense support for him to value education as they had high aspirations for their children. Brian reported that his parents made multiple investments to ensure their children could develop a solid educational foundation through private education. Brian and his siblings were expected to perform well in school and to pursue a higher education degree as their "...inheritance was essentially [a] strong education at the get go." The cultivation of substantial familial capital allowed Brian to strengthen his aspirational capital, aiding his navigation of higher education as an FG college student.

Peer and Institutional Support

Without recognizing the influence of peers and institutional actors, no discussion of support systems for those in higher education would be adequate. Fellow students, faculty, advisors, and mentors (both official and unofficial) were instrumental in providing motivation, guidance, and overall support across all our research participants' educational trajectories.

Sergio is a TFF in Mathematics at a doctoral-granting institution in the Midwest; he describes how, as a FG student entering an Ivy League college for his undergraduate he felt a lack of support from faculty in his department but found support outside of his department based on shared cultural backgrounds (ethnicity, FG student status, and both being community college graduates in this case):

One thing that I've benefited from was having mentors, but specifically, mentors that have similar backgrounds to me, because you can see yourself in them and think, oh, they succeeded. And I could do it, too. – Sergio

The efficacy of mentoring based on shared cultural experiences and identity characteristics was a theme throughout our project, and all our mathematics participants described some form of this

in their educational journey. Our women research participants described connecting and feeling supported by other women in faculty positions, particularly those who shared some other cultural touchpoint with them (e.g., international student status, ethnicity, and FG student status). All five of our participants described how, in their current faculty positions, they seek out and participate in mentoring relationships based on shared identity and cultural experiences, often describing students reaching out to them for these reasons.

All our participants highlighted the vital role that peer support networks played in helping them persist in mathematics and STEM. In addition to seeking mentorship from students who were more advanced in their programs and leveraging identity networks (e.g., Latine/Hispanic organizations), emotional and academic support from peers were reported to serve as tools in navigating the process of achieving essential milestones on the pathway, such as high-stakes situations:

So, we had our group, and it was a very supportive group. I [joined] with my best friend...without her, I wouldn't have passed my prelims because she was always pushing me to go to study every day, or, you know, asking me if I was ready for X or Y. – Gina

Social capital in the form of accountability is evident here. Still, aspirational and resistant capital also play a role. Gina, a Costa Rican American TFF at an R1 institution, describes how her best friend encouraged her to remain hopeful about passing her preliminary exams and helped her persevere despite the challenges and pressures. It is clear that social, aspirational, and resistant capital facilitated overcoming a hurdle that graduate students often face.

Tanya, an associate professor of digital and computational studies at a private liberal arts college, reported that her peer networks helped her find institutional support:

One of my fellow graduate students was like, well, my advisor is really great. And she asked about you the other day, and I think she would be willing to help...So I reached out to her like, because I was like, oh, she cares about me... So, I reached out and she really got the ball moving on, on that and made sure that that the defense happened. – Tanya

This use of social capital to navigate difficult situations in their PhD journey exemplifies the critical nature of peer networks and how those can bridge to positive faculty relations. Without this peer network, Tanya would have been left in a difficult situation, without a faculty member to advocate for her during a critical moment in the dissertation phase of her graduate studies.

It is important to note that peer relations are not unilaterally positive, nor are faculty interactions. Our women participants described having to navigate microaggressions from peers and advisors based on various factors. Gina describes being assumed as less competent than her domestic peers based on her country of origin:

One of [the professors] told me that he was not expecting [me to do well on my preliminary exams] because of where I was coming from...I hated that he said it, but at least it was in my face, because I know a lot of them were thinking about that...the stereotypes of growing up in a country that allegedly does not have any academia...or thinking that my curriculum was not strong enough because I come from Latin America... that was something that always affected my self-confidence. – Gina

While peers and institutional actors certainly can provide negative experiences in academia, overall, our participants described the benefits of positive experiences with both institutional and peer actors as a critical form of support along their educational journeys. However, we want to highlight that these individuals' stories only capture one piece of a larger puzzle: those who successfully navigated the 'leaky pipeline' of STEM higher education.

Discussion and Recommendations

In answer to our central research question, we found that social and familial capital support were central to the success of our participants in their academic journeys. Notably, forms of capital were leveraged simultaneously to overcome significant barriers along the pathway, suggesting the dynamic nature of CCW. For example, social and aspirational capital often served as a conduit for access to navigational capital, indicating that these forms of wealth are transmutable. We agree with previous scholars in the STEM education literature (Camacho & Lord, 2013; Herzig, 2004) who have discussed how the chilly climate of STEM departments is a significant barrier to Latine student success within higher education. Our contribution centers on the role of CCW and non-dominant forms of cultural capital that allow students to survive and thrive in these institutions and hostile cultural climates.

In terms of our recommendations for how institutions can effectively leverage and bolster these forms of support, we have two recommendations. The first is cultural, in that universities at a fundamental level need to recognize and acknowledge the funds of knowledge (Moll et al., 2005) that minoritized students bring with them into both the classroom and campus community. Instead of trying to force students to assimilate into the form of a model student by adopting and imitating hegemonic forms of cultural capital, we can encourage and appreciate their unique perspectives and forms of cultural wealth.

Second, our research has detailed the importance of culturally sustaining mentoring through the experiences of our research participants' journeys. This aligns with research on retention and student success in higher education in STEM (Johnson & Elliot, 2020). It cannot be understated that our participants described feeling isolated and marginalized, which was partly remedied by peer and faculty interactions with some form of cultural touchpoint. Our participants may have lacked the support necessary to succeed on the STEM pathway without these relationships. To enhance culturally responsive peer and institutional actor support, we suggest that colleges and universities (1) hire more Latine/Hispanic TFFs to lessen the already heavy load these faculty have on their shoulders, (2) recognize these faculty in tenure and promotion materials for their efforts to support students as agents of change by providing funding for programs they already run and (3) provide support for culturally oriented mentorship programs at the campus level, to move from only admitting Hispanic students to genuinely serving them (Garcia, 2020).

While the Latine/Hispanic experience in higher education is not monolithic, our research highlights the experiences of those who successfully navigated the STEM PhD pathway. However, this ultimately only tells us part of the larger story of Latine/Hispanic graduate education. Some are, of course, pushed out of higher education by institutional or sociological factors. Whether this disparity comes from a lack of mentorship, social/institutional support, discrimination/racism, or other structural factors is not covered by our study. Our suggestion for future researchers is to home in on the population victimized by the 'leaky STEM' pipeline to understand the pitfalls better.

References

- Bernard, H. R. (1988). *Research methods in cultural anthropology*. Newbury Park, CA: Sage.
- Camacho, M. M., & Lord, S. M. (2013). *The Borderlands of Education: Latinas in Engineering*. Lexington Books.
- Corbin, J., & Strauss, A. (1990). Grounded theory research: Procedures, canons and evaluative criteria. *Zeitschrift für Soziologie*, 19(6), 418-427.

- Garcia, G. A. (Ed.). (2020). *Hispanic serving institutions (HSIs) in practice: Defining "servingness" at HSIs*. IAP.
- Garcia, G. A. (2023). *Transforming Hispanic-serving institutions for equity and justice*. JHU Press.
- Herzig, A. H. (2002). Where have all the students gone? Participation of doctoral students in authentic mathematical activity as a necessary condition for persistence toward the PH. D. *Educational studies in mathematics*, 50(2), 177-212.
- Herzig, A. H. (2004). Becoming mathematicians: Women and students of color choosing and leaving doctoral mathematics. *Review of educational research*, 74(2), 171-214.
- Holbrook, v. (2021). Supporting Latinx Math Students in Community College Classrooms: A Qualitative Study Examining Teaching Practices That Promote the Success of Latinx Students in Mathematics.
- Johnson, A., & Elliott, S. (2020). Culturally relevant pedagogy: A model to guide cultural transformation in STEM departments. *Journal of microbiology & biology education*, 21(1), 10-1128.
- Lane, T. B., Espino, M. L., Nichols, M., Le, B. D., Rincón, B., Hernandez, R., ... & Camacho, M. M. (2024). *Latin* Students in Engineering: An Intentional Focus on a Growing Population*. Rutgers University Press.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.
- Moll, L., Amanti, C., Neff, D., & González, N. (2005). Funds of Knowledge for Teaching: Using a Qualitative Approach to Connect Homes and Classrooms*. In Funds of Knowledge. Routledge.
- National Center for Education Statistics (2023). *Table 318.45. Number and percentage distribution of science, technology, engineering, and mathematics (STEM) degrees/certificates conferred by postsecondary institutions, by race/ethnicity, level of degree/certificate, and sex of student: Academic years 2012-13 through 2021-22*. U.S. Department of Education. https://nces.ed.gov/programs/digest/d23/tables/dt23_318.45.asp
- Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard educational review*, 81(2), 172-209.
- Pawley, A. L. (2017). Shifting the "default": The case for making diversity the expected condition for engineering education and making whiteness and maleness visible. *Journal of Engineering Education*, 106(4), 531-533.
- Pelaez, K., Calleros, E. D., Parra, J., & Zahner, W. (2023). Examining community cultural wealth of a transfronteriza multilingual student in mathematics classrooms. *International Journal of Qualitative Studies in Education*, 1-16.
- Poulsen Stringer, B. (2023). Learning Assistants: The Assets of Relationships in Mathematics Classrooms. Proceedings of the 25th Annual Conference for the Research in Undergraduate Mathematics Education (pp. 966-971). Omaha, NE.
- Sablan, J. R., & Tierney, W. G. (2014). The Changing Nature of Cultural Capital. In M. B. Paulsen (Ed.), *Higher Education: Handbook of Theory and Research: Volume 29* (pp. 153–188). Springer Netherlands. https://doi.org/10.1007/978-94-017-8005-6_4
- Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race ethnicity and education*, 8(1), 69-91.

Zazkis, R., & Hazzan, O. (1999). Interviewing in mathematics education research: Choosing the questions. *Journal of Mathematical Behavior*, 17(4), 429-439.