

# 8. Social, Emotional, and Cultural Supports for STEM Equity

## *Lessons from Informal STEM Learning Programs*

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**Abstract:** This paper uses the connected learning framework to analyze equity-enhancing features of informal STEM (science, technology, engineering, and mathematics) learning programs: (1) sponsoring youth interests and identity, (2) shared projects and purpose, and (3) holistic and supportive relationships. The analysis highlights the unique strengths of informal organizations in advancing STEM equity, as well as the varied ways in which these strengths can manifest in diverse organizational settings.

## Introduction

Efforts to broaden participation in STEM (science, technology, engineering, and mathematics)

learning have increasingly recognized the influence of social and cultural factors, and the important influence of out-of-school environments. This paper examines the unique role that culturally responsive and socially connected informal STEM learning (ISL) programs can play in supporting STEM interest and engagement for Latinx youth, building on the connected learning framework (Ito et al., 2013, 2020). It draws from the All Together Now study, funded by the NSF Advancing Informal STEM Learning (AISL) program. The goal of the study is to identify ways that ISL programs can broaden participation in STEM by building STEM-relevant social capital and cultural connection for underrepresented youth.

The research team conducted observations and interviews at three ISL programs in Southern California with varied approaches and organizational contexts, serving predominantly Latinx youth. This paper describes features of these programs that support equity in STEM learning: (1) sponsoring youth interests and identity, (2) shared projects and purpose, and (3) holistic and supportive relationships. The analysis highlights the unique strengths of informal organizations in advancing STEM equity, as well as the varied ways in which these strengths can manifest in diverse organizational settings.

## Conceptual Framework

This study builds on prior research on how informal and out-of-school learning supports development of STEM interests and persistence (Dabney et al., 2012; NAS, 2021; National Research Council, 2009, 2015; Steinkuehler & Chmiel, 2006). Informal environments are uniquely well positioned to provide these kinds of support because they are often interest-driven, embedded in the culture of a community, and cultivate caring relationships that transcend a specific class or program. To identify equity-oriented features of ISL programs, we draw on the connected learning research and design framework that centers on learning that is interest-driven, socially connected, and expands opportunity (Ito et al., 2020). It emphasizes how learning spans both formal and informal environments, including school, home, and community-based organizations. Connected learning is also an asset-based approach that centers on diverse youth interests, identities, and strengths, rather than taking a standardized or one-size-fits all approach. This study draws

from evidence-based design elements of connected learning to analyze and understand how ISL programs support equity, specifically through interest-driven, culturally responsive, socially supportive, and project-based approaches.

Our study has an “appreciative inquiry” orientation (see [appreciativeinquiry.champlain.edu](http://appreciativeinquiry.champlain.edu)), where we focused on programs that exemplify productive ways of manifesting connected learning approaches in equity-oriented practice. Our site selection and identification of examples is not intended as a “representative” set of programs and practices, but rather as an exemplary set that can inform the field in identifying positive practices and design features. This orientation to research-practice partnership and analysis is particularly well suited to pursuing equity through informal settings and connected learning approaches that must be tailored to the assets and culture of diverse communities.

## Study Background

**Sites.** Research was conducted at three ISL organizations serving middle and high school students located in Southern California, which encompassed six physical sites (Table 1). The organizations were selected because they focus on achieving STEM equity goals in serving a majority Latinx population. They also embody key elements of connected learning, including project-based and interest-driven programming, a safe and socially supportive environment, and culturally responsive approaches.

Site	Location	# of Students	Main Characteristics
TGR Learning Lab (TGR)	Anaheim	200 every quarter	Afterschool learning center serving predominantly minority, low-income middle and high school students. TGR occupies a large, stand-alone campus with a golf course. Many students are bused in from local schools. In addition to their signature golf programs, they offer homework support, snacks, and a wide range of STEM programs that participants can choose from, including marine biology, universal sciences, robotics and video game design.
ListoAmerica	Santa Ana	50 per year	Member of the Clubhouse Network of technology-rich out-of-school learning settings established across the world. In addition to embodying the interest-driven approach to project-based learning that is the hallmark of the Clubhouse Network, ListoAmerica takes a culturally tailored approach, with a bilingual, bicultural staff strongly connected to their local Latinx community. Members can come by on a flexible, drop-in basis to pursue projects they are interested in, get help with homework, or just hang out with friends and mentors. Many members stay connected with ListoAmerica for many years, and even return as alumni during college and beyond.
Mathematics, Engineering, Science Achievement (MESA)	Anaheim	800 to 1,000 students in 28 middle and high schools in Southern California	National program that offers project-based STEM learning experiences with the goal of increasing enrollment in STEM college majors. Schools can offer MESA programs during school hours, as well as afterschool, on weekends, or in the summer. Participants in California MESA programs are over 90% Latinx. We conducted research in 1 high school and 3 middle schools in Anaheim that offered MESA programs as electives during school hours. Programs include computer-based projects such as animation or 3D printing, as well as woodshop and engineering projects. MESA educators have the freedom to adapt and draw from the national MESA curriculum.

Table 1. Sites and characteristics of three after-school and during-school STEM programs with Latinx populations for our study.

**Participants.** Demographic background was self-reported by participants as part of the interview. Students represented every grade level from 7th grade to junior in college (Table 2).

Participants	#	Gender	Age	Latinx	Asian	Multiracial	White	Black
Youth	110 1 <sup>st</sup> Wave; 48 2 <sup>nd</sup> Wave	42% Female 58% Male	13-21	62% - predominantly from Mexico	16%	15%	6%	2%
Educators	11	7 Male, 4 Female	N/A	64%	27%	N/A	9%	N/A

Table 2. Self-reported demographics of study participants and educators from two waves.

**Data Collection & Analysis.** Data collection consisted of program observations to observe unique program features of each organization, and youth and educator interviews. We interviewed 110 youth in first wave interviews, and 48 youth in second wave interviews between Spring 2019 and Spring 2020. Due to social distancing requirements of the COVID-19 pandemic, all research sites shifted online, and some closed their doors for long periods of time. Some interviews and program observations were conducted virtually as a result. Using the Dedoose platform, we analyzed data using open and axial coding methods to account for how youth and adults discuss youth interest, participation/persistence, and related outcomes. Program history, philosophy, activities, and organizational structures were also analyzed in this way, tracking connections between supports, activities, and outcomes. Field notes from observations were treated in a similar manner as interview transcripts and triangulated with interview interpretations.

## Findings

We analyzed emerging patterns from the data according to three elements of connected learning that prior studies have demonstrated support positive equity and STEM learning outcomes: (1) sponsoring youth interests and identity, (2) shared projects and purpose, and (3) holistic and supportive relationships.

### Sponsoring Youth Interests and Identities

Connected learning programs support equity through an “asset-based” orientation, meeting youth where they are and “sponsoring” their interests in a supportive, culturally responsive, and well-resourced environment. When learning grows out of personal interests and identities, young people can build connections between otherwise unfamiliar disciplines and home cultures and practices (Aikenhead & Michell, 2011; Pacheco, 2012). A culturally responsive and sustaining dimension is particularly important for youth who do not see their culture and identity reflected in the dominant culture of STEM (Alim & Paris, 2017; Gay, 2018; Gonzalez et al., 2005; Gutierrez & Rogoff, 2003; Morrell, 2007). Programs that focus on interest-driven, informal, and culturally connected approaches have demonstrated a positive influence on the development of and persistence in STEM learning (Dabney et al., 2012; NAS, 2021; National Research Council, 2009, 2015; Steinkuehler & Chmiel, 2006).

All the ISL programs in our study made efforts to connect to the culture and interests of their participants. For example, Ms. Linda, one of the four MESA educators we interviewed, implemented a sustainability project as part of her curriculum. She helped her students advocate for sustainable practices in their local community. Students lobbied for reusable soap and shampoo dispensers in local Anaheim hotels to reduce plastic waste. They created a campaign, wrote letters, and even went to the Anaheim Mayor’s office. She told us that she wants her students to “have a voice in their world and I want them to understand that. [...] I want them to be aware of their environment.” This activity provided students an opportunity to identify a problem in their community and develop a solution. Ms. Linda used MESA to

connect STEM with an economic, social, and political issue that speaks to her students and their communities directly. Daniel, a 13-year-old male, mentioned how he connected his learning at TGR to his community, and inspired others to take action: “In marine science, we learned about how plastic is endangering a lot of species in the ocean, and I told that to one of the people that lives in our neighborhood. [...] Then, a few months after I told her that, she made like a little group, and they started picking up trash and everything.” Projects like the ones discussed above, help connect STEM knowledge to larger societal and community-issues that students can relate to.

The asset-based orientation of building on Latinx youth identities and cultural competencies is evident in the case of Cianni, a 15-year-old female in Mr. Randy’s class. Cianni moved to California from Mexico a few years before starting MESA and is fluent in Spanish. She was selected as MESA class ambassador and is in charge of communicating about MESA to parents and other students. She told us that her bicultural background has been an asset in doing outreach in both Spanish and English:

Ever since I moved here, I have felt lost because I’m very shy, and I can’t talk in public. MESA gave me the chance to be the class ambassador. I feel very comfortable with this class. I usually see myself as a leader in this class. [...] Whenever a group of parents or students come to learn more about electives, I’m the one who stands up and talks about the class, like oh, this is MESA, and we usually build projects to learn more about engineering. They chose me because sometimes there are groups of students who don’t speak English, and I speak Spanish, so I translate everything.

ListoAmerica organizes events that bridge STEM and Latinx cultures and traditions such as Día de los Muertos and Cerebro (brain in Spanish). These events are open to students, parents, and community members and constitute opportunities to build trust with them, which ListoAmerica educators described as helping with program and STEM participation, retention, and success.

TGR organizes home visits so that educators learn about their students’ experiences outside of the program and develop more meaningful and long-lasting relationships. Ms. Danielle, the senior program manager at the Earl Woods Scholar Program at TGR – a program dedicated to college preparation –shared that her organization’s intention is to “really get to know the families on a more personal level [...]” Ms. Danielle describes how these home visits help the TGR team learn about the family dynamics and engagements students have outside of their ISL program, which helps them better understand their students’ needs and assets: “You see that sometimes students are maybe living in a one-bedroom apartment with nine other people, and they don’t have a place to actually study.” These understandings in turn inform the design of the Learning Lab space and schedule. She added that she learned from a mother during one of her home visits that on the weekends, her son “was waking up at five in the morning to help his dad collect cans and plastic bottles to help his family make ends meet. “At times, you know, he would have to hustle at school to sell Cheetos and candy, which is not allowed, but he had to somehow make it happen for him.” She learned of other initiatives that this student had engaged in that he “had actually been on the radio, talked about racial issues on the radio, but also merged it with the significance of being part of a mariachi band.”

## Shared Projects and Purpose

All the programs in this study took a project-based, experiential learning approach. In connected learning environments, people come together in an authentic purposeful or creative activity, and learning is a by-product of that activity rather than the sole focus. Often, informal programs can more easily embody connected learning than formal environments because of the freedom they have to embrace open-ended, collaborative, project-based learning and not require assessment of individual learning outcomes. Participants often describe these authentic, project-based STEM environments as more motivating and psychologically safe because they are making genuine contributions to a shared and purposive project (Ito et al., 2018; NAS, 2021).

Educators described their ethos of experimental, project-based and inquiry learning. Ms. Linda from MESA emphasized a “try again” and “don’t give up” motto during the building and creation processes. She pushes students to embrace trial and error. She reminds her students about when they first learned how to write, and when “the letters are messy at first, and writing is hard as a young student, but then it becomes easier with practice.” Mr. Gus thinks that what draws his students at ListoAmerica is the “free-flowing” nature of the program as opposed to the “old traditional school” system that might “disengage” them: “I think that’s what attracts them. At first, kind of defensive, like if we’re going to tell them what to do. I think they associate it with school. I think that’s what they gravitate towards, that it’s not a school. It’s a hangout. It’s a clubhouse.”

In our interviews, youth noted appreciating the hands-on learning environment offered in their programs and how it was tied to them feeling like they can do STEM. For example, Amaya, a 15-year-old female, explained that she has a better understanding of her science projects at TGR because she is able to conduct experiments and see herself as a hands-on learner: “I like the lesson plans a little bit more than the ones at school, because the ones at school it’s like a book. It’s a little more free-flowing, and there’s a little more understanding when you do the experiments because I’m more of like a hands-on learner. Doing more experimenting helps.” Frank, a 16-year-old male from TGR, feels like the creative learning environment at TGR has been positively impacting his STEM learning: “In here, they let you expand your mind, use your imagination, and really try to express how you’re feeling, and express what you’re trying to build. [...] it’s a place of designing and learning.”

Students described how this project-based approach was tied to feelings of psychological safety. Do’Jae, a 17-year-old female, said that through MESA, she learned that she “can do things and actually try, like and fail but if [she] puts in the effort, [she] will be good.” She added that in MESA, “I’m just myself. I’m able to learn. I’m able to push myself to challenges and be able to accomplish them.” MESA became a space where it was okay to not succeed or not to perform perfectly. She used to think that STEM wasn’t really for her, but MESA boosted Do’Jae’s confidence in doing STEM by providing her with a sense of psychological safety. Similarly, for Grant “having no pressure, no fuss attitude about there’s no right or wrong answers, no pressure on doing things like that, just approaching it with enthusiasm and like, it’s okay to fail. It’s okay not to understand it or be challenged. I think that’s what makes it worthwhile.”

Smaller class sizes and the informal, collaborative, and intimate setup also contributed to participants feeling comfortable and encouraged. For example, Mr. Gus discussed how the spatial organization at ListoAmerica contributes to creating a sense of community: “The open nature of this area is very much designed for them to interact and talk to each other. That concept, we call it creative chaos where they’re coming in here, and they’re interacting, and they’re clashing into each other. It builds that proximity with members here.” Similarly, Mr. Randy described small class sizes as an important benefit of the “MESA model:” “Since they are working in their groups, there is much more time to get to know them and try to have an impact on them. Versus, when I have 39 kids in a classroom and half of it is crowd control versus having that one-on-one.” The intimate scale and psychological safety of project-based programs and teams ties into the final characteristic of equity-oriented ISL programs that focus on holistic and supportive relationships.

## Holistic and Supportive Relationships

The sense of psychological safety ties into another important element of connected learning environments: holistic and supportive social relationships that go beyond the boundaries of STEM subjects and courses. This includes caring adults with whom learners share interests and background, or what we describe as “affinity-based mentorship” (Ito et al., 2020, p. 34). When young people identify with a mentor and peers because of a shared interest, background, or identity, the relationship helps keep a young person engaged in the program or interest area (Barron et al., 2014; Larson et al., 2013). Youth from underrepresented groups are less likely to have family, friends, and mentors involved in STEM fields and interests, or to encounter STEM role models who share their cultural identity (George et al., 2001), despite the fact that

they benefit more than mainstream youth when they have positive mentoring relationships (Bruce & Bridgeland, 2014; Schwartz et al., 2013b).

Studies suggest that informal programs are uniquely well suited to provide affinity-based mentorship because of the focus on shared interests and staff who often reflect the identities of the youth being served (Ben-Eliyahu et al., 2014; Maul et al., 2017). When youth were asked to name educators who supported their STEM learning, they named Black, Indigenous and People of Color (BIPOC) mentors most often. Melissa, an 18-year-old female from ListoAmerica, felt that because a majority of the people were Latinx at her ISL program, this contributed to “really hav[ing] a connection...I really do feel like it’s a family here.” Mr. Gus and Ms. Julie, two ListoAmerica educators, are uniquely positioned to connect with their students on a personal and cultural level. They identify as Latinx, were both first-generation college students, and come from similar socio-economic backgrounds as ListoAmerica members. Mr. Gus described a strategy for maintaining friendly and family-like relationships: “We don’t call ourselves teachers, or we’re not Mister whatever, so and so. We go by our first names. There’s no hierarchy here with the members.” According to Gayle, a 16-year-old female from ListoAmerica, educators are “more like my friends. They’re more like an older sister and older brother helping us through high school and letting us know about this new technology that’s being introduced.” Mr. Andy, a former TGR student who is currently an educator at TGR, discussed how cultural connections with the staff at TGR played an important role in his connection with the program: “I was like, hey. It’s weird seeing my teacher wearing Jordans, because I’m used to my other teachers being all professional. He was saying, hey, what’s up man [...] I felt like I knew this person [...] There’s a connection, I feel like he knows where I’m coming from and just of what I go through too.”

In addition to the focus on shared interests and identities, ISL organizations can support relationships that develop over time and are not limited to a subject, course, or grade level. At TGR and ListoAmerica, youth can participate throughout their middle and high school years. In these environments, youth described how relationships with educators and peers were a reason for their persistence in their STEM programs. Daniel, a 13-year-old male, has been coming to TGR for several years. He described his relationship with Ms. Hope as his primary reason for continuing to attend STEM programs at TGR:

She’s my favorite. I think she’s the only reason why I come. Ms. Hope is like my best friend. She’s really always there for me. Like when I have any problems, she would come to me and be like, what’s wrong? She would take me to her room, and we would talk. When I need somebody, she’s always there. [...] I see her every day. She’s the best.

Six months later, during our second interview with Daniel, he added that one of the reasons why he still comes to TGR is the staff, “I got really close with them. I kind of consider them like my family.”

Although MESA students do not have the option to continue in the program for as long as participants at ListoAmerica and TGR do, some also described the relationships in the class as “like family.” For example, Martha, a 14-year-old female from MESA said: “My class is kind of like my family,” because, “everybody knows each other, and they’re all friendly and nice. I feel like if I describe it to someone, I would say it’s like you being with your friends. Like collaborating, finding ideas, making stuff, like being with a family.” Ms. Linda referred to her MESA class as her “family” on multiple occasions and shared with us that her running the class like a family is probably one of the main reasons that draws students to participate in MESA. Ms. Linda added that building trust was part of the “MESA family” approach.

MESA students also described how connecting about their lives outside of class created strong and holistic bonds. For example, Cristian, a 13-year-old male, appreciated that his educator organized “counseling groups” where students sit in a circle and pass a ball around and ask questions such as: “What was your favorite thing about the summer? What was your favorite thing about winter break? How do you feel about MESA?” His teacher did not only talk about the MESA class, but also asked about other courses and other aspects of their lives, which was helpful for “students that have a hard time with their family and everything and have a hard time focusing.” The holistic and caring quality of the relationships in the ISL organizations we studied were tied to the educators’ commitment to providing a safe and inclusive space where they can engage in projects as well as socialize. Mr. Gus from ListoAmerica shared that creating a “very friendly, open, and inviting” environment was crucial to him: “if we see a kid or member that’s alone or something, even our members will approach them and build that friendship, introduce them. So, yeah, we definitely want to build

that culture here of, we're all in this together, and we're all a family type of thing." Ms. Danielle from TGR mentioned that "as an organization, making connections with students and relationship building is really at the core of our foundation of everything." Ms. Suzie, also from TGR, expressed that "for some students, especially my returning students, this is like their safe space. Maybe both their parents are working, or no one is usually home.... This is a place where they can see their friends too from other schools." She added that providing a safe space where students know "there's an adult out there that cares about them, and they can come to whenever they need something" is one of the ways TGR can "make sure they do come back."

## Conclusion

The goal of this paper was to highlight the unique contributions of ISL programs in supporting STEM interest and engagement for Latinx youth. We identified that through a connected learning framework with interest-driven, culturally connected, socially supportive, and project-based features, our selected ISL programs supported equity in STEM learning. This paper aimed to show that STEM support for nondominant youth can consist of offering STEM knowledge that connect to students' interests, cultures, and communities, creating a low-pressure and safe environment where students feel encouraged to experiment, and building relationships and providing emotional support. Ultimately, this study demonstrated that when advancing equity, STEM learning organizations should also develop and address cultural, social, and relational approaches. This paper offers an initial high-level framework and examples for understanding how some of the unique characteristics of ISL programs can support equity and inclusion in STEM learning. Additional research and analyses are needed to develop a more granular framework for specific programmatic and pedagogical features or ISL programs that support positive outcomes. In addition, the effectiveness of these approaches would need to be validated across a wider range of settings, at a time that is ideally more stable than when this research was conducted at the start of the COVID-19 pandemic.

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