# HSI STEM and Articulation Project: Experiential Learning Closing the STEM Talent Gap

According to the National Science Board (NSB), racial and ethnic representation varies in STEM education and careers. Hispanic and Black individuals are underrepresented among STEM degree recipients at the bachelor's degree level and above and among STEM workers with at least a bachelor's degree (2023). For the United States to sustain global competitiveness, the NSB expressed the importance of developing and expanding a STEM workforce that "fosters scientific and technological breakthroughs" (2024). To address the growing need for STEM Professionals and minimize inequities in STEM education, Moreno Valley College instituted the Hispanic Serving Institution STEM and Articulation Project, focused on experiential learning through the iMAKE Innovation Center, with the following goals: increase participation and enrollment in STEM, improve course success rates in gateway and transfer level STEM courses, strengthen student soft skills necessary for success in today's STEM fields, and increase the number of students completing STEM degrees or certificates, transferring to a baccalaureate program, and/or entering the workforce. To measure the progress of goals and impact of experiential learning initiatives on STEM, an evaluation was conducted, which led to the development of the iMAKE STEM Equity Framework, a scalable and replicable model to advance STEM equity.

*Keywords*: STEM, makerspace, experiential learning, innovation

## Introduction

There has been a focus on educational equity, *when educational policies, practices, interactions, and resources, are representative of, constructed by, and responsive to all people such that each individual has access to, can participate, and make progress in high-quality learning experiences that empower them towards self-determination and reduces disparities in outcomes regardless of individual characteristics and cultural identities,* in the literature since 1948, and a national and global prioritization since 1990 (Coleman & Ellis, 2023). There has been a focus on STEM (science, technology, engineering, and mathematics) integration in education for over 150 years, beginning with the Morrill Act of 1862, which expanded STEM integration in higher education; then the Progressive Education Movement of the 20th century, which focused on experiential learning and critical thinking; and next the Post-War Era and the Cold War Influences, which "highlighted the importance of scientific and technical expertise", and led to the National Defense of Education Act which funded STEM education on all levels, to remain globally competitive and "compete in the space race" (Berkopes, 2024). While there has been talk about equity for 75 years and a prioritization of STEM education for 150 years, the focus on STEM equity has had a much shorter life span of 35 years.

The focus on equity in STEM began in the 1990's, with the National Science Foundation and other STEM organizations promoting integrated STEM education that emphasized interdisciplinary learning and real-world application; as well as the enactment of legislation such as No Child Left Behind, Educate to Innovate, the Next Generation Science Standards, and Every Student Succeeds Act (Berkopes, 2024). While these initiatives were designed to advance STEM equity, according to the National Science Board (NSB) and the National Center for Science and Engineering Statistics (NCSES), inequities continue to persist in STEM education, careers, and salary level from racial, gender, and economic perspectives (NCSES, 2021; NSB, 2021; NSB, 2023; NSB 2026). According to the Bureau of Statistics, the demand for highly skilled workers is on the uptake and there will be more than 11 million new STEM-related jobs by 2030 (Junior Achievement (JA), 2019). The National Science Board states the "*broadening participation in STEM and ensuring equitable distribution of benefits from STEM fosters the development of a robust STEM workforce, which is critical for improving the nation's living standards, providing economic growth, and maintaining global competitiveness" (NSB, 2021).* The additional benefit of developing a highly skilled STEM workforce is to adequately address challenges related to healthcare improvement, national production capacity, and research excellence (Coleman, 2020).

The literature states that Hispanic Serving Institutions (HSI) play a critical role in advancing STEM equity from a racial perspective (NCSES, 2021; NSB, 2023). According to the NSB, community colleges are the first stop to an advance degree, as they offered 50% of STEM certificates and 76% of STEM associates degrees in 2024 (2023). This systemic approach that MVC initiated towards STEM equity was a result of internal concerns around student retention in STEM pathways as well as data that found persist underrepresentation of Hispanic student in STEM in the California State University system and informed by the D-STEM Equity Model: Diversifying STEM Education to Career Pathway (Coleman, 2020; Woodcock, Hernandez, Haddad & Hernandez, 2026).

This paper will take an intricate look into inequities in STEM from a racial perspective, with a focus on the Hispanic community and solutions to advance STEM equity through experiential learning in collaboration with makerspace. We will intricately examine the impact of the MVC HSI STEM and Articulation Project on advancing STEM equity and closing STEM talent gaps. In addition, the iMAKE STEM Equity Framework, a comprehensive, research-based scalable and replicable approach to advance equity in STEM will be shared.

# Literature Review

## STEM Inequities

The literature shares that there has been an increase in racial and ethnic representation within the STEM workforce, with Hispanic/Latino STEM workers accounting for the greatest amount of growth (NSB, 2021). However, there is still underrepresentation in the STEM workforce, which is connected and extends down to STEM education, at all levels. According to National Science Board, "*access to STEM courses in elementary and secondary education may be a factor in a student's future higher education or employment decisions, as these courses are often prerequisites for further education in STEM fields or training for STEM occupations" (2026).* The results of the 2024 National Assessment of Educational Progress shows that average scores on mathematics and science assessments for fourth, eighth, and twelfth graders have significantly declined over the past five years, with Black, Hispanic, and American Indian/Alaskan Native having the largest decline and the lowest scores, compared to Whites and Asians/Pacific Islanders (NAEP, 2026; NSB, 2026). This may be a result of lack of access to a full range of mathematics courses, with 69% of Asian students, 55% of White students, 51% of Hispanic students, and 47% of Black students attending high schools with those offerings (NSB, 2026). The Nations Report Card table below depicts the most current mathematics scores (2026):

*Table 1.* 2024 NAEP Assessment Mathematics Scores by Race

| | **8th Grade Math Score out of 500** | **12th Grade Math Score out of 300** |
|---|---|---|
| **Asian** | 305 | 176 |
| **Black** | 252 | 125 |
| **Hispanic** | 258 | 157 |
| **White** | 286 | 133 |

*Source:* Nations Report Card, 2026

This same underrepresentation is evident at the collegiate level, especially considering *"that students' mathematics achievement in high school is also associated with postsecondary STEM degree completion"* (NSB, 2026). About half of students from all racial groups are interested in STEM, and many establish a STEM major, but the persistence rate varies by race. While 70% of Asian and 62% of White students are retained in STEM, only 44% of Hispanic and 40% of Black students are retained in STEM (Coleman, 2020; Pew Research Center, 2021, Knox, 2025; NSB, 2026;). In terms of those who persist and attain a STEM degree, the same trend of underrepresentation by race exists. Data from the past ten years shows that a higher percentage of Asian and White students graduate with a bachelor's degree in STEM, compared to their Hispanic and Black peers (Ghazzawi, Pattison, Horn, 2021; NCSES, 2021; NSB 2026). There is overrepresentation of Asians, equitable representation of Whites, and an over representation of Blacks and Hispanics, as it relates to STEM degree attainment, depicted in the table below (College Board, 2023):

*Table 2.* STEM Degree Attainment by Race

| | Population Percent by Race | Bachelor's Degree Recipient Percent by Race |
|---|---|---|
| **Asian** | 8% | 15% |
| **Black** | 14% | 8% |
| **Hispanic** | 20% | 14% |
| **White** | 58% | 58% |

*Source:* College Board, 2023

With fewer Hispanic and Black students persisting in STEM education and attaining related certifications/degrees, it has contributed to inequity in the STEM workforce. Black and Hispanic workers remain underrepresented in the STEM workforce compared with their share of all workers, and with their White and Asian counterparts, which is impacting the "innovative capacity of the United States" (NSB 2022; Pew Research Center, 2021). Not only is there underrepresentation by race in the STEM workforce, but there are also inequitable salary structures that vary by race (NCSES, 2021; NSB, 2021; Pew Research Center, 2021; NSB 2026). The table below depicts the STEM workforce by race in relation to population and their related salaries:

*Table 3.* STEM Workforce and Salaries by Race

| | All Workers | STEM Workers | STEM Salary |
|---|---|---|---|
| **Asian** | 6.3% | 9.5% | $104,000/yr. |
| **Black** | 11% | 8.2% | $80,000/yr. |
| **Hispanic** | 18.2% | 14.8% | $80,000/yr. |
| **White** | 59.8% | 62.9% | $95,000/yr. |

*Source:* NCSES, 2021; NSB 2021

*Hispanics in STEM*

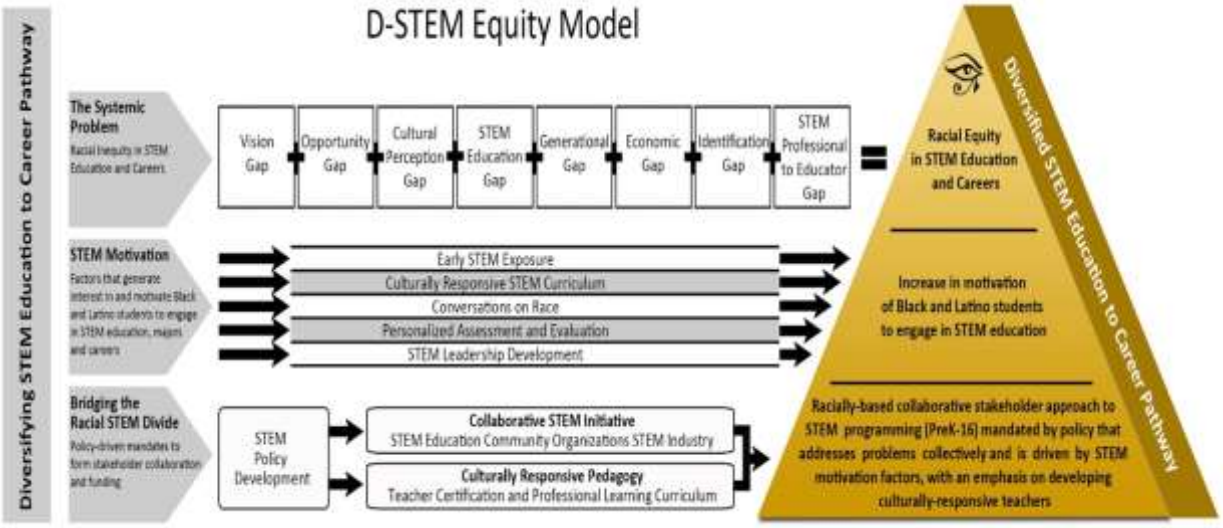
> *The Hispanic population of the United States has grown rapidly in recent decades, as has the number of Hispanic students who are enrolled in college. Despite this growth, Hispanic Americans remain underrepresented among workers in STEM jobs. This is the case even though demand for STEM workers is on the rise and they have higher median wages than non-STEM workers (Kikuchi, 2024)*

While there has been growth in the number of Hispanics enrolling in college since the coronavirus pandemic, there has been a decline in those engaged in STEM education and entering the STEM workforce (Kikuchi, 2024; Woodcock et al, 2026). Hispanic Serving Institutions play an integral role in the education of Hispanic students, especially those engaged in STEM, as almost half of Hispanic bachelor's degree recipients in STEM earned their bachelor's degree and 37.8% of Hispanics or Latinos earned their STEM doctorate degree from an HSI (NCSES, 202; Kikuchi, 2024).

This is possibly a result of STEM representation, as "*most Hispanic Americans say increased representation would help attract more young*

*Hispanics to STEM";* based on a study with STEM advocates that yielded the following results (Kikuchi, 2024). This data is consistent with other research that's been conducted around STEM equity in relation to the Hispanic Population, which identifies lack of representation, lack of applicability to real-life, negative perspectives about STEM, and lack of prepared teachers, as barriers to STEM educational engagement (JA, 2019; Coleman, 2020). The D-STEM Equity Model further identifies eight gaps that impede Hispanic students from STEM engagement: vision, opportunity, cultural perception, STEM education, generational, economic, identification, STEM professional to educator gaps.

*Figure 1.* D-STEM Equity Model Systemic Problems




*Source:* Coleman, 2020

These identified gaps shared in the D-STEM Equity Model align with Utility Value Theory which highlights "*that students are more likely to persist in STEM when they perceive science as relevant and valuable to their lives, and parents play a pivotal role in shaping these perceptions by reinforcing the importance of science through conversations, encouragement, and resource provision"* (Woodcock et al, 2026).

Considering the culture of the Hispanic population, and as indicated in the generation gap of the D-STEM Equity Model; parental and family support is important for student success, especially in STEM, (Coleman, 2020; Woodcock et al, 2026). The Parent Socialization Model further explains how parents and families shape motivation, achievement, and career goals, by demonstrating belief in their students' performance, being highly vested in it, and regarding it as of value (Woodcock et al, 2026). There was a study conducted on a related program, Familias por el-Exito en STEM (Families for STEM Success), in which parents of Hispanic students engaged in STEM gained an enhanced understanding and value of STEM, knowledge of how to support and advocate for student success, how to assist their student in building a positive cultural

STEM identity, and methods to encourage STEM persistence (Woodcock et al, 2026).

**Experiential Learning through Makerspace Utilization**

Since the initial focus of the United States on STEM in education and STEM equity, as well as indicated throughout the literature, especially as discussed in the Utility Value Theory and in programming done by Junior Achievement, there has been an underlying notion of experiential learning as an approach towards STEM engagement and persistence.

> *The use of experiential learning and STEM professionals as role models are seen as effective ways of creating a more engaging environment for students. Junior Achievement specializes in this approach, giving students real-world context to STEM concepts. This helps students better understand STEM opportunities, making them less abstract and seeing the full spectrum of STEM careers, many of which might align with students' talents and interests. Because these activities are done in a group setting, they can offset potential peer dynamics while also offering enriched learning experiences for educators to deliver lessons in a different and dynamic way (JA, 2019).*

The literature suggests that experiential learning has a positive impact on STEM engagement and retention, as it relates to critical reflection skills, self-directed learning, promoting critical thinking and innovation, and connecting students with real world problems (Huber et al, 2026; Peace, 2024; Talafian et al, 2019). According to the National Academy of Sciences, STEM education is vital to the United States in leading the charge to solve energy and environmental related challenges, and rooting experiential learning in education is one pathway towards that goal (Talafian et al, 2019).

A natural manner to apply experiential learning can be through a makerspace, which allows students to engage in more hands-on projects, enables them to express themselves creatively and to be innovative, provides opportunities for learners to participate in active problem solving, and generates an overall sense of community (Barrett, Pizzico, Levy & Nagel, 2015; Rouse & Rouse, 2021; Knox, Koh & Zalot, 2022;). The Maker Education Movement strongly supports the integration of makerspaces into STEM teaching and learning, to enhance innovation (Rouse et al, 2021). The application of experiential learning utilizing a makerspace can positively influence attitudes towards STEM and impact STEM-related knowledge creation, as these spaces have been *"designed to support the creation, design, and building of new projects and technologies",* using hands on experiences to promote innovation (Stevenson, Georgiou, Van Der Jagt, & Hellwig, 2026).

## Methodology

Moreno Valley College (MVC), a Hispanic Serving Institution (HSI), sought to understand the impact of experiential learning through the utilization of and collaboration with the iMAKE Innovation Center (makerspace) in advancing STEM equity and closing the STEM talent gap. This led to the implementation of the HSI STEM and Articulation Project that focused on equity by intentionally expanding access, opportunity, and support for Hispanic, low-income, first-generation, and other historically underrepresented students pursuing STEM pathways. The research question was does experiential learning in conjunction with makerspace utilization advance STEM equity among historically underrepresented groups? For purposes of this study,

> *Experiential learning is defined as an equity-centered, learner-driven process through which students develop knowledge, skills, confidence, identity, and career readiness by engaging directly in authentic, hands-on, and reflective learning experiences.*

For the purposes of this study, a makerspace is defined as an:

> *Equity-centered innovation ecosystem that provides students with access to tools, technologies, mentorship, collaborative learning, creative freedom, and real-world problem-solving opportunities, which functions as a STEM access point, a student success environment, a career exploration hub, a research and prototyping space, and a community-facing innovation center.*

Moreno Valley College applied a mixed-methods approach to examine the impact of experiential learning through the iMAKE Innovation Center on STEM equity, student success, and career-connected learning. This included conducting a comparative analysis of makerspaces, makerspace walk-through and observations, interviews and a STEM equity assessment, across three phases. This approach was selected because the impact of iMAKE cannot be fully understood through enrollment, retention, or completion data alone. A mixed-methods approach allowed the evaluation to capture both the quantitative evidence of progress and the lived experiences of the students, faculty, and staff who engage with the space. This research design provided a "*better and deeper understanding of impact, by providing a holistic picture of the project*" (Wasti, Simkhada, van Teijlingen, Sathian, and Banerjee, 2022).

It further allowed for the connecting of data across the three phases for strategic integration, to determine the comprehensive impact of the HSI STEM & Articulation Project (Meissner, 2010).

# Results

## Observations, Walk-Through, and Makerspace Comparative Analysis

An adaptation of the Midwest & Plains Equity Assistance Center Equity Context Analysis Process was utilized to conduct observations of the iMAKE Innovation Center at Moreno Valley College. This process included a walk-through of the space examination and observations focused on equity indicators within four domains. The initial walkthrough and observation took place over the course of two days during year 2 of the project, while the post walkthrough and observation took over the course of three days during year 4 of the project.

Walk-through Space Examination

According to a Review of University Makerspaces conducted by the American Society for Engineering Education, universities ranked in the top 100 of the U.S. News and World Report's Best Undergraduate Engineering Programs have eight types of equipment within the space (Barrett et al, 2015). Based on the walk-through, it is evident that the iMAKE Innovation Center has equipment beyond what typically exist in makerspaces. The table below depicts equipment available at the iMAKE Innovation Center in relation to the colleges and universities that had at least five of the eight types of equipment:

*Table 4.* Makerspace Equipment

| | ***3D Printer*** | ***Laser Cutter*** | ***Wood Shop*** | ***Metal Shop*** | ***Electronics*** | ***Textile*** | ***Technology*** | ***White Board*** | ***Biological, Aquaponics, Hydroponics,*** | ***Artificial Intelligence*** | ***Esports, Podcasting, Media, Entrepreneurship,*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **University of California, San Diego** | X | X | X | X | X | | X | | | | |
| **Case Western Reserve University** | X | X | X | | X | X | | | | | |
| **Columbia University** | X | X | X | | X | X | | | | | |
| **University of Colorado Boulder** | X | X | X | X | | | X | | | | |
| **Georgia Institute of Technology** | X | X | X | X | X | | X | | | | |
| **Moreno Valley College** | X | X | X | X | X | X | X | X | X | X | X |
| **Northwestern university** | X | X | | X | X | | X | | | | |
| **Rice University** | X | X | X | X | X | | X | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Syracuse University** | X | X | | X | X | X | X | | | | |
| **University of Texas at Austin** | X | X | X | X | X | X | | | | | |
| **University of South Florida** | X | X | | X | X | | X | X | | | |
| **University of Central Florida** | X | X | | X | X | | X | X | | | |

*Source:* American Society for Engineering Education, 2015

This data demonstrates that iMAKE Innovation Center has all types of identified equipment. It further demonstrates that iMAKE has surpassed the norm, with an array of resources, beyond what is typically included in Makerspaces.

Equity Indicators Observations

There were several equity indicators within four domains observed, including (a) Relationships, Rigor, and Inclusion, (b) Behavior Expectation, (c) Equitable Quality and Distribution, and (d) Inclusive and Responsive. Based on the post Equity Indicators Assessment, there was an overall score of seventeen equity indicators observed, out of eighteen observable indicators, within four domains, a demonstrated improvement with four additional observed equity indicators from the pre- to post-assessment. Overall, this data suggests that the iMAKE Innovation Center has successfully integrated systemic equity in STEM across all domains. The table below depicts the final results of the Equity Indicators Observations:

*Table 5.* Equity Indicator Observations

| **Equity Domain** | **Description** | **Pre # of Observed Equity Indicators** | **Post # of Observed Equity Indicators** | **# of Observable Equity Indicators** |
|---|---|---|---|---|
| *Relationships, Rigor, and Inclusion* | Positive rapport between visitors and establishment of a welcoming environment | 4 | 6 | 6 |
| *Behavior Expectations* | Mission and vision in relationship to equity, visual display of rules, norms, and expectations, as well as signage in multiple languages | 3 | 3 | 4 |
| *Equitable Quality and Distribution* | Availability of resources, technology infrastructure, and | 3 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| | overall appearance in terms of cleanliness | | | |
| *Inclusive and Responsive* | Images of underrepresented groups displayed, their experiences shared, and their works exhibited. | 3 | 6 | 6 |
| | | | ***17*** | ***18*** |
| | | | **Overall Score: 94%** | |

## Interviews

The HSI STEM and Articulation Project, specifically focused on experiential learning to close the STEM talent gap, was evaluated through a series of 60 to 90-minute interviews with identified stakeholders, during year 2 of the project, to assess the progress, effectiveness, and impact of the project, from the perspectives of multiple stakeholders, during Phase I. Interviews were conducted with 19 administrators, faculty, staff, and students, that included: 3 administrators, 2 STEM faculty, 3 iMAKE Innovation Center staff, and 11 iMAKE Innovation Student Employee Team members.

As a progress check and to further evaluate the project's effectiveness and impact, pulse interviews were conducted in 30-minute increments, during year 3 of the project, with a total, 11 stakeholders. As a final step in the external evaluation, Phase III interviews focused on the implementation, impact, equity outcomes, and sustainability, with 25 constituents,

Impact on Target Population

The four interview groups, students, staff, faculty, and administrators, were asked to discuss the impact of the HSI STEM & Articulation goal, to increase the number of Hispanic and low-income students who successfully attain degrees in STEM by utilizing the versatility of experiential learning. Fifteen themes, data points of impact. Below is a description of each theme, along with comments of interviewees across all three interview phases, in their authentic voices as evidence of goal impact.

STEM Knowledge and Skills are described as expanding knowledge, building skills, and learning the interconnectedness of both. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *I think it's mostly them learning new skills. You're learning chemistry. You learn all kinds of things better. You know, learning how to use math, how to use physics. ~ Staff*
b. *I've been exposed to a lot of different things here. Like, even not with just within the computer science, within woodworking, 3D printing. Which is pretty good for me, because I'm also on the more creative side as well,*

*which is something I also wanted. To explore more at the same time, while also doing things that I think will benefit my career path. ~ Student*

c. *So, I'd say, this space really helped me learn a lot of programs and machines that I wouldn't have been able to afford or have access to any other way. It's taught me a lot of good skills like Adobe. I've always wanted to learn that, but I never had the chance to, and I couldn't get the program. And I feel like I'm learning a lot of useful skills like the woodworking and everything, and the 3D printing. It's just really cool to be able to learn all the machine skills. ~ Student*

Bridging the Gap between Theory and Practice is described as practical application of theory. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *We look at what they're learning alongside the faculty and try to create hands-on projects that use those same concepts they are learning. For hands-on, even though it's smaller scale than what they would be doing in the real world, but it's just the way for them to see what they're learning applies too. ~ Staff*
b. *Hands-on really works. That's the best way for my students to learn. And they do tell me, they're like, oh, I really understood the concepts after this project, I really understood it. So, I am such a strong believer that, learning by doing it just helps it click. ~Faculty*
c. *Really it was a recurring problem. I see a lot with people that major in STEM is that they gain all this knowledge, and it was from the studies, the classes and schools; but the one thing that they don't have is practical experience. We give that opportunity for practical experience here. They can actually use what they learn in class and execute it in their own projects. ~Student*
d. *I think the hands-on actually not only piqued their interest, but I think it also kept them engaged. Kept them engaged enough as opposed to just learning about a theory and learning about a thing. They got to do the thing. They got to be the thing. So, I think that being able to do the thing and beat the thing. ~Faculty*

STEM Exposure is described as possibility, STEM being spread to the Community, especially to those who typically do not have access. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *I'd say the impact it's had on me is just exposure. Quite honestly. And the reason why that's important to me is because you don't see a lot of people of color in a position that he's [Director of Innovation] in. My philosophy has always been, if you want to get better at something then be around people that are already doing it. And so, I really kind of fall under his*

*leadership and learning about just the different things that feel different. Things that are around here to soak up. In addition to that, the things that I've seen here, I've only seen in certain communities, that I don't come from. And in terms of the DEI [Diversity, Equity, and Inclusion] aspect. You know I don't have; I wasn't raised around or grew up around a lot of resources. So, to have access to this, and not only for myself, but the people that I care about, and expose them to this as well. ...Every time that we get a new person in here, they're blown away at the fact that this place exists, and it's free because it's a very rare thing in today's world. So, I soak up a lot of information from [name omitted] in terms of how to be impactful and growing as an individual to learn to use these resources, to be impactful in the community. So, as I continue my educational journey, I want to take the things that I've learned here, the tools that I've learned, to spread that wherever I go. ~Student*

Culture and Identity is described as positive racial and STEM identity, as well as familial community that is positive, safe, and cohesive. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *We'll have like tech clubs, we'll have like a STEM engagement club come here and do their meetings, their activities they want to do. There'll be the diversity of people. And me, when I watch those races live, all I see is a bunch of white European. Like, that gives me a bit of imposter syndrome because I'm, how am I supposed to compete with those people if, like, the average good engineer is a European and I show up as a Mexican kid? It's much easier. So, it creates the diversity that you'll know, like, oh, anyone can be involved. Anyone can go and build a race car. It's always like, oh, the time is effortful. So, at that point, it doesn't come down to a point of am I the right race for it, or do they see me as one of them? It comes down to, like, do they see me work as hard as the other people here, because everybody looks different. ~Student*
b. *When we talk about the cultural part, we talk about the importance, the impact of having that reflection. We freely talk. We're Black and Mexican. We freely and openly talk about that. ~Administration*

STEM Portfolio Development and Certification is described as building collection of works and experiences to showcase skills and abilities for career expansion and professional marketability. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in the comment below:

a. *And I guess, my real appeal to going here was that as a computer engineer major, getting into that field is an important process, it's like*

*building your portfolio and stuff. And at home, you're able to learn things like code and stuff. But things like parts, moving things like making cars, you need to have something to create that and this place they have 3D printers, our woodworking room, our laser cutters. That allows me to utilize my skills and build a portfolio, to make projects like controllers and main consoles all that stuff. I learned real world experience, or at least something to put in my portfolio. ~Student*

STEM Education to Career Pathway is described as STEM related transfer to higher education, employment, internships, apprenticeships, alumni pathways, student employment, and workforce readiness. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in the comment below:

a. *As faculty who directs and utilizes this space for students, I incorporate career-connected learning through classroom activities, workshops, and collaborative projects that help students connect STEM learning to future college and career opportunities. These experiences encourage students to apply problem-solving, communication, and technical skills in meaningful and collaborative ways. The learning environment is designed to be inclusive and supportive of students from diverse backgrounds, while also helping students explore STEM pathways and build confidence in their ability to succeed in STEM-related fields. Through hands-on and collaborative learning experiences, students are encouraged to see the relevance of STEM education to real-world careers and future academic goals. ~Faculty*

STEM Research is described as students actively engaged in research projects. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in the comment below:

a. *I like it that all the students right now are focusing more on research. That's another thing that I didn't expect, that they're researching. We'll give them the ideas, throw out stuff, and they're researching. I love to see that, because that's teaching them how not to just come to school and learn their mathematics and go home. Learn history and go home. They're learning a lot of stuff here. They're learning how to present. They're learning how to write proposals. I didn't imagine that they would ever, you know, do. But we're pushing and they're doing it. ~ Staff*

STEM Enrollment and Retention is described as increased enrollment and retention in STEM courses. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *So, one thing we noticed about courses where we have hands-on projects, or we're involved with the course, the retention rates are around 70% by the end of the semester…95% of them said on those surveys that if it wasn't for the hands-on learning projects they would have dropped out, instead of trying to recover their grade, to pass. That definitely is showing some impact. ~ Staff*
b. *For my trig and my geometry students, I noticed the retention. The students definitely wanted to stay in class because they wanted to see this project through. ~Faculty*

Creativity and Innovation is described as innovative freedom of self-expression. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *And I feel like working here has kind of allowed me to express and also challenge my creativity. You don't really get those experiences, and you don't really get those chances to be able to apply your knowledge and challenge your knowledge and also expand your knowledge, all in one space. And I feel like that job allows me to do that, not just with neural things, but also in terms of creativity like 3D modeling. I'm free learning how to do that. Going back into that space that I used to do when I was younger and being able to re-expand and develop my skills further. So, it's just a lot of expansion while being in the space for me personally. ~Student*
b. *Creating themselves. You know. I'm not telling them what to do. I'm guiding them, but they get to design it. They get to have creative freedom. So, I feel like there was a lot more engagement. My students really try to understand the concepts from class and how to apply it right in real world with real world data, because they had to apply that knowledge. ~Faculty*

STEM Teaching and Learning is described as creativity in lessons and increased effectiveness in the classroom. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *It's really cool how, like, even professors here, like, ask us to, like, help them out. And being able to, like, teach their students, you know? Well, I like how it's been incorporated into the classroom. Yeah, I remember this one day for sure. The geometry class, they came in here wanting to 3D print a bridge because since it has all angles, architecture, all that stuff, they had to use the 3D printers. ~Student*
b. *I mean, it's helping me to learn how to incorporate more scientific inquiry into, you know, into my teaching about social justice issues,*

*social science, humanities concerns. I have students who actually are in STEM fields and they're starting to think of ways to incorporate the scientific aspect of their study into social justice and activism, that the Makerspace has helped me a lot in that way. ~Faculty*

c. *So, it's making a change, because the number of our professors are incorporating different ideas into the classroom. My professors, they are very close with makerspace. They go there on a regular basis. They take these students. They expose them. And a number of them, at least I can mention two that go there on a regular basis and take their students. Incorporate what they are doing in the classroom. To go and explore in the makerspace, and then they come back into the classroom to describe the application, their experience and what they have learned from Makerspace. ~Administration*

Entrepreneurship is described as utilizing iMAKE to start businesses/ produce prototypes. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *So that's what I'm able to do here, not only learn how to be a better student, but also learn to be an entrepreneur. So, with some of the tools and equipment here, I've learned to kind of create my own brand, made a few sales on some things. So, I'm really glad that I was able to find this place and be someone like [name omitted]l to kind of help push our community. ~Student*
b. *I've spoken already with two of our students who graduated from our programs. And then they started their businesses, and they're successful, and they keep coming back to makerspace to learn innovative skills and technologies and tools, they can take back to their small businesses and send some of their employees. ~Administration*

STEM Interest is described as non-STEM majors taking more STEM courses and students using iMAKE outside of course requirements. This theme was reported by all four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *It actually drove the interest, the interest in the community itself, and it drove the interest for the students. ~Faculty*
b. *It's not common for students of minority backgrounds to have experience in those areas. A lot of the students that do come in here are of the of that background. And so, we work alongside many other programs, such as EOPS and TRIO, that cater towards lower income students that don't have those resources. And not only does it provide a space for them to experience them, but to have fun in STEM, and to make it seem more appealing. ~Student*

Comfort with STEM is described unintimidated by STEM exploration. This theme was reported by three (no administrators) of the four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *A lot of people had Cricuts as gifts. And didn't have a place to actually get trained on how to properly use it. So, a lot of the Cricuts were just sitting in the closet collecting dust. So, them attending our workshops, they were able to bring those out and feel comfortable and start using those. So that's been like our longest running, most consistent Workshop. ~ Staff*
b. *It had impacted me very greatly because from the very beginning, I was very intimidated working on other technology or mechanics or tools that I wasn't very familiar or was scared that I would make constant mistakes. Well, working here, it allows me to practice. ~Student*
c. *They definitely feel like they're able to be themselves, be creative and do really well in the classes. I think that gives them confidence. I do have often a lot of students tell me, at the beginning, I felt like I wasn't a math major. I wasn't a math person. But now I feel like I can do it, I really understand math. Those are the kind of comments that let me know this is making a difference. ~Faculty*

Passion and Change is described as the development and exploration of life-changing passions. This theme was reported by three (no staff) of the four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in their comments below:

a. *Changes our students lives. I'm going to leave you with one thing. I feel very strongly that our makerspace at Moreno Valley College changes our students' lives…there is zero doubt in my mind. ~Administration*
b. *So, the Makerspace has changed me, on what I wanted to do with my life. Back in high school, I first tried out psychology. I didn't like that. Then I took a 3D media design class. I loved that. So, I started taking more of those classes when I arrived in college. I was required to take some 2D media design classes first, before I could take the 3D. I love that even more. I'm pretty much an expert at Illustrator by now. And working here at the makerspace has allowed me to use those skills more than I could in any other place that I've worked at before. ~Student*

Influence and Collaboration is described as Serving as a model/best practice for others through networks and partnerships. This theme was reported by three (no students) of the four interview groups as having an impact on increasing the STEM participation of targeted groups through experiential learning. This is evident in the comment below:

a. *The Mayor of Moreno Valley, he has like, let's just say, adopted the maker space. He's become a partner to where he's been doing projects out of the makerspace, he himself for the city. Also, the city has a library where they will come in, send guys in here, and so, they walked around our space, and now they have a small like mini maker space in one of their libraries, with hydroponics. We did hydroponics in here, now they didn't say that they copied us on that, but a few months later, they had an outdoor hydroponic or horticulture area. But this is what we were doing here like. Of the equipment that they have in theirs, from what we have in ours, we are definitely influential. ~ Staff*

Based on the combined data from all three interview phases, it is evident that the HSI STEM & Articulation Project has leveraged the versatility of experiential learning to drive STEM participation in meaningful ways. Across all phases, 15 data points of impact emerged from the interview process. Of these, twelve were reported by all four interview groups, and three were reported by three groups. Out of a possible 60 points (15 data points × four groups), stakeholders identified a total of 57 (1 point per each interview group that reported each data point of impact), reflecting broad and consistent evidence of progress across initiatives. The table below illustrates the distribution of these scores, showing which impacts were most universally recognized:

*Table 6.* Impact on STEM Interviews

| Data Points of Impact | Points of Impact Description | Students | Staff | Faculty | Admin | Score |
|---|---|---|---|---|---|---|
| STEM Knowledge and Skills | Expanding knowledge, building skills, and learning the interconnectedness of both | X | X | X | X | 4 |
| Bridging Gap between Theory & Practice | Practical application of theory | X | X | X | X | 4 |
| STEM Exposure | Possibility: STEM is spread to the Community, to those who typically do not have access | X | X | X | X | 4 |
| Culture and Identity | Positive racial and STEM identity, Familial environment that is positive, safe, and cohesive | X | X | X | X | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STEM Portfolio Development and Certification | Building collection of works and experiences to showcase skills and abilities for career expansion and professional marketability | X | X | X | X | 4 |
| STEM Education to Career Pathway | STEM related transfer to higher education, employment, internships, apprenticeships, alumni pathways, student employment, and workforce readiness | X | X | X | X | 4 |
| STEM Research | Students actively engaged in research projects | X | X | X | X | 4 |
| STEM Enrollment and Retention | Increased enrollment and retention in STEM courses | X | X | X | X | 4 |
| Creativity and Innovation | Innovative freedom of self-expression | X | X | X | X | 4 |
| STEM Teaching and Learning | Creativity in lessons and increased effectiveness in the classroom | X | X | X | X | 4 |
| Entrepreneurship | Utilizing iMAKE to start businesses/produce prototypes | X | X | X | X | 4 |
| STEM Interest | Non-STEM majors taking more STEM courses/Students using iMAKE outside of course requirements. | X | X | X | X | 4 |
| Comfort with STEM | Unintimidated by STEM exploration | X | X | X | | 3 |
| Passion and Change | Development and exploration of life-changing passions | X | | X | X | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Influence and Collaboration | Serving as a model/best practice for others through networks and partnerships | | X | X | X | 3 |
| | | **Total Impact Score:** | | | | **57/60** |
| | | **Total Impact Score Percentage:** | | | | **95%** |

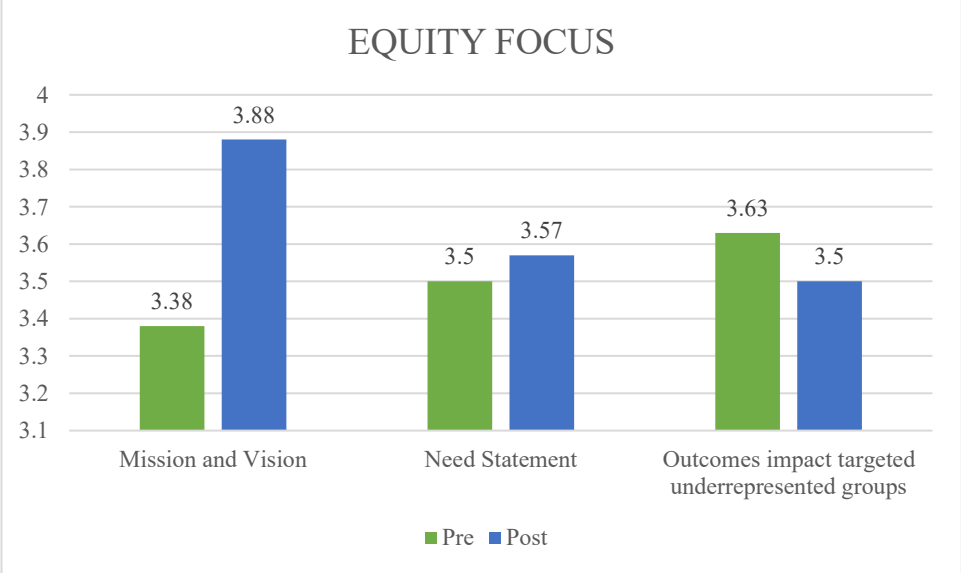
**HSI STEM & Articulation Project Equity Assessment**

The National Alliance for Partnerships in Equity (NAPE) STEM Equity Program Evaluation Rubric was utilized to assess the HSI STEM & Articulation Project. *This rubric is designed to help program administrators, designers, implementers, and funders identify the critical attributes of a STEM program to determine the degree to which it is inclusive and supports access and success for students who have historically not engaged in STEM.* The rubric measured progress in eight attributes and several sub-attributes, using a 4-point scale, completed by eight key stakeholders.

Equity Focus

Equity Focus is having a clearly stated equity in STEM mission and vision, need statement, and history of positive outcomes that explicitly impact underrepresented groups. This attribute ultimately received a rating of established, with an initial score of 3.50/4 and a final score of 3.65/4, depicted below:

*Figure 2.* STEM Equity Assessment - Equity Focus

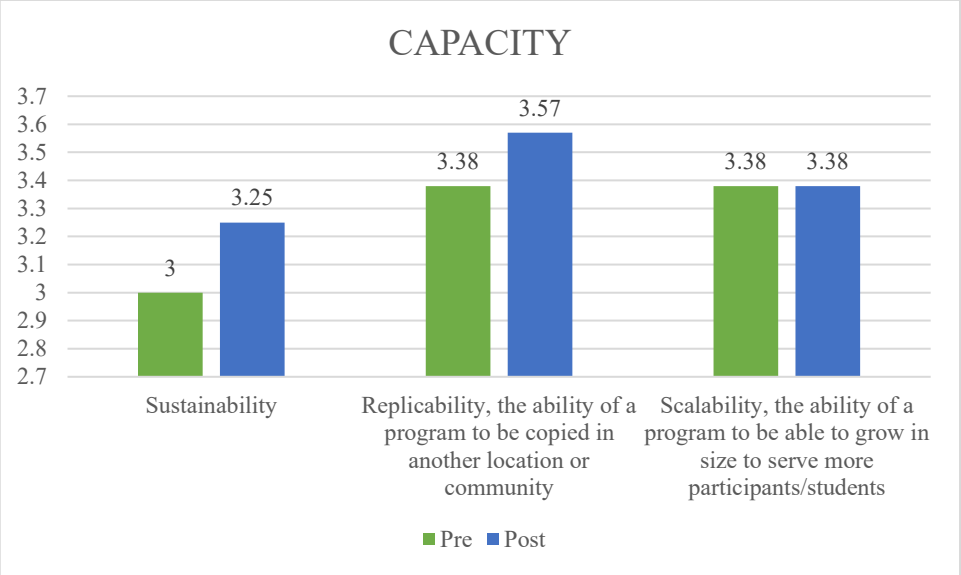



Capacity

This attribute is about the capacity to be sustainable, replicable and scalable with diverse students in diverse communities. This attribute ultimately received

a rating of established, with an initial score of 3.25/4 and a final score of 3.40/4, depicted below:

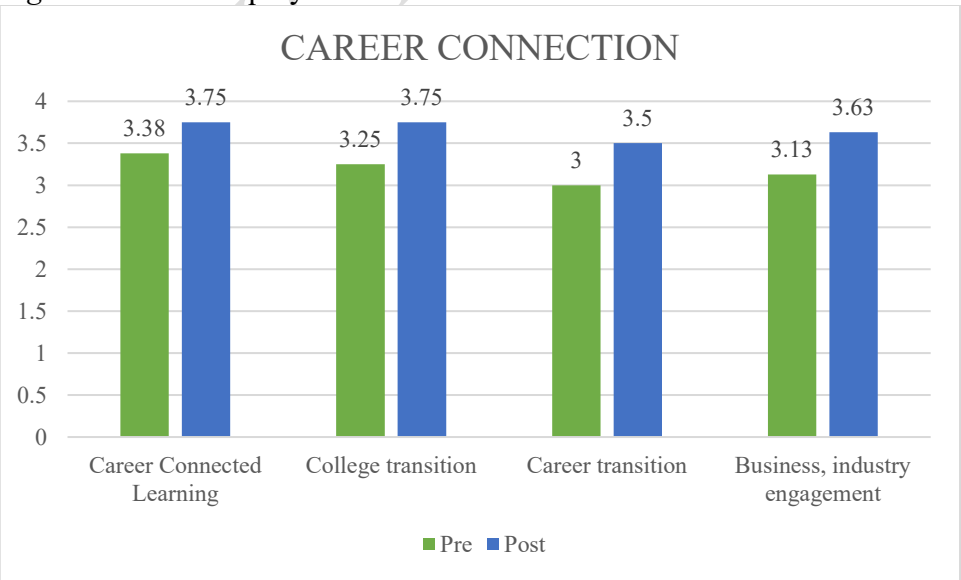
*Figure 3.* STEM Equity Assessment - Capacity




Career Connection

Career Connection is when students are connected to their future college and career goals and engage with business, industry who provide diverse STEM role models and work-based learning opportunities. This attribute ultimately received a rating of established, with an initial score of 3.19/4 and a final score of 3.66/4, depicted below:

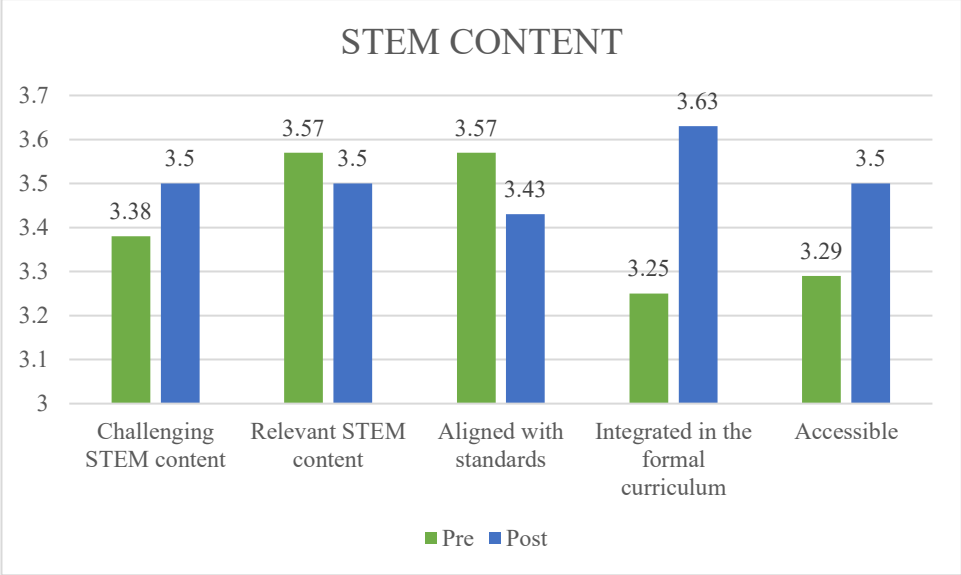
*Figure 4.* STEM Equity Assessment - Career Connection



STEM Content

This attribute is defined as challenging and relevant STEM content aligned with standards, integrated in the formal curriculum, technology rich, accessible by diverse students and leads to college and career transition in STEM. This attribute ultimately received a rating of established, with an initial score of 3.40/4 and a final score of 3.50/4, depicted below:

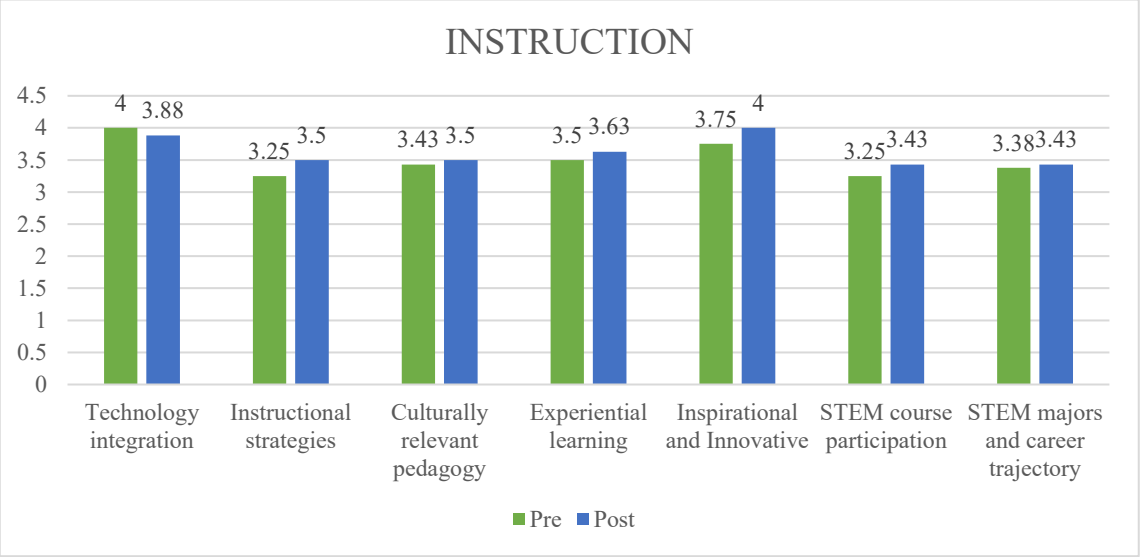
*Figure 5.* STEM Equity Assessment - STEM Content




Instruction

This attribute is focused on STEM instruction that integrates technology, utilizes multiple high impact instructional strategies that are culturally relevant, experiential, and inspires students to pursue more STEM course work or a career in STEM; high impact educational practice strategy, rooted in best practices in engaging diverse learners. This attribute ultimately received a rating of established, with an initial score of 3.50/4 and a final score of 3.62/4, depicted below:

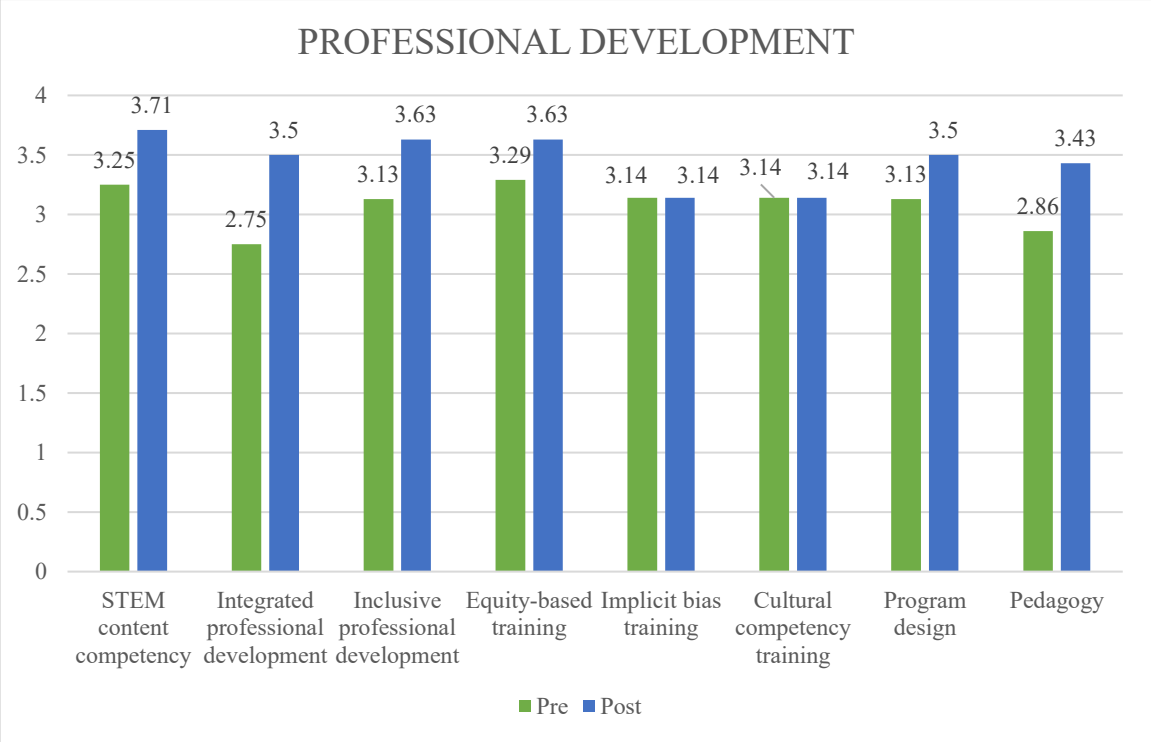
*Figure 6.* STEM Equity Assessment - Instruction




Professional Development

This attribute is defined as integrated professional development on equity, inclusion, and cultural competence in program design and pedagogy. This attribute ultimately received a rating of established, with an initial score of 3.09/4 and a final score of 3.46/4, depicted below:

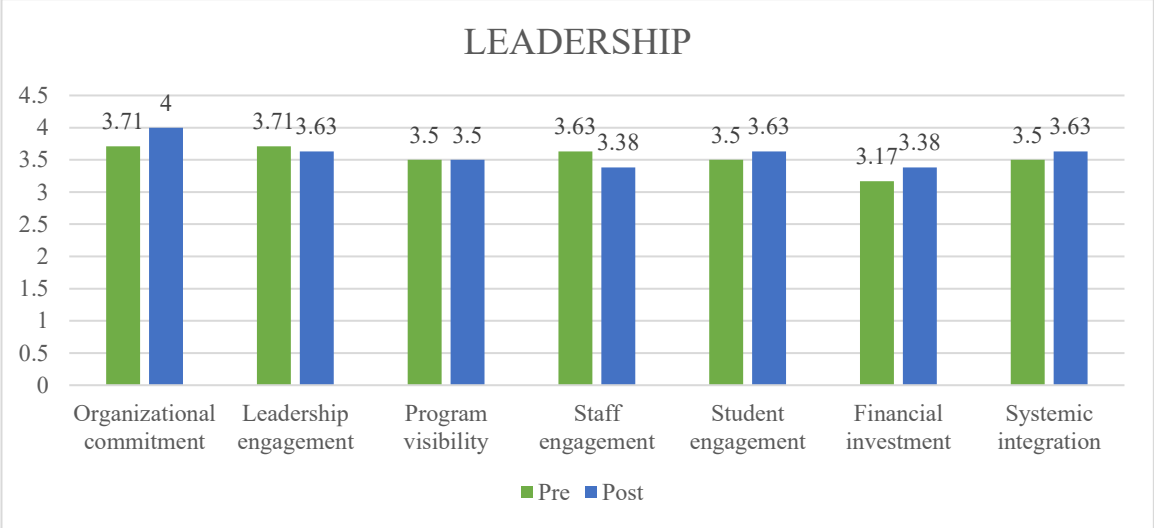
*Figure 7.* STEM Equity Assessment - Professional Development



Leadership

Leadership is defined as commitment from organization top leadership reflected by program visibility, faculty and staff engagement, financial investment, and systemic integration. This attribute ultimately received a rating of established, with an initial score of 3.53/4 and a final score of 3.60/4, depicted below:

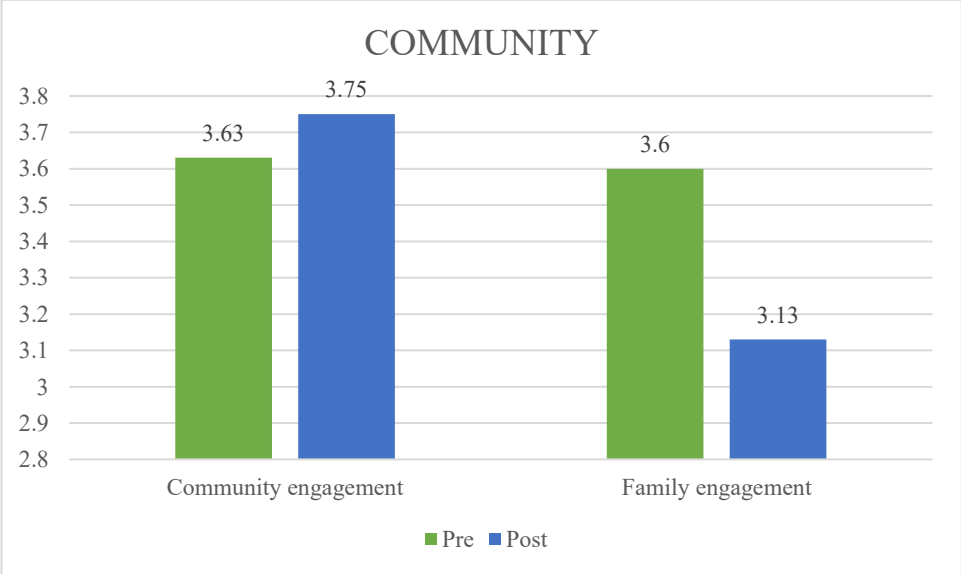
*Figure 8.* STEM Equity Assessment - Leadership




Community

This attribute is defined as authentic community partnerships and family engagement of the target population being served. This attribute ultimately received a rating of established, with an initial score of 3.61/4 and a final score of 3.44/4, depicted below:

*Figure 9.* STEM Equity Assessment - Community



Based on the equity assessment the HSI STEM & Articulation project has a rating of established, with an average initial score of 3.38/4 and a average final score of 3.54/4. From the pre to post tests, there was growth in each of the attributes, with the exception of Community, which is possibly a result of the current external climate concerns around immigration that emerged during the interviews, as it was previously one of the strongest attributes. The attributes that emerged as the strongest include Equity Focus, Career Connection, Instruction, and Leadership. While there has been substantial growth in the majority of STEM Equity attributes, one emerged as needing the most improvement, which is Capacity. The notion of Sustainability, a sub-attribute, has emerged as a challenge throughout this external evaluation process, but in Phase III interviews, it emerged that there is organizational commitment to sustain iMAKE.

Overall, this Equity Assessment Analysis demonstrates that the HSI STEM & Articulation Project has Established, and is on the verge of being Accomplished in the eight attributes needed to achieve its goal to increase the number of Hispanic and low-income students who successfully attain degrees in STEM by utilizing the versatility of experiential learning, as depicted in the table below:

*Table 7.* STEM Equity Assessment Results

| **STEM Attribute** | **Rating** *(Scale, 1 = Undeveloped, 2 = Developing, 3 = Established, 4 = Accomplished)* | **Pre-Score** *(out of 4)* | **Post Score** *(out of 4)* |
|---|---|---|---|
| Equity Focus | Established | 3.50 | 3.65 |
| Capacity | Established | 3.25 | 3.40 |
| Career Connection | Established | 3.19 | 3.66 |
| STEM Content | Established | 3.40 | 3.50 |
| Instruction | Established | 3.50 | 3.62 |
| Professional Development | Established | 3.09 | 3.46 |
| Leadership | Established | 3.53 | 3.60 |
| Community | Established | 3.61 | 3.44 |
| | **Average Score:** | **27.07/32** | **28.33/32** |
| | **Total Impact Score Percentage:** | **85%** | **89%** |

## Discussion

This evaluation of the HSI STEM & Articulation Project yielded that there has been progress made and a significant impact on its goal to increase the number of Hispanic and low-income students who successfully attain degrees in STEM by utilizing the versatility of experiential learning to develop an array of applied learning options that foster student interest and enrollment, improve student success, and facilitate degree completion and transfer; all done through

an established lens of equity and an approach of experiential learning. This was confirmed across all three Phases of the external evaluation and across all methodologies. Based on the observations, the iMAKE Innovation Center has a solid technology infrastructure and is rooted in equitable quality and distribution, with availability and utilization of an array of STEM resources, beyond the norm.

The interviews further demonstrated that there was a significant impact on all internal stakeholder groups around 12/15 data impact points including: (a) STEM Knowledge and Skills, (b) Bridging the Gap between Theory and Practice, (c) STEM Exposure, (d) Culture and Identity, (e) STEM Portfolio Development and Certification, (f) STEM Education to Career Pathway, (g) STEM Research, (h) STEM Enrollment and Retention, (i) Creativity and Innovation, (j) STEM Teaching and Learning, (k) Entrepreneurship, and (l) STEM Interest, which are consistent with the findings of the equity assessment.

From the equity assessment, it was found that HSI STEM & Articulation project has established STEM equity and created an inclusive community that supports access and success for students who have historically not engaged in STEM. It has been approached through a lens of equity and has accomplished a solid technology infrastructure, both of which also emerged in the observations and interviews. Furthermore, the strongest attributes which emerged are Equity Focus, Career Connection, Instruction, and Leadership, also emerged during the observations and interviews.

Overall, this external evaluation yielded a score of 102.33/110, 93% there in terms of achievement of the goal to increase the number of Hispanic and low-income students who successfully attain degrees in STEM by utilizing the versatility of experiential learning, as depicted in the table below:

*Table 8.* HSI STEM & Articulation Project Impact on STEM Equity

| **Methodology** | **Measured Aspect** | **Pre Score** | **Post Score** |
|---|---|---|---|
| Observations | iMAKE Utilization and Resources | 13/18 | 17/18 |
| Interviews | Impact of Experiential Learning | 54/60 | 57/60 |
| STEM Equity Assessment | Equity Focus of HSI STEM & Articulation Project | 27.07/32 | 28.33/32 |
| | ***Average Score:*** | ***94.07/110 (86%)*** | ***102.33/110 (93%)*** |

## Conclusion

The HSI STEM and Articulation Project demonstrated that experiential learning, when implemented through an intentional and equity-centered makerspace model, can play a significant role in advancing STEM equity. At Moreno Valley College, the iMAKE Innovation Center has helped students connect classroom learning to real-world application, develop technical and

professional skills, build confidence, strengthen their STEM identity, and see clearer pathways into transfer, careers, entrepreneurship, and community leadership.

The iMAKE STEM Equity Framework was developed as an outcome of the project's external evaluation and offers a scalable and replicable model for institutions seeking to close STEM talent gaps. The framework shows that makerspaces should not be viewed only as rooms with tools or technology, but also engines of access, belonging, applied learning, workforce preparation, and student transformation.

The iMAKE STEM Equity Framework explains that to achieve equity in STEM, there must be a focus on experiential learning, utilizing the elements of a Makerspace. By applying experiential learning with and through makerspace utilization, it will have a significant impact on STEM education and lead to a diversified STEM education to career pathway. As the D-STEM Equity Model informed the implementation of the project, with its success, the iMAKE STEM Equity Model has also led to an update of the STEM motivation steps to include Experiential Learning. Organizations that want to advance STEM equity can apply this iMAKE STEM Equity Framework as depicted below:

*Table 9.* iMAKE STEM Equity Framework

| | **iMAKE STEM Equity Framework** | | | | | |
|---|---|---|---|---|---|---|
| **STEM Equity** | **Experiential Learning**<br>*Experiential learning is defined as an equity-centered, learner-driven process through which students develop knowledge, skills, confidence, identity, and career readiness by engaging directly in authentic, hands-on, and reflective learning experiences. It is not limited to completing a project or using a piece of equipment. It is a structured process of discovery, creation, reflection, iteration, and application that allows students to connect classroom theory to real-world problems, personal interests, community needs, and emerging STEM careers.* | | | | | **Diversified STEM Education to Career Pathway** |
| | STEM Courses | All Other Academic Disciplines | Career and Technical Education | Enrichment Programs/ Student Organizations/ Extracurricular Activities | Community Organizations | |
| | ÷ | | | | | |
| | **Makerspace**<br>*Equity-centered innovation ecosystem that provides students with access to tools, technologies, mentorship, collaborative learning, creative freedom, and real-world problem-solving opportunities. While makerspaces are often described as physical spaces designed for creating, designing, building, and prototyping, it also functions as a STEM access point, a student success environment, a career exploration hub, a research and prototyping space, an integrated learning environment, and a community-facing innovation center.* | | | | | |
| | 3D Printing and Additive Manufacturing | Laser Cutting and Digital Fabrication | Woodworking/ Subtractive Manufacturing | Metalworking and Mechanical Fabrication | Electronics, IoT, Drones, and Robotics | |
| | Textiles, Design, and Creative Production | Computing, Virtual Reality, Simulation | Biological, Aquaponics, Hydroponics, | Artificial Intelligence and Data-Driven Innovation | Esports, Podcasting, Media, Entrepreneursh | |

| | | | | | |
|---|---|---|---|---|---|
| | | , and Technology | Environmental Systems | | ip, and Interactive Learning |
| | = | | | | |
| | **STEM Impact** | | | | |
| | ***STEM Knowledge and Skills*** | ***Bridging the Gap Between Theory/ Practice*** | ***STEM Exposure*** | ***STEM Portfolio Development*** | ***Culture and Identity*** |
| | Expanding knowledge, building skills, and learning the interconnectedness of both | Practical application of theory | Possibility: STEM is spread to the Community, to those who typically do not have access | Building collection of works and experiences to showcase skills for career expansion and professional marketability | Positive racial and STEM identity, Familial environment that is positive, safe, and cohesive |
| | ***Creativity and Innovation*** | ***STEM Research*** | ***STEM Enrollment/ Retention*** | ***STEM Education to Career Pathway*** | ***STEM Teaching and Learning*** |
| | Innovative freedom of self-expression | Students actively engaged in research | Increased enrollment and retention in STEM courses | STEM related transfer, employment/internship/ apprenticeships/student/ workforce readiness | Creativity in lessons and increased effectiveness in the classroom |
| | ***Entrepreneurship*** | ***STEM Interest*** | ***Comfort with STEM*** | ***Passion and Change*** | ***Influence and Collaboration*** |
| | Start businesses/produce prototypes | Students using makerspace outside of course requirements | Unintimidated by STEM exploration | Development and exploration of life-changing passions | Serving as a model/best practice for others through networks and partnerships |
| |  | | | | |

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