



Engineering Identity Development of Latina and Latino Members of the Society of Hispanic Professional Engineers

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Despite the efforts made in at least the last forty years, Latinas and Latinos continue to be underrepresented in engineering. Research has shown that engineering college students who identify as engineers are more likely to persist in engineering than those who do not identify as engineers^{1,2}. One way to study identification with engineering is through a study of engineering identity development. However, much of the literature on engineering identity has focused on an aggregated population of engineering students, doing so often leaves the experiences of students of color unexplored^{3,4,5}. This paper addresses this literature gap and aims to broaden the conceptualization of engineering identity by studying the development of engineering identity of Latina/o undergraduates from their perspective and experiences.

The forecasted growth of Latinas/os in the United States has encouraged a range of institutions to assess how this shift in population will affect various programs of study especially those in science, technology, engineering, and mathematics (STEM) where Latinas/os are currently underrepresented. In engineering, the number of Latina/o students enrolling has increased since the 1990s and it is projected to continue to increase, though not at the same rate as the Latina/o population growth. Engineering is one program of note because it is the second most chosen career path by Latinas/os in the sciences, and one that many Latina/o students denote as prestigious or synonymous to being called a doctor⁶. Yet, Latinas/os remain underrepresented in engineering. This paper aimed to address the problem of underrepresentation in engineering for Latina/o engineering students via a study of engineering identity that is grounded on the Latina/o student experience. This study was guided by the following research question: In what ways does membership in the Society of Hispanic Professional Engineers influence the engineering identity development of Latina and Latino students?

Literature Review

Latinas/os are a growing minority group in the United States that is underrepresented throughout the educational pipeline. The Pew Research Center estimates that Latinas/os will represent around 29% of the population by 2050⁷. Currently the Latina/o population comprises around 16.7% of the overall national population. With regard to the educational pipeline, of 100 Latinas/os who start elementary school, only 26 of them will enroll in college, and only 10 will graduate from college⁹. The majority (50.6%) of students who enroll in college enroll in 2-year public colleges⁸. Latinas/os are overrepresented in 2-year and/or community colleges. While enrollment in community colleges can lead to transferring into a 4-year institution and attaining a bachelor's degree, Latina/o transfer students face a greater possibility of not attaining a bachelor's degree⁹.

Although engineering is among the top ten majors for Latinas/os, in the 2011-2012 academic year, only 4.3% of Latinas/os bachelor degree recipients received a degree in engineering. Only 10% of undergraduate students who enroll in engineering in the United States are Latina/o¹⁰. Compared to other minority groups such as African Americans and Asian Americans, Latinas/os have had an upward enrollment trend in engineering since the early 2000s. Latinas/os have high aspirations for majoring in engineering compared with other

underrepresented groups¹¹. Hispanic Serving Institutions may serve as role model institutions for graduating Latinas/os in engineering⁶. About 37% of bachelor's in engineering degrees awarded to Latinas/os come from high-Hispanic enrollment institutions¹⁰.

Some of the factors that contribute to the success of Latinas/os in engineering include self-concept/self-efficacy^{12,13,14}, pre-college educational experience and preparation^{15,16}, family¹⁵, a welcoming campus culture¹⁷, positive interactions with faculty including mentoring relationships^{16,18,19}, and involvement in summer programs including research and academic enrichment programs^{15,20,21}. Latina/o students who have parents with engineering degrees are more likely to matriculate into engineering and choose an engineering career¹³ than those who do not have parents with engineering degrees. However, the majority of Latina/o parents of engineering students have only a high school education^{16,21}.

In addition to these factors that contribute to the success of Latinas/os in engineering, May and Chubin emphasize the importance of policies and institutional factors for the success of underrepresented groups in engineering²². They discuss the importance of admission policies with regard to affirmative action, minority serving institutions, 2-year colleges, and dual degree programs. Also important, May and Chubin argue that the media image of an engineer is generally that of a white male:

One reason that minority children don't think of engineering as a career to which they can aspire is that people who look like them are so seldom portrayed as engineers or scientists, making recruitment of minority students into engineering fields all the more challenging. (p. 32)²²

Minority Engineering Programs (MEPs) have also been key in the success and retention of underrepresented students in engineering. The MEPs often address aspects of academic, social, and professional development for students with a focus on academics^{22,21}. Part of the success behind MEPs is the use of collaborative learning to structure the student experience²². Collaborative learning and the MEP goals are achieved through freshman orientation, clustering groups of students in the same courses, study center, and structured study groups. As a result of these efforts, the students who participate in MEPs are more likely to be retained in engineering than those who do not participate in MEPs.

Another way of addressing retention of Latina/o engineering students is by studying how students identify with the field. Research has shown that students who identify as engineers during their college years are more likely to persist in engineering^{1,2}. In their analytic framework on how students become engineers, Stevens, O'Connor, Garrison, Jocuns, and Amons argue that identification with and by engineering is an important aspect of becoming an engineer²³. Tonso's work on engineering identity shows that identifying as an engineer can promote a sense of belonging in the engineering culture⁵.

There are factors that play a role in one's identification as an engineer. In Carlone and Johnson's science identity model, the authors highlight recognition as an important dimension for science identity²⁴. Recognition by self and by others is an important aspect of a person's identity as a scientist. Being called an engineer is also an important aspect of an engineering student developing an engineering identity. Faculty often call students engineers even before degree completion, which aids students in early identification as engineers⁴. Meyers, Ohland,

Pawley, Silliman, and Smith find that there are intangible factors that students use to identify as engineers such as “making competent design decisions, working with others to share ideas and accepting responsibility”⁴. At minority serving institutions, African American and Latina/o students’ identity development is shaped by the positive experiences with faculty and peers in their programs²⁵. In identifying as engineers, students express a certain pride in the rite of passage of overcoming the challenges of the engineering curriculum^{3,25}. There are some gender differences with regards to engineering identity; women are less likely to identify as engineers than men, especially freshmen female students⁴.

Significance of Study

The majority of the research in engineering identity has focused on an aggregate group of students, which can leave the experiences of underrepresented students unexplored. Often there is no statistical power to disaggregate data by race or ethnicity and results are reported for aggregate groups of underrepresented students, which can lead to a loss of the nuanced, individual student experience²⁶. This study can broaden the conceptualization of engineering identity by studying the development of engineering identity of Latina/o undergraduates that is grounded on the students’ perspectives and experiences.

Methods

The overall research study is a sequential²⁷, developmental²⁸ mixed methods study. The first phase of the study was qualitative and was composed of interviews and observations. The second phase was quantitative and entailed development of an engineering identity survey. The overall research study was guided by the following research question: In what ways and to what extent does membership in the Society of Hispanic Professional Engineers influence the engineering identity development of Latina and Latino students?

This paper focuses on the first phase of the overall research study; namely, the qualitative exploratory phase. For the qualitative phase, I answered the research question through interviews with engineering undergraduate members of SHPE and through observations. I focused on membership in SHPE because SHPE brings together people who are interested in engineering and who share similar cultural values.

Data Collection and Participants

I employed purposeful sampling to recruit students to participate in semi-structured interviews. Purposeful sampling allowed me to achieve intensity in the data by recruiting information-rich participants²⁹. To obtain information-rich participants, I sampled participants from those who attended the 2013 SHPE national conference. The following student characteristics were used to recruit information-rich participants and seek variation in the data: major, ethnicity, gender, institution type, and number of years as members of SHPE. Interview participants were recruited via an email message sent to all undergraduate attendees of the 2013 SHPE national conference. The annual conference took place in Indianapolis, Indiana in October 2013. During a short one-on-one meeting at the conference, I connected in person with over thirty of one hundred potential participants who responded to the email invitation. In the spring of 2014, I sent a second email invitation to the participants who responded to the first invitation

to invite them for the interview. More than twenty potential participants responded and I interviewed twenty-two of them. Two interviews could not be included in the study. One of the participants did not return the signed consent form after several attempts to reach him. The other participant did not meet the criteria for the interview; he disclosed this information near the end of the interview. I interviewed the majority of participants virtually via video conferencing. I interviewed three of the participants via phone call as video conferencing was not an option at the time of the interview. The interview length ranged from 27 minutes to 78 minutes. On average, the interview lasted around 50 minutes. The names presented with quotations from students are pseudonyms, most of which were chosen by the interview participants.

The interview protocol was created and guided by three frameworks to elicit conversation about engineering identity development. Primarily, the interview protocol was guided by Yosso's Community Cultural Wealth theoretical framework³⁰. In this framework, Yosso emphasizes and argues for the importance of understanding students of color as owners of capital rather than as capital deficient. Yosso presents six forms of capital that represent "an array of knowledge, skills, abilities and contacts possessed and utilized by communities of color to survive and resist macro and micro-forms of oppression" (p. 77). These forms of capital are aspirational, linguistic, familial, social, navigational, and resistant. Guided by these forms of capital, I created interview questions to have conversations with students about their engineering identity development. The second framework I used to guide the interview protocol was the model of multiple dimensions of identity³¹. Using the lens of multiple dimensions of identity, I created questions that would evoke conversations about various identities (e.g., ethnic, gender, generational) that play a role in the students' lives as engineering student members of SHPE. The remainder of the interview questions was guided by research literature on engineering identity^{4,5}.

To triangulate the results from the interviews, in the fall of 2014, I was a participant observer at public events held by a SHPE student chapter and at the 2014 SHPE conference. I observed these events because they were key events highlighted by students in their interviews. Through the observations, I sought to triangulate what I learned in the interviews. Specifically, at a Midwest, public university, which I will refer to as Flatlands University, I attended general body meetings held by the SHPE chapter. The SHPE chapter at Flatlands University was an information-rich site as this chapter has had a very active membership. The chapter has also been recognized locally and nationally for their efforts. At the SHPE conference, I attended and observed professional and leadership workshops, the career fair, and an awards banquet.

Trustworthiness

Trustworthiness and rigor of this research study were addressed using standard practices in the field³². I kept a paper trail throughout the research process that included interview documents, consent forms, a researcher journal, any type of communication with participants, observation notes, and analyses documents. To address the quality of the data, I took notes during the interview, which were incorporated into the data analysis, and reflected on the quality of the data after the interview by answering post-interview reflection questions²⁹ such as: "How did the interviewee react to the questions?" and "How was the rapport?" After I developed a draft of the findings in the form of themes, I conducted member checks via a phone call with

twelve of the participants. During this phone call, I asked the participants for their feedback and comments on the themes. All of the twelve participants agreed with the themes.

Prior to this project, I had not used the Community Cultural Wealth framework for data analysis. To address my ability to code the interviews in accordance with the framework, I recruited a graduate student who had experience working with the framework to assist me in joint analysis. We coded three interviews individually and met twice virtually to go over those interviews in sequence. In our first meeting, we discussed one interview and negotiated on codes. In our second meeting, we discussed the remaining two interviews and completed negotiating codes. Each interview took at least an hour to discuss and analyze together. Through extensive dialogue³³, we concluded that we were in agreement about the vast majority of codes.

Limitations

The purpose of this mixed methods study was to use what is learned from interviewing and observing members of SHPE to develop a culturally situated instrument of engineering identity for Latinas/os. As a result, this study was limited to Latina/o members of SHPE, which may not generalize to the experience of all Latina/o engineering students. While the goal of qualitative methods is not necessarily to generalize to a larger population, one of the ways this study will address the influence of SHPE membership on engineering identity development is through a follow up survey. In the future, the survey will be administered to Latina/o students who are members of SHPE as well as those who are not members of SHPE. Another limitation of this study is that the sample is limited to students who attended the 2013 national SHPE conference. Conference attendees may be more highly involved than their peers. However, these students can be considered information-rich participants as attending the national conference is an important aspect of being a SHPE member. Finally, the student population was composed of self-selected students. Students who self-select to participate may have different experiences compared with students who do not participate.

Findings

I found five themes that answer the research question. Through SHPE, students developed their professional and leadership skills. Students had an impact in their community mostly through outreach to kids. Students engaged in engineering role modeling. Students nurtured a *familia* or a home away from home.

Developing professional and leadership skills

Through their involvement in SHPE, students developed professional and leadership skills that were instrumental for their development as engineers. When asked the question: “What role has SHPE played in your journey as an engineer or engineering student?” the majority of students answered that SHPE provided opportunities for professional and leadership development specific to the engineering field. As explained in Edgar’s representative quotation, students highlighted the workshops hosted by their chapters on campus and the annual national conference as primary avenues for their professional and leadership development.

SHPE has played an important role for me. It's helped me develop as a professional and as a leader...I've been able to attend several of the SHPE national conferences and through those conferences, ...I've gotten to network and connect with employers, I've gotten to connect with representatives from graduate schools and I've gotten to make connections with students from other [chapters] and it's helped me develop professionally...So for me SHPE has been a big part of my journey as an engineer and an engineering student. –Edgar

Specifically at the four-day annual conference, students networked with potential employers and SHPE alumnus. As part of my observations, I attended three workshops as a participant observer at the 2014 national SHPE conference, which took place in Detroit Michigan the first week of November. Two of the workshops were marketed as leadership development workshops and one was marketed as a professional workshop. These workshops were hosted by the following companies: General Electric, Verizon Communications, and Intel. The presenters at all of these workshops were Latina/o engineers.

The career fair at the SHPE conference was another event that was mentioned by almost all of the students as an avenue for professional development. The career fair is one of the largest events during the conference. I also attended the career fair at the conference as a participant observer. In 2014, the ribbon cutting ceremony for the career fair was led by a local Detroit band, with saxophones and drums, the band along with the national board walked and danced towards the entrance of career fair to initiate it. Students, dressed in professional attire and with resumes and portfolios on hand, awaited impatiently near the entrance. After the ribbon cutting ceremony, all of the students waiting near the entrance populated the large exhibit hall. At this hall, hundreds of engineering companies recruited students. As Emily put it, the career fair was invaluable and in some cases irreplaceable for students' professional career advancement.

I actually got an internship through the national conference, mmm, the employer who recruited me doesn't come to any career fairs at my school or anything so I would have never been able to connect with them if I hadn't gone to the conference, and I did and I ended up getting a job with them. –Emily

Finally, in addition to the workshops at the national conference, students mentioned the workshops hosted locally by their SHPE chapters as important to their development of professional and leadership skills.

Professionally, SHPE really, at least the members in SHPE, really helped me out since freshman year go out and at least start networking with these different companies and be able to expose myself up to these recruiters in a professional manner...So because of SHPE I've been able to have a good problem: where I was actually struggling to decide where I wanted to go work because I had so many offers and it was mostly led because of SHPE. –Bob

We [SHPE] provide a channel to, for professional development, how to dress, how to umm write your resume, how to talk to professionals, or how to approach professionals, interviewing techniques. –Jacob

Making an impact in the community

Through their involvement in SHPE, the students made an impact in the community. More importantly, they viewed their ability to make an impact in their community as part of their engineering identity development. For the most part, students were involved in community outreach to middle schools and high schools. *Noche de ciencias* (science night), an outreach science and engineering program for middle school students and parents, was mentioned by most students.

*So we have a whole day for elementary [school] kids, a whole day for middle school kids, and a whole day for high school kids and to see the gears turning and to see those smiles, the frustration, and the face of accomplishment when they do these and participate in these events is really gratifying because you know, you're starting the fire, or you're getting the gears turning and possibly influencing future engineers –Mike II
Also I really like the fact that, that giving back to the community by doing things like noche de ciencias (science night) was really...something really great that I can involve myself in and also connect with the kids so they can get inspired as much as I got inspired to be an engineer. –Robby*

Being a role model to current and prospective engineering students

An important aspect of developing as an engineer for the students was having the opportunity to be a role model to current and prospective engineering students. Students talked about not just setting an example, role modeling, for other students, but also being active participants in other students' successes. Bob, a senior in civil engineering, conceptualized this idea as "paying it forward," he discussed that he had received invaluable help from other, often older, engineering SHPE students and that now he wanted to do the same for others.

I wanted to help out and pay it forward so maybe there will be another kid down the line who due to my contributions will influence them to pursue something that as difficult as an engineering program here at [this university]. –Bob

Karina also discussed this idea of paying it forward, or being a role model to others, as thinking beyond herself. She commented that being part of SHPE helped her think beyond just her individual success.

I think it's made me more humble in the sense that it's not all just about you and that you can help other engineering students also prosper. So I initially started off my SHPE career very focused on just me...mmm...but toward the end of being a SHPE member I definitely became more humble and wanted to help other students also prosper. –Karina

Finding engineering role models

Students found engineering role models in SHPE who helped them develop as engineers. These role models were usually older SHPE engineering students or SHPE alumni. Students

expressed the importance of being able to find people like them who had attained their degree in engineering or were in the process of attaining their degree. For some students, just being able to find other Latinas/os who were engineers was important to their personal journeys as engineers.

That [The older SHPE student's] motivation translated into their school as well, into them being engineering students, and to their professional development, and you could tell every single one of these people here, these guys are going to accomplish their education, accomplish their career. –Manolo

I quickly started to see the benefits of SHPE...most importantly hearing what other Latino engineers were like, and how they got there, hearing their story. –Anthony

Nurturing an engineering *familia*

Within SHPE students found more than friendship and collegiality, they found a *familia* (family) of engineers. The students discussed the strong ties that connected them to their peers in SHPE. They described this *familia* as a “huge network” of people who want to see each other succeed. Hector described being part of the SHPE *familia* as,

Being there for each other, you know, when things really got rough...help each other out during that process too during that time. –Hector

Cesar, a senior in computer science, used words like “brothers” and “sisters” to describe the close ties he has with his SHPE *familia*.

They were like my brothers and sisters at the time so...we took care of each other....And then of course there is the familia aspect so you have, as soon as you join you have a huge network of people who want you to succeed and will help you succeed. –Cesar

Similarly, Joaquin, highlighted the importance of the SHPE advisor in being part of the *familia*. Joaquin described the SHPE advisor, usually a faculty member in engineering, as his “second mom.”

I would have to say my SHPE advisor at my university. She has been one of the biggest support I've had, she has been like a second mom to me here. –Joaquin

Joaquin talked about an instance where in the middle of the night, he was caught driving through an ice storm, something he was not used to, and felt comfortable to call his SHPE advisor and ask for help.

In my observations at the national conference, the sense of being part of a *familia* was clear. Throughout the conference, students used the hashtag #SHPEFamilia on social media. Through the use of this hashtag, students shared pictures and memories of their time together at the conference. At a large dinner during which professionals and students receive awards for their achievements, one of the presenters urged the attendees to use the hashtag to showcase the SHPE *familia*.

Discussion

Through the use of the Community Cultural Wealth framework³⁰, I was able to understand the ways students develop as engineers using an asset-based approach. Previous studies of engineering identity that have studied the topic from the student perspective have focused on the experience of an engineering student, often not taking into account differences for underrepresented students. Through the use of the Community Cultural Wealth framework, I was able to explore culturally situated ways in which students develop as engineers. Specifically, I identified how students used their aspirational, familial, social, and navigational capitals to develop as engineers.

With aspirational capital, students maintained their high hopes and dreams through having engineering role models within SHPE. This finding challenges the idea that being part of an ethnic enclave means that a student of color has a low level of social³⁴. Instead results from this study show that by having Latina/o engineering role models, students were able to find people who look like them and through whose stories they can aspire to achieve and succeed.

With familial capital, students nurtured their SHPE *familia* and maintained a commitment to the well being of the community. In the Community Cultural Wealth framework, family or kin is understood to include not just immediate family, but also friends and extended family. Confirming what is also in literature³⁵ about Latina/o student commitment to the community, I found that the students maintained a commitment to the well being of the community through their community outreach, especially with middle and high school students, and their community service. The students also stayed committed to each other's success and treated each other as family. As has been found elsewhere³⁶ with Latina/o college students, the students' conceptualization of family included other people in SHPE to whom, prior to joining the organization, the students had no relationship.

Although in the literature becoming an engineer is usually framed as an individual's success, these students viewed being and becoming an engineer with a collective perspective. In that being or becoming an engineer was not just about one's success, but it was also about the success of the group. In this case, that group included peers in SHPE, but it also included the success of other Latina/o engineers and the Latina/o community at large. In his study of Latino *logradores* (achievers), Perez found that the students "invested a considerable amount of time co-curricular activities that presented them with opportunities to give back to their communities and peers at-large" (p. 115)³⁷.

With navigational and social capital, students navigated the engineering field and profession through their involvement with SHPE. In this way, SHPE can be understood as a form of counterspace, especially in environments where students face a chilly climate. Counterspaces "serve as sites where deficit notions of people of color can be challenged and where a positive collegiate racial climate can be established and maintained" (p. 70)³⁸. Within these counterspaces, Latina/o students can build a sense of community that represents the cultural wealth of their home communities³⁹. SHPE and the SHPE *familia* served as a social and academic counterspace for these students. Additionally, SHPE can serve as a professional

counterspace for students. The field of engineering is a professional field; students can start their professional careers after graduating with an undergraduate degree. As a result, learning and knowing the professional field does not only happen after graduation, but it happens during college while attaining an engineering degree. While in college, SHPE can serve as a professional counterspace for students where being Latina/o is congruent with being an engineer.

Conclusion

Through the use of the Community Cultural Wealth framework to study engineering identity development for Latina/o students, I found new dimensions of engineering identity grounded in the experiences of Latina/o students. These new dimensions are engineering role modeling, having a commitment to the community, and being part of an engineering *familia*. These new dimensions suggest new ways of thinking about how students develop as engineers and how programs of engineering can support all students in identifying with the field.

SHPE served as an academic, social, and professional counterspace for students, which was key in their engineering identity development. Through SHPE, students were able to identify with engineering and develop an engineering identity by being involved in the community, by engaging in role modeling, and by nurturing an engineering *familia*. Programs of engineering should consider incorporating these dimensions of engineering identity into the curricula and co-curricula so that Latina/o students can have an integrated engineering identity development.

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