Asset-Based Approaches to Transformative Learning: Community and Culture in an Undergraduate Engineering Research Program at a Hispanic Serving Institution

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Abstract

The idea of exploring better models of instruction that emphasize collaboration, community, and culture, using student-centered and asset-based approaches in engineering is a pressing need. These innovative approaches are particularly important in Minority-Serving Institutions (MSIs), such as Hispanic-Serving Institutions (HSIs), where the student body is increasingly diversifying. This study presents the federally funded Research-Oriented Learning Experiences (ROLE) program housed at New Mexico State University (NMSU). This program combines the acquisition of engineering technical skills with the development of interpersonal, academic, professional, and service abilities necessary to succeed in college and beyond. The Ecological Validation Model of Student Success and its educational practices reflecting the social evolution framed this study. Information was collected through surveys and interviews from three student cohorts. The findings revealed how this culturally asset-based program reinforced the identity of students as Hispanics by centering culture and community aspects that students were familiar with, promoted teamwork with peers as a strategy to make learning better situated in their interest to support each other, and contributed to creating a research space where students felt integrated, included, and valued considering who they were or represent. Programs that center on student asset-based features and pedagogical culturally relevant approaches could make a difference in the academic performance and future of the minoritized student college population.

Introduction

Educational experiences in rigorous engineering programs are deeply influential on a student's lived experience and future in terms of identity, sense of purpose, and professional opportunities. Students experience engineering programs in several ways; one is to reward those who can score good enough grades in prescribed coursework thus proceeding in the program and the other way reflects those who experience programs that support creative and innovative problem-solving. The author in [1] described the issues engineering programs face concerning the retention and graduation of at-risk engineering students; these include a profound disconnect between creativity and engineering programs designed in stagnant and archaic ways. Another need is the use of asset-based pedagogical approaches to learning that promote inclusivity, embrace diversity, and retain students, particularly from minoritized, underrepresented, and marginalized backgrounds. In this article, we argue that Hispanic-Serving Institutions (HSIs) can make use of culturally relevant approaches influencing their academics and programs to create meaningful learning environments. Given the steady increase of HSIs and emergent HSIs as a result of a switch in the U.S. demographics and the projections of Hispanics becoming a minority-majority by 2042, it is critical to implement new approaches and ensure that students persist and graduate. Despite HSIs enrolling many Hispanic students, these students do not persist and graduate at

lower rates with engineering degrees than their White counterparts. This is particularly true for Hispanic female students. To increase interest and persistence among Hispanic students enrolled in engineering programs at New Mexico State University (NMSU), the Research-Oriented Learning Experiences (ROLE) program was created. NMSU serves a large number of Hispanic students, but similar to other institutions, college persistence, graduation rates, and interest in graduate studies in STEM disciplines, like engineering, remain low. ROLE is a National Science Foundation (NSF) funded program whose goal is "to improve Hispanic students' research skills while building strong connections with other peers and near-peer mentors" [2]. ROLE also aims at building community through peer and faculty interaction, teamwork, and Latino culturally relevant experiences. For this study, authors in [3] used repertories of practice coined in sociocultural aspects to understand culture, understood as fluid, flexible, and contextual to people's everyday practices and shared values. Such practices and values can evolve and be negotiated by group members. Due to this evolution, culture cannot be static and fixed to a group that identifies with similar practices and values [4]. According to authors in [3], learning with a culturally relevant approach is historically situated by using cultural practices and tools usually shared by a group of people.

In the academic realm, an asset-based approach that promotes culturally responsive teaching should consider the cultural backgrounds and experiences of learners and incorporate them into the learning process. This enhances relevance and connection to the subject matter. Collaborative Learning in engineering is often a team-oriented field, and collaboration is crucial. The asset-based approach can encourage group work, where students with different strengths collaborate to tackle complex engineering problems, leveraging each other's skills and expertise. Two components are crucial: 1) Mentorship and Role Models: Providing mentorship and showcasing successful engineers from diverse backgrounds can inspire and empower students. Highlighting the achievements of individuals with similar assets can motivate learners and increase their sense of belonging in the field [5]. And 2) Inclusive Classroom/Research Environment: Creating an inclusive classroom/research environment where diverse perspectives are welcomed and appreciated can foster a sense of belonging among students. Encouraging open discussions and respecting various viewpoints can enrich the learning experience. The purpose of this study is to understand and explore how ROLE is challenging the status quo of engineering education through the development and implementation of a learning community that utilizes an asset-based pedagogical model of instruction. ROLE centralizes collaboration, community, and culture in student-centered programming to encourage retention and degree completion for Hispanic student participants. The research questions framing this study investigated:

1. How does a collaborative learning environment like ROLE promote asset-based pedagogical practices in engineering education at NMSU?
2. How does the centralization of culture and community in ROLE contribute to supporting student success in rigorous engineering programs at NMSU?

Literature review

Asset-based pedagogical approaches to learning are an inclusive theme within educational research. As such, teachers and learners have a mutual understanding and appreciation that learners come to learning environments with wide-ranging knowledge and attributes that will positively influence their learning outcomes if those assets are acknowledged and nurtured. College faculty, higher education institutions, and specifically engineering programs may lack an understanding of just how important and liberating it is to approach teaching and learning with an asset-based mentality [6]. To truly understand asset-based pedagogical practices, this literature review will explore three specific themes that honor and underscore its importance: 1) recognizing diverse assets within diverse students, 2) building on the strengths that are present in underrepresented students in engineering programs, and 3) the realization of empowering students when asset-based pedagogy is practiced.

Recognizing diverse assets

Learners have a wide range of assets, including cultural, linguistic, social, and experiential, that can positively influence their learning. These assets may not always align with conventional academic measures, but they are valuable resources that can be tapped into. For instance, Hispanic students, among other minority groups, benefit from learning scientific concepts using their native language and cultural-related aspects, particularly in thinking about science logically and rigorously [7]. Authors in [8] described the importance of recognizing and defining assets in students that will be beneficial to their experiences in higher education and rigorous engineering programs. Subpopulations of students are identified to include first-generation, low-income, and those from minoritized backgrounds. The subgroups of students have assets listed that reference the life skills they acquired as a result of their categorization within the subpopulations of engineering students. The life skills turned assets include their various forms of capital as explained by Yosso [9], as well as innovative problem-solving abilities, adaptability, empathy, and leadership [10, 11, 12].

Building on strengths

The asset-based approach aims to build on learners' existing strengths and knowledge. By doing so, learners are more likely to actively engage in the learning process and feel empowered as active participants in their education. Additionally, educators should recognize diverse skills and backgrounds in engineering education; diverse students approach problem-solving in innovative ways when collaboration is not only supported but expected as an integral part of the learning process [13]. Additionally, educators and mentors should assess students' skills, prior knowledge, and experiences and use that information to tailor their teaching strategies to individual needs. The strengths students display such as resilience and persistence are often expected personal attributes, however, as [14] would contend, they are attributes that educators need to help build up and support.

Educators that learn about their student's strengths have an opportunity to encourage deeper learning, heightened levels of self-efficacy, and persistence in engineering programs that lead to the development of expertise [15]. Authors in [4] highlighted the idea of including "familismo-affirming spaces" in STEM-oriented contexts. Therefore, minoritized students such as Latinx students can benefit from integrating social, cultural, and academic elements. Reciprocity, care, and trust are at the core of the experience of familismo that students pursuing STEM degrees rarely encounter affecting their academic performance and persistence [4]. Furthermore, students who develop expertise in engineering disciplines are more likely to continue their education, pursue higher-profile positions in leadership, explore creative and non-linear professional pathways, and experience life-long learning [16]. Building on students' strengths has profound implications for their success in engineering programs; however, authors in [17] asked how higher education institutions understand how students learn engineering. They found this is a deeply underexplored topic about engineering sciences and even more so concerning underrepresented minorities in engineering. Particularly, Latinas pursuing engineering greatly benefit from institutional support initiatives such as scholarships and faculty mentoring as well as peer support and family-type relationships [5, 18, 19].

Empowering learners

Learners are empowered when their assets are recognized and validated. This empowerment fosters a positive learning environment, leading to increased motivation and self-confidence. Learning spaces where students feel respected and respect others and possess enough information for making informed decisions develop in students a sense of authority, determination, and certainty [7]. Authors in [20] described the importance of authentic learning environments where real-world problems are explored in all their complexities. The goal is not to solve the problem in a linear process, but to collaboratively explore solutions that empower and connect the student to the real world. Other scholars [21] proposed that the following elements should be considered:

1. Active and project-based learning: Engineering education can incorporate active and project-based learning, where students work on real-world engineering challenges. This approach allows students to apply their existing knowledge and skills to solve problems, fostering a sense of accomplishment and motivation.
2. Formative Assessment: Implementing formative assessment strategies allows educators and researchers to identify and appreciate individual progress and growth. Recognizing and acknowledging improvements can further motivate students to continue learning and developing their skills.
3. Contextualizing Engineering Concepts: Relating engineering concepts to real-world applications and contexts that align with students' backgrounds can make the material more accessible and engaging. This approach helps students see the relevance of their assets in engineering practice.

The ROLE program has been developed with empowering students as a central goal as well as recognizing their diverse assets and considering their strengths and knowledge.

Conceptual framework

The author in [22] described the importance of asset-based pedagogical practices in higher education as a driving force behind community development which leads to increased student success. The asset-based approach to learning is a theoretical framework that focuses on identifying and leveraging the strengths and existing knowledge of learners to promote effective learning. This approach recognizes that individuals come into the learning environment with diverse backgrounds, experiences, and skills [8]. Instead of solely focusing on deficits or gaps in knowledge, the asset-based approach highlights the valuable assets learners possess and seeks to build upon them to enhance the learning process. Alternatively, the anti-deficit approach as described by authors in [6] explored how researchers are reframing their questions to move out of the deficit mentality to an asset-based one about engineering education research. The author in [23] described how his research process has evolved from a deficit mentality to an asset-based one by changing the focus of research from shortcomings and limitations to advantages and abilities, especially within Communities of Color that are underrepresented in engineering education. For this study, the researchers utilized the theory of Validation in conjunction with the theory of Culturally Sustaining Pedagogy to conceptualize asset-based pedagogical practices in engineering education. The Ecological Validation Model of Student Success [24] argues that how student support services are developed is more important than what gets developed because how they are developed influences policies, practices, and institutional structures. Validation is central to student motivation, persistence, resilience, and deeper learning [25]. The author in [26] explored the concepts of culturally relevant teaching proposed by Ladson-Billings [27] and the need to take this concept a step further to be a sustaining process for people of color. The wide-ranging implication of this concept is that education is increasingly becoming multiethnic and multilingual so educational practices should reflect the social evolution happening in society.

Research study

NMSU houses the ROLE program, a National Science Foundation (NSF) funded program whose goal is to encourage the participation of Hispanic students in engineering research. ROLE has had three cohorts of six/nine students each since 2022. Students spend six hours in the lab every week for an academic year where they learn fundamental ideas behind UAS technologies and develop the technical skills associated with manual and autonomous operation. During the first semester, students learn about Linux OS, Robot Operating System (ROS), and the Phyton programming language. They also learn about how to operate a motion capture system, which provides indoor GPS capabilities. Finally, these software and hardware tools are put together to control the flight of a real-time aerial robotic system – the Bebop quad rotorcraft manufactured by the company Parrot. Students' time in the laboratory is intentionally overlapped to increase interaction and foster community. In the second half of the year, students are divided into teams

to develop specific projects such as vision-based object detection and obstacle avoidance. The focus is to replicate in a controlled laboratory environment, real-world missions like flight surveillance operations. Students schedule their laboratory times based on their team members' availability.

While in the program, students also develop other skills such as 1) interpersonal abilities through opportunities to engage with their fellow cohorts and their peer and faculty mentors. These interactions help them reflect on key positionalities that include culture, language, and traditions, and assess their academic and professional needs. They also develop 2) academic and professional skills to learn about developing and presenting research, meeting with working professional engineers, and broadening their knowledge about their future as graduates and professionals. Finally, students cultivate 3) service skills by participating in outreach where they get to interact with K-12 students, become role models for individuals to connect with, and support interdepartmental, and community agency partnership development [28]. Students participated in culturally relevant activities, such as Dia de Muertos (the day of the death) and posadas (Christmas celebration). Spanish was commonly used by students and mentors for technical aspects and socialization. Lastly, students attended professional development workshops to learn more about research, mentorship, public speaking, and graduate school.

Participants mostly self-identify as Hispanics, non-first-generation students, and first-time involved in a research program. Table 1 shows a summary of student demographics and academic information:

Table 1. Student participant demographics

	N=23		
	S22 6 students	F22 – S23 8 students	F23 –S24 9 students
Self-identify Ethnicity			
Hispanic	66%	87.5%	100%
White	17%	-	-
Native American	-	12.5%	-
Middle East	17%	-	-
Declared Gender			
Woman	50%	50%	44.4%
Men	50%	50%	55.5%
Student Classification			
Freshmen	17%	-	-
Sophomore	-	12.5%	-
Junior	66%	75%	33%
Senior	17%	12.5%	67%
Major			

Electrical and Computer Eng	17%		33%
Mechanical & Aerospace Eng	66%	75%	56%
Mechanical Technology	17%	-	11%
Others	-	25%	-
Bilingual (English/Spanish)			
Yes	17%	50%	100%
No	83%	50%	-
First-generation			
Yes	17%	25%	33%
No	83%	75%	67%
First research experience			
Yes	83%	75%	89%
No	17%	25%	11%

S=Spring / F=Fall

The third cohort can be partially considered for this study due to their recent involvement with ROLE and not having all data collected yet from this student group.

Methods

Data collection

IRB was granted to conduct this research. This study used a mixed methods approach to capture Hispanic engineering students' learning process and benefits from participating in a research program tailored to support and value their knowledge. All students were invited, in person and by email, to participate in the two sets of data collection. A consent form was used, and students had the opportunity to ask questions. The consent form was dated and signed. The first two cohorts completed pre- and post-experience surveys and participated in a set of two interviews. The interviews were conducted at university facilities at a convenient time for each student. In both cohorts, the pre-experience survey and first interview explored students' prior academic, research, and mentoring experiences. This data collection happened during the first month of students' participation in ROLE. The post-experience survey and second interview examined the benefits and learning outcomes of participating in ROLE in terms of student self-confidence, perceptions of research, and mentoring relationships. These data were collected in the last month of ROLE. Each interview lasted on average 40 minutes. The surveys were administered using REDCap, an institutional tool that collects and stores data. Due to the number of participants, the results included in this study are descriptive and complement the information presented through the qualitative data. Participants selected pseudonyms to protect their identities.

Data analysis

Survey data were exported from REDCap to Excel, where the researchers analyzed students' responses and included information relevant to this study. Interview data were recorded and

transcribed, and the transcriptions were used for the analysis. Researchers read the interviews several times, identified data units, and classified the information using Dedoose, a software that helps in the analysis of qualitative data. Through constant comparative techniques and content analysis [29], researchers found themes and categories in the interviews that helped answer the research questions and complemented the information students reported through the surveys. The theoretical framework, previous research, and research questions informed the analysis by providing the researchers with a deeper understanding of what to look for in the students' survey and interview responses. The researchers took note of key themes and topics that surrounded identity formation, laboratory climate, relationship with peers, language use, research interests, and scientific formation.

Authors' Positionality

Author1. As a first-generation Latina scholar, I am passionate about the education and progress of Hispanic college students in STEM fields. In my professional role, I have been able to serve as an instructor, mentor, tutor, and advisor of minority undergraduate and graduate students, mostly Hispanics, which provided great insight and knowledge. As a researcher, I have conducted and participated in several studies addressing minority and underserved students' experiences in college. Such experiences relate to advising, mentoring, tutoring, learning, and socializing in college.

Author2. My background is framed with a deep knowledge of this borderland area as a local inhabitant, a first-generation student, and a Mexican American mixed-race person. My education in history, anthropology, and technology education along with my professional experiences in STEM focused on K-12 and higher education informs my approach to supporting undergraduate students in STEM. I know how to connect with students and enjoy interacting with them in my role as a graduate research assistant.

Author3. I am a Hispanic engineer eager to provide mentoring and guidance to minority undergraduate students, interest them in scientific careers, and encourage them to pursue graduate studies. I have experience in advising student organizations, such as the Society of Hispanic Professional Engineers (SHPE) and organizing outreach activities such as the annual Unmanned Aerial Systems Summer Program (UASSP). During my career, I have been committed to promoting underrepresented minorities (URMs) in STEM, enhancing curriculum, and improving classroom teaching and learning.

Results and findings

The following section addresses the study's results through descriptive statistics and findings that reflect participant experiences in being involved in an asset-based pedagogical model of instruction and culturally relevant research approach. Participants' responses and reflections relate to how participating in ROLE reinforced their identity as Hispanic students, contributed to

their teamwork, and made them aware of the importance of research for their academic and professional development.

Reinforce identity as Hispanic students – centralization of culture and community

Results of the post-experience survey indicated that participants were highly satisfied with their involvement in this research opportunity and 83.3% opined that they would pursue another mentored research opportunity in the future. In terms of their professional and technical development due to their participation in ROLE, student responses related to their levels of agreement from pre- to post-experience surveys are summarized next:

Table 2: Student survey responses on their professional and technical skills gained by their participation in ROLE

	Pre-Survey	**Post-Survey**
Assertions	*SA/ Agree	*SA/ Agree
I am able to write a research abstract.	52%	59%
I am able to create a research poster.	44%	67%
I am able to give an oral research presentation.	68%	100%
I possess a basic understanding of how to interpret research data.	68%	91%
I possess a basic understanding of how to apply research data.	68%	92%
I am able to communicate technical information to people within my discipline.	72%	100%
I am able to communicate technical information to people outside my discipline.	72%	100%

*SA: Strongly Agree

The responses indicated in Table 2 inform ROLE's programmatic efforts to support students in developing their abilities to succeed in engineering. The program included professional development opportunities that included research presentations through poster sessions, research data dissemination, technical information communication, and professional network importance. These results complement the findings collected through interviews in which students explained how they benefitted and took advantage of this research opportunity to strengthen their ethnic identity. For instance, Troy and Pepito mentioned feelings and perspectives linked to the ROLE program. On the one hand, Troy expressed finding similarities between being in ROLE and at home in terms of supporting each other. He said, “ROLE has given me that same feeling I have when I'm back home because like we're all looking out for each other.” On the other hand, Pepito commented, “ROLE helped me broaden my perspective of what it means to be Hispanic in the United States. Cause I saw there is a wide range of people who have the same as me different cultural experiences or languages.” Both comments addressed finding ROLE as a space with similarities with home and the community students grew up. In turn, there were also comments on differences among ROLE participants, particularly, those students who were raised in Mexico

and those who grew up in the US. Xiomara said, “I noticed how Hispanic people grew up compared to Hispanic Americanized people. I think that's something that I've noticed, I don't speak Spanish and there are things that [a peer] talks about that I've just never grown up with.” Pepito added, “ROLE helped me be more aware of the differences between someone who has lived in Mexico and someone who has been raised here [in the U.S.].” These two participants shared thoughts on notable differences among self-identified Hispanics with different experiences. On the one hand, one person with experience of growing up on the US-Mexico border and who was highly influenced by the Spanish language; and on the other hand, another person was born and raised as a traditional monolingual U.S. citizen.

Another important aspect that is highly promoted in ROLE is to create opportunities to reflect on students’ culture. Culturally relevant activities are usually connected to one’s family, values, and identity, and ROLE promotes the participation of students in cultural-based activities. The following two quotes highlight such activities, emphasizing the significant role of working and supporting each other in meaningful ways. Zeus revealed,

> The cultural activities that the program created for us, such as the Day of the Dead…helped me know the cultural side of the program. It wasn’t just gathering the Latinos and throwing them into their new program. It was like we could actually do events with each other.

Additionally, Ivy included, “The workshops we did last year, I think that was really a good memory that I will have about this program…we were getting teamwork to do something that is really meaningful for my culture.” Both students mentioned a relationship between the program activities and their culture that participants found meaningful. Overall, participants found ROLE supportive of their culture and endorsed awareness of cultural differences based on their upbringings. Such differences highlighted a wide range between speaking English as a native language, knowing some Spanish, and being completely fluent in Spanish. Another difference noted a strong ethnic identity as a Hispanic, some knowledge about Hispanic culture and values, and a diffused/vague identification with the Hispanic culture and its people.

Teamwork with peers

Survey results indicated that 67% of students spent on average 15 hours weekly of interaction with ROLE members, including peers and mentors. Students were expected to spend 6 hours per week of lab work, meaning students spent 9 more hours than expected. Also, 75% of students perceived participant interactions as usual and always useful or helpful. Despite teamwork being widely practiced in engineering in the industry and research productivity, barely, students in engineering take full advantage of this type of pedagogical shared knowledge. Participants expressed themselves to have enjoyed being part of ROLE, mainly due to the type of interactions and trust among students. Juan mentioned, “I saw the same thing in my teammates and group

members…we went through the process of being frustrated, being excited, being like happy that we got it to work and all that...It was a really great experience." Xiomara added, "I think it's like the best group I've ever been in academic terms. Like we all, since day one, we have started a community and talked or helped each other and got to know each other." Gene commented, "I feel like we work together pretty well, and we communicate together pretty well." All three participants were convinced of the great connections, interactions, support, and mutual help that their cohort members generated. Each cohort has created a unique synergy where shared knowledge and emotional support in accomplishing challenging tasks generate a sense of enjoyment and fulfillment.

One of ROLE's purposes is that students build a community that reflects their cultural values and shared knowledge. Therefore, there are days when all students work together in the laboratory, and they commonly use these days to solve problems, collaborate, and clarify questions. Two participants, Troy and Leo, expressed their perspectives on this community learning approach,

> Friday everybody's just more engaged trying to solve the same problem at the same time and we're all trying to help each other out. It's been a lot of teamwork and collaboration to solve common problems. So, everybody just got together and like a teamwork environment, and it's been pretty good.
>
> Sometimes we're all there at once and you can see us just bouncing questions off each other, helping each other. Some students know more than others, like sometimes I'll be able to go and help them and explain to them what a command is and then I can ask them when I need help. So being able to have that diverse knowledge helps. And communication also helps the process.

These two quotes reflect the teamwork that ROLE promotes where students comment on mutual learning, support among them, and contribution to a common goal. Participants noted the importance of each student and the potential of the group work to accomplish a research project. Besides ROLE seeking to create a community with participants in each cohort, ROLE also aims to generate long-lasting relationships among participants. Students' networks must be widened, and ROLE is helping students to grow. On this subject, Pepito mentioned, "Most of the people that are in the cohort were taking the same classes. So, we are able to see each other outside of this lab. So, we'll have maintained communication besides the ROLE program." This participant confirmed that interacting with students outside of ROLE will help keep those relationships.

The teamwork described by participants helped understand the instructional shared knowledge happening in ROLE, where peer support, mutual learning, and team-based collaboration were at the core of the learning process, applied knowledge, and real-world applications.

A research space for Hispanic students

Participants were asked what part(s) of ROLE they found most valuable or helpful in the post-experience survey. Mostly, participants highlighted the teamwork and community-centered approach. Participants shared the following information:

1. Liked working with other students and getting to do hands-on work with the research.
2. All of it. Especially the team development portion.
3. I found everything about this program valuable. From the community to the outreach and technical side.
4. The culture was very valuable when it came to having a leisure activity to learn from each other.
5. How to work together as a team towards a common goal.
6. The workshops and speakers were valuable too.
7. The community-centered research.

The student responses above indicate what elements participants found valuable about ROLE, confirming the importance of interacting with others, shared values through their culture, and community building. When participants were interviewed, they reflected on more specific examples. For instance, participants were aware of ROLE's research space created to encourage research activities among minority and underrepresented students in engineering. Some participants reflected on their ethnic and engineering identities. Troy vented, "Being a Latino engineer, it's definitely a minority in the engineering field…it made me sort of form more of a bond if I see a Latino engineer because we share the same cultural backgrounds…helps the team bonding a lot more." Jaylen revealed, "I think it was good that we had a lot of diversity, especially with gender as well as ethnicity." Jose added, "I think just being able to be a part of a Latino program like this really just brought out the best in me." These quotes highlight how participants perceived ROLE as an eye-opening experience and also a safe space for students who oftentimes do not see themselves reflected in the scientific community. Also, the fact that engineering is a male-dominated field, two participants commented on women's role in engineering and particularly, in ROLE. Mark said, "We saw the women in our group and how someone like (a female peer), she has a lot of leadership qualities...breaking the stereotype, the norms, and gender roles." And Ivy added, "What I like about ROLE, it's that we get like coming back to the teamwork, peers don't care if you're woman, because we are all Latinos…we have to help each other for us to all, all succeed." These two quotes represent the thoughts of participants in having or being women in ROLE. Both participants emphasized the potential of women's presence in engineering and research-related activities.

As ROLE has evolved, we have seen a difference in student participants in terms of their linguistic abilities. In the first cohort, only one student was bilingual. In the second cohort, 50% of participants were bilingual, and for some of them, Spanish was their first/native language.

Therefore, finding peers who shared the same language created a sense of trust, sympathy, and relief in using Spanish whenever they needed or wanted. Troy mentioned, “I don’t think I’ve ever talked as much Spanish as when I did here. And it, it did kind of form that level of comfort that we can all just talk to each other how we want.” Ivy shared, “If I don’t know how to say something in English, they’re like, just tell me in Spanish. Like, I will understand you, and I will help you to get better now.” The frequent use of Spanish among participants in the lab increased the interest among a few participants to try to speak Spanish and practice when they were in the lab. Other cohort members were less interested and never tried to speak. In sum, participants commented on the contribution of ROLE to becoming aware of their ethnic, engineering, gender, and linguistic identities. Participant quotes reflected the intersectionality of two or more identities in situating themselves and others within engineering and the research context.

Conclusion

This study sought to understand two main questions 1) How does a collaborative learning environment like ROLE promote asset-based pedagogical practices in engineering education at NMSU? and 2) How does the centralization of culture and community in ROLE contribute to supporting student success in rigorous engineering programs at NMSU? This study demonstrated that undergraduate research programs like ROLE should be spaces where creative, innovative, and approachable instructional and community-based approaches coexist. Collaborative learning in ROLE is one of its core elements and students take full advantage of learning from each other. Besides the mentor intervention and guidance, ROLE participants share their knowledge and use those days when they were all together to solve problems, collaborate to accomplish tasks, and clarify questions. Aligning with asset-based pedagogical practices, ROLE promotes collaboration by finding times in which students work together in the lab. Such collaboration brings other assets that students are familiar with, such as mutual care, trust in one another abilities, building of self-confidence, and use of preferred language. Students find such interactions among ROLE members meaningful, enjoyable, and relatable to their homes and communities.

In terms of centralizing both culture and community and keeping the rigor of an engineering research focus program, ROLE’s structure and activities make it possible. In providing an opportunity for minoritized and underrepresented students in engineering, ROLE seeks to find a balance between involving students in research and making their experience culturally relevant and community-centered. Cultural and family values are commonly discussed by participants of ROLE, in which they perceived big differences according to their upbringings, including socioeconomic level, residency, citizenship, most proficient language, and gender. Finding their engineering identity comes with the recognition of how other identities intersect and shape who they are and how they approach and contribute to engineering and research.

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References

[1] D. H. Cropley, “Promoting creativity and innovation in engineering education,” *Psychology of Aesthetics, Creativity, and the Arts*, vol. 9, issue 2, pp.161-171, 2015.

[2] H. C. Contreras Aguirre, L. R. Garcia Carrillo, and N. Delgado, *Latinx Engineering Students Surviving the Odds to Accomplish their College Degree*, ASEE Annual Conference & Exposition, June 25-28, 2023, Baltimore, Maryland.

[3] K. D. Gutiérrez and B. Rogoff, “Cultural ways of learning: Individual traits or repertoires of practice,” *Educational Researcher*, vol. 32, issue 5, pp. 19–2, 2003.

[4] E. J. López, V. Basile, M. Landa-Posas, K. Ortega, and A. Ramirez, "Latinx students' sense of familismo in undergraduate science and engineering," *The Review of Higher Education*, vol. 43, issue 1, pp. 85-111, 2019.

[5] P. O. Garriott, R. L. Navarro, L. Y. Flores, H.-S. Lee, A. Carrero Pinedo, D. Slivensky, M. Muñoz, et al., "Surviving and thriving: Voices of Latina/o engineering students at a Hispanic serving institution," *Journal of Counseling Psychology*, vol. 66, issue 4, pp. 437-477, 2019.

[6] J. A. Mejia, R. A. Revelo, I. Villanueva, and J. Mejia, “Critical theoretical frameworks in engineering education: An anti-deficit and liberative approach,” *Education Sciences*, vol. 8, issue 4, pp. 158-171, 2018.

[7] R. Kumar, Z. Akane, and B. Rhonda, "Weaving cultural relevance and achievement motivation into inclusive classroom cultures," *Educational Psychologist*, vol. 53, issue 2, pp 78-96, 2018.

[8] H. Budinoff, and V. Subbian, *Asset-based approaches to engineering design education: A scoping review of theory and practice*, ASEE Annual Conference & Exposition, July 26-29, 2021, virtual.

[9] T, J. Yosso, “Whose culture has capital? A critical race theory discussion of community cultural wealth,” *Race Ethnicity and Education*, vol. 8, issue 1, pp. 69-91, 2005.

[10] S. M. Lord, M. M. Camacho, C. E. Brawner, J. B. Main, and C. Mobley, *Military veteran students’ pathways in engineering education (Year 5)*, ASEE Annual Conference & Exposition, June 16-19, 2019, Tampa, Florida.

[11] J. B. Main, M. M. Camacho, C. Mobley, C. E. Brawner, S. M. Lord, and H. Kesim, "Technically and tactically proficient: How military leadership training and experiences are enacted in engineering education," *International Journal of Engineering Education*, vol. 35, no. 2. pp. 446–457, 2019.

[12] C. Carrigan, E. A. Riskin, J. L. Borgford-Parnell, P. N. Mody-Pan, D. Wiggin, and S. Cunningham, *Learning from Pell-eligible engineering students' class standpoint*, ASEE Annual Conference & Exposition, June 14-17, 2015, Seattle, Washington.

[13] E. Mercier, M. H. Goldstein, P. Baligar, and R. J. Rajarathinam, "Collaborative learning in engineering education. In *International Handbook of Engineering Education Research*, A. Johri, Ed. New York, NY, Routledge, 2023, pp. 402-432.

[14] A. K. Winkens, and C. Leicht-Scholten, "Does engineering education research address resilience and if so, how?–a systematic literature review," *European Journal of Engineering Education*, vol. 48, issue 2, pp. 221-239, 2023.

[15] T. Litzinger, L. R. Lattuca, R. Hadgraft, and W. Newstetter, "Engineering education and the development of expertise," *Journal of Engineering Education*, vol. 100, issue 1, pp. 123-150, 2011.

[16] A. Johri, "Lifelong and lifewide learning for the perpetual development of expertise in engineering," *European Journal of Engineering Education*, vol. 47, issue 1, pp. 70-84, 2022.

[17] A. Johri, and B. M. Olds, "Situated engineering learning: Bridging engineering education eesearch and the learning sciences," *Journal of Engineering Education*, vol. 100, issue 1, pp. 151-185, 2011.

[18] H.C. Contreras Aguirre and R. Banda, "Importance of mentoring for Latina college students pursuing STEM degrees at HSIs", in *Crossing Boundaries/Crossing Borders: Narratives of Intercultural Experiences*, L. Hemmer, Phyllis, R. and Jana, S. Eds. CEDER Yearbook, 2019, pp. 111-128.

[19] 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*, vol. 33, issue 8, pp. 810-823, 2020.

[20] V. Svihla, A. Datye, J. Gomez, V. Law, and S. Bowers, *Mapping assets of diverse groups for chemical engineering design problem framing ability*, ASEE Annual Conference and Exhibition, June 26-29, 2016, New Orleans, Luisiana.

[21] A. S. De Novais, M. B. Silva, and J. Muniz, "Strengths, limitations, and challenges in the implementation of active learning in an undergraduate course of logistics technology," *International Journal of Engineering Education*, vol. 33, issue 3, pp. 1060-1069, 2017.

[22] B. D. Missingham, "Asset-based learning and the pedagogy of community development," *Community Development*, vol. 48, issue 3, pp. 339-350, 2017.

[23] S. R. Harper, "An anti-deficit achievement framework for research on students of color in STEM," *New Directions for Institutional Research*, vol. 148, pp. 63-74, 2010.

[24] R. Hallett, G. M. Bettencourt, A. Kezar, J. A. Kitchen, R. Perez, and R. Reason, "Re-envisioning campuses to holistically support students: The ecological validation model of student success [Brief]," USC Pullias Center for Higher Education, May 2021.

[25] L. I. Rendon, "Validating culturally diverse students: Toward a new model of learning and student development," *Innovative Higher Education*, vol. 19, pp. 33-51, 1994.

[26] D. Paris, "Culturally sustaining pedagogy: A needed change in stance, terminology, and practice," *Educational Researcher*, vol. 41, issue 3, pp. 93-97, 2012.

[27] G. Ladson-Billings, "Toward a theory of culturally relevant pedagogy," *American Educational Research Journal*, vol. 32, issue 3, pp. 465-491, 1995.

[28] Y.S. Lincoln and E. G. Guba, *Naturalistic inquiry*, Beverly Hills, Ca: Sage,1985.