Latinas' Resilience and Persistence in Computer Science and Engineering

Preliminary Findings of a Qualitative Study Examining Identity and Agency

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***Abstract*— Most professions have reached gender equity with the exception of computer science and engineering. To understand the mitigating factors influencing Latinas' enrollment and persistence in engineering and computer science, an interdisciplinary team of scholars at a majority Hispanic four-year institution has undertaken a three-year project to explore these phenomena. The following overarching question has guided us: What is the relationship among identity, resilience, and persistence of Latinas in computer science and engineering? The study was framed using a sociocultural theory of identity drawn from the work of Gee and from Holland, Lachicotte, Skinner, and Cain. Our findings suggest the majority of women encountered and dealt with some kind of adversity in their career trajectory. Their ability to overcome this adversity depended on many factors, such as the role of peer groups, family, and professors. Eighteen of the 26 participants referenced group participation phenomenon as beneficial to their success. They also identified spaces that accommodate group interaction including: the library, homes, local coffee shops, and university study areas.**

Keywords—women in engineering; narrative analysis; qualitative study; sociocultural theory of identity.

I. INTRODUCTION

The disciplines of engineering and computer science have served as preeminent and prestigious fields of study, yet have been historically underrepresented in gender despite other professions reaching parity [1]. With engineering as "one of the few remaining of sex-segregated disciplines" [2, p. 1], only eighteen percent of engineering degrees are awarded to females with two percent awarded to Latinas [3].

Local and national pre-college outreach endeavors have addressed this disparity in the last 20 years, including the National Center for Women in Information Technology, the Computing Alliance for Hispanic-Serving Institutions, Grace Hopper Regional Consortia, CRA-W, ACM-W, and Tapestry. Although female enrollment numbers are far from parity (under 19%, with Latinas representing only 9% of the total number of females) in computer science and engineering, they would no doubt be worse without their dedication.

The disproportionately low share of Latinas earning undergraduate degrees in engineering is an indicator that the discipline could face its own crisis point. To resolve the crisis, it is crucial to listen to the voices of Latinas already in the field. Our study was designed to further understand the ways that educational institutions may help recruit and retain these and other minority women in engineering and other STEM fields.

This study applies qualitative research methods to investigate the experiences, from their youth through university life, of Latinas toward enrolling and persisting in engineering studies. Located on the U.S.-Mexico border, the research site is a Hispanic Serving Institution where female enrollment in engineering is twenty percent --slightly higher than the national average.

To understand the mitigating factors influencing Latinas' enrollment and persistence in engineering and computer science, an interdisciplinary team of scholars at a majority Hispanic four-year institution has undertaken a three-year NSF-funded research grant project to explore these phenomena. The following overarching question has guided us: What is the relationship among identity, resilience, and persistence of Latinas in computer science and engineering?

II. THEORETICAL FRAMEWORK

We draw on a sociocultural theory of identity construction to understanding how participation in socio-cultural contexts mediates identity. In particular, we draw on the theoretical perspective of Holland, Lachicotte, Skinner, and Cain [4] who describe particular sociocultural contexts as "figured worlds," or social configurations, such as family, school, and other social institutions. Holland et al. [4] describe figured worlds as "a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 52). In a figured world, individuals shape subjective meaning of themselves as actors who participate and navigate as they move in, through, and out of these worlds throughout their lives; these social configurations shape how one makes sense of the world and how one perceives oneself in that world. This perception is how an actor "authors" herself—an embodied self in a particular social configuration [4, p. 32] where actors' participation and position can be one of privilege or subordination [4,5].

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Using a figured worlds theoretical framework in their study of middle school girls of color in science classes and laboratories, Calabrese Barton et al. [4] focused their study on "identity work," rather than identities specifically, and defined it as

> actions that individuals take and the relationships they form (and the resources they leverage to do so) at any given moment and as constrained by the historically, culturally, and socially legitimized norms, rules, and expectations that operate within the spaces in which such work takes place. Individuals author possible identities through identity work over time both with and against the norms of the worlds they inhabit. (p. 38).

While we examined identity work in our investigation of three Latinas as they participated in similar activities as pre-college youth, for this paper we focus on their narratives.

Narratives or stories told to mediate identity construction in the figured world of engineering and computer science studies. It is through the stories people tell about their experience where we can come to understand how they make sense of their lives within this world. Through telling a narratives we are able to understand a number of things. For instance, we may understand the significance of events a narrator assigns to particular events, the value that have, the important people in narrator's lives, the significance to be had from hearing particular stories and how the narrator understands herself within the frame of this figured world.

III. Research Design

Twenty-six (26) participants were selected using purposeful sampling [7]. They were interviewed using an ethnographic method of deep interviewing developed by Seidman [8], which combines life history using focused, in-depth interviewing to provide rich descriptions of participants' life experiences. These interviews provided research participants an opportunity to construct meaning of their life history in making their respective career choice, and their current experiences in navigating barriers and/or gateways as a female engineering student. Each interview lasted approximately 90 minutes. The three open, in-depth interview questions were:

(1) What experiences brought you to engineering?

(2) What has been your experience as an engineering student?

(3) What it will mean for you to be an engineer?

Probing and clarifying questions are asked of the participants based on what they share in answering these questions. For example, they may mention a class where they were one of five females. The interviewer would then ask, "Tell me what that meant for you" or "Could you tell me more about that experience?" In this manner of collecting data, the descriptions of their life experiences were thick as they provided details of their experiences.

The team is in its final phase of analyzing these data using the following analytical methods: narrative analysis, constant comparative, and life charting. For this paper, the unit of analysis is the narrative, defined by narrative plot elements [9]. For this paper we purposefully selected narratives in which narrators included a crisis point where they wondered aloud if they identified as engineers. More than one third of participants presented what we termed a "narrative of uncertainty" due to the words narrators used, such as "doubt," "not sure," and "don't know."

Data were analyzed using an approach to narrative analysis that has a long tradition. It has been used in research for [10,11, 12] approximately five decades. This sociolinguistic approach to narrative analysis relies on linguistic markers to identify narrative structure. The following elements are found in narrative structure: a Setting (in which the narrator reveals the who, when, what, where of the story), a Catalyst (where the narrator identifies a the situation leading up to a crisis), Crisis or Problem (the narrator mentions an issue that complicates the situation), Resolution (the narrator says how the crisis issue was resolved), Evaluation (the narrator elaborates on the significance of the story), and Coda (closes out narrative). Analysis relied on linguistic cues, such as speech tone, rhythm, and vocabulary choice [13] as well as content to determine the structural elements of a narrative.

IV. Findings

The findings from the data analysis of our larger study are: (1) negotiation of adversity in Latinas' non-academic and academic lives; (2) being female in a male-dominated space; and (3) the development of engineering identity, which is informed by the roles of (a) affinity spaces; (b) supportive people; and (c) engineering-related artifacts and play experiences.

For this paper, we will focus on the negotiation of adversity in Latinas' academic lives.

More than one third of participants volunteered what we termed a "narrative of uncertainty" i.e., they used particular phrases, such as "doubt," "not sure," and "don't know" or questions ("I wondered if engineering was for me"). Our analysis pointed to recurring themes in Latinas' narratives of uncertainty: 1) Crisis points revolved around events in lower division courses— what some of them call "weed out" or "gatekeeper" courses; 2) participants drew on their communities of practice to make sense of these difficulties; and, 3) a number of participants identified their mothers as the figure who confirmed engineering as the right career choice for them.

1) "I wasn't really sure that I was smart enough…"

Many of the participants were among the brightest and most talented students in middle and high school, with some of them earning scholarships and/or attending engineering magnet high schools.

Early in their engineering coursework, participants began to question whether engineering was the right path for them.

Table 1 shows the courses in which participants told us they began to doubt themselves. In the second column, the courses where narratives of uncertainty are set are presented. Significantly, these courses are all lower-level courses, suggesting that participants' moments of uncertainty came early in their college career—not later.

Pseudonym and engineering major	Spaces of local struggles	Resources for resolving crises/struggles
Amber (Electrical)	Pre-Calculus (lower division course)	Her mother, school counselor
Autumn (Mechanical)	Physics (lower division course)	Self-motivation to become a NASA engineer
Briana (Mechanical)	Chemistry (lower division course)	Parents, sister, professor
Britany (Industrial)	Electro-Mechanical Systems (lower division course)	Change of major would delay graduation
Elena (Civil)	Statics (lower division course)	Upper division students; parents
Gabriela (Mechanical)	Calculus II (lower division course)	Her mother
Gina (Mechanical)	Dynamics (lower division course)	Her professor
Juliet (Computer Science)	Intro to CS	Her professor
Karla (Civil)	Didn't see the application of concepts in Statics and Mechanics of Materials (lower division courses)	Her family, especially her mother
Natalie (Civil)	Physics and Dynamics (lower division) Structural Analysis (upper division)	Self-motivation

TABLE I. SUMMARY OF NARRATIVES OF UNCERTAINTY

An example of one such narrative is Autumn's, a mechanical engineering major, who is now employed at NASA. She revealed that Physics I was when she doubted her identification with engineering.

> *[In] one of my classes, we were learning about moments and statics, equilibrium forces and things like that, and I'd never been exposed to that. So I was completely confused. I was really lost. And yeah, I was going back and forth thinking, this is pretty difficult. I'm not sure that I'm grasping these concepts and. "Is engineering really right for me?" You know? 'Cause I guess I'd gotten accustomed to everything comes easy, and it wasn't coming easy*.

Like Autumn, all of the participants who volunteered a narrative of uncertainty pinpointed lower division courses as the moment when they began to wonder. Similarly, research has shown that lower division courses are a significant barrier for female students and students of color [14]. This finding suggests that colleges of engineering interested in retaining females might do well to target these (often large) courses.

2) "If it weren't for those friends who are upper division students…"

As noted above, narratives always contain a disclosure of how crises were resolved. Often narrators name other key people at this stage. Here, participants identified the resources and key people they turned to in order to resolve conflicts. Table 1 also shows the key people narrators named at the resolution stage of their narratives.

A few students drew on affinity groups [15], which served as support mechanisms that helped them navigate challenging coursework [16]. For instance, Elena constructed affinity groups with upper division students in a Statics course in which she needed guidance:

> *But that's what all the upper division students would tell me, "Just – just get through it. Just get to your upper division. Just keep fighting. Just keep working at it. And once you get to your upper division it's going to be a lot easier." So I think if it weren't for those friends that I had made who are upper division students, I don't think I would've done as well as I wanted to in the class afterwards.*

Note that Elena's narrative is set when she is a lower division student, in a "weed out" course that may often lead to moments of uncertainty for many students.

Similarly, Gina, Briana and Juliet said that they relied on professors in moments of uncertainty. Gina said that she would often meet with her affinity group, and together they would visit the professor. A combination of these relationships signaled to Gina that engineering was the right space for her. She said that, when faced with difficult homework, she first worked by herself; followed by an internet search; then asked her friends; and, when doubts persisted, they asked a professor.

V. SIGNIFICANCE AND RELEVANCE

This paper contributes to the body of research on women's persistence and resilience in engineering, where they are significantly underrepresented. It confirms what other studies have shown, namely that gatekeeper courses posed a threat to these women's persistence in engineering [14]. However, the paper also adds new information regarding the ways in which successful women resolve and make meaning out of these experiences. Moreover, research has also shown that social support serves to curtail the loss of underrepresented students, particularly women, in STEM fields [17]. In this paper we drew on women's narratives to show the specific actors who

serve as support for undergraduates, namely their peer groups, professors and families.

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References

[1] Beede, D. Julian, T.A., Langdon, D., McKittrick, G, Kahn, B., & Doms M. Women in STEM: A gender gap in innovation. Economics and Statisitics Administration Issue Brief No. 04-11. Retrieved from http://ssrn.com/abstract=1964782, 2011.

[2] Madsen Camacho, M., & Lord, S. The borderlands of education: Latinas in engineering. Lanham, MA: Lexington, 2013.

[3] National Science Foundation. Table 5-9. Bachelor's degrees by reace / ethnicity, citizenship, sex and field: 2009. Women, minorities, and persons with disabilities in science and engineering. Retrieved from www.nsf.gov/statistis/wmpd/pdf/tab5-7.pdf

[4] Holland, D. C., Lachicotte, W., Skinner, D., & Cain, C. (1998). Identity and agency in cultural worlds. Cambridge, MA: Harvard University Press, 1998.

[5] Lave, J., & Wenger, E. Situaated learning: Legitimate peripheral participation. Cambridge: Cambridge University Press, 1991.

[6] Calabrese Barton, A., Kang, H., Tan, E. & Brecklin, C. Crafting a future in science: Tracing middle school girls' identity work over time and space. American Education Research Journal, 50(1), 37-75, 2013.

[7] Merriam, S. Qualitative research and case study applications in education. San Francisco, CA: Jossey-Bass Publishers, 2001.

[8] Seidman, I. Interviewing as qualitative research: A guide for researchers in education and the social sciences (3rd ed.). New York: Teachers College Press, 2006.

[9] Labov W &Waletzky J. Narrative analysis. In A study of the non-standard English of Negro and Puerto Rican speakers in New York City. W. Labov (Ed.) New York: Columbia, 1968.

[10] Gee, J. P. A linguistic approach to narrative. Journal of Narrative and Life History, 1(1), 1991, 15-39.

[11] Gee, J. P. An introduction to discourse analysis: Theory and method. New York: Routledge, 1999.

[12] Ochs, E. & Capps, L. Narrating the self. Annual Review of Anthropology, 25, 1996, 19-43.

[13] Poindexter, C. C. Meaning from methods: re-presenting narratives of an HIV-affected caregiver. Qualitative Social Work, 1(1), 2002, 59–78.

[14] Brainard, S., Laurich-McIntyre, & Carlin, L. Retaining female undergraduate students in engineering and science: 1995 annual report to the Alfred P. Sloan Foundation. Journal of Women & Minorities in Science & Engineering, 2(4), 255-267.

[15] Gee, J. P. Identity as an analytic lens for research in education. Review of Research in Education, 25(1), 99-125, 2001, doi: 10.3102/0091732X025001099

[16] Villa, E. Q., Nuñez-Mchiri, G., Esquinca, A., Hampton, E., & Wandermurem, L. Accumulating aspirational capital for Latinas to pursue and persist in engineering. Paper presented at the 2014 Annual Meeting of the American Educational Research Association, AERA, Philadelphia, PA.

[17] Seymour, E., & Hewitt, N.M. Talking about leaving: Why undergraduates leave the sciences, 1997, Boulder, CO: Westview Press.