

Identity Capital and Persistence among Latinx Engineering/CS Undergraduates at an HSI on the US-Mexico Border

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About 10% of engineering and computer science degrees in the U.S. were awarded to Hispanics from 2004 to 2014 [1], while only 8% of the engineering workforce and 7% of the computing workforce, respectively, was comprised of Hispanics, as of 2018 [2]. In spite of concerted efforts over the last several decades at expanding their enrollment and participation in engineering and Computer Science (CS), students from a range of backgrounds – including women, Latinx, Black, indigenous, and first-generation – continue to be underrepresented in these fields. This persistent underrepresentation impacts not only postsecondary engineering/CS programs, but also the profession more widely, as engineering/CS fields fail to reflect the diversity that is representative of U.S. society at large. A number of studies have focused on the challenges and barriers faced by students from underrepresented backgrounds in engineering/CS. As a response to deficit-focused narratives related to underrepresented groups in engineering, there is also an emerging body of engineering education scholarship that highlights more asset-based approaches to understanding the experiences of underrepresented groups in engineering, including the forms of community cultural wealth [3] that minoritized students bring to their studies.

This study draws on two years of ethnographic data collection to uncover the tangible and intangible assets leveraged by Latinx engineering/CS undergraduates in order to persist in their studies to graduation and into the profession. The study is situated in a unique context: at a large, public Hispanic Serving Institution (HSI) on the Mexico-US border whose student population is more than 80% Hispanic and that employs an explicit student success framework focused on equity and inclusion. The study included 27 Latinx engineering/CS students – 17 men and 10 women – who we followed from their final year of undergraduate studies through graduation and beyond. Our analysis bring together two theoretical frameworks – that of community cultural wealth [3] and identity resources [4] to identify and categorize the assets leveraged by participants as they persisted in their studies and into the field (or not). The six primary sets of assets leveraged by this group of students included aspirational, positional, relational, tenacious, communicative, and strategic. Each of these are be described in detail in our paper.

Conceptual Framework: Identity and Theories of Capital

This paper draws on two primary conceptual lenses to identify and understand the tangible and intangible assets leveraged by Latinx engineering/CS students at the HSI: identity capital and community cultural wealth (CCW). Both frameworks share similar conceptual underpinnings: the notion of capital taken from critical social theory, particularly from the work of French sociologist and philosopher Pierre Bourdieu. Bourdieu highlights the role that capital plays in maintaining and perpetuating the social order and hierarchies within that order. His work pinpoints three primary types of capital: economic, social, and cultural [5]. While economic capital refers to tangible wealth (e.g. money, property), cultural capital has both material and symbolic manifestations, including (but not limited to) formal education and its accompanying

credentials. Social capital refers to the social connections held by individuals – “the aggregate of actual or potential resources which are linked to a durable network of more or less institutionalized relationships of mutual acquaintance and recognition” (p. 21). Bourdieu’s theories of capital sheds light on how resources – both material and symbolic – can be accumulated to give individuals and groups a social advantage.

Yosso’s CCW framework draws on Bourdieusian social theory, as well as critical race theory, to highlight six primary forms of capital possessed by Latinxs: linguistic, social, familial, navigational, aspirational, and resistant [3]. Importantly, Yosso’s framework seeks to “center the research, pedagogy, and policy lens on Communities of Color and call into question White middle class communities as the standard by which all others are judged” (p. 82). In drawing on critical race theory, and specifically LatCrit theory, Yosso’s framework highlights the “layers of racialized subordination” experienced by Latinx, where “racism, sexism, and classism are experienced amidst other layers of subordination based on immigration status, sexuality, culture, language, phenotype, accent, and surname” (p. 72). In engineering education, scholars have utilized CCW to understand the experiences of underrepresented groups in STEM, such as the use of navigational capital by low-income students to persist at a Predominantly White Institution [6] and the different forms of capital if possessed by eight engineers of unidentified backgrounds [7]. A thorough meta-analysis of the literature in this area highlighted 33 studies explicitly focused on the community cultural wealth of “nondominant” groups in STEM [8].

Sociologists Cote and Levine draw on critical social theory, as well as psychology, to put forth the notion of identity capital, which they define as the tangible and intangible resources “cashed in” by individuals for particular ends [4]. Educational anthropologists have deployed Cote and Levine’s notion of “identity resources” in studies of identity development in athletes and professional learning among teachers. In an earlier analysis of a subset of participants from our two-year ethnographic study, we identified four primary kinds of identity resources articulated by nine focal participants in their decision to pursue engineering/CS: affinity, aspirational, positional, and relational [9]. The current paper expands this earlier analysis to include all 27 students participating in our study, with a focus on the resources that they identified as being supportive of their persistence to graduation.

Research Context and Methodology

This paper presents the findings from a two-year, NSF-funded ethnographic study of Latinx students’ trajectories through undergraduate engineering and computer science studies and into the profession. The study took place at a large, public, research-intensive HSI on the Mexico-US border with an explicit student success framework focused on equity and inclusion, and asset-based approaches to teaching, research, and student support. The study included 27 participants, who were selected based on their enrollment in the engineering or Computer Science capstone courses and their backgrounds as Latinx students. Of the 27 participants, 14 were Computer Science (CS) majors, of which four were women, and 13 were mechanical engineering (ME) majors, from which six were women. In total, we had 10 women and 17 men, all of whom could be categorized as Latinx, in the broadest sense.

Four primary sources of ethnographic data were collected: demographic questionnaires; participant observation; artifact collection; and three in-depth interviews with each participant. Two interviews per participant took place during their studies, and the third interview took place 9-12 months after graduation. Each interview lasted between 60-90 minutes and was conducted in the language of choice of the participant (English or Spanish or both).

The primary research question that guided this paper was: What are the struggles that Latinx students encounter in their engineering/CS studies, and how do they describe facing these struggles to persist to graduation?

Data were analyzed over multiple stages through an iterative process of open and focused coding [10], where large themes were identified across all data sources, starting with the interview transcriptions. For the purposes of this paper, the two primary thematic categories identified in early rounds of data analysis were “struggles” and “overcoming.” The analysis focused on participant accounts of the challenges and struggles that they faced during their engineering/CS studies, as well as the ways that they reported addressing these challenges. In the next section, we present a summary of the primary struggles identified by participants and the identity resources that they marshaled to manage the struggles that they encountered.

Identity Resources Leveraged by Latinx Engineering/CS Students in the Face of Struggle

Thematic analysis of the in-depth interviews with Latinx engineering/CS undergraduates uncovered six primary categories of struggle that they reported experiencing during their studies: financial, sociopolitical, academic, interactional, familial, and intersectional. Financial struggles included covering the cost of schooling, including tuition, which often entailed students’ working a part-time job while going to school. Participants who were Mexican nationals often experienced sociopolitical struggles related to obtaining and retaining a visa to study in the U.S., as well as the difficulties associated with crossing the border on a daily basis to attend university. Academic struggles ranged from the individual to the institutional. Some participants highlighted the experience of learning academic English as a challenge; others emphasized the challenges they faced with teaching approaches in some of their classes, and the resulting difficulties in grasping content. Many of the participants noted that they experienced struggles with their peers, particularly related to the teamwork required for their capstone projects. At the familial level, some participants highlighted struggles that ranged from losing loved ones (often a parent) to perceiving a lack of support from parents and family. Intersectional struggles referred to the ways in which participants were positioned in engineering/CS based on different aspects of their identities; these struggles included feeling undervalued for being a Latina in engineering, or gay in engineering.

One important finding from our in-depth analysis of interviews was the ways in which participants described the struggles that they faced and the ways that they overcame those struggles within the same account. In some instances, the source of struggle was also the source of overcoming that struggle. It was in our analytical focus on “overcoming,” that we uncovered six primary sets of “identity resources” [5] marshaled by students to successfully

navigate challenges during the course of their engineering/CS studies: aspirational; positional; relational; tenacious; communicative; and strategic.

In this analysis, we focus on the three most prevalent types of struggles reported by participants: academic, economic, and sociopolitical. We provide details on the struggles as narrated and experienced by the students, and also provide analysis on the identity resources that students described to navigate these struggles in order to persist in their studies to graduation.

Academic Struggles and Resources

One common category of struggle reported by participants was related to academics. In our study, sixteen participants described different academic struggles through their engineering/CS studies. The academic struggles highlighted by our participants included a range of challenges, including: difficulties in understanding content in engineering/CS ; difficulties in adjusting to the pedagogical approaches of instructors; difficulties understanding and communicating in English; failing courses and being at risk of probation; and difficulties in transitions between educational systems (e.g. from Mexico to the US or from community college to the university).

Participants in engineering/CS programs found struggles facing difficult course content related to their majors. For example, Samantha told us how she and her class were advised by the professor about the difficult content they were going to find in his class: “[in] my first engineering class, the teacher said, ‘it’s going to make you or break you.’ That to this day is the hardest semester I had.” Even though she lived in the US, she frequently traveled to Mexico on the weekends to visit her mom. She told us how limited her free time was during that semester: “My social life was very limited. All I did was visit my mom, like always. So visit my mom, visit my mom. Other than that it was just staying up to three in the morning.” While Samantha showed value for her time with family, she also demonstrated tenacity by committing the time to study for her courses.

Another example is mechanical engineering student Elisa, who struggled with an engineering class. In addition to the difficult content of the course, she explained she was struggling to understand based on the professor’s teaching style. She told us “He would talk and use the board. No PowerPoints or anything. You had to be in class to be up to date with what was happening.” Similarly, Herman shared his academic struggle with a physics class in which the professor only used a PowerPoint to present each class and was inconsistent with the class assignments. He said, “in our classes he just stood there with a PowerPoint; sometimes he would ask us to do some assignments that he never remembered to pick up. Also, in some assignments he would add topics that he never taught.”

Also, 19 participants mentioned working part-time or full-time jobs during their engineering/CS studies. During an interview, Alex shared with us that although his parents insisted that he stop working and focus on school, he felt the need to work; as a result, he struggled to juggle school and his full-time job. Alex told us: “I would go to thermodynamics, thermo is one of the hardest

classes ever. So I pretty much would study all day at work. I was working sometimes more than 50-hour weeks, but I had a routine. I'd go to school, go to work, go home and then study, maybe go to bed, fall asleep early because I was exhausted sometimes." In this account, Alex describes his academic and work commitments; what's significant is his emphasis on the routine that he developed. In this way, he showed both tenacity in his work-school commitments as well as strategic resources in managing his time to balance both work and school.

Financial Struggles and Resources

Fifteen participants in our study highlighted financial struggles during their engineering/CS studies. These struggles included having sufficient funds to cover the cost of school and working to support themselves or their families. Although these tangible financial struggles added layers of emotional and academic stress onto our participants' college experiences, participants also described the intangible resources that they drew on to navigate these struggles.

Eight students mentioned the challenge of paying for school. However, these students also identified aspirational resources (continuing with their education by changing from their first choice university), positional resources (being granted a scholarship based on having good grades), relational resources, and communicative resources (communicating with friends as providers of support and information to get financial aid), which helped them to face and overcome these struggles. For instance, Edgar, a Mexican-origin student who recently graduated from mechanical engineering with a 4.0 GPA, made use of his aspirational and positional resources in his struggle to pay for his college education. During his last year of high school, when it was time to choose a university, Edgar chose a well-known US university. Studying at a prestigious university was something that Edgar wanted since he was in high school. However, Edgar's parents lived and worked in Mexico; therefore, the high cost of tuition and cost of living in a big city was something Edgar did not want his family to struggle paying for.

I had an interview with [well-known university]. The interviewer asked me if I could pay for Boston. I told him I wanted to work while going to college, but he told me that the minimum wage is not enough. So he said, "I need to know if your parents have the financial resources or you will take them to bankruptcy." That really impacted me, made me conscious about my social class.

After being interviewed by the university recruiter, Edgar realized that neither he nor his family was in the financial position to pay for his dreamed-about education. Therefore, instead of giving up, Edgar made use of his aspirational resources and chose to continue with his education in a more affordable university. As the literature from LatCrit theory indicates, resilience and resistance are forms of aspirational capital that Latinx students leverage to accomplish their goals [3]. Edgar's account represents an illustrative example of using aspirational resources to navigate the financial struggle of paying for his college education. After Edgar adapted his plans to a more attainable university degree, he graduated with a

bachelors' degree in mechanical engineering, taking advantage of every opportunity he could. Throughout his college education, he participated in four different internships at large companies and prestigious universities. He also presented at and competed in engineering conferences and competitions, while being actively involved in one university-based engineering organization. Based on his academic accomplishments, Edgar was positioned as "smart" by professors and other peers. Aware of this, he made use of these positional resources, which helped him to obtain a scholarship that ultimately covered the cost of his college education.

Other students used their relational and communicative resources when they faced the struggle of paying for school. In our study, six students mentioned asking for help from their family, friends, or peers to enroll and get financial assistance to pay for school. One particular example was Javier, a CS major from a low-income background who was a first-generation college student. Javier started his K-12 schooling in Mexico, where he lived with his brother and parents. After concluding high school, he started to work two full-time jobs in Mexico with the goal of saving money to pay for his college education. On one occasion, he ran into a high school friend who told him about the opportunity of attaining financial aid to continue with his postsecondary education. Although Javier was a US citizen, he did not know about the availability of financial aid or loans to pay for college. By making use of his relational resources, Javier was ultimately able to obtain financial aid to pay for school. He told us how surprised he was after getting his tuition bill with the financial aid discount:

I got financial aid and they told me, "so your tuition total is 76 dollars for this semester" and I was like "how can it be such a difference without financial aid?"

Getting financial aid was an important catalyst in Javier's continuing with his college education and ultimately completing his degree in CS. Javier's aspirational and positional resources not only helped him to pay for school, but also to find a job within the CS department. After working for the CS department for four years, Javier was able to buy a car to go back and forth from his home to the university, something he struggled with during his CS studies. During our last interview, one year after graduating from CS, he told us:

CS was not the hardest, it was going back and forth from the university to my home. Sometimes I got a ride with somebody coming to the university. But sometimes that is why I stayed the night here [at the university], I spent all night sleeping in the service workers' room - it is really cool for sleeping.

In the context of limited financial and informational resources, Javier drew on a significant range of identity resources to achieve his goal of obtaining a bachelor's degree, which ultimately warranted him the social mobility to support his family's financial situation after concluding with his education. Throughout his college studies, Javier leveraged aspirational and relational resources in his efforts to obtain a degree. Aspirationally, he maintained commitment to his goal of achieving a college degree; one way he was able to do so was through important information about the availability of financial aid, which he accessed

through his social networks (relational resources). He also drew on his tenacity and strategic resources in getting rides to and from campus for classes and even sleeping on campus when otherwise necessary.

In addition to struggles tied to covering the cost of school, seven students participating in our study mentioned having financial struggles and having to work to support themselves and/or their families. However, they also mentioned the identity resources they used to succeed in their ultimate goals of graduation from their university programs. The participants mentioned how their relational, positional, aspirational, and communicative resources serve them as assets to overcome the financial obstacles they found along their way.

Another example of a student who experienced financial struggles and who worked was Ximena, a CS student. Ximena was married and had two kids at the time of this study. She had to work to support her family and to pay for school, which resulted in a stressful situation for her to manage. She struggled to be a full-time mother, employee, and student, and she was a straight-A student. Along the way she encountered many difficulties to balance her time and financial resources. She also told us how she had to turn down a stipend from her department to attend an important professional conference because of not having enough money to bring her kids with her. Attending this conference was something that could have potentially helped her to build and expand relational resources, which could have been of assistance in landing a job post-graduation. However, despite the financial difficulties she encountered during her college studies, Ximena was observed as consistently interacting well with others, demonstrating kindness, and supporting her peers during team interaction - all of which contributed to her relational resources.

Studies show that college students who come from low socioeconomic backgrounds and belong to marginalized communities struggle to feel confidence in their abilities and knowledge [11][12]. This is also true for Ximena, who felt she was not good enough, despite her high grades and the support of her professors. She was recognized by peers and her professors as a good student due to her grades. Despite (or because of) the struggles she endured, she was committed to doing well in school to serve as a role model for her children, to prove to professors she could be a good student, and for social mobility to help her family's financial situation. Besides these aspirational resources, being recognized as a "good student" served as a positional resource to help her obtain a scholarship to pay for her college. She was encouraged by a staff member who knew about her good grades to apply for a scholarship that the CS department was offering at the time. In one interview, she shared what happened when she was called to a professor's office to talk about this scholarship:

He told me, "The scholarship is yours. We think you're great. We believe in you and we think you're going to do well. But you cannot turn down any more trips. I know you don't have a babysitter. I will then get together the money so that you can bring your kids with you." I thought to myself, "this man doesn't realize he just changed my life because I was having to work full-time." I was going to cry. It was \$9,000 a year. "He doesn't realize the giant difference he just made." He has no idea. I couldn't pay for my

car. We got to the point where we were in debt because I had been sick before, years before. So we were still carrying that with us.

Ximena's relational, positional, and aspirational resources helped her to successfully navigate the financial struggles she faced. She made use of her positional resources to receive a scholarship. Her relational resource gained her the support of her peers and professors. Finally, by not giving up despite all the struggles she encountered in her pathway, she leveraged the tenacity needed to complete the program. During our last interview with her, Ximena shared that she is working at a prestigious medical company as an engineer developer, where she still makes use of her tenacity, positional, and aspirational resources to navigate the struggles she faces by being a Latina female in a majority-white context.

Sociopolitical Struggles and Identity Resources

Given the university's close proximity with Mexico, it is not uncommon for people to cross the border between the US and Mexico on a regular basis. Regardless of citizenship, people in this region can live either in Mexico or the US and cross the border legally on a daily, weekly, or monthly basis for family, academic, or economic purposes, barring recent border restrictions because of the COVID-19 pandemic. In the research literature, students who cross the border regularly are known as transfronterizx students [13]. Transfronterizx students have unique experiences because of all the implications of having to physically cross the bridge between Mexico and the US to attend school.

Fourteen participants in our study were identified as transfronterizx, meaning they crossed the border on a daily or weekly basis. These transfronterizx participants crossed for two reasons: to attend college in the U.S. (because they lived in Mexico), or to visit family and friends in Mexico (because they lived in the U.S.).

Crossing the border on a frequent basis entailed particular struggles faced by our participants in their studies and in their efforts to graduate and pursue their professional pathways. The particular challenges faced by transfronterizx students in this study included: getting and maintaining a student visa; struggles to cross the border; limits on professional trajectories because of citizenship status; and navigating a lack of diversity in career settings. Participants described overcoming these sociopolitical challenges by persevering through their majors to keep their immigration status, showing tenacity through internship and job rejections, and finding resilience to graduate and find a job. In this section, we highlight illustrative examples of engineering/CS students in navigating these sociopolitical struggles.

Alicia, a mechanical engineering major from Mexico, told us she struggled to get her student visa. Although she preferred to stay at a private university in Mexico, she applied to a US university based on her parents' advice. When applying for her visa, she told us she was stressed about dealing with the process; she felt tremendous pressure in facing an immigration procedure that would decide her professional future. Another example is Francisco, who decided to come to the US from Mexico to start his studies in mechanical engineering. He

began his core courses at a community college, but struggled academically since he could not understand or speak English at the beginning of his college studies. He told us that his academic struggles extended the time it took him to finish with his degree and that his visa expired sooner than what was needed to conclude his education. Francisco realized his visa was expired when he crossed the border one day to attend class: "I was barely passing the exams even though I was studying and then one day that I was crossing the border [and] they stopped me at the bridge and they told me, 'You cannot cross. Your visa is expired.'" Francisco told us he was subsequently not able to cross to the US for one year; meanwhile, he feared he would not be able to continue with his education. During that year, he continued to work as a full-time employee at a maquila in Ciudad Juarez until he could apply for another student visa. Despite these difficulties, Francisco showed the aspiration and tenacity to wait until his visa was approved to go back to school with the goal of finishing his degree. Francisco completed his program and was most recently working as an engineer for a company local to the region.

Alejandra, a CS major student with a high GPA, told us how she struggled to pass a math class earlier in her studies. She said that regardless of how much they put into their studying, she and most of her classmates were failing the course. She told us that students were dropping the course; however, she was not allowed to drop the course due to her immigration status in the US. She told us:

Like, everyday, less and less people showed up [in class]. And, well, I thought about dropping it, but I'm an international student, and I need 12 credit hours or more so that I can be full-time. Otherwise, I get in trouble with Immigration and my visa and my papers and everything, so I decided not to drop it. I said, 'Well, if I get a bad grade and I have to retake it, that's better than getting in trouble with Immigration.'

Alejandra, as many other students with student visas, could not drop the course; she needed to pass the course in order to maintain her immigrant status. For Alejandra, failing the course would mean risking the scholarship she had to pay for her college studies. Despite these circumstances, she showed the tenacity to continue and successfully pass the course. Academic struggles like these were not uncommon; however, many students with immigrant status as Alejandra, made use of their aspirational resources to persevere in their education in the US.

Conclusion

This paper presents findings from a larger two-year, NSF-funded ethnographic study examining the experiences of Latinx undergraduates in engineering/CS through completion and into the profession or graduate school. The paper analyzes the first-hand accounts not only of the struggles that they faced throughout their studies, but also the resources that they leveraged to navigate these struggles to persist to graduation. This paper contributes to a growing body of scholarship that disrupts deficit views of minoritized engineering students by highlighting identity resources, both tangible and intangible, that underrepresented students bring to their studies. We highlighted three key types of struggles that Latinx students in our study faced: academic, financial, and sociopolitical. In navigating these struggles, participants drew on six

primary sets of identity resources: aspirational, positional, relational, tenacious, communicative, and strategic. All participants ultimately persisted to graduation, and most secured jobs in the profession or continued onto graduate school.

This study helps expand asset-based theories to understand the unique strengths and resources deployed by Latinx students in engineering/CS in the face of difficult challenges that are both institutional and personal in nature. Findings from this study have implications for faculty and program administrators, whose adoption of an asset-based (rather than deficit-focused) lens in their teaching and program administration has the potential to transform the experiences of Latinx and other underrepresented students in engineering/CS, contributing to their greater recruitment and persistence in the field.

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