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Engineering Identity for Latina Undergraduate Students: Exploring Development and Intersecting Identities

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Abstract

Latinas are entering higher education at greater rates than before, yet they have disproportionately lower completion rates and engineering career representation than their peers (Excelencia in Education, 2015). In many cases, Latinas may have difficulty envisioning themselves as engineering, being validated by the engineering community, and continuing within the engineering disciplines (Carlone & Johnson, 2007; Lord & Camacho, 2013). Therefore, it is imperative that scholars examine the engineering identity development of Latinas during college.

This study was framed by two research questions: 1. How do Latinas in engineering develop their engineering identities during college? 2. How do other intersectional identities influence the development of an engineering identity during college?

This study utilized role identity theory, which addresses the meanings that individuals attach to the context of their social and cultural roles, to understand the engineering identity development of undergraduate Latinas (Stryker & Burke, 2000). The study utilized a phenomenological approach to examine lived experiences of 5 undergraduate Latinas majoring in engineering at a tier-one predominantly white university. Phenomenology allowed for exploring experiences in depth and providing rich detail of meaning making and "essence" (Moustakas, 1994). Each student participated in two one-hour, semi-structured face-to-face interviews.

This study found that engineering identity for Latina students is formed and supported through interactions and involvement with individuals and groups outside normal classroom and laboratory activities. The five Latina participants named their families and campus organizations focused on women in engineering as important sources of support as they pursued their education. Further, this study found that Latinas in engineering encounter tension between their engineering identities and other identities such as their gender and racial/ethnic identities. By understanding the process of professional identity development and its interactions with other personal identities, researchers, practitioners, and administrators may develop support mechanisms that provide a holistic approach to supporting the present and future success of its engineering students.

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Engineering Identity for Latina Undergraduate Students: Exploring Development and Intersecting Identities

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Engineering Identity for Latina Undergraduate Students: Exploring Development and Intersecting Identities

Latina/o students remain underrepresented in the engineering industry despite enrolling in higher education in greater numbers than ever before (*Excelencia* in Education, 2015). Such inequities are particularly pronounced for Latinas, who make up only 2% of all employed engineers (National Science Foundation, 2017). In order to create a more diverse workforce within the United States and to ensure equitable access and success for Latina engineering students, a greater understanding of their educational experiences and pathways to the field is needed.

As both women and underrepresented minorities within the field of engineering, Latina students often encounter inequities that present barriers to their success. Students may experience oppression as a result of pervasive racism and sexism present in the engineering environment; in particular, Latinas, as women of color, may experience intersectional oppressive forces that discriminate against them in unique ways as a result of both racism and sexism (Bruning, Bystydzienski, & Eisenhart, 2015). Latinas may encounter negative stereotypes as a result of their various identities and even experience stereotype threat, in which they fear being stereotyped and attempt to prove others wrong, which often inflicts stress on the student (Solorzano & Delgado Bernal, 2001; Steele & Aronson, 1995). As a result of these forms of oppression, Latina students in engineering may find it difficult to see themselves as potential engineers and feel a sense of engineering identity (Carlone & Johnson, 2007; Author, 2017).

Engineering identity refers to how engineering students are incorporated into the larger professional community and how they negotiate their role within that community (Downey & Lucena, 2003; Tonso, 2006, 2007). Prior research has shown that engineering identity influences student academic and personal development and persistence in the field (Matusovich, Streveler, & Miller, 2010; Stevens, O'Connor, Garrison, Jocuns, & Amos, 2008; Stevens, O'Connor, & Garrson, 2005). Engineering identity development enables researchers to examine students' negative experiences, including moments of disconnection from or invalidation by the professional community (Carlone & Johnson, 2007). Due to persistent gender and racial/ethnic inequities in engineering, women of color may face challenges developing an engineering identity (Carlone & Johnson, 2007).

Although an extensive body of literature exists regarding women and underrepresented racial/ethnic minorities in engineering (e.g. Bix, 2004; Marra, Rodgers, Shen, & Bogue, 2009), limited research has focused on Latinas separately from larger discussions on Latina/o or other minority students, women, or even women of color in engineering (e.g. Camacho & Lord, 2013; Martin, Simmons, & Yu, 2013). Therefore, it is imperative that scholars examine the engineering identity development of Latinas in order to enhance their experiences and encourage an environment that nurtures their identity development.

This study examined how undergraduate Latinas made meaning of their college experiences and developed engineering identities. The study explored how students' engineering experiences informed their engineering identity development and how other intersectional identities influenced that development during college. It focused on the following two research questions:

1. How do Latinas in engineering develop their engineering identities during college?
2. How do other intersectional identities influence the development of an engineering identity during college?

Conceptual Framework

This study drew upon interrelated concepts from role identity theory to understand the engineering identity experiences and development of undergraduate Latinas in the field. Role identity theory explores the ways in which individuals define themselves within social structures, how internal dynamics determine actions, and how identities are established and revealed in interpersonal interactions (Stryker & Burke, 2000). This theory includes three interrelated conceptual factors (recognition, interest, and performance/competence) which influence identity development (Stryker & Burke, 2000). External recognition (or students' perception of how others view them) refers to students' perception of themselves. Interest refers to students' involvement in or inclination toward a discipline or major. Performance/competence refers to how students understand discipline-specific knowledge and skills and to what extent they see themselves as participants in the discipline.

For the purposes of this paper, role identity theory was utilized to understand the meaning that Latina students attached to their engineering experiences as well as the interplay between these experiences, their intersecting identities, and how these identities became more or less important depending on the context. These concepts guided the analysis of participants' interactions with others and how they viewed their roles within the broader engineering community on their campuses and within the profession.

Methods

The study took place at an urban, research-intensive, and predominately white institution. Snowball sampling was used due to the relatively small number of Latinas in engineering. The five participants were 18 or over, identified as Latina, and were senior undergraduate engineering majors who came from varied fields including aerospace, architectural, biomedical, chemical, and mechanical engineering. Four of the participants were of Mexican origin, and one identified as Salvadoran. The participants varied in their self-identified socio-economic status (three high; one middle; one low). One identified as a first-generation college student; three of the five had at least one parent who possessed a bachelor's or master's degree.

This qualitative research study utilized a phenomenological approach to examine the lived experiences of five Latina engineering majors. As a method, phenomenology allowed for a deeper understanding of the meaning-making processes and essence of an individual's identity development (Husserl, 1931; Moustakas, 1994). Students participated in two one-on-one interviews, lasting 60-90 minutes each, and the interviews were audio-recorded and transcribed. The first interview examined how the students' interest in engineering developed, what they experienced as an engineering undergraduate, and how their identities as Latinas, females, and other intersecting identities met with the engineering discipline. The second interview provided opportunity for follow-up questions in order to more deeply delve into issues of identity development as well as to provide any clarification from the first meeting. The researchers conducted member checks by sharing transcripts with participants in order to allow participants to modify or further elaborate on previous statements in order to boost the trustworthiness of the data. During the review of the interview transcripts, the researchers focused on the ways in which participants attached meanings to their interactions with others and their roles within the engineering community. The transcripts were inductively coded by first understanding the lived experience described in each student interview, then comparing those experiences across participants. In order to establish a rigorous and trustworthy research study, data were systematically analyzed, and interpretations by each individual researcher were monitored by the others for potential biases.

Findings
Family, Particularly *Papás y Hermanos*, Influenced Identity Development
	The Latina participants expressed how family members in engineering, particularly *papás y hermanos* (fathers and brothers), influenced their engineering identity development. In short, having multiple family members who were engineers positively influenced the professional identity development of the participants. Ana, who grew up with several engineers in her family, possessed a clear direction to her future professional path:

> There are a lot of engineers in my family, so that also influenced me. My older sister is an engineer, my dad is an engineer, a lot of uncles and aunts. So I guess I just knew that's what I should do.

	Brothers and fathers, in particular, were also highlighted as important to the engineering identity development process. Brothers were particularly influential as they shared similar experiences, were often completing engineering degrees simultaneously, and were often a source of encouragement, paving the way for their sisters in the same field. For example, Lydia's older brother led the way, inspiring her interest and encouraging her to become an engineer: "I think a lot of it was influence from my older brother…my brother always really pushed me to do engineering." Lydia's sibling engineering connection was strengthened by the fact that her nuclear family, including her brother, was a major part of her support system:

> My brother came to [this institution] the year before. He's a year older than me, so I had already familiarized myself with it. I felt really comfortable, and I really liked it…He studied electrical engineering…I don't know if I mentioned that before, but I only have my parents and my brothers here. The rest of my entire family is in Mexico. Just knowing that we're here with no family support, I guess, and the struggles we've had to go through. It's been a lot.

Because her brother pursued engineering at the same institution, Lydia felt a sense of comfort in doing the same. Lydia's brother forged a path to engineering and encouraged her interest in the same profession.
	Echoing Lydia's experience, another participant, Sofia, related how her brother also inspired her to pursue engineering:

> We were super close and we still are. I saw how much [my brother] loved his major and when I was in high school he'd show me his textbooks and what kind of work he was doing. He was just so enthusiastic about it. I thought if he's happy I know I would love it…I was kind of born into it…My older brother was a mechanical engineering [major] also at [this institution] and that was probably my biggest influence of why I ended up going into mechanical…I think subconsciously I knew my older brother did it, so I just kind of followed him, but also I'm so glad I did it.

Lydia's brother inspired her interest in engineering and demonstrated to her that she could become a part of the professional community.
	Fathers also emerged as individuals who nurtured engineering interests from a young age, taking their daughters to work with them, showing them what the profession entailed. Lydia remembered that her dad

> would always take me along on projects around the house or anything if it was building or designing something, I would tag along. So I think that's where it started from…It's not like he was telling me 'Oh you should do this,' it was like, 'Hey do you want to tag along?'

Lydia's father subtly introduced her to engineering concepts and encouraged her interest in these projects. Similarly, Ana, believed that her father played an important role in her engineering identity development:

> [C]ause he is a computer engineer, and he used to have a computer store. And, since we were little, we would go with him to his store, and help him out with trying to fix stuff, so he would try to like get us into kind of the engineering side of his job.

Through her father bringing her to work, Ana was immersed in the computer engineering environment from a young age. She not only gained an interest in technical knowledge but also became familiar with the engineering environment.

Together, fathers and brothers provided the Latinas in this study a sense of inspiration and support for their pursuit of the engineering field. These family members ignited their interests in the technical concepts of engineering and provided an introduction to the engineering environment.

Women in Engineering Organizations Encourage Identity Development

Participants called attention to the influence of on-campus professional organizations that were specifically for female students. Students felt these programs provided them with opportunities and resources geared specifically for women in engineering and enabled them to connect with other women in engineering to support their academic endeavors and inspire future young female engineers.

Sofia felt as though her participation in the women in engineering program was integral to her success in mechanical engineering. Her connections to other women in the organization lessened the fear of failure that she held when coming into the program: "I came in – and this is the dumbest thing ever looking back – I came in assuming I'd at some point within my first year change majors and drop out of engineering. I thought it would be extremely hard and I just assumed I'd end up changing my major…I thought it'd be easier. I just never thought I'd actually graduate." Upon entering the program, she felt lost much of the time, and was unsure whether she would have persisted without the built-in support system associated with the organization for women in engineering:

> Actually, after that first interview, I went and talked to my friends and said, "I couldn't describe why [connecting with women engineering students] is so important. I just couldn't put it into words" and I asked them if they could explain it 'cause they felt the same way. They said, "just because other people don't understand." It's good to have people that you're comfortable with because you can't really excel or succeed if you feel intimidated or if you don't want to speak out. If you're comfortable with who you're with. I just feel like being around other women is less intimidating. I was able to bring up more ideas or be more comfortable with the environment I was in. If I'm around a lot of guys I do tend to be more quiet and more shy and I don't know, more quiet-spoken I guess.

Sofia felt comforted and less guarded in the presence of female students who shared the same major. This environment offered a stark contrast to her insecurities around male engineering peers. With women, she could be more creative and felt empowered to share her ideas with her peers.

Lydia also highlighted how her involvement with a Latinas in engineering sub-organization (situated within a larger Latina/o engineering organization) influenced her engineering identity development:

> It was really exciting because I came from not knowing anybody who wanted to do

engineering – specifically girls – to going to this organization and seeing so many girls who were doing engineering who were Hispanic just like me. It was really exciting. They actually have a program within [the organization] called [Latina subgroup], which is specifically for the girls in a retention program for Hispanic girls. That was a big part of it. It's hard and you sometimes don't know who to go to if you have a question or if you have a problem if you're thinking about, "Do I really want to do engineering, or do I want to keep going?" It's hard because I don't feel like you have a lot of people to go to and ask questions about it, so that's definitely hard. The people who are girls and are in engineering we kind of look for each other.

This involvement with the Latina subgroup became more specific to supporting and being supported by her Latina female engineering peers. In this way, Lydia's experiences with the student organization represent an intersection between her racial and gender identities and the influence that this experience had on her engineering identity development. Her involvement connected her with other Latina women in engineering who were coping with similar academic struggles and provided a way for her to inspire her more junior peers to be successful:

Girls that know the struggles of being in my major or in a similar major and knowing that if I talk about it, they will understand what I'm going through…just knowing that somebody else is at the same position that I am, and knowing that those girls have graduated and gone through it and succeeded. Just kind of gives me hope that I do the same, and, hopefully, I'll do the same for the younger girls as well.

Through this involvement, she was able to see other Latina women in engineering roles and envision similar success for herself. Lydia also saw herself as a role model for future generations of Latina engineers.

Latinas Battle Multiple Stereotypes as They Develop Engineering Identities

Within this study, Latinas made sense of their engineering experiences as their multiple identities manifested and were negotiated through their college years. Participants described how multiple aspects of identity were salient in shaping their engineering identity development, including immigrant, race/ethnicity, gender, and motherhood.

Dora's experience as an immigrant to the United States was distinct, as the lens of her immigrant status filtered her sense of worthiness and success:

I think the only reason they helped me is because they saw that I was an investment. That I wouldn't turn out the way that they expect everyone else that came from my situations…I'm the model citizen that all these conservatives want immigrants to be. If I had been something else maybe they wouldn't have liked it.

The participants in this study felt their engineering identity development experiences were negotiated through the lens of their racial/ethnic and gender identities as Latinas. Participants believed that their peers considered them inferior and did not recognize them as future engineers. Lydia noted how due to her race and gender she was not generally considered an engineering person:

I think it's rewarding and just being an engineer, people look at you differently. In that sense it's nice but just knowing that you're in engineering and you're finishing engineering. People I think do look at that especially because you're a girl people don't expect you to be a Latina girl who's an engineer. They do look at you different…

Lydia's sense of identity around the study of engineering connected to her other identities, her femaleness and what could be called her sense of Latinidad, or feeling of connection to the Latina/o community. She acknowledged that "people look at you differently" and that her

experience was mediated by the fact that she held other identities simultaneously. The "people" that she referred to in this statement are primarily her engineering peers, but she also extended these ideas to include faculty members and potential engineering employers. She was instantly set apart by society due to the demographics of her field, thus making her science identity, and subsequent achievement in graduating from this field, be viewed in terms of her multiple identities.

Dora pointed out the extra burden that is placed on her as both a racial/ethnic minority and a woman in engineering and how her racial/ethnic minority and gender identities impacted her future in a male-dominated field:

I realize that as I'm minority, as Latina, I have to work extra hard because whether someone believes that I got to where I'm at because of my color or because of my origin instead of actually myself, my hard working. I always have to prove that I can accomplish things on my own...I always try to be able to inspire other girls I guess, to be able to motivate them that they can also be in a male field and achieve success in it.

As a result of her multiple, intersecting identities, she often felt a need to prove herself and dispel any stereotypes regarding her abilities and role within the engineering community. Claiming her successes and committing to serving as a role model are acts of resistance against those stereotypes.

Victoria was forced to negotiate her identities as a young Latina mother and an aspiring graduate student. She feared that she might reinforce the stereotype of the young Latina mother and was hesitant to share that part of her identity with others:

I feel that people are make me or embody me as the whole population of Latinos and I don't want the first thing that they think of as "oh well they all have babies at 17 years old"…it's really been on my mind especially moving forward to graduate school where nobody at [this future institution] knows my personal life and that I do have a daughter…I only told two [institutions] about my daughter because they had more personal statements about my life and only those two schools accepted me to their [master's] program and [my faculty advisor] kind of laughed because she said ,"We only accept students into the master's program if we think they are good but we are still not sure. It is kind of like a test run." So I am kind of glad that she was more like it is not in your head. It is a real thing, and so we talked a lot about strategy and how it should come up if it comes up at all. I do feel like it could negatively affect me in finding an advisor and being treated like everyone else…truth be told graduate students are perceived as work horses, and if you can't give 80 hours a week in lab because you have family commitments, that is never looked at positively…I feel that could prevent someone from working with me because it is a gamble.

Potential future advisors may possess negative stereotypes about women engineering students who are also mothers. Victoria fears not only that she will reinforce negative gender and racial/ethnic stereotypes, but also that she will be treated unequally as a result of the identities that she holds.

Summary of Findings

This study found that Latinas developed their engineering identities as a result of their interactions with family members, particularly fathers and brothers, as well as their involvement with organizations focused on promoting the success of women in engineering. These interactions provided Latina students with much-needed support for their educational journeys and encouraged them to build a sense of engineering community. In addition, the study also

found that Latina students had to battle multiple stereotypes as they developed their engineering identities. Negative stereotypes often were the result of deeply held racist, sexist, xenophobic, or other prejudices within the field.

Implications

This study found that Latina/o family members, particularly brothers and fathers, influenced the engineering identity development of undergraduate Latinas. Researchers, program administrators, and practitioners (e.g., engineering faculty) may recognize the value of Latina/o engineering families and how they support their students' choice to major in engineering. As such, this familial culture can be valued not only for its creation of a college-going culture but in its potential development of a legacy among Latina/o families with strong engineering identities. If researchers in particular can better understand the role that family plays in supporting their students, they may also be able to hone in on what factors lead Latinas to major in engineering and persist to graduation. Efforts to recruit and keep Latina engineering majors can be strengthened by finding creative ways to connect with or incentivize engineering siblings or familial groups so that siblings and/or other relatives become more likely to encourage their relatives to major in engineering. This practice may take the form of sibling legacy scholarships within specific programs at universities. Similarly, departments may create formal programs for siblings and relatives to mentor each other on campus. Programs may also create partnerships with community-based organizations in order to encourage engineering-focused activities that bring together Latino fathers and their daughters (e.g., parent/guardian and daughter robotics competitions and design competitions). In particular, this institutional support might take the form of starting or increasing support for First Robotics, Lego League, or Girls Who Code initiatives. Embedded within these community programs could be materials geared toward Latino males on the underrepresentation of Latinas in engineering and other STEM fields and the role their support can play in supporting female students in these majors and careers.

This study also found that involvement with women's engineering organizations influenced the way in which undergraduate Latinas developed their professional identities. One way that engineering programs can foster community within their programs is to institute first-year engineering experiences that cluster together women, women of color or Latinas in these majors, depending upon the size of the various populations and the institutional contexts. These experiences can be used to encourage women early on in their engineering training to continue their involvement with various women in engineering groups available on campus. These formal first-year experiences could build up female-centered engineering organizations on campus and help students develop more robust networks of support. To build community support and increase networking opportunities, institutions might also consider improving communications and points of contact between future, current, and former members of women in engineering organizations. These opportunities might be facilitated by an enhanced social media presence (e.g. Twitter, Facebook, Instagram) and through face-to-face events such as alumni gatherings for organizations' members. Next, programs might encourage their staff to reflect on their experiences with various women of color in engineering throughout their academic careers. Program coordinators in particular may consider better understanding the needs and expectations of women who come into these organizations and the ways that the organizations do or do not meet their students' needs and expectations. Third, broader engineering organizations (e.g., those that are for all Latina/o students or those that span all engineering fields) may want to acknowledge the need for women's subgroups and foster discussions on how to connect

subgroups who may feel further marginalized due to multiple intersecting identities (e.g., issues of gender and racial/ethnic identity in being a Latina in engineering).

Finally, this study found that undergraduate Latinas in engineering encountered a variety of stereotypes that influenced the ways in which they negotiated their identities. Engineering programs may be able to systematically support their female students and women of color in engineering if they acknowledge the ways in which groups (e.g., Latinas) continue to face multiple stereotypes as they complete their academic programs. Institutions might consider how these stereotypes influence the self-perceptions, interactions, and behaviors of Latinas in engineering. In order to make these changes more intentional and visible, institutions may consider training their faculty and staff regarding implicit bias and eliminating stereotypes about marginalized groups. These trainings could be instrumental for helping individuals understand their own positions of power and privilege as well as consider the ways that entrenched sexism, racism, and nationalism influence their interactions with others. As a next step following the training of personnel, engineering programs can engage students, both those with marginalized and those with privileged identities, in a discussion of how their various identities have influenced their experiences thus far and how those identities may influence their interactions with others. Furthermore, these activities might include a discussion of how larger systems of oppression dictate stereotypes and create a system of inequities. Such activities might be further enhanced by offering ally training in which faculty, staff, and students gain the knowledge and tools to combat these forms of oppression and create a more welcoming engineering environment. Last, programs might engage in open conversations with their students about racism and sexism in the field and provide them with knowledge and tools for combatting these forms of oppression that students may encounter both before and after graduation. Further, it would be crucial to create a programmatic culture where students have space to process and share these experiences and determine how to move forward as engineers despite negative experiences.

Limitations & Areas of Future Engineering Identity Research

Several limitations exist for the current research study and, thus, provide implications for future engineering identity research. First, this study examined engineer identity development among Latinas; however, the majority of these perspectives came from undergraduate women of Mexican descent. Because many Latina women in engineering within the United States are of Mexican origin, this is primarily a function of the population and available sample. Future research should seek to disaggregate this group in order to understand the unique experiences of subgroups within this larger group (e.g. Salvadoran women, Puerto Rican women). Second, this study also aggregated engineering identity development experiences rather than focusing on discipline-specific experiences (e.g. computer engineering, mechanical engineering). As a result of this limitation, the study cannot make interpretations regarding specific engineering disciplines and their environments. Future research is needed in order to understand the possibly unique environments and related engineering identity experiences that may occur. Third, this study focused entirely on the experiences of senior undergraduate Latinas in engineering, and, while this may allow for students to reflect on identity experiences throughout several years, it may exclude the perspectives of Latinas who are early-program or who have left an engineering program. Future research may seek to include these perspectives or consider a longitudinal design to understand identity development over time.

Conclusions

This study found that engineering identity among Latina students is formed and supported through interactions and involvement with individuals and groups outside normal classroom and laboratory activities. The five Latina participants named their families and campus organizations focused on women in engineering as important sources of support as they pursued their education. Further, this study found that Latinas in engineering encounter tension between their engineering identities and other identities such as their gender and racial/ethnic identities. By understanding the process of professional identity development and its interactions with other personal identities, researchers, practitioners, and administrators may develop support mechanisms that provide a holistic approach to supporting the present and future success of Latina engineering students.

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