

Board 331: Latinx Engineering Students Surviving the Odds to Accomplish Their College Degree

Dr. Hilda Cecilia Contreras Aguirre, New Mexico State University

Hilda Cecilia Contreras Aguirre received an Ed.D. degree in Higher Education Leadership from Texas A&M University-Corpus Christi (TAMU-CC), and an M.Sc. from the University of Technology of Compiègne, France. She is now a researcher at New Mexico State University (NMSU). She focuses her research on qualitative studies addressing minority and underrepresented student college persistence, such as Latinas' performance in STEM, mentoring, and Latinx' research involvement in Engineering. She is also interested in participating in collaborative efforts promoting interdisciplinary research. Lastly, she is currently the PI and Director of the Research-Oriented Learning Experience (ROLE) in Engineering, a National Science Foundation-funded project, and the coordinator of a Latinx Femtoring/Mentoring program at NMSU.

Nicole Delgado, New Mexico State University

I am a first-year Ph.D. student at New Mexico State University in the department of Curriculum and Instruction. I currently work on a sponsored project that supports Latinx undergraduate sophomore, junior, and senior-level students in developing research, technical, interpersonal, academic, and professional skills that are transferable in their decisions to enter into graduate studies or the professional world

Dr. Luis Rodolfo Garcia Carrillo, New Mexico State University

Luis Rodolfo GARCIA CARRILLO received the PhD. degree in Control Systems from the University of Technology of Compiègne, France. He was a Postdoctoral Researcher at the Center of Control, Dynamical systems and Computation at UC Santa Barbara, USA. He currently holds an Assistant Professor position with the Klipsch School of Electrical and Computer Engineering at New Mexico State University, USA.

Latinx Engineering Students Surviving the Odds to Accomplish their College Degree

Abstract

This study explains a National Science Foundation (NSF) funded program established at a Hispanic-Serving Institution (HSI). The Research-Oriented Learning Experiences (ROLE) program's goal is to improve Latinx undergraduate students' research skills while building strong connections with other peers and near-peer mentors. Funded under the NSF Broadening Participation in Engineering Program, the ROLE program seeks to encourage Latinx students to become involved in research activities in Engineering, where students can experience and perform research through hands-on activities. As a theoretical framework, the Resilience Cycle guided this study with the rationale that Latinx as minority students face numerous challenges and find strategies to overcome them. With a qualitative approach, this study also included descriptive statistics to complement each other. Findings revealed that Latinx student participants perceived and experienced *Engineering as competitive and challenging*, especially to interact and develop long-lasting relationships with their classmates. Also, participants reflected on the different learning outcomes they gained by participating in the ROLE program highlighting their *personal discoveries and academic and research development*. Overall, participants enjoyed the experience of acquiring a new skillset through research activities and were highly satisfied by the community building they created among all peers and mentors.

Background

While increasingly more minority students are enrolling in college, the number of college graduates with STEM degrees is still not favorable to minority students such as Latinx [1]. In particular, Latinas enrolled in STEM programs continue to experience hostile environments in men-dominated spaces such as Engineering, even in Hispanic-Serving Institutions (HSIs) [2, 3]. HSIs are all degree-granting higher education institutions with 25% or more full-time Latinx undergraduate students [4]. Institutional strategies, financial assistance, faculty representation, mentorship opportunities, and culturally responsive research opportunities are all critical in retaining and graduating students, especially minority and underrepresented students [5]. We aim at increasing such student retention with an intentionally designed program for Latinx students in Engineering at a specific borderland HSI.

The primary focus of the Research-Oriented Learning Experiences (ROLE) program, a National Science Foundation (NSF) funded program, is to improve Latinx research skills while building strong connections with other peers and near-peer mentors. The ROLE program, funded under the Broadening Participation in Engineering Program, seeks to encourage Latinx students to become involved in research activities in Engineering, where students can experience and perform research through hands-on activities. ROLE student participants interact with their Engineering peers, graduate students, and faculty as they develop research and interpersonal skills [6]. Other activities include attending workshops on academic and research topics as well as participating in outreach activities within the local community, see Figure 1.

This study aims to gain insight into the experiences of undergraduate Engineering students in their academic journeys and how the ROLE program helped them in their personal, academic, and professional growth. The research questions framing the study addressed:

1. What type of experiences did Latinx Engineering students go through in their academic programs at NMSU?
2. How did Latinx Engineering students boost their academic journeys by participating in the ROLE program?

The Lab	Colleagues and Mentors	Workshops	Outreach
<ul style="list-style-type: none"> • Technical skills • Programming • Coding • Flying the UAS • STEM identity • Career exploration 	<ul style="list-style-type: none"> • Interpersonal Skills • Culturally relevant mentorship • Critical thinking • Persistence • Resilience • Collaboration 	<ul style="list-style-type: none"> • Academic and Professional Skill • Real world experiences • Asset-based professional and academic development • Skills assessment 	<ul style="list-style-type: none"> • Service Skills • Cultural communities • Affirmation and validation • Skills showcase • Home, community, and school

Figure 1. Core elements of the ROLE program

Conceptual framework

The acts of resilience that these students participating in the ROLE program have shown contribute to our understanding of their persistence and willingness to accomplish their college degrees. The Resilience Cycle guided this study [7, 8]. This theoretical framework demonstrates critical moments and decisions concerning the academic goals of at-risk students. The core aspect of this framework is emotional intelligence, which includes important aspects such as skillful and effective management of emotions amid stressful times, adeptness in social environments, impulse control, and effective decision-making under duress [9]. As shown in Figure 2, the cycle has five stages that progressively show student educational resilience including 1) identifying needs/challenges; 2) acquiring protective factors; 3) working on excelling; 4) building self-efficacy; and 5) enduring motivation. This cycle can also be shaped by students' identities and how they interpret their experiences.

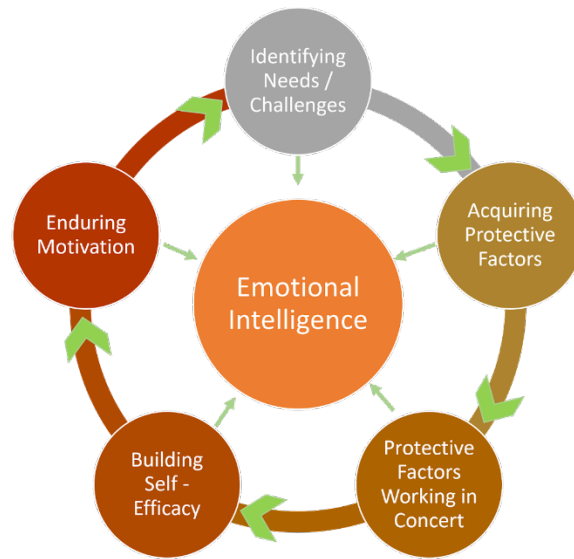


Figure 2. Conceptual framework on Resilient minority students

Methods

The ROLE program has had two student cohorts, the first in January, and the second in August 2022. Both cohorts consisted of 16 minority minoritized students, 90% Latinx, and 60% women, enrolled in different Engineering academic programs and student classifications from sophomore to senior. Student participants completed two surveys and participated in a set of interviews. The first survey and interview explored students' prior academic, research, and mentoring experiences. The second survey and interview examined the benefits and learning outcomes of participating in the ROLE program in terms of confidence as students, perceptions of research, and mentoring relationships. The surveys were administrated using RedCap, an institutional tool that collects and stores data. Due to the number of participants, the results included in this study are descriptive in nature and complemented the information presented through the qualitative data. The interviews were recorded and transcribed; the transcriptions were used for the analysis. Researchers read the interviews several times, identified units of data, and classified the information using Dedoose, a software that helps in the analysis of qualitative data. Through constant comparative techniques and content analysis [10], researchers found themes and categories that helped answer the research questions.

Results and findings

Results from the quantitative component and findings from the qualitative portion found that challenging environments in Engineering, but also interest in finding research opportunities, and students' involvement in ROLE contribute to increasing their resilience and broadening their career horizons. The following information includes students' experiences as Engineering students and participants of the ROLE Program.

Competitiveness and hostility in Engineering programs

The determination of students to pursue Engineering often restrains students to interact with peers and creates a hostile climate for women and other minorities, who are more likely to communicate and work collaboratively. Participants of ROLE are not alienated from these contexts and the following assertions in Table 1 prove the need to develop self-efficacy to be able to navigate Engineering:

Table 1. Participants' opinions on navigating Engineering

Assertions	Strongly Agree/ Agree	Undecided	Disagree/Strongly Disagree
I am able to work effectively on my own.	94%	-	6%
I am able to manage my time effectively.	81%	13%	6%
I am able to work through obstacles or challenges.	100%	-	-

Despite feeling autonomy, self-reliance, and determination, students showed low initiative to apply to research internships with 69% of students indicating that besides applying to ROLE, they did not apply to any other research opportunity. Or that only 43% of students agreed that if they were not participating in ROLE, they would be participating in another mentoring or research-focused program. The challenges to being an Engineering student are diverse, while participants mentioned aspects related to the lack of connection with their peers because of how they looked or how they feel about their classmates, the following two quotes mentioned,

The first year was pretty hard because I was feeling like they were looking at me like I didn't belong here and I was having second thoughts. But...no matter who looks at me anyway, or if nobody wants to help me out or anything like that, this is what I want and I'm going to continue to push myself to strive to be able to reach my goals and dreams in life, no matter how hard I have to work (Jose - Junior in Mechanical Engineering Technology).

If I would say if I have one good friend, which I only really do... Otherwise, I just know people. They know my name, I talk to them sometimes. Like, " Hey, how was that homework? Or how did you do on the exam?" But that's the furthest (Mark - Sophomore in Mechanical and Aerospace Engineering).

Both students felt a lack of belongingness and integration with their classmates, even showing microaggressions and intentional avoidance because of how Jose looked like. Despite experiencing hard moments, Jose showed that he is very committed to his studies, and he was on the path to accomplishing his goals. Other participants noticed a different dynamic between peer women and men, highlighting men as quick, confident, and competitive and women as doubtful, and timid, but also more interactive and easier to talk. Gillian and Zeus commented,

I've always had more male friends than I have female friends, but I think a big difference within the Engineering department is the males are always very quick to answer, and have very confident responses, whereas when I talk to my female friends, they're like,

"oh, like maybe", or they're shy (Gillian - Junior in Mechanical and Aerospace Engineering).

I think the males are more competitive towards the topics, it's even competitive in the classroom...but I... guess you do see women interacting more with other students than you do see what the males do...(Zeus, Senior in Mechanical Engineering).

The information that participants shared illustrates the struggles that minorities face in classrooms where the emotional intelligence of students in Engineering plays a critical role in knowing how to *manage their emotions and stress* as they identify such challenges. Learning how to surpass difficult situations quickly and find strategies that increase their self-efficacy and motivation are incredibly important to develop resiliency [8].

A change in the Engineering landscape

The ROLE program was created as a space for learning, gaining new skills, building community, and reinforcing student science and cultural identity. Students agreed that participating in ROLE opened the horizon to other academic and professional paths. This section includes data from the pre-and post-experience surveys and information shared by students through the interviews.

The pre-experience survey included questions that addressed students' interests in a research program in terms of why they would be interested in being part of it. See Table 2. The question was why did you choose to participate in the ROLE program? Students could check all options that applied to them.

Table 2. Participants' interests in participating in research programs

Statement	Response
To help prepare me for graduate school	50%
It was a paid position	19%
It will enhance my resume	88%
To develop a mentoring relationship with a faculty member	50%
A faculty/staff member approached me about the opportunity	-
To gain practical experience for a future career	94%
It sounded interesting	50%

Gaining practical experience for a future career and enhancing their resume were ranked first and second respectively. Students perceived this opportunity as unique in providing hands-on activities that could help smooth the transition into the workforce. Linked to this perception was the need to make themselves more competitive in their resumes by participating in ROLE.

By the end of the first cohort, students took the post-experience survey, which focused on their whole experience with ROLE in terms of their involvement, relationships, learning, changes, and improvement. See Table 3. The following statements helped us realize the impact that ROLE had on students in the following assertions:

Table 3. Participants' experience with ROLE

Statement	Strongly Agree	Agree	Disagree
Participating in this research experience improved my research skills	80%	20%	-
Participating in this research experience increased my interest in graduate study	60%	40%	-
Participating in this research experience helped prepare me for graduate study	60%	40%	-
Participating in this research experience helped define my career goals	60%	40%	-
Participating in this research experience strengthened my resume	80%	20%	-

All students agreed that participating in ROLE was an eye-opening experience. This experience both improved their research skills and increased their interest in graduate school. Students could *identify the needs and challenges* associated with their college journey and rigorous academic programs, one of the components of developing emotional intelligence and becoming more resilient. Students also confirmed the positive impact it has on them and consequently, on their resumes. Being competitive in Engineering is a common behavior among most students and participants perceived it.

Personal, academic, and research learning

Students were asked what they learned about themselves that maybe they did not know before participating in ROLE and students mentioned different learning outcomes including the following, Mark vented, *"I feel like it's one thing I learned that I am proud of is how I can pick up on things pretty quickly with this semester...And I'd say being able to adapt, that's something I learned about myself."* Jaylen, a Sophomore student in Mechanical and Aerospace Engineering, added *I'm more confident in my coding abilities and into a different field."* And, Gene, a junior student in Mechanical and Aerospace Engineering, mentioned *"I just learned a lot of patience and a lot of staying disciplined and committing to finding the answer to the problem."*

Students found the experience of being involved in research challenging but rewarding. They worked hard to learn new ways of working, besides the classroom, the dynamic of working on research is intense and requires self-discipline, and ongoing motivation to accomplish a research-related task. The resilient framework considers such aspects as essential in triggering a sense of accomplishment [8]. *Building self-efficacy and enduring motivation* were key aspects that students faced in working on their research activities and projects.

A core aspect of ROLE is that students increase their academic and research skills with new knowledge. Students come from different Engineering academic programs with some knowledge of programming and coding, for others, this is the first time they learned about these programs and systems. Most students opined to have enjoyed this learning experience and acquired a new set of research skills. For example, Jaylen said, *“I enjoyed the ROLE program, I got to learn about the different operating systems and also into Roth and just setting it up as well as the different repositories and also some coding and C++, but mainly Python.”* And Jose added, *“The skills that I gained as a role student is being able to understand and analyze coding, troubleshooting, and diagnose, lasting any errors or any complications that we had with the drone.”*

Students reflected on the different types of learning (e.g., academic, and professional) after participating in ROLE. They realized that the technical aspect was important but also the connection they developed with their peers and the community they built with all involved in ROLE, including near-peer and faculty mentors. Students identified their strong relationships with each other in the program and one student decided to stay to be a near-peer mentor for the new cohort.

Conclusion

Through the ROLE Program, Latinx undergraduate students combined their courses and theory-based knowledge with research and hands-on activities. With a community-based approach, Latinx students could support each other and find allies, peers who were participating in ROLE, would be eventually their classmates. Latinx students perceived and experienced Engineering as competitive, the interaction with their classmates, especially men was one of the more challenging aspects of being an Engineering student. Also, Latinx students reflected on their personal discoveries and academic and research development accomplished through their participation in the ROLE Program. Overall, students enjoyed the experience of learning new skills with their involvement in this research-oriented program and showed satisfaction and engagement with the community they created among peers and mentors.

Program future directions

There are different ways in which ROLE can expand and add more elements to it. One of them is partnering with local community organizations where ROLE participants can utilize their new technical skills in practical ways. An example of this real-world experience is students will have an opportunity to go to a local farm where they will program and fly the unmanned aircraft system (UAS) over the harvest land to take different measurements on the crops and assess them from an aerial vantage point. ROLE will also collaborate with community organization partners in different programs targeting children and youth. Another aspect could be adding an additional summer month to the program for students to concentrate on finishing testing and writing results to present at national conferences along with the mentor graduate student.

References

- [1] Hispanic Association of Colleges and Universities. "Hispanic Higher Education and HSIs Facts." https://www.hacu.net/hacu/HSI_Fact_Sheet.asp (Date Accessed February 6, 2023).
- [2] H. Blackburn, "The status of women in STEM in higher education: A review of the literature 2007-2017," *Science & Technology Libraries*, vol. 36, issue 3, pp. 235-273, 2017.
- [3] H.C. Contreras Aguirre, E.M. Gonzalez, and R.M. Banda, "Latina college students' experiences in STEM at Hispanic-Serving Institutions: framed within Latino critical race theory", *International Journal of Qualitative Studies in Education*, 33(8), 810-823, 2020.
- [4] D. Santiago, "Inventing Hispanic-Serving Institutions (HSIs): The Basics", *Excelencia in Education*. NJ1, 2006.
- [5] G. Crisp, A. Nora, and A. Taggart, "Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of Students attending a Hispanic Serving Institutions", *American Educational Research Journal*, vol. 46, issue 4, pp. 924–942, 2009.
- [6] N. Delgado, H. C. Contreras Aguirre, and L. R. Garcia Carrillo, "Latinx undergraduate students: Finding a place of belonging in Engineering". Annual Meeting of the American Society for Engineering Education (ASEE), Baltimore, Maryland, 2023.
- [7] E. E. Morales, "A contextual understanding of the process of educational resilience: High achieving Dominican American students and the "resilience cycle," *Innovative Higher Education*, vol 25, issue 1, pp. 7-22. 2000.
<https://link.springer.com/content/pdf/10.1023/A:1007580217973.pdf>
- [8] E. Morales and F. Trotman, Eds., *Promoting academic resilience in multicultural America: Factors affecting student success*. New York: Peter Lang, 2004.
- [9] E. E. Morales, "A Focus on Hope: Toward a More Comprehensive Theory of Academic Resiliency Among At-Risk Minority Students," *Journal of at-risk issues*, vol.14, issue 1, pp. 23-32, 2008
- [10] Y.S. Lincoln and E. G. Guba, "Naturalistic inquiry," Sage,1985.