

More Than Support: Leveraging Familial and Community Cultural Wealth on the Path to Engineering

Dr. Lara Perez-Felkner, Florida A&M University - Florida State University

Lara Perez-Felkner is a Professor of Higher Education and Sociology and Faculty Fellow in the Graduate School at Florida State University (FSU).

Ravi Bhatt, Florida A&M University - Florida State University

Luis Ricardo Morales Guemarez, Florida A&M University - Florida State University

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Abstract

The retention of students from historically underrepresented groups in engineering is too often examined through a deficit lens, overlooking the rich sociocultural resources these students bring to their institutions. Utilizing Yosso's community cultural wealth (CCW) framework, this qualitative study explores how undergraduate engineering students leverage familial and navigational capital to persist through their rigorous degree programs. Drawing on data from 65 students across six cohorts (2018–2023) within a mentored undergraduate research intervention based at a Historically Black University, this study investigates family influence beyond early STEM interest. Findings demonstrate that family members serve as key mentors irrespective of their own engineering or STEM background. Furthermore, the study reveals a complex financial motivations, whereby students navigate their engineering pathways while driven by a dual desire to "pay back" current relatives and "pay forward" to aspirational future families. Ultimately, this work provides actionable implications for contemporary engineering programs to move beyond "one-size-fits-all" advising to build holistic mentorship practices that holistic mentorship models that actively validate and integrate students' evolving familial networks.

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The retention and persistence of students from historically underrepresented groups (URG) in engineering remain critical challenges for higher education institutions in the United States. Despite slight gains in enrollment, national data indicate that Black, Latine, and Indigenous students continue to leave engineering programs at disproportionately higher rates than their white peers [1]. Traditionally, engineering education scholarship has examined this attrition through a deficit lens, attributing disparities to students' lack of academic preparation, financial instability, or insufficient prior exposure to technical concepts [2-4]. This perspective often frames the students and their families as lacking the necessary "capital" [5] to succeed in the rigorous culture of engineering.

However, a growing body of research challenges these deficit-oriented narratives by highlighting the rich sociocultural resources—or *community cultural wealth* (CCW)—that minoritized students bring into the university [6, 7]. Within this asset-based framework, the family unit emerges not as a liability or a passive background variable, but as a dynamic source of capital that fuels persistence. While extensive research has documented the role of parental influence in shaping early interest and access to STEM pathways [8, 9], significantly less attention has been paid to how familial support mechanisms evolve and function during the undergraduate engineering experience.

This study addresses this gap by utilizing Yosso's [6] CCW framework to explore how engineering students leverage familial and navigational capital to persist through their degree programs. By shifting the analytical focus from what families "cannot" provide (e.g., specific knowledge of engineering curricula) to the cultural assets they do provide (e.g., resilience, moral grounding, and institutional maneuvering), this study seeks to understand the mechanisms by which family remains a central pillar of student success in engineering. Furthermore, this study captures family influence and support beyond early STEM interest through an exploration of the mechanisms by which such familial factors shape their career aspirations and educational outcomes throughout their higher education journeys.

Literature Review

Family's Role in Engineering Identity and Career Development

While previous research has acknowledged the importance of parental encouragement in early STEM interest, less attention has been paid to how familial influence evolves and sustains students throughout the rigors of an undergraduate engineering degree [10]. For first-generation and minoritized students, families often serve as a primary source of *community cultural wealth* (CCW), providing not just emotional support but specific forms of capital, such as resilience, navigational skills, and aspirational drive [6]. Notably, families serve as a primary site for the socialization of values, career aspirations, and the construction of academic identity. In the context of engineering, family members often act as the initial "recruiters" who legitimize a student's potential and foster early identification with STEM [11, 12]. This influence extends beyond the initial choice of major. Families provide a distinct form of *familial capital*, defined by

Yosso [6] as the cultural knowledge nurtured among kin that carries a sense of community history, memory, and cultural intuition.

Research indicates that this familial capital is instrumental in helping students navigate the *chilly climate* often found in predominantly white engineering institutions [13, 14] (Cononeles, 2025; Sewell, 2024). For instance, Martin et al. [10] found that for Mexican American engineering students, family serves as a crucial emotional anchor, where the motivation to "give back" to the family unit transformed into a powerful persistence strategy. Family capital, then, illustrates the intense parallels that families experience when navigating their appearance in students' lives. While families shape students' baseline educational and economic trajectories [15, 16], their influence extends deeply into students' motivation, educational expectations, and resilience [17-19]. Thus, family does not materialize as simply a background variable.

Because this multifaceted support equips students with the tools to survive in complex environments, familial capital serves as a critical foundation for *navigational capital*. Operationalized here as the ability to maneuver through social institutions, navigational capital is often transmitted through family narratives of resilience and resistance against systemic barriers [6, 20]. Even when family members lack direct experience with higher education, they often equip students with the "soft skills" necessary to advocate for themselves, manage time, and decode bureaucratic processes. However, the intersection of family and engineering identity is complex. Students must often engage in identity negotiation to reconcile their home identities with the professional norms of engineering, which can sometimes feel exclusionary or culturally misaligned [21]. Understanding how students draw upon familial resources to bridge these worlds is essential. By recognizing families as holders of intellectual and social wealth, engineering programs can develop more culturally responsive support systems that validate rather than erase students' home communities.

Familial Financial Background and Economic Mobility

For many students from minoritized backgrounds, the pursuit of an engineering degree is inextricably linked to the economic mobility of the entire family unit. The return on investment of an engineering credential is often viewed not merely as individual gain, but as a mechanism for collective uplift and intergenerational stability. Research suggests that this responsibility to "give back" serves as a powerful form of resistance capital, motivating students to persist through academic difficulty [6, 20]. However, this dynamic also creates a unique *double bind*: while the long-term promise of engineering salaries provides motivation, the immediate financial reality of the degree often strains the very family relationships that support the student.

This strain is exacerbated by the specific, often hidden costs associated with engineering curricula. Unlike other disciplines, engineering majors frequently require significant out-of-pocket expenditures for high-performance computing hardware, specialized software licenses, and lab fees—costs that financial aid packages may not fully cover [22-25]. For first-generation families who may be unfamiliar with these discipline-specific financial demands, these unexpected costs can create anxiety or the perception that the degree is unattainable [26, 27]. Furthermore, students from low-income backgrounds often balance these academic costs with the

need to contribute financially to their households, leading to a precarious balancing act where time spent working to support the family competes directly with the time required for rigorous engineering coursework, making the familial transmission of navigational capital all the more critical for persistence [28]. These intersectional challenges of finance, family, and academic rigor underscore the critical relevance of Minority Serving Institutions (MSIs) in the engineering education landscape.

While PWIs may view familial obligations as a distraction from academic immersion, MSIs—including Historically Black Colleges and Universities (HBCUs) and Hispanic-Serving Institutions (HSIs)—historically operate with an understanding of the "communal" student identity [29]. These institutions are often better positioned to leverage cultural wealth and provide holistic support structures that validate the student's dual role as an aspiring engineer and a family member. Together, this study investigates how students navigate these financial and familial dynamics within an MSI, to understand the way this unique MSI context offers vital insights into retention strategies that honor, rather than sever, students' community ties,

Theoretical Framework

Within MSIs and PWIs alike, family plays a pivotal role in a student's decision to pursue engineering [11, 12], as does a students' gender, socioeconomic status, and cultural background [30]. To understand exactly *how* families shape engineering persistence, this study draws on Yosso's [6]'s community cultural wealth and its antecedent: Moll and colleagues' [31] *funds of knowledge* concept, referring to the skills, survival strategies, and culturally developed knowledge accumulated within families and the broader community. Together, these concepts help us understand how students actively leverage their cultural backgrounds and familial motivations to navigate their engineering programs. Yosso's [6] *community cultural wealth* (CCW) is an asset-based alternative to prior framings that lean on middle and upper class norms [e.g., 5]. Yosso's [6] framework identifies six overlapping dimensions of community cultural wealth: aspirational, linguistic, familial, social, navigational, and resistant capital. Rather than viewing marginalized students through a deficit lens, this perspective highlights the rich, diverse strengths that communities use to survive and overcome systemic barriers [32]. For engineering programs, this may mean affirming to students that their home community is not a disadvantage to be mitigated, but rather a vital source of wealth.

While CCW's six dimensions interact dynamically to support students, this study narrows its focus to two highly synergistic forms described above: familial and navigational capital. We focus specifically on these dimensions because they emerged organically as the most salient themes during our qualitative observations of the summer undergraduate research cohorts, which were immersed in intentionally supportive and diverse structured research mentorship, inclusive of near-peer undergraduates, graduate students and postdocs, and faculty.

The Current Study

Previous research has demonstrated how engineering students' educational trajectories are informed by their family's ethnic, migratory, and socioeconomic backgrounds [33, 34]. Similarly, scholars have well established the role that students' social identities (including gender) play in shaping their perceptions of prospective career pathways and educational opportunities [35]. Despite past studies repeatedly showing the significant role that familial influence plays in early

decision-making of STEM students' educational pathways, most do not directly explore the role of family influence/support on students throughout their undergraduate experience. Through qualitative analysis, the present study sought to better understand the mechanisms by which engineering students' experiences and career choices are shaped by familial influences beyond the decision of entering engineering and throughout their path to degree completion.

Methodology

This qualitative paper uses data from a comprehensive, multi-year external evaluation of a mentored undergraduate research intervention housed at a Historically Black University (HBCU) within a shared engineering college model. While previous iterations of this work have examined specific sub-groups of students, the present study leverages the full qualitative dataset spanning six distinct cohorts from 2018 through 2023 (ranging from 8 to 22 students annually, dependent on funding and pausing during the pandemic). This scope allows for a robust examination of 65 undergraduate students, offering a wider array of "counter-stories" regarding student persistence than significantly smaller or single-year samples could provide.

The program was situated in an "intentionally diverse" research setting, recruiting participants not only from the host HBCU but also from community colleges, PWIs, and other MSIs across the United States. This recruitment strategy ensured a rich heterogeneity of experiences, representing diverse intersections of race, gender, socioeconomic status, and academic origin. To capture the nuance of these students' trajectories, data were collected at the culmination of each summer cohort through a combination of semi-structured individual interviews, focus groups, and open-ended survey responses. This data triangulation provides multiple lenses into how students engage the "hidden curriculum" of engineering and the role of family in their academic lives.

Our analytic process followed an inductive, iterative approach grounded primarily in Yosso's [6] community cultural wealth framework. Transcripts from the interviews were coded to identify emerging themes related to familial capital, navigational strategies, and the development of engineering identity. By aggregating data across the active study years, the research team was able to map how these forms of capital are deployed differently across changing social and educational contexts.

Findings

Familial Encouragement throughout Engineering Path

Family members appeared most saliently within the experiences of the undergraduate students through their encouragement, engagement, and representation of engineering as a career possibility. Students continuously highlighted critical ways their parents and families informed their interest in engineering whether through their own study of it or their appreciation and motivation toward furthering education. When speaking about their grandfather, for example, Jerome explained, "My granddad... when I grew up, he taught me about different cars and different things, and I could work with him on different cars, and stuff like that. So, I really liked at that." Here, Jerome, a mechanical engineering major, highlights the way motivation from a

young age, and direct engagement in career aspirational tasks, consequentially encouraged them to pursue engineering more directly and tangibly as a career pathway.

Many students within the study highlighted the direct influence their parents had on their engagement with engineering throughout their collegiate experience. Mechanical/aeronautical engineering students Nelie and Carina echoed similar sentiment to Jerome in the way they directly attributed their educational prowess to their mothers' academic pursuits as an educator and a chemist, respectively. These educational aspirations, as encouraged by their mothers, guided them throughout their undergraduate experiences and continued to motivate them forward in the ways they pursued their academic goals. Binh also experienced encouragement in a way that developed through circumstance.

For a while in college, Binh lived with their parents. In speaking to this experience, Binh candidly shared:

They are so proud of me. It's great. Honestly, this past year, like, moving back in with my parents, and then also just talking to them about research and other things, it's helped our family get so much closer together. Because then, I think, in the past where maybe I'd felt more distant with my parents, I thought they're more like the Asian stereotype where it's like, oh, they just want me to go to graduate school just to fulfill their cultural thing. But then, talking to them more, and how excited they are about my research, or seeing me on TV and things like that, they're so ecstatic to see me do stuff like research and science. At first, I thought it was kind of more like a chore, but then I wanted it to help my relationship with my family, and then also, meeting all the people in the labs, they also feel like a new family to me.

Binh's experience provides an opportunity to further understand the bridge education, engineering, and families can be for students. While this can be an inspirational impetus, strenuous relationships can complicate and weaken this bridge.

In a different engagement of parent and study, Amanda and Toussaint shared a more arduous engagement. In taking care of her father who was diagnosed with cancer, Amanda expressed how she had to miss parts of the research experiences. Similarly, Toussaint highlighted that her experience supporting her dad conflicted with her desires and responsibilities toward her own research. Here, these students articulate a particularly unique interaction between Yosso's [6] navigational and familial capital. Through the appearance or absence of collective encouragement, healing, motivation, and inspiration of their family members, they traverse college in extremely intentional ways. Students often explained that their family's encouragement communicated high expectations: it was a strong reason to keep going, but it also felt like an exhausting responsibility. While parents may foster this bridge, students highlighted parenthood and family as influencing it as well.

In addition to one's own parents, seeing parents in classroom also has lasting ramifications for representation [36, 37]. For Jordan, the representation of *motherhood* in

engineering, served as a paramount motivation. In seeing a mother in her aspired program, Jordan relays:

She was an African American female. She had worked for several companies and came back to Tuskegee to work and to teach. And I think seeing her teach really showed me that is achievable and she really inspired me to keep going actually. And it's great because she has a family. She was very successful, very intelligent... I think that's what made me really be interested in the program.

Jordan highlights an important additional avenue that presents itself when pursuing the engineering space, which is that of the potential of having and supporting a family. For Jordan, it was incredibly important for her to witness representation of parenthood as an educator and practicing engineer as a motivator.

The intersection between gender, race, and parenthood articulate the crucial importance in seeing engineers who are women and parents successfully engage, and dismantle, a patriarchal society that superimposes gendered expectations upon women. This intersection also demonstrates Yosso's [6] navigational capital in the way Jordan's resilience in this program was informed by representation in a way that will uniquely and notably inform her input into the practice of her familial capital.

While Jordan's story highlights the unforgettable influence witnessing a working engineer, educator, and mother had on her in college, Michelle purposefully noted her perception of gendered boundaries in the field. Specifically, Michelle highlights that she even as she has "girl cousins [who] are engineers." Together, their stories emphasize not only the profound impact of seeing a working mother in academia, but also their often family-based sensemaking of women's paths through engineering. Both experiences seem poised to contribute to the familial capital they will pass down to future family members, a noteworthy finding of this project.

Engaging in meaningful and thorough engineering experiences within the engineering space in college means recognizing that families materialize for engineering students in complex, tangible, and imaginary ways. This includes the presence of gender expectations, pressure, and familial aspirations throughout the students' educational experience within and far beyond the classroom. These very experiences also reflect and inform familial and navigation capital in remarkably notable ways, further complicated by finances.

Family and Financial Motivation

In reflecting on college and life motivations, Isaiah said, "My whole reason to going to college is just to work, have a decent life, and help my mom and my dad out." The relationship between the students in this study and finances is incredibly notable in the way finances continued to be a motivating factor throughout the students' lives before, during, and after their time in college. Specifically, as Isaiah reflected upon, the ability to build a high-income post-graduation beckons students to select engineering as their undergraduate major intentionally. Students described an intense, dual-directional relationship with financial stability: the drive to

both "pay back" and "pay forward." While family resources often dictated where students initially attended college, their ongoing undergraduate experiences were heavily shaped by the pressure to provide. For many, securing long-term financial stability motivated both their current relatives and aspirational future families throughout their engineering journeys.

Brittany, an Industrial Engineering student, spoke to a nuanced situation where her financial responsibilities as a student materialized for her in college. Brittany explained:

...I don't necessarily want to work for anyone forever. I'd like to have my own business, and my dad is also an entrepreneur, so he really pushed that my whole life as well... But, like, I have bills that have to be paid, and I don't necessarily want to ask my dad because he's a single parent right now. My mom passed away a couple of years ago, so I don't want to be a burden on him.

While Brittany balanced her perception of her father's financial responsibility, her personal decision-making reflects the commonly repeated complex relationship these students often shared in the way many students did not want to ask for more financial support from their parents. This fear of needing financial support from family was often associated with increased stress and overextension.

Sam echoes this feeling of internalized pressure to resolve personal and familial financial responsibilities where they say, "... if my family ever needs me to do something, I can just go in and be like, 'Okay, I have the money to help.'" Much like Michelle, who took on a second work-study position to meet need, and Brittany, who felt constant pressure to step in financially, many students internalized the heavy burden of ensuring both current and future financial stability. This hidden responsibility further complicated an already rigorous engineering curriculum.

Dion illustrates the complex synergy between familial encouragement and the financial realities that shaped his academic trajectory. He recalls:

And then it was because of family and finances that we came to [new state], and I thought it would be really great to go to [state research university]. Then financially, it took a turn for the worse for me, so I had to go to other institutions and transfer credits... to quote my father: 'If you have a fire in your belly, we'll help you.' My family, we literally moved every one to two years, so I was always the new kid. So, when you talk about rebranding engineering, I had to rebrand myself every time I moved.

Dion's reflection highlights the potential value of holistic support for students who carry heavy, out-of-classroom expectations. As Dion notes, the nuance that came with moving, finances, and passion can invite further reflection on the engagement between finances and engineering undergraduate students, including dialogue on socioeconomic status, undergraduate job availability and accessibility, and advising for and of engineering students.

Each of these students extend the bridge discussed earlier in their dialogue on finances and their families. These students demonstrate the appearance of financial security within

Yosso's [6] family and navigational capital. Particularly, while students gain essential resilience and values from these forms of capital, they often feel a responsibility to return that support financially, as a form of reimbursement. Specifically, these students articulated that as they maneuvered their engineering programs with their familial and navigational capital, they did so with aim to reciprocate financial capital toward both their current and future family members.

Discussion

By moving beyond the notion of family as merely a background variable, we argue that familial and community knowledge are central mechanisms through which students construct their engineering identities and resist systemic barriers. For the women in this study, extrinsic motivations—such as financial stability and aspirational familial growth—were deeply intertwined with cultural expectations. In tapping into their families' funds of knowledge (their culturally accumulated skills and practical wisdom) [31, 38-40], these students consistently drew upon their familial capital to drive their pursuit of career security and high achievement [37, 41]. Drawing on the literature, this currency can further bolster students' self-efficacy, reinforcing their confidence in their own capacity to succeed in a highly demanding field like engineering [42, 43]. Consequently, students' academic persistence is not an isolated endeavor, but a collective family-engaged project, that also expands into financial expectations.

While students expect positive social experiences, student services, and institutional reputation in their educational journeys due to increased tuition and fee requirements [44], they may also expect higher income as recipients of their institutions' engineering education and prestige. This study complicates this expectation by recognizing family and navigational capital as a significant contributor. Within this study, students repeatedly discussed internalized financial expectations and motivations that encouraged them to approach, navigate, and persist through their engineering programs. As institutions navigate this connection between financial expectations and familial capital, they should recognize “family income” and “future income” as two interrelated variables in their student support models. By recognizing both variables in program assessments and evaluations, engineering programs and research can better understand how they relate to each other and inform future student success models.

Effectively integrating the family requires breaking down institutional barriers, including around accessible communication about students' experiences in the field. Participants such as Binh described explaining their coursework to relatives as a chore, constrained not by native language, but by alienating academic jargon. Accordingly, programs may proactively enhance their communication strategies to include students' families, potentially further aligning their familial support while navigating challenging engineering coursework and career steps. In communicating from early stages of the program on what attainable expectations might look like, students may engage with familial and navigation capital in strengthened ways. Further, this communication will also reinforce familial approaches to support and motivation. With family communication achieved, mentorship and representation then become highlighted.

As students highlighted representation on campus as shaping their perceptions of their futures, mentorship and advising models rooted in representation should be intentionally implemented across campus. Because students rely heavily on deep-rooted familial support systems, traditional, "one-size-fits-all" academic advising often falls short. Students articulated a need for mentorship that mirrors familial support: rooted in absolute belief, continuous motivation, and active encouragement. Engineering faces a historical tendency toward disproportionately burdening the few available mentors of color [45]; however, systems of reductive or universal advising, mentorship, and supervision provide inequitable opportunities for engineering students. As these students may have varying experience with university systems, programs may instead benefit from developing holistic mentorship models that explicitly recognize and integrate students' navigational needs through creating inter-institutional mentorship programs.

While we know that gender desegregation factors into engineering students' lives [46-49], this study furthers our understanding on the concept of family as an evolving construct. Specifically, family here encompasses both present and aspirational future family relationships, complicating Yosso's [6] familial capital. Aspirational future family relationships thereby demonstrate an engineering student's ability to inform their own navigational and familial capital rooted in growth and development. Elaborating on the bridge metaphor presented throughout this paper, if students are entering engineering programs with a bridge of support consisting of familial and navigational capital, they not only exit this experience with this attained capital, but also with aspirational input into their practice of such capital in the future.

Conclusion

Engineering students view their families as foundational mentors, driven by a profound gratitude to repay this support through academic achievement. Consequently, contemporary engineering programs must evolve to treat families as active, relevant members of the educational community rather than external bystanders. Because institutional engagement with families often varies by socioeconomic and immigration status [39, 50], engineering programs should also actively validate these evolving, forward-looking familial motivations to foster student persistence. As Yosso's [6] CCW framework provides us a powerful vision into how families support a minoritized student's desire to succeed in a space so often not built for them. This study expands this understanding to articulate these supports as influential inputs into an engineering student's life throughout and beyond their program. It leaves institutional engineering programs with the important implication to recognize not only the influence of but the influence for past and future engineers, and their families. These students represent a substantial effect of familial and navigational capital, and in reconceptualizing traditional mentorship to include recognition of this capital, engineering programs can make significant strides toward inclusive engineering education. Such mentorship should represent kinship networks through practical and inclusive initiatives—such as family orientations, faculty-family social events, and accessible informational resources. Investment in cohort models also encourages relationships that can bolster and support familial investment, while alleviating stress and isolation. Ultimately, intentionally validating and integrating the family's role is essential to holistically supporting student persistence and success.

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