A Community-Based, Culturally Engaging STEM Learning Environment and Its Impact on Students' Psychosocial Attributes at a Rural Hispanic Serving Institution (HSI)

Elvira J. Abrica,[†]* Deryl Hatch-Tocaimaza,[‡] Sarah Corey-Rivas,[§] Justine Garcia,[‖] and Aalap Dixit[¶]

[†]Department of Educational Administration, University of Nebraska-Lincoln, Lincoln, NE 68588; [‡]Department of Educational Administration, University of Nebraska-Lincoln, Lincoln, NE 68588; [§]Department of Biology, New Mexico Highlands University, Las Vegas, NM 87701; [‖]Department of Biology, New Mexico Highlands University, Las Vegas, NM 87701; [¶]Department of Forestry, New Mexico Highlands University, Las Vegas, NM 87701

ABSTRACT

Using the Culturally Engaging Campus Environments (CECE) Model, this qualitative study examined development of psychosocial attributes (i.e., sense of belonging, science identity, and self-efficacy) among 1st-year life science undergraduate students who participated in integrated and culturally engaging research activities at New Mexico Highlands University, a rural Hispanic Serving Institution (HSI). Research activities were part of a project called SomosSTEM [We are STEM], which included four major components: 1) course-based undergraduate research experiences (CUREs) that are laboratory modules integrated into introductory life science classes; 2) summer Bridge Science Challenge Academy for 1st-year students; 3) full summer internship program; and 4) Community Voices lecture series. We found the integrated nature of SomosSTEM represents an engaging learning environment that positively impacted students' perceptions of their development of psychosocial attributes. This paper's significance is it outlines specific, integrated activities that are also community-based and culturally engaging. We discuss community-based and culturally engaging learning environments as a viable solution to the problem of individualistic and exclusionary learning environments.

Stacy Alvares, *Monitoring Editor*

Submitted Jan 26, 2024; Revised Sep 3, 2024; Accepted Oct 21, 2024

CBE Life Sci Educ December 1, 2024 23:ar62

DOI:10.1187/cbe.23-12-0238

Conflicts of interest: The authors declare no conflicts of interest.

*Address correspondence to: Elvira J. Abrica (elvira.abrica@unl.edu).

BEYOND INTERVENTIONS: COMMUNITY-BASED, CULTURALLY ENGAGING STEM LEARNING ENVIRONMENTS AND THEIR IMPACT ON STUDENTS' PSYCHOSOCIAL ATTRIBUTES

Decades of research on racial and ethnic disparities in science, technology, engineering, and mathematics (STEM) fields has established the crucial role of psychosocial attributes we know influence persistence and degree completion both in STEM fields and undergraduate education more broadly (e.g., Carlone and Johnson, 2007). Among the most well-established psychosocial attributes in higher education research are sense of belonging, efficacy, and identity. Generally, sense of belonging refers to a sense of feeling accepted, valued, and included in the learning environment (Harper and Quaye, 2007; Rodriguez *et al.*, 2019). Sense of academic self-efficacy, a student's confidence in their own intellectual abilities to succeed academically, positively impacts persistence and degree completion (e.g., Hausmann *et al.*, 2007; Vuong *et al.*, 2010; Honicke and Broadbent, 2016;

Strayhorn, 2018). Finally, science identity, an ability to see oneself as a scientist, has been identified as an important factor in undergraduate STEM success.

Substantial research evidence points to the importance of psychosocial attributes in shaping students' interest, commitment, persistence, and degree completion in STEM. Yet, researchers must explore questions about whether and how students' psychosocial attributes are developed or fostered through institutionalized, systemic, and culturally attuned environments designed for this purpose. In other words, STEM education literature consistently documents what matters in STEM success; positive psychosocial development is correlated to specific intervention activities. Yet, questions of whether and how a web of integrated interventions across diverse STEM educational environments result in substantive and meaningful differences in the lives of students in the ways intended are comparably under researched. Thus, a critical gap in STEM education knowledge is how to create learning environments, not sole interventions, that nurture psychosocial development.

Distinction in research objectives—studying environments rather than interventions—is nuanced but important to move beyond identification and description of beneficial factors in STEM education and toward creation and development of the contexts that foster them. For example, undergraduate research opportunities are often identified as a key intervention to foster STEM success specifically because these opportunities not only provide deep and meaningful engagement with science content but also opportunities to engage with faculty and peers, all of which support efficacy, identity, and belonging. Yet, even more holistic intervention approaches are limited in attending to the cultural contexts in which these interventions unfold. To promote diversity and inclusion truly and meaningfully in STEM, there is a need to understand how to foster culturally relevant, STEM learning environments across diverse social contexts, centering students' perspectives, and experiences of their multilayered, complex learning environment.

In this paper, we provide an empirical basis for understanding how students' psychosocial development is potentially connected to the STEM environment in a rural Hispanic Serving Institution (HSI). We present findings from a qualitative study of student perceptions of the *SomosSTEM* [We are STEM] Program, a grant-funded intervention designed to provide early, integrated, and culturally informed research experiences for undergraduate students at New Mexico Highlands University (NMHU). NMHU, founded in 1893, is a rural, open-enrollment public HSI in northeastern New Mexico, and serves a large rural population characterized by diverse cultural, economic, linguistic, and educational backgrounds. At this rural HSI, SomosSTEM offers multiple opportunities to engage in undergraduate research experiences that are community-based, culturally engaging, and integrated across time.

STUDY CONTEXT

NMHU serves a large rural population characterized by diverse cultural, economic, linguistic, and educational backgrounds. The most recent IPEDS data available from Fall 2022 indicate the student demographics of NMHU were reported as 54% Hispanic, 21% White, 10% American Indian or Alaska Native, 4% Black or African American, 3% two or more races, 2% unknown, and 1% Asian. U.S. nonresidents, for whom race/ethnicity is not tracked, were 5% of the student body. Among undergraduates, 45% were 25 years or older. The unduplicated 12-mo student enrollment was 2066 undergraduate and 1386 graduate students, with a total of 3452 students. Forty percent of undergraduate students are part-time status. Based on this demographic profile, NMHU has the second highest enrollment of students from underrepresented populations[1] among New Mexico HSIs that are also members of the Hispanic Association of Colleges and Universities. According to Carnegie classifications, NMHU is classified as a large public 4-year institution, primarily baccalaureate institution.

SomosSTEM was developed specifically to support retention of 1st-time, full-time, 1st-year STEM majors, particularly life science majors for whom retention rates are lower than non-life science STEM majors. Specifically, one challenge to retention before SomosSTEM was that 1st-year students 87% of incoming STEM majors did not have the math prerequisites needed to start life sciences introductory courses. Subsequently, most life sciences majors would not enroll in the STEM gateway courses until their 2nd year; and therefore, not have opportunity to engage with STEM faculty and upper-level STEM majors at early stages of their academic careers. Relatedly, although NMHU has demonstrated improvements in outcomes for Hispanic STEM students through the incorporation of the evidence-based best practice of Supplemental Instruction in STEM gateway courses with historically low pass rates, many students do not have these courses until their 2nd year or later. Additionally, other evidence-based strategies incorporated at NMHU (e.g., undergraduate research experiences, internships, and NSF S-STEM scholarships) target upper-level students, leaving 1st-year and 2nd-year students without support and disconnected from the STEM community. SomosSTEM fills a critical need specifically for 1st- and 2nd-year life science majors by providing them with an *early* constellation of research-intensive activities that are designed to promote retention through development of students' positive psychosocial outcomes. Retention data thus far are positive. For example, before SomosSTEM was designed, life sciences retention 1st to 2nd year was 51%, and to the 3rd year was 36%, to fourth year 33%. After 2-3 years of SomosSTEM, life science retention has increased from 51% to 58% and retention to 3rd year has risen to 56%. It is important to note that within this same 3-year period, the community has been challenged by the global COVID-19 pandemic, a series of severe wildfires, and most recently, a water contamination crisis.

[1]We use "underrepresented populations" to refer to student populations who are not statistically represented in STEM or higher education at rates that are on par with their overall population size. In reference to demographics and data, we use "under represented" to be consistent with institutional and federal demographic reporting which focuses on the extent to which demographic groups and/or identities (racial, gender, socioeconomic) are represented or overrepresented relative to the size of their population nationally or relative to other groups. Later on this this paper, we use the terms Students of Color to refer specifically to groups of students belonging to racial categories of American Indian/Alaska Native, Asian, Black, Hispanic, Pacific Islander, and of Two or more races. Finally, we use the term "racially minoritized students" to also to refer to students of color, but do so in cases where we wish to emphasize racially minoritized status in relation to STEM learning environments.

SomosSTEM involves four major components: 1) course-based undergraduate research experiences (CUREs) that are laboratory modules integrated into introductory life science classes at NMHU (Lo and Mordacq, 2020); 2) summer Bridge Science Challenge Academy for 1st-year students; 3) full summer internship program; and 4) Community Voices lecture series. It provides a structured pathway for students early in their careers at NMHU to develop science identity, sense of belonging, and science self-efficacy, all of which are critical to STEM success. One of the distinguishing features of SomosSTEM is the program was designed to offer students *multiple opportunities* to engage in undergraduate research experiences, both in a classroom and outside of the classroom setting. In SomosSTEM, they engage research in their undergraduate coursework, but also coconstruct new research experiences for incoming groups of students through internship activities. CUREs developed by interns are called intern-based course-based undergraduate research experiences (ibCUREs). In addition to the student activities in SomosSTEM, there were also professional development activities for faculty and staff focusing on the development of CUREs, culturally responsive teaching practices, and development of research and teaching protocols for academy and internship activities. Agency partners who work with faculty, staff, and students through the lecture series or as student mentors represent the following units in the local community: Albuquerque Wildlife Federation, U.S. Fish & Wildlife, New Mexico Forestry Division, Hermits Peak Watershed Alliance, U.S. Forest Service, Los Alamos National Labs.

The goal of this paper is to strengthen the conceptual and empirical linkage between students' learning and development and their learning environment by investigating, from the perspective of college students, how facets of a purpose-built culturally engaging environment might uniquely contribute to their development of important psychosocial attributes. We describe why psychosocial outcomes, particularly sense of belonging, self-efficacy, and science identity development matter in student success. We also highlight higher education literature on STEM learning environments, which overwhelmingly points to the holistic and cultural context of STEM learning as an important factor in success. For this reason, we applied Museus' (2014) Culturally Engaging Campus Environments (CECE) model to an empirical study of students' perceptions of sense of belonging, self-efficacy, and science identity development in the SomosSTEM environment. The research questions guiding our investigation were:

1. To what extent do students experience a purpose-built web of integrated interventions as a culturally engaging learning environment?
2. How do students perceive this learning environment as influencing their sense of belonging, science identity, and self-efficacy?

LITERATURE REVIEW

Psychosocial Development Informs Success Outcomes in STEM

Decades of STEM education literature identify science identity, building self-efficacy and sense of belonging as being critical to STEM success outcomes (broadly defined as persistence, degree completion, and retention) but often not sufficiently or equitably nurtured in the STEM learning context. Briefly, science identity broadly refers to the degree one sees oneself and is recognized by others, as a "science person" (Carlone and Johnson, 2007). Science identity includes internal processes, such as an interest in science and motivation to pursue a career in STEM disciplines (Vincent-Ruz and Schunn, 2018). Science identity also includes social processes, such as socialization into the norms of particular STEM disciplines and recognition by others that one is a "science person" (Carlone and Johnson, 2007; Vincent-Ruz and Schunn, 2018). Students develop a science identity through socialization experiences that keep them motivated and identified with the science domain.

Though science identity is essentially how one views themself in terms of being a scientist, self-efficacy is whether a person sees themself as capable of success. Students with strong self-efficacy persist despite challenges and reach academic goals, and academic achievement, in turn, bolsters self-efficacy and supports persistence (Bandura, 1997; Valentine *et al.*, 2004). STEM self-efficacy is conceptualized as a subarea of academic self-efficacy and characterized as a student's confidence in their ability to complete tasks specifically related to mathematics and science (Britner and Pajares, 2006; Mensah and Jackson, 2018). Inherent in building STEM self-efficacy is the opportunity to engage in authentic experiences that allow students to form judgments about their capabilities to engage and succeed in STEM.

Such opportunities are relatively few in the first years of most STEM coursework that focuses on transmission and mastery of fundamental concepts, with applied and generative work typically reserved for upper-level coursework. In the absence of relevancy of course material, feelings of community, and opportunities to establish efficacy and identity, new college students who otherwise wish to pursue STEM studies may turn to other fields of study. A sense of belonging—students' feelings of connectedness or sense of mattering on campus—is equally important in fostering retention in STEM, yet, as we will describe in coming sections, is differentially fostered across student populations (Strayhorn, 2018). Development of these psychosocial traits is particularly important at a rural HSI such as NMHU, where out of 2066 undergraduate students in Fall 2022, 54% were Hispanic and 74% from minoritized racial and ethnic groups. Hispanic/Latinx populations remain underrepresented at every stage of the STEM pipeline (NSF, 2017) making the need for early interventions to enhance retention and development of psychosocial traits timely.

Interventions to Develop Psychosocial Outcomes

Specific intervention activities are correlated with positive psychosocial development in STEM. Specifically, interventions that promote critical thinking, problem solving, and application of course materials support STEM self-efficacy. The most successful interventions are those which integrate collaboration, mentoring relationships, and critical thinking. For example, when students have opportunities to collaborate through peer supplemental instruction and peer collaborative learning, there are gains in student motivation, autonomy, and critical thinking in STEM fields (Stigmar, 2016). Robnett *et al.* (2018)

identified a relationship between instrumental mentoring (i.e., support in learning tasks, skills, and professional development) and STEM self-efficacy. STEM higher education literature consistently points to faculty interaction and relationships as being among the most important factors in shaping student experiences and outcomes (McCoy *et al.*, 2017; Park *et al.*, 2020).Though research evidence is clear that meaningful relationships among students and faculty promote positive psychosocial development, it is difficult to create formalized mentoring relationships when mentors rarely receive guidance or training in effective mentoring or identify cultural practices which support students from minoritized ethnic and racial groups in recognizing strengths they bring (Yosso, 2005; Robnett *et al.*, 2019; Espinoza and Rincón, 2023). Instead, faculty often act as gatekeepers, providing access to opportunities for specific students, and beneficial learning opportunities to those whom they deem as prepared or talented. For example, in a study by McCoy *et al.* (2017), Students of Color[2]experienced faculty interactions in which they felt they were dismissed and actively being "weeded out" of STEM through repeatedly negative interactions with their professors. Students of Color frequently report negative faculty interactions, and "nuances of faculty interactions" are largely understudied (McCoy *et al.*, 2017; p. 659). Much of the literature on faculty interactions comes from predominantly white (PWI) 4-year universities, with very little empirical studies conducted in rural and/or Hispanic serving (HSI) contexts. Research is unclear around whether and how diverse cultural contexts might provide culturally relevant mentoring, validation of students' diverse backgrounds and talents, and creation of opportunities for students to engage in research, as these have been studied as interventions in PWIs (Griffin *et al.*, 2020).

Much emphasis is on opportunities for students to engage in undergraduate research through formalized, course-based research (Estrada *et al.*, 2018). Specifically, CUREs are research opportunities integrated into curriculum in entry-level classes. Importantly, CUREs offer "authentic" research experiences that allow students to have hands-on engagement with course material. Research on CUREs over the past decade has shown CUREs impact knowledge acquisition and psychosocial outcomes and persistence for students (Shear and Simmons, 2011; Brownell *et al.*, 2012; Alkaher and Dolan, 2014; Bangera and Brownell, 2014; Jordan *et al.*, 2014). CUREs have been shown to increase student self-efficacy and clarity about STEM careers and may enhance students' sense of science identity (Corwin *et al.* 2015). The success of CUREs is consistent with extant higher education which documents when students have opportunities to learn and share knowledge about the issues in and needs of their own communities of origin, it can be associated with stronger connections to their respective institutions, higher levels of motivation, and greater likelihood of success (e.g., Guiffrida, 2003, 2005; Harper and Quaye, 2007; Kiang, 2002, ; Museus, 2008, 2011; Museus *et al.*, 2012).

STEM Learning Environments

Given the significance of psychosocial development in STEM success, it is important to understand whether and how STEM learning environments shape this development. STEM fields are high stakes, competitive, and academically demanding learning environments. The culture of STEM is one that privileges an individualistic, meritocratic, and survival-of-the-fittest mentality (McGee, 2016, 2020). In this cultural context, students from racially minoritized backgrounds are often underrepresented in STEM fields, and experiences of racial isolation, and negative stereotypes from peers and faculty, and their deleterious effects, are well documented (Hurtado *et al.*, 2009; Estrada *et al.*, 2018; McGee, 2016, 2020). There remains a widespread tendency to rely on individual-level circumstances, effort, and abilities leading to make sense of one's success or failure in STEM studies and career pursuits, rather than a misalignment between the STEM environment and students' diverse cultural backgrounds.

Although customs, norms, and values in STEM may be seen as normal and race-neutral, they directly align with customs, norms, and values of white culture. White culture is a value system that prioritizes rugged individualism, competition, linear and future time orientation, objective science, owning goods and property, and hierarchical power structures (Mills, 1997; Bonilla-Silva and Forman, 2000; Sue, 2004; Bonilla-Silva, 2022). Students of Color in STEM environments will deny their own cultural values, ideas, and customs to assimilate into the white norms and values of STEM that tell them they alone need to work harder, do more, and align themselves with the dominant cultural environment. For example, McGee *et al.* (2022) challenge ways Students of Color are made to feel like imposters, and these students do not really have what it takes to succeed in STEM. Imposter syndrome, rather than racism, is often identified as the individual-level attribute that limits student success. From a nuanced and critical lens, the STEM learning environment is understood as a fixed constellation of norms, values, and practices that epistemically exclude different ways of knowing and being.

STEM learning environments assimilate racially and ethnically diverse students into white culture, values, and ideologies rather than including materials, values, and norms that resonate with culturally diverse student populations. For this reason, the experience of learning in STEM is linked to various forms of racial stress. For example, Abrica (2022) recently argued racial stress creates an additional cognitive load for Students of Color where they must constantly reassess and reappraise their identity, values, beliefs, and ways of being with respect to white norms and values. For example, empirical studies of Latina/o/x students in higher education capture nuanced and complex ways racial consciousness, beliefs, and meaning making (Abrica and Dorsten, 2020) that are relevant to our argument in favor of learning environments that support diverse student populations.

[2]In the context of higher education research literature, authors most frequently use the terminology "Students of Color" as a broad term to identify and refer to individuals who are American Indian/Alaska Native, Asian, Black, Hispanic, Pacific Islander, and of two or more races. We use this term throughout the literature review section because this is the term used in literature cited. In other sections in the paper, we use the term "racially minoritized" students to refer to the same populations. We prefer the term racially minoritized because it more critically points attention to the active ways in which students of color are minoritized and oppressed on the basis of race. "Students of color" is a more general and descriptive term we borrow from higher education literature while "racially minoritized" implicates the minoritizing and oppressive consequences of racial minority status.

Community-Based, Culturally Engaging STEM Learning Environments

In contrast to highly individualistic learning environments, STEM learning environments are designed to validate students' backgrounds, so students are not forced to assimilate to white norms and values traditionally upheld in STEM environments. Community-based and culturally engaging STEM learning environments embrace students' cultural values and are reflective of the communities they are a part of (Hurtado *et al.*, 2009; Estrada *et al.*, 2018). We highlight two important dimensions of community-based, culturally engaging STEM learning environments: 1) a focus on community-based learning and 2) culturally relevant undergraduate research opportunities. Researchers have long identified a community-oriented learning environment as promotive or science identity, self-efficacy, and sense of belonging, particularly for Students of Color (e.g., Syed *et al.*, 2018). A student's sense of belonging to a community has been shown to influence student academic motivation, well-being, and academic achievement (Trujillo and Tanner, 2014; Ashley *et al.*, 2017). For example, Lane and colleagues' work (2016) establishes community building involves coordinated services and activities designed to support underrepresented students in STEM (Lane, 2016). Communities emerge because of shared interests and connectedness among participants, which is strengthened through program features that can include social activities, mentoring, and familial atmosphere among staff, students, and mentors (Lane, 2016).

CUREs can be understood for how they exemplify and facilitate the kinds of cohort-based research projects in STEM courses and scale up the impacts of individual internships in a more inclusive environment for students to experience the positive psychosocial and content learning benefits of research (Bangera and Brownell, 2014). For example, firsthand involvement in research relies on a strong relationship between sense of belonging and community involvement. Early research experiences are important and directly contribute to student motivation to persist in STEM and lead to the student identifying as a scientist (Schultz *et al.*, 2011; Graham *et al.*, 2013; Rodenbusch *et al.*, 2016).

Considering literature on student success and the college learning environment, Museus (2014) explains culturally engaging learning environment are those that incorporate educationally purposeful engagement strategies while also attending to racial and cultural context (e.g., nature of the campus cultures in which students' involvement or engagement behaviors occur). Specifically, educational engagement includes challenging students with rigorous academic activity, academic and collaborative learning including in-class discussions, group projects, service-learning, and academic discussions outside of the classroom. Additionally, engagement involves cross-cultural involvement, participation in service work, internships, learning communities, and strong relationships with faculty, students, administrators (Pike and Kuh, 2005).

Higher education research offered perspectives of student engagement that consider how racial and cultural contexts shape experiences and outcomes of diverse student populations. Researchers need to closely examine the cultural norms of the learning environment to understand how members of dominant and nondominant groups on campus are provided with different opportunities to engage (Museus, 2014). Indeed, engagement experiences cannot be understood as universally beneficial (Dowd *et al.*, 2011). For example, the concept of student engagement implies frequency of faculty–student interactions will enrich the college experience and facilitate success. However, if those frequent interactions consistently send signals to students their cultural identities are devalued, they are second-class citizens, or the faculty member does not care about their success, such experiences might not have a positive influence on the college experience or success at all. As such, frameworks that consider the qualitative aspects of the environments where students are immersed in and activities, they participate in are warranted (Museus, 2014).

We used the CECE model to understand students' development of sense of belonging, self-efficacy, and STEM identity in relation to their learning environment. By emphasizing and specifying dimensions of the learning environment that students perceive as promotive of positive psychosocial outcomes, we move toward greater empirical understanding of STEM learning environments.

THE CECE MODEL

The CECE model by Museus (2014) posits undergraduates who encounter more CECE are more likely to 1) exhibit a greater sense of belonging, more positive academic dispositions like self-efficacy and intent to persist, and higher levels of academic performance and 2) ultimately be more likely to persist to graduation. The CECE model suggests nine indicators of CECE that engage students' racially diverse cultural backgrounds or identities, reflect their diverse needs as they navigate their respective institutions, and facilitate their success in college.

CECE Indicator #1: Cultural Familiarity

The CECE model posits the extent college students have opportunities to physically connect with faculty, staff, and peers with whom they share common backgrounds on their respective campuses being associated with greater likelihood of success.

CECE Indicator #2: Culturally Relevant Knowledge

Second, the CECE model indicates postsecondary institutions that offer opportunities for their students to cultivate, sustain, and increase knowledge of their cultures and communities of origin can positively impact their experiences and success.

CECE Indicator #3: Cultural Community Service

The CECE framework hypothesizes cultural community service positively impacts the experiences and success of racially diverse populations. Cultural community service manifests when institutions provide students with spaces and tools to give back and positively transform their cultural communities including engaging in community activism, participating in community service and service-learning opportunities, or engaging in problem-based research projects that aim to solve problems in their cultural communities. The model suggests the level of access students have to opportunities to develop such transformational cultural connections is positively associated with success.

CECE Indicator #4: Opportunities for Meaningful Cross-Cultural Engagement

Fourth, the CECE Framework indicates students' access to opportunities for meaningful cross-cultural engagement is positively associated with their success in college. The model indicates opportunities to engage in positive and purposeful interactions with peers from disparate cultural origins can positively impact college experiences and success. Although research examining the relationship between meaningful cross-cultural engagement and persistence and attainment in college is difficult to find, existing literature does offer substantial evidence campus environments that promote meaningful cross-cultural engagement are conducive to many positive outcomes in college.

CECE Indicator #5: Collectivist Cultural Orientations

Fifth, the CECE model proposes college students who encounter institutional environments that are based on more collectivist cultural orientations, as opposed to more individualistic ones, are more likely to succeed. This proposition is congruent with existing evidence indicating both white students and Students of Color from communities with more collectivist cultural orientations might encounter salient challenges adjusting to and navigating colleges and universities with more individualistic orientations (Thompson and Fretz, 1991).

CECE Indicator #6: Culturally Validating Environments

The CECE model postulates culturally validating environments are positively related to success in college. Specifically, the CECE framework suggests students who are surrounded by postsecondary educators who validate their cultural backgrounds and identities will have more positive experiences and be more likely to succeed in college (Rendón, 1994; Museus and Quaye, 2009; Barnett, 2011; Rendón and Muñoz, 2011).

CECE Indicator #7: Humanized Educational Environments

The CECE model hypothesizes students who encounter humanized educational environments on their campuses are related to more positive experiences and greater likelihood of success. The concept of humanized educational environments refers to campus environments characterized by institutional agents who care about, are committed to, and develop meaningful relationships with their students.

CECE Indicator #8: Proactive Philosophies

Proactive philosophies are present when faculty and staff go beyond making information and support available to making extra efforts to bring that information and support to students and maximize their likelihood of success, so students can increase the rates of persistence and attainment of among the racially diverse college student populations they serve.

CECE Indicator #9: Availability of Holistic Support

Holistic support is the extent postsecondary institutions provide their students with access to one or more faculty or staff members they are confident will provide them with the information they seek, offer the help they require, or connect them with information or support they need. More specifically, evidence suggests when students are not always expected to hunt down information and support they require on their own, but rather can access one or more institutional agents that function as conduits to broader support networks on their campuses, those students are more likely to succeed in college (Museus and Neville, 2012).

MATERIALS AND METHODS

This research study used a qualitative approach to understand how and why a sequence of community-based student STEM experiences (i.e., CUREs, science challenge academy, and internships resulting in the creation of intern-built CUREs) contributed to the development of psychosocial attributes (i.e., science identity, sense of belonging, and science self-efficacy) among 1st-, 2nd-, and 3rd-year life science students. We include qualitative data collected over 3 years, part of a 5-year, cross-sectional, longitudinal, and mixed methods study designed to assess the influences of SomosSTEM activities on educational outcomes (i.e., persistence in STEM education, academic performance, and degree completion). This paper covers only our qualitative findings and quantitative analysis and reporting is forthcoming.

Study Participant Recruitment

SomosSTEM CUREs are offered in introductory life science courses, which are open to all 1st- and 2nd-year students at NMH. There was a total of 561 students who participated in CUREs between 2020 and 2023. A total of 247 students participated in seven CUREs in Year 1, 147 students in six CUREs in Year 2, and 167 students in seven CUREs in Year 3. All 561 1st- and 2nd-year students were invited to participate in the research study. Criteria used to determine which students were eligible or ineligible to participate in the study included students who were enrolled I introductory life science classes and were 18 years of age or older.

Participants were recruited through a combination of purposive and convenience sampling strategies. The instructional administrators and faculty members distributed information to students via the course syllabus and course Learning Management System (LMS), in addition to sending individual emails to students who were enrolled in the course(s). Additionally, instructional administrators were invited to publish regular announcements to the LMS system for all students enrolled in their courses, where students saw the announcement and information link when they logged in to the LMS. Students who agreed (via the initial survey consent process) to be contacted again for subsequent survey administrations wer sent emails directly. Participants were recruited across program activities, primarily through CURE courses. Recruitment was characterized by email recruitment primarily, which led to presurvey participation, postsurvey participation, and focus group interview participation. Surveys (pre and post) were administered at the beginning and end of each main Fall and Spring semester, although due to low response rate and ongoing analysis of our comparatively small quantitative sample, we engage only our qualitative study findings at this

TABLE 1. Characteristics of participants, of those interviewed and in the overall study

	Interviewed		In overall study	
	N	%	*N*	%
Age				
18 years old	16	45.7	82	34.2
19 to 21	10	28.6	98	40.8
22 to 27	5	14.3	26	10.8
28 or older	1	2.9	14	5.8
Gender				
Man	8	22.9	80	33.3
Woman	24	68.6	131	54.6
Prefer to self–describe	–	–	7	2.9
Prefer not to say	–	–	3	1.3
Enrollment				
Full time	30	85.7	211	87.9
Less than full–time	2	5.7	10	4.2
Transfer				
Started college here	23	65.7	162	67.5
Started college elsewhere	9	25.7	59	26.7

Note. Percentages do not include missing data from nonresponses. Participants who indicated a preference to self-describe their gender left the field blank.

point in time. The integration of quantitative and qualitative findings to support the original mixed-method study design is forthcoming.

Data Collection

Data for this research paper are drawn from qualitative study data, specifically, cross-sectional focus groups that were conducted in the first 3 years of our study, 2020–2023. A qualitative cross-sectional focus group design involves conducting focus group discussions at a single point in time to explore and understand the participants' perspectives on a specific issue. The original study design targeted 6–8 students per focus group, with a total of 3–4 focus groups each semester, for 3 years. However, in light of the wildfire national disaster and the realities of the COVID-19 pandemic, nine focus groups were conducted during the 3-year period but with far fewer participants. In some cases, focus groups included only 2–3 students. Focus group interviews lasted 60 min and were audio-recorded and transcribed. All focus groups were conducted by the first author who identifies as a Chicana female from Southern California. The study was conducted in accordance with the ethical guidelines set forth by the Institutional Review Board at NMHU and UNL, which approved all study procedures, including the informed consent process.

Study Participant Demographics

Participants (Table 1) for our study tended to be younger, identified as women, and described themselves using multiple-response and open-ended prompts (Table 2) as Hispanic, New Mexican, or of Mexican descent. We collected demographic data for all participants via an online survey in Qualtrics. As of Spring 2023, 196 participants were enrolled in the full mixed-methods study. Of the larger study sample, we interviewed 36 of the 196 students in the overall study. To date there are 240 students in the study. Our tables provide data of participants: those interviewed in our qualitative study and those enrolled in the overall study.

Data Analysis

In accordance with the qualitative research approach, we used a conversational, semistructured interview approach aimed at understanding participants' meaning making of the perceived influence of SomosSTEM activities on sense of belonging, self-efficacy, and science identity. Data analysis followed a four-stage process informed by Moustakas' (1994) framework for analyzing student experiences. The analysis was led by the first author of this paper, along with a small research team of educational researchers with qualitative expertise at her campus who could conduct multiple reviews and code study transcripts. As a smaller team of qualitative researchers, [first author] and colleagues engaged in reflexive journaling to document and examine beliefs and assumptions, these reflections were integrated into the analysis and development of our coding process and schema. Specifically, the coding process began with open coding, where the research team independently reviewed transcripts to identify emerging themes and meaning units. To ensure rigor, intercoder reliability was assessed, with any discrepancies resolved through discussion and consensus over a year's time. The coding scheme was refined iteratively, leading to the development of higher-order themes that encapsulate the core of the students' experiences. Trustworthiness was further ensured through triangulation, where data from different focus groups were compared, and through member checking, where participants were invited to review and validate the findings. [First author] reported high-order themes over a year of bi-weekly meetings with [second, third, fourth, and fifth author] where, as a larger team of authors and investigators, we worked together to make meaning of themes, discuss the qualitative analysis process, and contextualize findings with our collective ideas and observations. As a team, we worked to develop this paper's presentation of findings and continue to collaborate around how our research findings and the SomosSTEM program can be leveraged across other institutional contexts.

Limitations

This study has several limitations that should be acknowledged. The small size of some focus groups, particularly those affected by the national wildfire disaster and the COVID-19 pandemic, limits the depth that conversations with a slightly larger group of students might have yielded and delimits the overall power of the focus group design. Additionally, the online format of the focus groups, while necessary due to pandemic restrictions, likely influenced the dynamics of the discussions. Participants often had limited technology and internet access and because many reside in rural areas, connections were often lost or interrupted. These limitations were considered during data interpretation, and the challenges rural students faced in accessing learning technologies was a point of analysis and discussion to be reported in forthcoming reporting efforts.

TABLE 2. Racial and ethnic identity or origin, of those interviewed and in the overall study

	N interviewed (of *N* in overall study)						
Racial/Ethnic Identity or Descent	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**
1. Black or African American	7 (24)	3 (7)	– (2)	– (2)			
2. Hispanic, Latino/x, Spanish	3 (7)	23 (155)	5 (38)	1 (6)	– (2)	– (1)	– (1)
3. White	– (2)	5 (38)	9 (79)	1 (4)	– (3)	– (1)	– (1)
4. American Indian, Alaska Native, Indigenous, or First Nations	– (2)	1 (6)	1 (4)	3 (13)			
5. Asian or Asian American	–	– (2)	– (3)	–	– (7)	– (1)	
6. Native Hawaiian or other Pacific Islander	–	– (1)	– (1)	–	– (1)	– (2)	
7. Some other race or origin	–	– (1)	– (1)	–	–	–	– (2)
8. Total	10 (35)	32 (206)	15 (128)	5 (25)	– (13)	– (5)	– (4)

Note. Totals are greater than number of participants (36 interviewed of 240 in overall study) since respondents could select all that apply.

FINDINGS

In response to our research questions of how students experience the purpose-built SomosSTEM environment, our interviews with students provided ample evidence that SomosSTEM provided holistic and integrated interventions nested in a culture of validation and cultural engagement. This was achieved through four activities that we describe below, specifically as they map onto or relate to the various dimensions of the CECE framework outlined by Museus (2014). We found no evidence diversity was explicitly engaged to support students' science identity, efficacy, or belonging (Indicator #4). SomosSTEM activities include the following: 1) CUREs that are laboratory modules integrated into introductory life science classes at NMHU; 2) full summer internship program; and 3) Community Voices lecture series. Through the lens of the CECE model, we found students involved across SomosSTEM activities consistently noted faculty engagement was key to their sense of validation, contributing to their view of NMHU as an inclusive and respectful environment.

Indicator #1 Cultural Familiarity

The CECE model posits the extent college students have opportunities to connect with faculty, staff, and peers with whom they share common backgrounds on their respective campuses is associated with greater likelihood of success. Students who can establish connections, preferably in person, with institutional agents who have similar backgrounds and experiences are more likely to succeed in college. Students shared their experiences in strengthening or building connection with community agents was most important in developing their science identity—that they could see themselves as filling important roles in science like the members of the community they interacted with. This happened through the SomosSTEM Community Voices lecture series in which local-area scientists and professionals who share students' cultural, racial, and/or ethnic backgrounds gave presentations, focusing on real-life illustration of what it looks like to conduct place- and community-based science in real life.

Students articulated how speakers validated their experiences and connection to their home communities, sharing each speaker inspired them to pursue science in some way. For example, students mentioned being exposed to people in different careers, all of which were ways of being a scientist or doing science. One student stated, "there's a huge range of jobs in the STEM field." They learned about a myriad of options for working in a science field while also seeing how those careers related to, as one student said, "the land and the history of this place." In providing talks that were place-based, students not only received information about science careers but discussed the ways science is connected to people around them and land where they were situated. Having speakers from the local area, individuals who have graduated from their local schools, were particularly inspiring to students. Several students remarked the lecture series speakers disrupted their idea that pursuing STEM had to be a linear path. Many of the speakers had unpredictable and challenging pathways into their STEM careers and students were inspired by meeting successful people in STEM who perhaps changed their path along the way (e.g., changed majors, left, and came back to school, failed, and succeeded).

Indicator #2: Cultural Relevance

The CECE model posits opportunities for students to cultivate, sustain, and increase knowledge of their cultures and communities of origin can positively impact their experiences and success. Students create, maintain, and strengthen connections to their home communities through opportunities to acquire knowledge about their communities of origin, which supports academic success. Cultural relevance was exemplified in the two main activities of SomosSTEM: 1) course-based undergraduate research experiences (CUREs) and 2) the 9-wk SomosSTEM summer internship. The internship is a summer experience in which advanced students receive hands on mentorship, training, and coconstruct place-based and culturally relevant curriculum for future students. Specifically, during the last week of the internship, students work with faculty to connect their internship experiences to the classroom by helping to create ibCUREs (intern-built CUREs). Ideally, SomosSTEM sets students up to participate in a CURE, internship, and series of activities which culminate in them designing their own ibCUREs. Next, ibCUREs are integrated back into introductory life science courses, so students can support peers as part of their own individual learning. Students shared because they had the opportunity to learn *and share* knowledge about the issues in and needs of their own communities, these activities promoted their sense of self-efficacy, can "do" science, and their perception they can be a scientist, thereby providing evidence of enhanced self-efficacy and emerging science identity.

Community relevance was achieved through place-based, localized learning opportunities where students worked in their community. A group of student interns collaborated with the U.S. Forestry Service during a summer when the community faced life-threatening and destructive wildfires. These interns described the tension between helping the community by providing resources and support for specific land practices and recognizing the politicized nature of that assistance, as experienced by the rural residents. For instance, cattle grazing practices are managed differently by local residents compared with federal regulations. Students highlighted the complexity of the assessments they were learning about during their internship with the U.S. Forestry Service. One student shared: "It has been an interesting summer working for the forest service. Even being in the trucks and driving around… yeah. The public is not always the most reasonable when we are out there just trying to help."

"Driving around" in a forestry truck, attending community meetings with landowners whose land bordered U.S. forestry land, and being engaged in discussions about land use was an impactful and engaging learning experience where students witnessed firsthand the ways science was intertwined with local social and political context. Students' learning experiences highlights historical transitions of land control from Spanish to Mexican, and finally to U.S. governance. Each transition brought changes in land ownership and management practices, impacting the local communities' way of life and their relationship to the land. This history is crucial to understanding current conflicts and cultural dynamics in the region. The communal land grants under Spanish and Mexican rule created a deep cultural and familial connection to the land for the local people. Students learned this connection persists despite changes in governance, illustrating the enduring bond between communities and their ancestral lands. The wildfire incident, where a controlled burn by the forestry service got out of hand, exacerbated these tensions, highlighting challenges of managing land in a way that respects both ecological needs and cultural heritage. Students identified their local communities continue to resist and assert their rights to land they have historically used and managed. This place-based and culturally relevant learning experience gave students deeper knowledge of their home community, which they said motivated them to pursue STEM and teach others.

CECE Indicator #3: Cultural Community Service

The CECE framework posits cultural community service enhances the success of diverse students. It involves institutions providing resources for students to positively transform their cultural communities including engaging in community activism. Inherently, by focusing on culturally relevant, and place-based content, SomoSTEM promoted strong relationships with and learning about their local community. We found service to the community was implied as an integral part of doing science or being a scientist in the community. For example, students were not explicitly instructed on how to engage in community activism, but CUREs, internships, and lectures all prompted students to think about relationships between what they are studying and the social and political context. For example, faculty led CUREs specific to the COVID-19 pandemic and explicitly encouraged students to think about the social and community effects of the pandemic. A student said:

> We have been making connections in our labs between the human body and health, and that's been something we've been discussing in our biology class. Especially because of this time of pandemic, our teacher has made that a main focus and how we've been throughout it, how we think other people have been reacting to it. She took a whole section off during like a week or two, just talking about the pandemic and how it can affect people in different ways. That's been really interesting.

Perhaps the strongest way community service was communicated as an important consideration for students was through the exposure to agency partners through the lecture events, internships (where students were mentored and worked in a community organization) and CUREs where agency partners provided access to field areas, data, support, and resources. Partners included Fish and Wildlife (Rio Mora), Albuquerque Wildlife Federation, U.S. Forest Service, Hermit's Peak Watershed Alliance, New Mexico State Forestry Division, and Mora Valley Community Health Services. Although activities did not seem to explicitly advocate for community service, students worked firsthand across multiple activities with representatives of the community who communicated through real-world and place-based information, what the community needs are/were and invited students to consider themselves in these service-oriented careers.

CECE Indicator #5: Collectivist Cultural Orientations

The CECE model suggests students are more likely to succeed in collectivist-oriented environments than in individualistic ones. This aligns with evidence students from collectivist communities, both white and color, often struggle in more individualistic college settings (Thompson and Fretz, 1991). Students described SomosSTEM environments as spaces where students worked collaboratively to solve problems and used technology to help their community. CUREs and the internship experience provided opportunities for students to work together and described their collaborative efforts as rewarding and impactful. For example, in describing a CURE, Jacob said:

> Usually with each lab, we work as a group. So that always makes me feel kind of important because we all have to help each other out and we all don't know everything either. So, we all help each other out, and some of us, maybe I'm better at something than one of my lab mates, so then I kind of am a little bit important there.

Jacob's experience of feeling important, that he was doing science and behaving as a scientist. Specifically, he said,

> I think in my class, everyone would see themselves as a scientist, because our groups are just of three people, so it's not really a big group where someone could do all the work, or someone could just watch what's happening. Everyone is having to do something. And that gives them a sense of… [identity, belonging, efficacy]. Honestly, everyone is just, I feel like they're pretty dedicated to their major and stuff,

and they're willing to learn and stuff. So, it just makes the atmosphere that much better.

Another student, Gianna did not feel a strong sense of efficacy or science identity, but she did describe feeling "a little bit of importance." As she described what she meant by a sense of importance, she described it as a sense of mattering, belonging, and feeling a part of a scientific community, even if she did not see herself yet as a full-fledged scientist. Jacob seemed to benefit from peer interaction in an in-person lab where all his classmates were equally engaged and empowered to learn. However, Gianna did not feel she strongly identified as a scientist or efficacious but was still committed to biology. She said she wanted to do more outdoor work in the field, and she looked forward to her internship over the summer providing her with that experience. Gianna and Jacob described use of technology and working in small groups in the CURE as a particularly valuable experience, that gave them a sense of ownership over learning and enhanced their efficacy. The cultural norms of CUREs and internship were to work collaboratively and use tools to support community-based work.

CECE Indicators #6 and #7: Culturally Validating and Humanizing Environments

Cultural validation refers to how much postsecondary educators value the cultural backgrounds and identities of their diverse student populations. Humanizing educational environments, where institutional agents show care, commitment, and build meaningful relationships with students, lead to more positive experiences and greater success. Students emphasized the importance of these humanizing and validating interactions with faculty in affirming their sense of belonging, efficacy, and science identity development. One student, who previously felt disconnected at another institution, described the supportive environment at NMHU after meeting SomosSTEM faculty. For instance, Dr. Medina encouraged her to engage deeply with material and provided opportunities to present at conferences, boosting her confidence and sense of belonging. She stated, "I practiced in front of my peers…. Hearing their feedback… gave me the confidence to say, 'Yeah, I can present this and I'm comfortable doing it."

Another student highlighted the importance of faculty support in understanding course material, praising Dr. Snow for her thorough and responsive teaching. "She makes sure you understand it… if you do have more questions, she'll wait for us to ask," the student shared. Yet another student added all her professors made students feel heard and valued, creating a supportive classroom atmosphere. "Anytime we have a question…they're just ready to help us and explain it… They'll make sure and take the time to help us understand. These students' experiences illustrate the CECE framework's indicators of effective faculty support and engagement, showing how humanizing and validating educational environments contribute to positive outcomes and student success.

CECE Indicator #8 and #9: Proactive Philosophies and Availability of Holistic Support

Students reported a strong sense of support, understanding, and belonging due to the personalized and empathetic approaches of their faculty. For example, Henry felt a strong sense of belonging and personalized attention at NMHU compared with larger universities. He noted professors at NMHU knew students by name and were more accessible, which enhanced his academic experience and helped him learn better. For example, Henry shared his professor: "understands if you're going through something, if you need an extension or something, he's not just like, 'No, that's in the syllabus. You have to turn in at this date.' He's super understanding. He went on to say,

> If you're confused about anything, you could just email him about anything, and he always helps… He's really just very inviting and everything. If we can't make it to class…. he does Zoom so that we can do that too. It makes us feel like someone cares about how we feel and how we're doing because during the pandemic it was so hard to feel that way.

Similarly, Ethan shared how Dr. Snow's assignments during the COVID-19 pandemic allowed him to engage with important and personal topics. This opportunity to discuss real-world issues related to his sister's experience as a nurse made him feel more connected to his studies. Overall, these experiences highlight the importance of a proactive and holistic approach that supported students' sense of belonging and efficacy. The faculty's proactive support, anticipating and asking about students' needs, enhanced students' sense of belonging.

DISCUSSION

Perception of the Structured Environment of SomosSTEM

Our inquiry began with the recognition in STEM and other social contexts, white cultural norms often reinforce racial trauma, microaggressions, and other harms, limiting the development of psychosocial attributes crucial for student success (McGee, 2016, 2020). Cultural norms shape STEM environments. If meritocratic, highly individualized, and competitive learning environments hinder formation of science identity, self-efficacy, and sense of belonging, then we need to empirically document environments that are the opposite: collaborative, humanizing, validating, and culturally responsive learning environments and their effects.

As early research experiences are important in connection to students' cultural values and communities (Schultz *et al.*, 2011; Graham *et al.*, 2013; Rodenbusch *et al.*, 2016), we found validating actions were more than faculty taking interest in and caring for students. Rather, students talked specifically about how instructors and community partners drew on culturally relevant matters that validated students' experiences and backgrounds. For example, the community voices lecture series was consistently viewed by students to see people who look like them having careers that were science-based and in the community. Students pointed out how CURE activities and summer internships focused on matters and settings in their immediate environment, prompting them to consider not just the pure scientific questions involved, but sociohistorical dimensions of those issues. This opportunity provided students to not only be validated across multiple aspects of their identity (i.e., social identity, rural identity, and science identity) but also be tangibly connected to issues in their community.

We also observed validation in students' diverse ways of knowing and being. This finding is in line with the literature showing how CUREs and related early research experiences can be very effective in fostering self-efficacy, science identity, and other near- and long-term educational outcomes (Auchincloss *et al.*, 2014; Corwin *et al.*, 2015). What our findings contribute is further insight into how CUREs can be effective in providing opportunities for students from underrepresented backgrounds to engage in scientific research and gain experience that may not be typically available to them (Bangera and Brownell, 2014). Specifically, just as we saw how validation involved cultural engagement along with demonstrations of care, evidence suggested the effectiveness of CUREs for these students from minoritized backgrounds goes beyond just facilitating hands-on authentic scientific inquiry in a structured setting. Rather it occurs through, or at least is bolstered by, students having opportunities to learn and share knowledge about the issues in and needs of their own communities of origin, just as researchers have proposed is the case for higher education generally (Guiffrida, 2003, 2005; Harper and Quaye, 2007, Museus, 2008, 2011; Museus *et al.*, 2012).

This finding is particularly salient to the challenge of improving STEM college success and career trajectories for students from and in minoritized communities. We consider observations in student performance in a CURE are generally a more accurate estimate of how well a student will perform in a research environment than standard criteria, such as grade point average or high school experience (Bangera and Brownell, 2014). Prior literature underscores the primacy of community for science self-efficacy and science identity (Lane, 2016; Syed *et al.*, 2018; Robnett *et al.*, 2019). Our findings affirm this assertion and show it is necessary to understand community as not limited to peers and college personnel, but extending the concept of community to be inclusive of the people and places students are connected to, an important consideration for those crafting culturally engaging college environments.

Finally, a note about dissonance. We did not find evidence of the dissonance so often found in literature on racially minoritized students in STEM. Our findings point to students' perceptions of validation, but they did not experience the burden often faced by minoritized students in navigating cultural dissonance (Museus and Quaye, 2009). As Abrica (2022) explains, Students of Color in STEM fields are constantly engaged in a process of reappraising and reassessing their own value systems relative to white norms of STEM, resulting in added cognitive work. Then, STEM learning environments are not only exclusionary but play an often unnoticed but significant role in delimiting opportunities for learning and development. Having to evaluate their own abilities, belonging, and efficacy in relation to the culture they are being assimilated into is a heavy emotional, mental, and cognitive load to carry. Future research should continue to explore evolving forms of cultural dissonance and stressors related to assimilation in the white norms and values that continue to permeate educational spaces. Rather than not naming and taking as normal the whiteness of STEM spaces, we can do better to acknowledge and name the cognitive, emotional, and physical stress of even being in these environments while simultaneously working to change them.

The Learning Environment's Influence on Psychosocial Attributes

Turning to the question of how students perceived the influence of their learning environment on their sense of belonging, science identity, and self-efficacy, we found supporting evidence throughout their experiences with SomosSTEM and its various activities, acknowledging the activities necessarily complement and reinforce each other from our participants' perspective.

Sense of Belonging. Faculty emerged as validating agents through their collectivist and holistic approaches that led students to feel part of a larger academic community. Gianna's experiences made her realize she was more inclined toward forestry and outdoor work than indoor lab work. Though this might be seen as a student deviating from or only partially feeling a sense of belonging in STEM, it represents the realization there are multiple avenues and paths in science-related fields as described when students experienced the Community Voices lecture. For Gianna, working in labs as part of a group made her feel important, even if she estimated she was not as knowledgeable in certain aspects of the labs. Still, the group's collective effort made her realize everyone in the group contributed, reinforcing her belongingness, true to the proposition of the benefits of a collectivist cultural orientation (Museus, 2014). This insight translated to Gianna's understanding and pursuit of an internship with the U.S. Forest Service meant she could explore her interests in forestry while still maintaining ties to the biological sciences field broadly.

We observed such a nuanced sense of belonging emerged through interpersonal interactions in the experience of others. For instance, one student who—despite finding the learning environment and programs at NMHU impersonal overall—was nonetheless pushed by their professor to help present alongside them at an academic conference. This demonstration of trust, combined with a supportive peer group to rehearse with, translated to a sense of purpose in being a part of NMHU. In essence, this created a sense of belonging because of validating experiences (Rendón, 1994). A sense of belonging depended on more than the amiable nature of individuals (Strayhorn, 2018), as what mattered more was authentic displays of care, investment, and recognition. Most importantly, this experience occurred in a community of peers who shared similar experiences, which is particularly salient for minoritized groups (Abrica *et al.*, 2022).

Science Identity. SomosSTEM program elements were instrumental in fostering a robust science identity among students that expands on what we know of the role of socialization in three ways (Carlone and Johnson, 2007; Vincent-Ruz and Schunn, 2018). First, through CUREs, students began to understand how being a scientist involved mastering the tools and methods of science and how wielding them to solve real problems positioned the student relative to others around them. Jacob expressed feeling like a leader when called to answer applied questions using technology as part of a CURE, and Alexander began to imagine a future role as a faculty member in biology. We see a relational mechanism for developing a scientific identity in how a person takes on a leadership and expert role which benefits others.

The second way we saw science identify formation was a function of a learning community. The design of SomosSTEM intentionally included student interns designing CUREs for students entering the program after them to close the loop from apprentice to expert in a way that acknowledges and develops their capacity to contribute to a community of learners and scientists. This was the case for Alexander whose budding aspirations as a scholarly researcher emerged during his role in his internship developing a CURE for use in future classes. Importantly, the boost to students' science identity was from these experiences. As important as the hands-on CURE activities were, students identified the impact of insights from speakers in the Community Voices Lecture Series and mentoring of community partners. Peers were another source of secondhand inspiration. Jacob noted how fellow students were dedicated to their majors, creating an atmosphere where professionalism was respected and valued.

Last, it was clear in our findings specific settings and locations selected to inform various components of SomosSTEM had significant influence on students' formation of a science identity, with students frequently highlighting the relevance of places and issues in their communities, revealing this aspect as an important ingredient to their identify development beyond observing and conducting science in action, as previously established (Rodenbusch *et al.*, 2016). For instance, when students deliberated on the complex dynamics of assisting their community with resources and land practices, they also grappled with nuances of politics and community sentiments related to the land's history. Such reflections accentuate the importance of interweaving scientific insights with tangible political and community contexts scientists play a role in influencing.

Self-Efficacy. Multilayered experiences offered by SomosSTEM, from CUREs to faculty mentoring and community interactions, cumulatively contribute to heightened self-efficacy. However, a heightened self-belief is not an isolated outcome, it is profoundly influenced by how students perceive their place in the scientific community and how they envision their future role in it, as authentic experiences allow them to judge their abilities (Britner and Pajares, 2006). In our analysis looking for evidence of the development of self-efficacy, we found the moments students felt a strong sense of belonging and identity were also the instances they felt most empowered and competent. Without evidence or reason to propose an influential ordering of the phenomena, what we can conclude is nuances of these moments in relation to self-efficacy lie in the confidence students displayed in talking about their capabilities and envisioning of future roles. For instance, though Alexander's confidence in creating a CURE highlighted his budding scientist identity, further realization he could teach others underscores a newfound confidence in his abilities—a strong marker of self-efficacy. Similarly, Jacob's pride in using technology to answer real-world questions can be viewed as a manifestation of his science identity. Yet, the way he embraced a leadership role during this process sheds light on his self-assurance and his belief in his potential.

What stands out in our analysis of this dimension of our inquiry, like in the rest of our findings, is how these facets of self-efficacy do not just stem from individual accomplishments but are also shaped by their interactions in the academic community (Syed *et al.*, 2018) made up of individuals who provided both instrumental and socioemotional mentoring (Robnett *et al.*, 2018). This also extends to peer mentors. Jacob's observations about his peers' dedication to their majors reinforced an environment of mutual respect and aspiration, pushing everyone to believe more in their capabilities. In students' descriptions of the structured environment and human-centric focus of SomosSTEM, we saw students exhibiting increased engagement, openness to feedback, willingness to ask questions, and tackle challenges and opportunities they would have otherwise avoided or not encountered.

CONCLUSION

This study sought to understand how an integrated, culturally engaging STEM learning environment, rather than isolated interventions, impacted development of students' sense of belonging, self-efficacy, and science identity. The study found students who participated in the SomosSTEM program reported feeling more connected to their community and to STEM. They also reported feeling more confident in their ability to succeed in STEM fields. The study also found the program helped students to see how STEM can be used to address real-world problems. The study's findings suggest integrated, culturally engaging STEM learning environments can have a positive impact on students' sense of belonging, self-efficacy, and science identity.

More importantly, these findings contribute to current understandings and rhetoric about interventions to improve STEM education as they underscore how STEM education can be more effective if it is designed to be culturally relevant beyond incorporating topics and values that resonate with students, but also connects students to their communities in tangible ways. According to participants in our study, the SomosSTEM program was promotive of a sense of belonging, science identity, and efficacy because it embodied a culture marked by a humanizing educational experience where students were encouraged to work collaboratively and collectively to learn and develop as scientists. The culture of SomosSTEM was characterized by caring, commitment, and relationships that all served to validate students' diverse cultural backgrounds and was designed to ameliorate the burden of having to assimilate into white cultural norms and values.

The SomosSTEM learning environment at New Mexico Highlands University challenged the exclusionary nature of STEM by tailoring effective strategies (i.e., course-based undergraduate research experiences, summer academy and internship programs, and community involvement) to center students' diverse cultural backgrounds and emphasizing a community-oriented approach to learning and development. Our findings affirm to perform well in any postsecondary learning environment, it is important for a student to perceive what they are learning as an extension of who they are and where they come from. Learning must be seen as involving behaviors that do not require sacrificing the culture and values of one's community.

ACKNOWLEDGMENT

This work was supported by the , Award No. 1953487. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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