ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #40721

Assessing Key STEM Identity Constructs among Hispanic Engineering Students and Professionals

Dr. Dayna Lee Martínez, Society of Hispanic Professional Engineers, Inc.

Dayna is a Senior Director of Research & Impact at the Society of Hispanic Professional Engineers (SHPE), where she leads a team of professionals who specialize in data-driven design and implementation of programs and services to empower pre-college students, parents, graduate students, and faculty members in STEM fields, with a particular focus on advancing Hispanic representation and success. With over 15 years of experience in creating data collection tools, analysis methodologies, and effectively presenting results, she dedicates herself to promoting Hispanic excellence in STEM.

She joined SHPE's staff in 2021, after serving as a faculty member at Northeastern University and a post-doctoral fellow at the James A. Hailey Veterans Hospital and the HSyE Institute. Holding a PhD in Industrial Engineering from the University of South Florida and a certificate in Diversity, Equity, and Inclusion from Cornell University, Dayna is deeply passionate about increasing Hispanic representation and success in STEM. Leveraging her analytical skills and data-driven approach, she is committed to creating and evaluating impactful programs and services for the Hispanic STEM community.

Dr. Kimberly D Douglas P.E., Society of Hispanic Professional Engineers, Inc.

Over 25 years of experience as an engineering educator and administrator developing and funding programs for increasing the persistence and degree completion rates of STEM students. Particular expertise in creating mutually beneficial partnerships and pro

Ms. Esther Gonzalez

Esther González is a PhD candidate in the Price School of Public Policy at the University of Southern California (USC). Her research domains are organization behavior and diversity management. Her research is multidisciplinary and applies methods and fields in public policy, management, political science, and sociology. Upon completion of her Bachelors of Arts degree in International Development Studies at UCLA, she began a successful career in banking and finance at Bank of America, Merrill Lynch. She has completed various post baccalaureate certifications through UCLA Anderson and the Harvard Business School; most recently, she completed her MPA at California State Polytechnic University, Pomona, and MBA at Cornell Tech. She has published in multiple academic journals including ASEE, ROPPA, and APPAM. Additionally, her scholarly work has been featured in Forbes magazine. She believes that research can inform diversity, equity, and inclusion (DEI) policies and programs to one day have a workforce that is representative of the society it aims to serve.

Andrea D. Beattie, Society of Hispanic Professional Engineers, Inc.

Andrea D. Beattie is a graduate from Texas A&M International University in Laredo, Texas, where she earned a Bachelor of Arts and Master of Arts in Political Science in 2011 and 2012, respectively. Currently she serves as Manager, Research and Impact at SHPE. In this role, she assists the organization with research, program evaluation, and data analytics.

Assessing Key STEM Identity Constructs among Hispanic Engineering Students and Professionals

Background & Motivation

The United States continues to be a leader in scientific innovation (Merigó et al., 2016); its position as a global leader in innovation is of utmost importance especially during a time were solving the world's most pressing and complex issues, including the recent pandemic, climate, environmental challenges, and a sustainable economy require innovative solutions. This need is reflected in Science, Technology, Engineering and Mathematics (STEM) occupation growth which has increased 79% since 1990 and is projected to grow by 10.8% by 2031 (U.S. Bureau of Labor Statistics, 2022). The demographics of the United States are undergoing a profound transformation, marked by the significant and growing presence of Hispanic and Latino individuals within the population. According to the U.S. Census Bureau, as of 2020, Hispanics and Latinos constituted approximately 18.7% of the U.S. population, marking a substantial increase from previous decades (U.S. Census Bureau, 2020). This demographic shift is driven by factors such as immigration, higher birth rates among Hispanic communities, and natural population growth. The growth of the Hispanic population in the U.S. not only reflects the nation's increasing diversity but also has significant implications for various aspects of society, including education, the workforce, and political representation. As this trend continues, it underscores the importance of addressing issues related to diversity, inclusion, and equitable access to opportunities to ensure that the changing demographics are accompanied by shared prosperity and representation for all demographics of the population. That being said, the Hispanic and Latino population in the United States has been historically underrepresented in STEM (Science, Technology, Engineering, and Mathematics) fields, raising concerns about diversity and inclusion in these critical sectors. According to data from the National Science Foundation (NSF) in 2019, Hispanic and Latino people accounted for only 9% of the STEM workforce in the United States, despite comprising nearly 19% of the overall population (NSF, 2019). This underrepresentation is a result of complex systemic factors, including limited access to quality education, economic disparities, and cultural barriers (Villarejo et al., 2008). The underrepresentation of Hispanic and Latino individuals in STEM not only deprives the field of valuable perspectives and talent but also hinders the pursuit of innovation and scientific advancements. To address this disparity, it is crucial to establish research initiatives that examine the root causes and develop targeted strategies for increasing Hispanic and Latino representation in STEM fields. These initiatives should focus on improving access to quality education, creating mentorship programs, and fostering a supportive and inclusive environment that encourages members of the Hispanic and Latino community to pursue STEM careers (National Academies of Sciences, Engineering, and Medicine, 2016). By addressing the historical and ongoing underrepresentation of Hispanics in STEM, we can promote diversity and equity in these fields, ultimately leading to a more inclusive and innovative scientific community.

The public, nonprofit, and private sector alike have made large investments in the recruitment and retention of diverse talent in STEM industries across varying educational and professional levels. One type of organization dedicated to this purpose is affinity, or focal demographic, professional associations who provide community and a social network for underrepresented groups in STEM. One of these professional membership associations, the Society of Hispanic Professional Engineers (SHPE), is dedicated to change lives by empowering the Hispanic and Latino community to realize its fullest potential and to impact the world through STEM awareness, access, support, and development. As such, SHPE provides educational programs that aim to narrow the Hispanic and Latino representation disparity in STEM education and career fields. Demographic-specific professional societies, like SHPE, play a crucial role in providing underrepresented students with a sense of community and support throughout their academic careers in STEM (Science, Technology, Engineering, and Mathematics). They offer a welcoming and inclusive environment where students from diverse backgrounds can connect with peers and mentors who share similar experiences and challenges. By facilitating networking opportunities, mentorship programs, and conferences that celebrate diversity, these societies help underrepresented students build a strong sense of belonging within the STEM community. This sense of community fosters resilience, boosts self-confidence, and provides invaluable resources and role models, ultimately contributing to the retention and success of underrepresented individuals pursuing STEM careers. That being said, a key to understanding the success of their efforts is being able to measure the impact they have on factors that influence recruitment and retention in STEM academic and professional careers.

STEM identity and a sense of belonging play pivotal roles in shaping college student success and retention in STEM degree programs. Research in this area highlights the significance of these factors in influencing students' persistence and academic achievement. A strong STEM identity is often correlated with a higher likelihood of remaining in a STEM program. Riconscente discusses how students with a robust STEM identity tend to have a clearer sense of purpose, motivation, and self-efficacy within their chosen field, making them more likely to persist (2013). Additionally, studies emphasize the importance of fostering a positive STEM identity, especially among underrepresented minority students, as it can counteract stereotypes and boost students' resilience in the face of challenges (Cheryan et al. 2017).

Belongingness is another critical aspect. Research finds that students who feel like they belong in their STEM community are more likely to remain engaged and persist in their programs (Good et al. 2012). Similarly, Walton and Cohen (2007) discuss the concept of "belonging uncertainty" and its detrimental effects on students' academic success. They highlight the importance of creating inclusive environments that reduce this uncertainty, helping students feel that they are valued members of their STEM community. Furthermore, both STEM identity and belonging are influenced by classroom and programmatic practices. Research emphasizes the role of faculty-student interactions, mentorship, and supportive pedagogy in shaping STEM identities and fostering a sense of belonging (Estrada et al., 2011). Scholars argue that these factors can help students overcome feelings of marginalization or imposter syndrome. Convincingly, STEM identity and a sense of belonging are crucial factors influencing college student success and retention in STEM degree programs. It is imperative for educational institutions to prioritize interventions and practices that promote a positive STEM identity and create inclusive environments where students from all backgrounds can truly belong, as this will contribute to a more diverse, equitable, and successful STEM workforce.

Measuring STEM identity and a sense of belonging is critical for understanding their impact on academic success and retention in STEM fields. Scholars have developed various methods and instruments used to assess STEM identity and belonging among college students. STEM identity is often measured through self-report surveys or scales that assess students' identification with and commitment to their STEM field. The "STEM Identity Scale" developed by Setren et al. is a commonly used instrument that evaluates students' sense of belonging and identification with STEM disciplines (2019). Additionally, studies have used surveys to assess students' identification with stereotypes and their connection to STEM (Cheryan et al., 2017). Belongingness is typically assessed using self-report measures that gauge students' feelings of inclusion, social acceptance, and connection within their academic community. The "Belongingness Scale" developed by Good et al. is widely utilized to measure students' sense of belonging in STEM fields (2012). Expanding on Good et al.'s work in belongingness measurement, Walton and Cohen have also employed surveys to assess belonging uncertainty and its impact on student outcomes (2007). Emerging research incorporates neuroscientific techniques like fMRI to examine neural responses associated with STEM identity and belonging. For example, studies have used neuroimaging to investigate the brain's response to in-group and out-group cues, shedding light on the neural underpinnings of belongingness (Mason & Zonia, 2015). Qualitative methods, such as interviews and focus groups, are valuable for exploring the nuanced aspects of STEM identity and belonging. These approaches allow researchers to delve deeper into students' experiences, uncovering the qualitative dimensions that may not be captured by quantitative measures (Estrada et al., 2011). Some studies employ behavioral measures, such as participation rates in STEM-related extracurricular activities or enrollment patterns in advanced STEM courses, as indicators of STEM identity and belonging (Riconscente, 2013). These measures offer insights into how identity and belonging influence students' choices and behaviors.

As highlighted above, the measurement of STEM identity and belonging is multifaceted, combining self-report surveys, qualitative approaches, behavioral indicators, and, more recently, neuroscientific methods. Developing the proper construct for measuring these factors is key for measuring the efficacy of programs developed to increase STEM identity and belongingness. Moreover, Estrada et al. highlight the integration of cultural components of these measures particularly for underrepresented groups in STEM. This paper contributes to existing literature on the pathways and STEM identities of Hispanic students and professionals in STEM fields. In 2022, SHPE conducted a comprehensive needs assessment survey among its members. The survey aimed to gain a deeper understanding of the challenges and needs faced by members and identify ways in which the organization could provide support. The collected data was utilized to develop tailored programs, services, and events that cater to the community's needs and assist members in achieving their personal and professional goals.

As part of the needs assessment, the research team examined key factors such as STEM identity, STEM belonging, and satisfaction in STEM careers. The construct validity of the survey instrument was assessed using Cronbach's alpha coefficients, and subgroup comparisons were conducted based on career stage, gender, generation-to-college status, community college experience, and various combinations thereof.

This paper provides an overview of the constructs utilized, the methodology employed for data analysis, and essential findings derived from the results. The study sheds light on important insights and implications for supporting Hispanic individuals in their STEM journeys.

Methodology

In this section, a detailed account of the methodology employed for SHPE's 2022 Needs Assessment is provided. The primary objective of this study was to gain a profound understanding of the multifaceted challenges, needs, and issues confronting SHPE's members. Additionally, the aim was to identify innovative ways to bolster their personal and professional growth and pave the path for their success within the SHPE community.

The study was undertaken with a clear goal in mind—to enhance the success and well-being of SHPE's members. By gaining insights into their unique challenges and requirements, the organization was better equipped to design programs and services that would address these issues directly.

To gather the crucial data that would inform these efforts, SurveyMonkey, a widely recognized online survey platform, was chosen as the data collection tool. The questionnaire, carefully crafted for precision, consisted of 54 questions. These questions spanned a broad spectrum, encompassing demographics and delving into the nuanced aspects of members' needs, preferences, and recommendations.

Respondents, on average, dedicated approximately 17 minutes to completing the survey. The survey invitations were distributed in four distinct batches, spanning the timeframe from December 2021 to April 2022. A total of 36,186 invitations were sent out to engage SHPE's members in this critical assessment as shown in Figure 1.

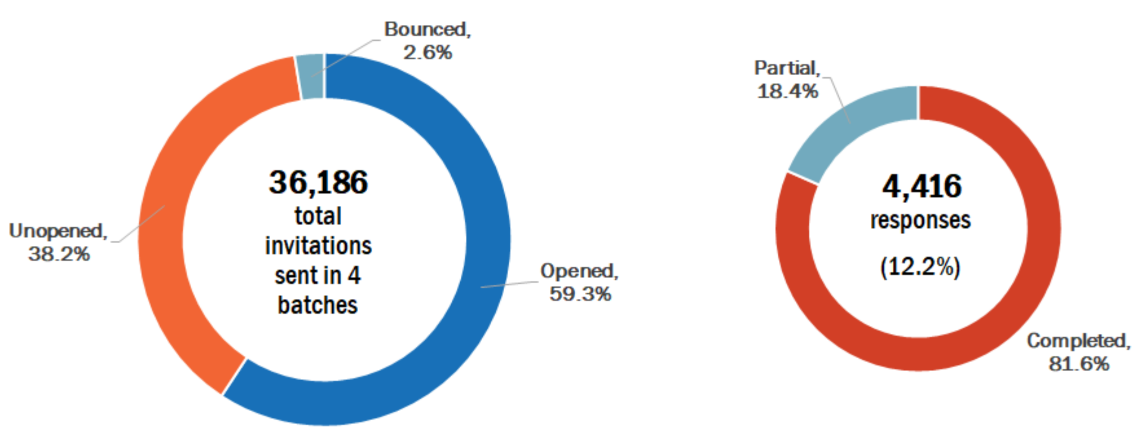


Figure 1 SHPE's 2022 Needs Assessment Response Rate

Figure 1 also shows the opening rate, which stood at a significant 59.3%. This rate significantly exceeded industry benchmarks, typically hovering between 15-25%. Furthermore, 12.2% of those responded to the survey, culminating in a robust sample size of 4,416 responses. This response rate was well above the industry-standard click rates of 3-5%, underscoring the remarkable significance of the study within the SHPE community.

The completion rate for the survey further affirmed its success, boasting a remarkable 81.6%. This figure exceeded the typical response rates, which generally range from 5% to 30%. This high level of participation demonstrated SHPE's members' strong engagement and commitment to contributing to this assessment.

The survey harnessed the perspectives of 4,416 individuals, creating a comprehensive dataset to inform SHPE's future endeavors. It's essential to highlight that the survey included optional questions, leading to varying sample sizes for different aspects of the study.

Regarding member types, undergraduates emerged as the largest response group, followed by professionals, graduate students, and professionals in graduate school, as illustrated in Table 1.

Table 1 Member Type (Sample Size 4,248)

Group	Sample Size	Percentage
Undergraduate	2,296	54.0%
Graduate	470	11.1%
Professionals	1,307	30.8%
Professionals in Grad School	121	2.8%

The demographic composition of the respondents unveiled a diverse tapestry within the SHPE community. Specifically, 53.7% of respondents identified as male, 44.6% as female, and 1.7% selected other categories, including non-binary.

Table 2 provides a detailed breakdown of racial and ethnic identities among the respondents, with a significant 87.1% identifying as Hispanic, Latina/o/x/e. Notably, the top four heritage groups represented were Mexico (54.5%), Puerto Rico (8.8%), Colombia (6.8%), and Spain (5.5%).

Table 2 Race/Ethnicity Composition (Sample Size 4,280, "Select All That Apply" Question)

Race/Ethnicity	Percentage
Hispanic, Latina/o/x/e	87.1%
White or Caucasian	17.6%
Asian or Asian American	7.2%
Black or African American	3.6%
American Indian or Alaska Native	2.7%

Within the survey, 65% of respondents were born in the United States and were not immigrants themselves, shedding light on the diverse backgrounds within the SHPE membership.

In terms of STEM fields, Figure 2 offers an insightful snapshot, with 80.2% of respondents identifying themselves as part of the engineering field, followed by technology.

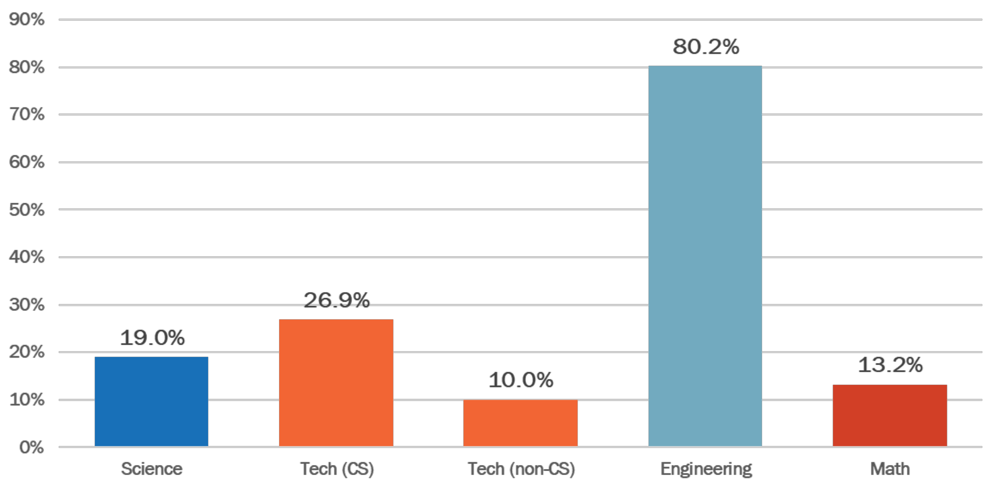


Figure 2 How Respondents Identify Their Field (Sample Size 4,286, "Select All That Apply" Question)

Further insights revealed that 54.3% of respondents had completed some community college credits, and 52.8% identified as first-generation college students. This classification was calculated by asking respondents to indicate the highest level of education attained by each of their parents. As depicted in Table 3, this data was further dissected to provide a comprehensive view of these results across various demographic groups. These comprehensive insights into SHPE's members' backgrounds and affiliations offer a thorough understanding of the survey's participant characteristics.

Table 3 First-Gen to College Percentage per Group

Group	Percentage
Undergraduate	52.1%
Graduate	54.3%
Professionals	51.0%
Professionals in Grad School	53.7%

The survey also incorporated a range of constructs to comprehensively assess the experiences, perceptions, and identities of respondents within the STEM landscape. These constructs were meticulously designed to gauge various dimensions of their STEM education and career journeys. In this section, we delve into the details of these constructs and how they were employed to gain deeper insights into the multifaceted factors shaping our respondents' experiences and aspirations.

<u>STEM Identity</u>

STEM identity, a pivotal construct in the study, refers to an individual's sense of belonging, satisfaction, and professional identification within the STEM community. This construct plays a crucial role in shaping one's STEM education journey and career aspirations. To gauge STEM identity, participants responded to a set of questions presented on a scale from "strongly disagree" to "strongly agree," probing their perceptions of themselves in relation to their STEM identity.

Cultural Perspective

Cultural perspective, another important construct, involves how people see the alignment of their ethnic and cultural background with their choice of a STEM career. It examines how cultural values and support from family and elders impact their journey in STEM. Participants expressed their agreement or disagreement with statements that explored their cultural perspective.

Recent Events

The construct of recent events focuses on the impact of life circumstances and experiences over the past month on respondents' thoughts and feelings, aiming to understand how these events influence their STEM education and career journey. Participants indicated how often they felt or thought in certain ways during the last month.

Underrepresented Status

Underrepresented status is a critical construct examining the impact of one's minority status within the STEM discipline, assessing perceptions of stereotypes, biases, and evaluations related to underrepresented status. Participants shared their experiences at school/work and how often they felt their underrepresented status influenced others' perceptions.

Perspectives on Micro-Affirmations

Micro-affirmations, defined as small, often subtle acts of support that promote success, were explored as a construct, considering how frequently participants experienced micro-affirmations related to their academic and career journeys in STEM. Participants estimated their frequency of experiencing micro-affirmations over the past month.

Perspectives on Classes/Work

This construct delved into participants' perspectives on their academic experiences, specifically their classes and coursework within the STEM field, aiming to understand their level of engagement, satisfaction, and intrinsic motivation in their educational pursuits. Participants indicated their level of agreement or disagreement with statements describing their experiences in classes or work.

Perceptions on Feelings of Belonging

The construct of feelings of belonging explores how participants perceive their acceptance, recognition, and inclusion within their STEM major or work, delving into their sense of identity, safety, fairness, autonomy, and understanding within their STEM academic/work environment. Participants rated the extent to which they felt each statement was true for them in their STEM major on a scale from 1 (never) to 10 (always).

In the analysis of the data obtained from these constructs, the research team initiated their examination by calculating Cronbach's alpha coefficients as a measure of construct validity. Cronbach's alpha, a statistical measure, assesses the internal consistency and reliability of a set of items within a questionnaire or scale. It quantifies the extent to which the items within a construct consistently measure the same underlying concept. A high Cronbach's alpha value, typically ranging from 0 to 1, indicates greater internal consistency and reliability. In the context of this study, a high Cronbach's alpha signifies that the questions within each construct reliably measure the targeted aspects of respondents' experiences and perceptions within the STEM landscape.

Once the validity of the constructs was established through Cronbach's alpha, the research team proceeded with subgroup comparisons based on various demographic factors. These demographic factors included:

Career Stage: This comparison segment explored differences in responses among individuals at different stages of their careers within the STEM field (student vs. professional), providing insights into how experiences and perceptions vary throughout one's professional journey.

Gender: An examination of gender-related differences aimed to uncover potential disparities in STEM experiences and perceptions, contributing to a broader understanding of gender dynamics within the field.

College Generation: This subgroup analysis delved into the experiences of individuals based on whether they were first-generation college students or not, shedding light on the influence of familial educational backgrounds on STEM pursuits.

Community College: Respondents who had completed some community college credits were examined separately to discern any unique experiences or challenges faced by this group as they transitioned into STEM fields.

Graduate Program: A specific focus on individuals pursuing graduate programs within STEM provides insights into the experiences and perceptions of those at advanced stages of their education and careers.

U.S. Generation: This analysis explored differences between respondents who were born in the United States and those who were immigrants, offering insights into the diversity of backgrounds within the STEM community.

Combinations: To gain a more nuanced understanding, all possible subgroup pairs were also explored.

Each of these subgroup comparisons offered valuable insights into the intricacies of respondents' experiences and perceptions. In the next section of the paper, we delve into the results of the subgroup comparisons based on the demographic factors mentioned above.

Results and Discussion

As stated in the methodology section, Cronbach alpha coefficients were calculated to assess the internal consistency of the measurement scales for the various constructs examined in the study. A Cronbach alpha coefficient exceeding 0.7 is generally considered indicative of strong internal consistency.

Table 4 Cronbach Alpha Coefficients for Constructs Examined

Construct	Cronbach Alpha
STEM Identity	0.90
Cultural Perspective	**0.59**
Recent Events	**0.68**
Underrepresented Status	0.88
Perspectives (Micro-Affirmations)	0.92
Perspectives (Classes/Work)	0.86
Perspectives (Feelings)	0.95

The study's results revealed that, for most constructs, the Cronbach alpha coefficients surpassed the 0.7 threshold, signifying good internal consistency among the items (Table 4). However, two constructs, specifically "Cultural Perspective" and "Recent Events", exhibited low Cronbach alpha coefficients. This implies that the items within these two constructs were not as closely related or internally consistent as desired. Consequently, these were excluded from further analysis.

Table 5 presents the average responses across the various constructs, providing a quick overview of the overall sentiment expressed by the survey participants. These general results lay the foundation for the subsequent analyses and discussions presented.

Table 5 Constructs Average Responses

Construct	Average Response
Underrepresented Status	2.32
Perspectives (Micro-Affirmations)	3.30
STEM Identity	4.10
Perspectives (Classes/Work)	4.27
Perspectives (Feelings)	7.25

Starting with "Underrepresented Status" and an average score of 2.32 which suggests that participants tended to disagree or only slightly agree with statements related to stereotypes, biases, and unfair evaluations associated with their underrepresented status within the STEM discipline. In other words, participants did not strongly endorse these negative perceptions.

This suggests that many participants in the study do not perceive themselves as subject to stereotypes that suggest lower competence due to their underrepresented status. They also do not often feel that others view them as insufficient solely because of their underrepresented identity. Furthermore, the average responses indicate that participants do not often feel that their ethnicity significantly affects judgments about their performance, nor do they perceive systemic bias in the evaluation processes they encounter.

The average response of 3.3 for the construct "Perspectives on Micro-Affirmations" offers significant insights into how the survey participants perceive the impact of micro-affirmations within their academic and career journeys in the STEM field. This score indicates that, on average, participants believe they receive a moderate level of support through micro-affirmations in this context.

In practical terms, this means that many participants reported experiencing affirmations and acts of support that contribute positively to their academic and career endeavors in STEM. These micro-affirmations likely include messages of encouragement, recognition of their abilities, and a sense of belonging, all of which can bolster their confidence, motivation, and overall well-being within STEM disciplines.

STEM identity emerged as a crucial construct, reflecting individuals' belonging, satisfaction, and professional identification within STEM fields. The average score of 4.21 indicates a strong and positive STEM identity among participants.

This robust identity signifies that many individuals in the study strongly affiliate with the STEM community, seeing themselves as integral members who derive fulfillment and belonging from these fields. It underscores the significance of nurturing and supporting STEM identity, as it can motivate and contribute to success in STEM education and careers.

The construct of "Perspectives on Classes/Work" provides valuable insights into participants' attitudes and experiences concerning their academic and professional endeavors. The aim of this construct was to assess the level of engagement, satisfaction, and intrinsic motivation in their educational and career pursuits.

With an average score of 4.27, the responses indicate a notably positive perspective among participants regarding their experiences in classes or work activities within the STEM discipline. This average score highlights the positive outlook and intrinsic motivation that participants associate with their educational and career-related activities in STEM. These findings suggest that many individuals within the study not only excel academically and professionally but also derive deep personal fulfillment from their educational and career pursuits.

Finally, the average score of 7.25 for “Perspectives on Feelings”, while not at the highest end of the scale, underscores the positive perceptions participants hold regarding their experiences within the STEM academic or work setting. These findings signify that many individuals not only find a sense of belonging but also experience recognition, inclusivity, fairness, autonomy, and understanding in their STEM pursuits. Such perceptions are pivotal in fostering a welcoming and supportive environment within STEM fields, contributing to the well-being and success of individuals pursuing careers and education in these disciplines.

With a comprehensive understanding of the general sentiments and perceptions of participants as they relate to each of the constructs, the next phase of the analysis delved into the examination of these constructs across different groups. Table 6 displays the Cronbach alpha coefficients for each construct within the various groups examined. All Cronbach alpha coefficients exceed 0.7, once again indicating strong internal consistency in the constructs and ensuring the survey’s reliability in measuring participants’ sentiments and experiences.

Table 6 Cronbach Alphas per Construct and Group

Group/ Construct	STEM Identity	Underrepresented Status	Perspectives (Micro-Affirmations)	Perspective (Classes/ Work)	Perspective (Feelings)
Undergraduate	0.88	0.88	0.92	0.83	0.94
Graduate	0.89	0.86	0.93	0.91	0.96
Professional	0.91	0.89	0.92	0.85	0.96
Professionals in Graduate School	0.92	0.89	0.91	0.86	0.96
Female	0.89	0.87	0.92	0.85	0.95
Male	0.89	0.90	0.92	0.85	0.95
First-Gen	0.89	0.88	0.92	0.85	0.95
Non-First Gen	0.88	0.88	0.92	0.85	0.95
CC Experience	0.89	0.88	0.91	0.84	0.95
No CC Experience	0.89	0.89	0.93	0.85	0.95
Masters	0.90	0.88	0.93	0.87	0.95
PhD	0.85	0.89	0.91	0.87	0.95
1st Generation	0.91	0.88	0.92	0.85	0.95
2nd Generation	0.88	0.89	0.92	0.85	0.95
3rd Generation	0.88	0.85	0.93	0.86	0.95

The initial comparison involved stratifying participants by their career stage, allowing for a comprehensive analysis that compared results across four categories: undergraduate, graduate, professionals, and professionals in graduate school, for each of the constructs. An analysis of variance was conducted to compare groups, revealing statistically significant differences for all of them (P-value of 0.01). This analysis was complemented by a Tukey test to identify the specific groups that exhibited differences. Figure 3 below displays the results of the Tukey test for the various constructs.

Table 7 Average Responses per Construct per Group

Construct	Undergraduate (U)	Graduate (G)	Professional (P)	Prof. in Grad School (P-s)
STEM Identity	4.04	4.08	4.17	4.18
Underrepresented Status	2.48	2.36	2.23	2.23
Perspectives (Micro-Affirmations)	3.51	3.40	2.98	3.31
Perspective (Classes/Work)	4.44	4.24	3.72	4.67
Perspective (Feelings)	7.01	7.12	7.29	7.56

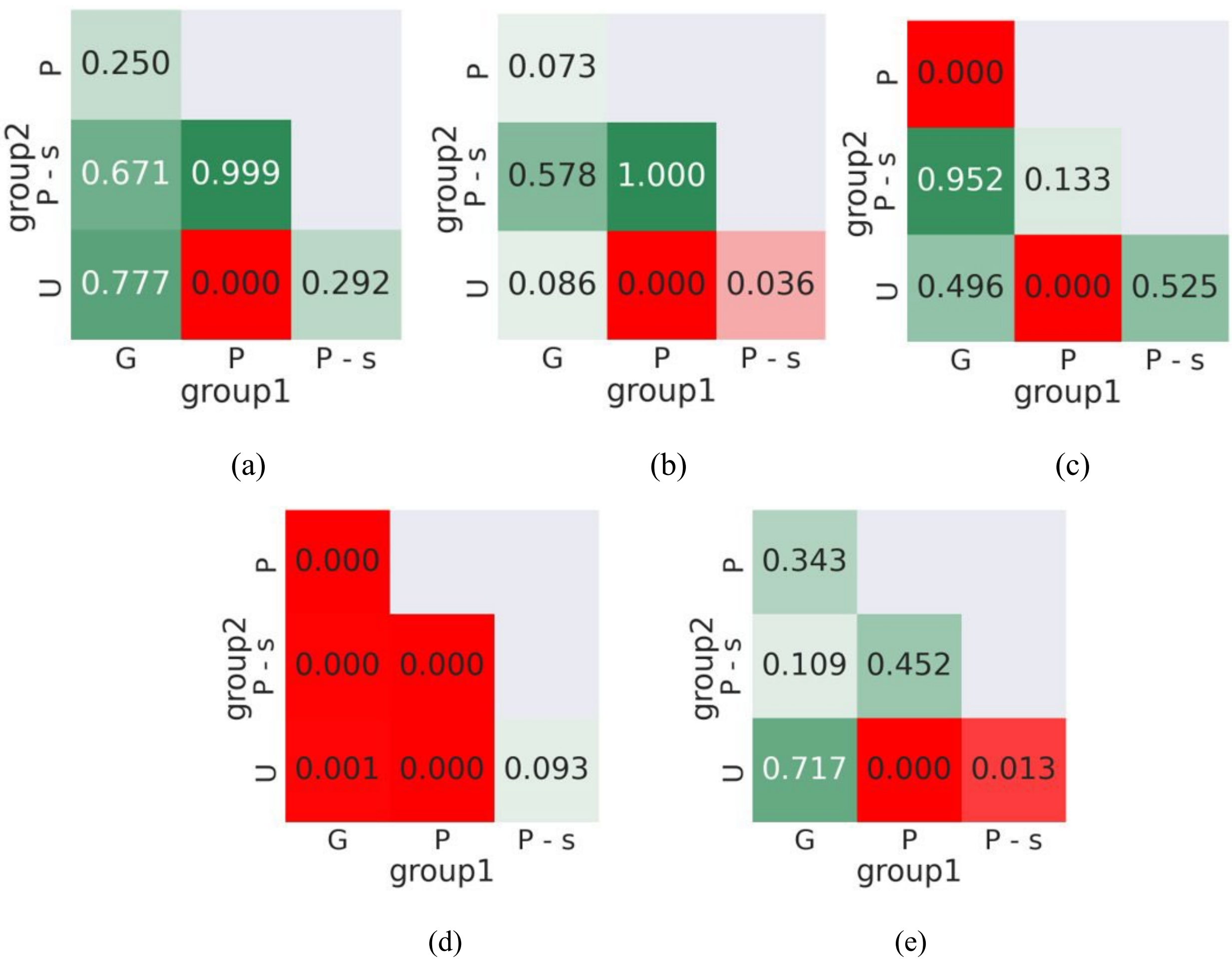


Figure 3 Tukey Test Results for (a) STEM Identity, (b) Underrepresented Status, (c) Micro-Affirmations, (d) Classes/Work, (e) Feelings

From these figures in combination with the averages, we can conclude the following:

- For STEM Identity, statistically significant differences were observed between undergraduates and professionals, suggesting that professionals tend to have a slightly stronger sense of STEM identity than undergraduate students.
- For Underrepresented Status, statistical differences were found between undergraduates and professionals, as well as between professionals and professionals in graduate school. This indicates that undergraduates tend to have a somewhat higher perception of underrepresented status compared to professionals and professionals in graduate school, who hold similar perceptions. A higher perception in this context suggests that undergraduates are more likely to perceive that they face challenges, stereotypes, biases, or unfair evaluations associated with their underrepresented identity within their STEM discipline.
- For Micro-Affirmations, differences were observed between undergraduates and professionals, as well as between graduate students and professionals. This suggests that undergraduates and graduate students tend to experience micro-affirmations more positively than professionals.

- For Perspectives about Classes/Work, statistically significant differences were found among all groups, except for undergraduate and professionals in graduate school. Results suggest that while undergraduates and professionals in graduate school tend to report more positive perceptions, professionals, who are already established in their careers, may have somewhat less positive views.
- For Feelings, differences were noted between undergraduates and professionals, as well as between undergraduates and professionals in graduate school. While undergraduates may initially perceive slightly lower levels of belonging, professionals, and especially those in graduate school, continue to experience high levels of inclusion and support.

The subsequent analysis involved comparing the constructs between genders. Table 8 presents the average responses and p-values of the comparison between the two gender groups. Notably, all constructs demonstrated statistically significant differences between genders, with the exception of Perspectives on Classes/Work, where no significant difference was observed.

Table 8 Average Responses per Construct and Gender

Construct	Female	Male	P-value
STEM Identity	4.06	4.13	0.009
Underrepresented Status	2.44	2.33	0.001
Perspectives (Micro-Affirmations)	3.26	3.39	0.015
Perspective (Classes/Work)	4.18	4.22	0.456
Perspective (Feelings)	7.06	7.22	0.009

As shown, women tended to score lower in STEM identity, micro-affirmations, and feelings of belonging, indicating potential areas of concern. The lower score in STEM identity among women suggests that they may experience a somewhat weaker sense of belonging, satisfaction, and professional identification within STEM fields compared to their male counterparts.

Moreover, women scoring higher in underrepresented status may indicate that they are more acutely aware of the challenges, stereotypes, biases, or unfair evaluations associated with their underrepresented identities within STEM. In the context of micro-affirmations and feelings of belonging, lower scores among women suggest that they may be experiencing fewer affirmations and a reduced sense of acceptance, recognition, and inclusion within the STEM environment.

The analysis progressed by comparing individuals who are first-generation college students with those who are not. In Table 9, the average responses, and corresponding p-values for the comparison between these two groups are displayed. Statistically significant differences were observed for STEM identity, underrepresented status, and perspectives on feelings, indicating distinct experiences and perceptions between first-generation college students and their counterparts.

Table 9 Average Responses and P-Values per Construct and Generation to College

Construct	1st-Gen	Non-1st-Gen	P-value
STEM Identity	4.06	4.12	0.027
Underrepresented Status	2.42	2.34	0.010
Perspectives (Micro-Affirmations)	3.30	3.36	0.288
Perspective (Classes/Work)	4.20	4.21	0.833
Perspective (Feelings)	7.05	7.21	0.007

As seen in Table 9, first-generation students scored lower in STEM identity, indicating a potentially weaker sense of belonging, satisfaction, and professional identification within the STEM community. Furthermore, first-generation college students scoring higher in underrepresented status suggests a heightened awareness of challenges, stereotypes, biases, or unfair evaluations associated with their minority status. Lastly, the lower scores of first-generation students in the construct of perspectives on feelings indicate that they may be experiencing a reduced sense of acceptance, recognition, and inclusion within the STEM environment when compared to non-first-generation college students.

Table 10 Average Responses and P-Values per Construct and Community College Experience

Construct	Community College	No Community College	P-value
STEM Identity	4.09	4.09	0.918
Underrepresented Status	2.39	2.38	0.748
Perspectives (Micro-Affirmations)	3.29	3.36	0.176
Perspective (Classes/Work)	4.20	4.21	0.696
Perspective (Feelings)	7.13	7.13	0.987

Comparisons between individuals with community college experience and those without such experience were conducted as part of the analysis. Table 10 presents the average responses along with corresponding p-values for the comparison between these two groups. Notably, the analysis revealed no statistically significant differences between these two groups across the measured constructs. This suggests that starting one's STEM education at a community college does not appear to have a discernible effect on the constructs under investigation.

Table 11 shows there was also an absence of statistically significant differences between graduate students pursuing a master's degree and those pursuing a Ph.D. suggesting that, in the context of this study, both groups share similar perceptions and experiences across the measured constructs independent of the type of graduate degree being pursued.

Table 11 Average Responses and P-Values per Construct and Graduate Degree Pursued

Construct	Masters	PhD	P-value
STEM Identity	4.03	4.16	0.138
Underrepresented Status	2.35	2.36	0.893
Perspectives (Micro-Affirmations)	3.38	3.29	0.613
Perspective (Classes/Work)	4.18	4.27	0.433
Perspective (Feelings)	7.21	7.00	0.315

The final set of comparisons focused on generational status, which reflects individuals' family history and presence in the United States. As outlined in Table 12, these generational groups were defined as first, second, and third generations.

- First Generation: This category includes individuals who are immigrants themselves, having been born outside of the United States and subsequently migrated to the country.
- Second Generation: Second-generation individuals are born in the United States to immigrant parents, representing the first generation of their family to be born in the U.S.
- Third Generation: This group comprises individuals who are born in the United States to U.S.-born parents, signifying that neither they nor their parents are immigrants.

Additionally, the "third generation +" category included individuals who are beyond the third generation, indicating an even longer history of their family's presence in the United States.

Table 12 Average Responses and P-Values per Construct and US Generation

Construct	First Generation	Second Generation	Third Generation +	P-Value
STEM Identity	4.07	4.11	4.09	0.365
Underrepresented Status	2.34	2.42	2.37	0.070
Perspectives (Micro-Affirmations)	3.33	3.35	3.28	0.651
Perspective (Classes/Work)	4.24	4.20	4.13	0.077
Perspective (Feelings)	7.26	7.05	7.09	0.007

The analysis revealed the sole difference within the constructs to be in the category of perspectives, specifically feelings. It's worth noting that underrepresented status and perspectives of classes/work would qualify as different if a threshold of 0.1 were applied, but the more commonly used threshold of 0.05 was employed for this analysis.

Among these generational groups, first-generation individuals rated feelings highest, followed by third-generation individuals, with second-generation individuals rating them the lowest. The complementing Tukey test revealed a statistically significant difference between the first and second generations as seen in Figure 4.

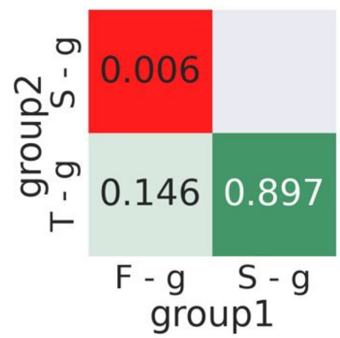


Figure 4 Tukey Test Results for Generational Differences

In the context of this analysis, this suggests that, among Hispanic individuals in the U.S., those who are first-generation tend to report the highest levels of positive feelings in the STEM community. In contrast, second-generation individuals, who may have a more complex cultural or identity experience bridging their heritage and American culture, reported slightly lower levels of these positive sentiments.

Various combinations of these groups were also compared, and it was found that only the comparisons involving gender and career stage, as well as college generation and career stage, yielded statistically significant differences. Tables 13 and 14 display the Cronbach alpha coefficients for the various combinations, with all coefficients exceeding the 0.7 threshold, ensuring the reliability of the data, and allowing for the continuation of the analysis and Tables 15 and 16 display the average responses and P-values.

Table 13 Cronbach Alpha Coefficients per Construct and Group Combination. F is for Female, M is for Male, U is for Undergraduate, G is for Graduate, P is for Professional and PGS is for Professional in Graduate School.

Construct	FU	FG	FP	FPGS	MU	MG	MP	MPGS
STEM Identity	0.88	0.88	0.91	0.87	0.89	0.88	0.89	0.91
Underrepresented Status	0.87	0.86	0.86	0.86	0.89	0.91	0.90	0.85
Perspective (Micro-Affirmations)	0.92	0.92	0.92	0.93	0.92	0.92	0.93	0.91
Perspective (Classes/Work)	0.83	0.86	0.88	0.78	0.85	0.88	0.84	0.81
Perspective (Feeling)	0.95	0.95	0.95	0.92	0.94	0.96	0.95	0.96

As depicted in Table 15, when examining the combinations of gender and career stage, significant differences emerged for underrepresented status, micro-affirmations, and classes/work. A deeper analysis through Tukey tests (Figure 5) unveiled the following insights into these various constructs.

Table 14 Cronbach Alpha Coefficients per Construct and Group Combination. 1st is for First Generation-to-College, Non-1st is for Non-First Generation-to-College, U is for Undergraduate, G is for Graduate, P is for Professional and PGS is for Professionals in Graduate School.

Construct	1st U	1st G	1st P	1st PGS	Non-1st U	Non-1st G	Non-1st P	Non-1st PGS
STEM Identity	0.90	0.88	0.90	0.90	0.88	0.90	0.90	0.88
Underrepresented Status	0.88	0.90	0.88	0.86	0.89	0.87	0.89	0.87
Perspective (Micro-Affirmations)	0.93	0.91	0.93	0.92	0.92	0.93	0.92	0.92
Perspective (Classes/Work)	0.84	0.87	0.87	0.81	0.84	0.87	0.86	0.79
Perspective (Feeling)	0.95	0.95	0.96	0.95	0.94	0.95	0.95	0.96

Table 15 Average Responses per Construct and Group Combination. F is for Female, M is for Male, U is for Undergraduate, G is for Graduate, P is for Professional and PGS is for Professional in Graduate School.

Construct	FU	FG	FP	FPGS	MU	MG	MP	MPGS	P-value
STEM Identity	4.05	4.02	4.07	4.20	4.11	4.12	4.16	4.27	0.090
Underrepresented Status	2.51	2.41	2.32	2.42	2.39	2.31	2.26	2.20	0.000
Perspective (Micro-Affirmations)	3.37	3.23	3.01	3.44	3.50	3.45	3.22	3.48	0.000
Perspective (Classes/Work)	4.31	4.05	3.98	4.65	4.34	4.31	3.98	4.44	0.000
Perspective (Feelings)	7.02	7.02	7.15	6.64	7.17	7.24	7.25	7.62	0.029

Table 16 Average Responses per Construct and Group Combination. 1st is for First Generation-to-College, Non-1st is for Non-First Generation-to-College, U is for Undergraduate, G is for Graduate, P is for Professional and PGS is for Professionals in Graduate School.

Construct	1st U	1st G	1st P	1st PGS	Non-1st U	Non-1st G	Non-1st P	Non- 1st PGS	P-value
STEM Identity	4.06	4.06	4.07	4.14	4.10	4.07	4.15	4.31	0.186
Underrepresented Status	2.51	2.33	2.32	2.22	2.38	2.38	2.25	2.34	0.001
Perspective (Micro-Affirmations)	3.42	3.39	3.06	3.39	3.46	3.31	3.20	3.47	0.001
Perspective (Classes/Work)	4.34	4.20	3.95	4.34	4.31	4.19	4.00	4.62	0.011
Perspective (Feelings)	6.97	7.21	7.10	7.48	7.22	7.04	7.29	6.99	0.012

Underrepresented Status:

The difference between female professionals and female undergraduates indicates that, within this context, female undergraduates tend to perceive a higher degree of underrepresented status-related challenges. This might imply that female undergraduates are more attuned to or affected by issues related to stereotypes, biases, and unfair evaluations based on their underrepresented status.

Similarly, the distinction between female undergraduates and male professionals suggests that female undergraduates may be more sensitive to or have a stronger awareness of underrepresented status-related issues compared to their male professional counterparts.

Perspectives (Micro-Affirmations):

The finding that male undergraduates score higher than female professionals in experiencing micro-affirmations might suggest that male undergraduates perceive a greater frequency of subtle support or encouragement in their STEM academic and career pursuits. This could indicate that support mechanisms like micro-affirmations may be more effective or prominent for male undergraduates.

The observed difference between female professionals and female undergraduates, where female undergraduates score it higher, implies that female undergraduates tend to perceive a higher level of micro-affirmations compared to their female professional counterparts.

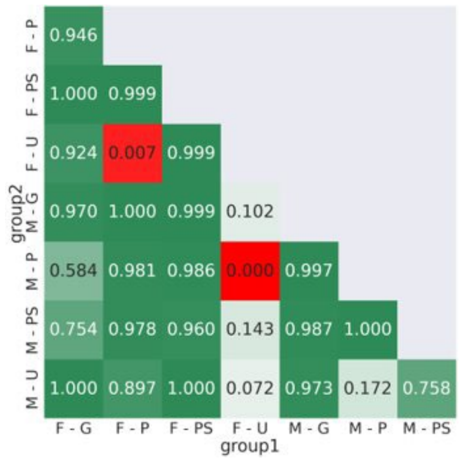
Similarly, the difference between male professionals and male undergraduates underscores that male undergraduates in this context report experiencing micro-affirmations more frequently.

Perspective (Classes/Work):

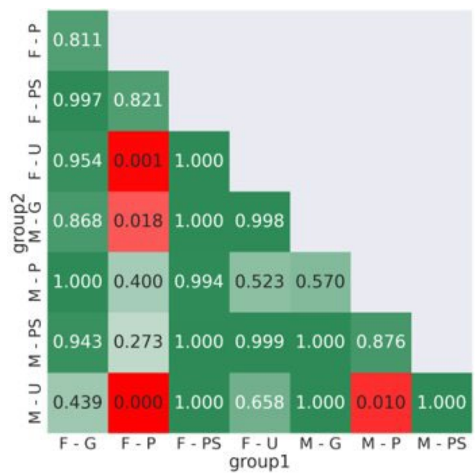
Differences noted between female graduates and male undergraduates signify that, within these groups, male undergraduates tend to have a more positive perspective on their STEM classes and work experiences. This may suggest variations in engagement and satisfaction levels between these two subgroups.

The extensive differences observed among various groups in this construct highlight a complex interplay of demographic factors. For instance, male undergraduates and male professionals in graduate school express more positive perspectives compared to female graduates and female professionals in graduate school. This intricate dynamic might stem from a combination of career stage, gender, and educational background, indicating the multifaceted nature of these perceptions.

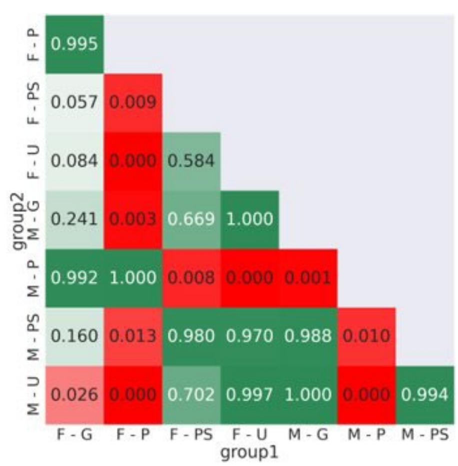
Furthermore, the distinction between female professionals in graduate school and male professionals suggests that female professionals in graduate school report more favorable perspectives on their STEM classes and work compared to their male counterparts. The remaining differences, such as between female undergraduates and male professionals or between males in graduate school and male professionals, imply variations in how different groups perceive their STEM academic and professional experiences.



(a)



(b)



(c)

Figure 5 Tukey Test Analysis comparing Gender and Career Stage for (a) Underrepresented Status, (b) Perspectives Regarding Micro-Affirmations, and (c) Perspectives of Classes/Work.

Table 16 provides a comprehensive overview of the intricate relationship between college generation and career stage, revealing significant differences in underrepresented status perceptions and various perspectives, encompassing micro-affirmations, classes/work, and feelings. Combining this with the Tukey analysis shown in Figure 6, implications within the context of this study are discussed below.

Underrepresented Status:

The observed difference between first-generation undergraduates and non-first-generation professionals suggests that first-generation undergraduates may be more acutely aware of the challenges linked to underrepresented status within STEM. This heightened awareness could be attributed to their transitional status, potentially making them more sensitive to stereotypes, biases, and unfair evaluations.

Furthermore, the distinction between first-generation professionals and first-generation undergraduates implies that even within the same college generation group, transitioning from college to a professional STEM career may bring about a change in perceptions. This suggests that as individuals move from an educational setting to a professional one, their experiences and perceptions may evolve.

Perspectives (Micro-Affirmations):

The difference between first-generation professionals and non-first-generation undergraduates indicates that micro-affirmations are encountered more by non-first-generation undergraduates during their academic journey.

Similarly, the contrast between first-generation professionals and first-generation undergraduates underscores that micro-affirmations appear to have a more significant impact on the latter, contributing to their positive perceptions in the STEM field.

Perspectives (Classes/Work):

Differences noted between first-generation professionals and non-first-generation undergraduates indicate that non-first-generation undergraduates tend to view their STEM classes and work more positively. So even when evolving to professionals, first-generation-to-college professionals scored lower this construct when compared to their non-fist-generation-to-college undergraduate counterparts. This could be due to a variety of factors, including prior exposure to STEM environments or the influence of micro-affirmations, contributing to a more optimistic outlook during their undergraduate years.

The distinction between first-generation undergraduates and non-first-generation professionals highlights that independent of college generation there’s a dip when transitioning from undergraduate student to professional in regards of perspectives around classwork and work.

Perspectives (Feelings):

First-generation undergraduates differed from both non-first-generation undergraduates and professionals, indicating that they may face unique challenges in terms of feelings related to belonging, recognition, and inclusion within STEM.

Moreover, it's evident that the difference in college generation status, specifically between first-generation-to-college professionals and their non-first-generation-to-college peers, significantly influences perceptions related to belonging and recognition during the transition from college to a STEM profession. Non-first-generation-to-college professionals tend to experience a smoother transition, benefiting from their prior experiences and established support networks from their college years, which can lead to more positive feelings in the STEM profession.

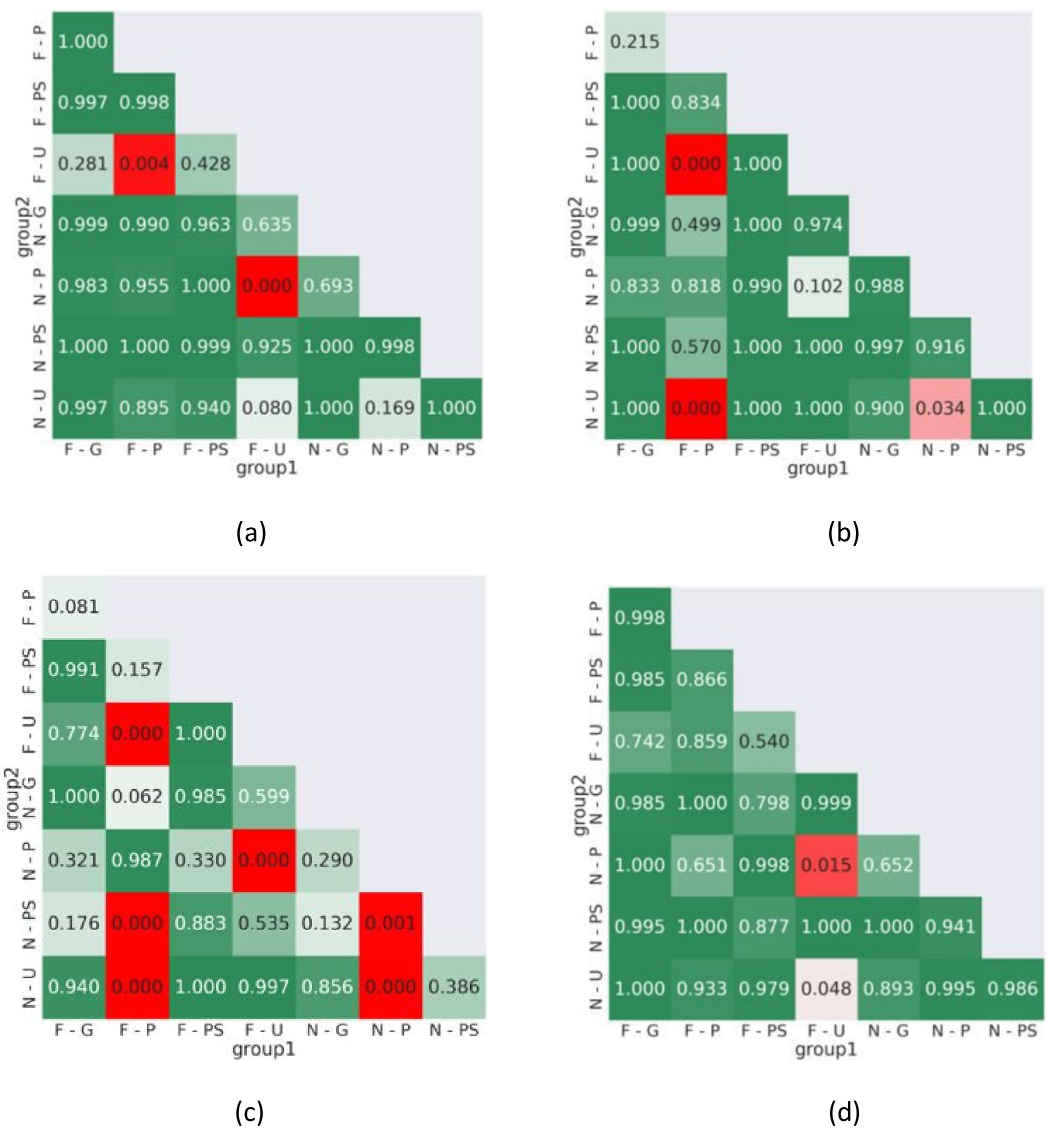


Figure 6 Tukey Test Analysis comparing Generation to College and Career Stage for (a) Underrepresented Status, (b) Perspectives Regarding Micro-Affirmations, (c) Perspectives regarding Classes/Work, and (d) Perspectives regarding Feelings.

Conclusions & Recommendations

In this study, we embarked on a comprehensive exploration of the experiences and perceptions of Hispanic individuals in STEM fields, with a particular focus on understanding the role of key constructs such as STEM identity, micro-affirmations, and a sense of belonging. Our findings provide valuable insights into the dynamics of the Hispanic STEM community and offer opportunities for enhancing support and inclusivity in these critical disciplines.

Key Findings:

- Resilience and Self-Assuredness: Our participants demonstrated a remarkable level of resilience and self-assuredness, effectively resisting negative stereotypes and biases associated with their underrepresented status in STEM. This resilience speaks to their determination and confidence within the Hispanic STEM community.
- The Significance of Micro-Affirmations: Micro-affirmations, those subtle acts of support and encouragement, emerged as a meaningful force in the lives of our participants. These gestures fostered a moderate yet impactful level of support within the STEM community, contributing to a sense of inclusion and empowerment.
- The Vital Role of STEM Identity: Our study underscored the pivotal role of STEM identity in shaping the educational and professional trajectories of Hispanic individuals in STEM. A robust STEM identity correlated with a higher likelihood of persistence and success in STEM programs, especially among underrepresented minority students.
- The Power of Belonging: Feelings of belongingness within the STEM community emerged as a driving force behind engagement and persistence. Creating inclusive environments that reduce belonging uncertainty is essential for fostering a sense of value and acceptance among STEM students and professionals.
- Gender and Generational Background Matters: Gender-based differences in STEM identity and belonging highlighted the need for targeted support for women in STEM. Additionally, generational background influenced perceptions within the Hispanic STEM community, emphasizing the importance of tailored initiatives.
- The Potential of Community College Pathways: Our findings suggest that community college students can develop a strong STEM identity and experience a sense of belonging similar to their peers from other educational backgrounds. Recognizing the value of community colleges as entry points into STEM education is important.

Recommendations for Action:

Building on these key findings, we propose a set of actionable recommendations to further support and enhance the experiences of Hispanic individuals in STEM:

- Promote STEM Identity Development: Develop programs and initiatives that actively nurture STEM identity among Hispanic students and professionals. Emphasize the significance of their contributions to STEM fields.

- Expand Micro-Affirmation Programs: Invest in micro-affirmation programs within educational institutions and workplaces, providing consistent and subtle support to underrepresented individuals in STEM.
- Further Research on STEM Identity: Conduct additional research to explore the factors influencing STEM identity, particularly among Hispanic individuals. Utilize this knowledge to tailor interventions and strategies that strengthen STEM identity.
- Foster Passion and Engagement: Create educational environments that encourage passion and engagement in STEM disciplines. Encourage hands-on experiences, exploration, and innovative learning approaches.
- Nurture Positive STEM Environments: Continuously assess the STEM environment to identify areas needing improvement. Address challenges related to diversity and inclusion promptly and create spaces that empower individuals.
- Support Women in STEM: Develop targeted support programs for women in STEM, focusing on enhancing STEM identity, promoting inclusivity, and providing mentorship and networking opportunities.
- Support First-Generation College Students: Design initiatives that address the unique needs and challenges of first-generation college students in STEM. Foster a supportive and inclusive environment that actively promotes feelings of belonging and well-being.
- Recognize the Value of Community Colleges: Acknowledge the role of community colleges as valuable entry points into STEM education. Ensure equitable access to resources and support for students from all educational backgrounds.
- Equitable Support for All Students: Commit to providing equitable resources and support for all STEM students, regardless of their educational pathway. Promote an inclusive and diverse STEM community.
- Consider Generational Background: Tailor support and initiatives to consider the influence of generational background on perceptions within the Hispanic STEM community. Address the unique experiences and needs of diverse subgroups.

In summary, our study has illuminated the complexities of the Hispanic STEM experience, shedding light on the importance of constructs such as STEM identity, micro-affirmations, and a sense of belonging. By implementing these recommendations, we aim to foster a more inclusive, diverse, and supportive STEM community, empowering Hispanic individuals and driving innovation and scientific advancements in the process.

Limitations of the Study and Future Research Directions

While this study has provided valuable insights into the experiences and perceptions of Hispanic individuals in STEM, certain limitations should be acknowledged. These limitations include the use of a cross-sectional design, which offers only a snapshot of participants' experiences and perceptions at a single point in time. Furthermore, the findings may not be generalizable to all underrepresented groups in STEM or individuals from different ethnic backgrounds. Additionally, the study did not extensively investigate potential cultural or regional variations within the Hispanic STEM community. Also, the study did not consider other dimensions of identity, such as socioeconomic status and sexual orientation, which may also impact STEM experiences.

In light of these limitations, we intend to pursue several avenues for future research to further advance our understanding of Hispanic individuals' experiences in STEM. Firstly, we plan to implement longitudinal research designs, allowing us to create a longitudinal dataset that can track changes and trends in the experiences and perceptions of Hispanic individuals in STEM over time. This approach will provide a more comprehensive analysis and shed light on the evolution of their experiences.

Additionally, we aim to diversify our research by exploring potential cultural and regional variations within the Hispanic STEM community. By conducting regional studies, we can gain insights into how geographic factors may influence STEM experiences. Moreover, we intend to consider a broader range of identity dimensions, such as socioeconomic status and sexual orientation, in future studies. This will contribute to a more holistic understanding of diversity within STEM and its intersection with various aspects of individuals' identities.

Furthermore, we plan to complement quantitative data with qualitative methods, including interviews and focus groups. These qualitative approaches will allow for a deeper exploration of personal narratives and contextual factors that shape STEM journeys. We believe that combining quantitative and qualitative data will provide a more comprehensive view of the challenges and opportunities faced by Hispanic individuals in STEM.

Lastly, we aspire to conduct comparative studies that contrast the experiences of Hispanic individuals in STEM with those of other underrepresented groups. This comparative approach will offer valuable insights into the unique challenges and opportunities within the Hispanic STEM community while placing them in a broader context of diversity in STEM fields.

Through these future research endeavors, we aim to address the limitations identified in this study and contribute to a more comprehensive and nuanced understanding of STEM experiences among Hispanic individuals.

Acknowledgements

We extend our sincere gratitude to Dr. Mica Estrada who created the original testing instrument that was adapted for this work. This original instrument development was funded by the National Science Foundation (Grant #DBI-1444853) to Sara EchoHawk (PI), American Indian Science & Engineering Society.

Additionally, we thank Carlos Jerez González for his invaluable contributions to data analysis.

References

Cheryan, S., Plaut, V. C., Davies, P. G., & Steele, C. M. (2017). Ambient belonging: How stereotypical cues impact gender participation in computer science. Journal of Personality and Social Psychology, 113(6), 879-904.

Estrada, M., Woodcock, A., Hernandez, P. R., & Schultz, P. W. (2011). Toward a model of social influence that explains minority student integration into the scientific community. Journal of Educational Psychology, 103(1), 206-222.

Estrada, M., Young, G., Flores, L., Hernandez, P. R., Hosoda, K. K., & DeerInWater, K. (2022). Culture and quality matter in building effective mentorship relationships with native STEM scholars. BioScience, 72(10), 999-1006.

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. Journal of Personality and Social Psychology, 102(4), 700-717.

Mason, M. F., & Zonia, S. (2015). An fMRI investigation of racial ingroup bias. Social Neuroscience, 10(5), 574-585.

National Academies of Sciences, Engineering, and Medicine. (2016). Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways. National Academies Press.

National Science Foundation. (2019). Women, Minorities, and Persons with Disabilities in Science and Engineering. Retrieved from https://ncses.nsf.gov/pubs/nsf21321

Riconscente, M. M. (2013). The role of the affective and social experience of introductory computer science in persistence and achievement. Journal of Educational Computing Research, 48(2), 153-176.

Setren, E., Cortes, K. E., & Lundy, M. (2019). The Role of STEM Identity and Stereotype Threat on Women's STEM Outcomes: A Research Synthesis. AERA Open, 5(1), 2332858419838431.

U.S. Bureau of Labor Statistics, "Employment in STEM Occupations." Employment Projections. Sep. 2022. Retrieved from: https://www.bls.gov/emp/tables/stem-employment.htm

U.S. Census Bureau. (2020). Hispanic or Latino Population. Retrieved from https://www.census.gov/quickfacts/fact/table/US/PST045219

Villarejo, M., Barlow, A. E. L., & Kogan, D. (2008). Encouraging Minority Undergraduates to Choose Science Careers: Career Paths Survey Results. CBE—Life Sciences Education, 7(4), 394–409.

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. Journal of Personality and Social Psychology, 92(1), 82-96.