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Insights and Updates on Identity Constructs Among Hispanic Engineering Students and Professionals: A Longitudinal Study

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Background and Motivation

The significance of STEM (Science, Technology, Engineering, and Mathematics) fields in driving innovation and economic growth in the United States cannot be overstated. STEM occupations have seen a remarkable growth of 79% since 1990, with projections indicating an additional 10.8% increase by 2031 (U.S. Bureau of Labor Statistics, 2022). This expansion underscores the critical role that STEM plays in sustaining the nation's global competitiveness and advancing technological progress (Merigó et al., 2016).

Within this context, the Hispanic/Latino community holds a pivotal role due to its substantial and rapidly growing population. As of 2020, Hispanics and Latinos made up approximately 18.7% of the U.S. population, a figure that has continued to rise significantly over recent decades (U.S. Census Bureau, 2020). Recent reports highlight the economic impact of this demographic, noting that if the U.S. Latino population were its own country, it would rank as the fifth-largest Gross Domestic Product (GDP) in the world. Moreover, Latinos constitute nearly 20% of the U.S. population and 25% of the nation's youth, emphasizing their influence on the future workforce (SHPE-LDC Report, 2023).

Despite these promising demographics, Hispanic/Latino representation in the STEM workforce remains disproportionately low, revealing a vast reservoir of untapped potential, particularly among Latinas. In 2019, Hispanic and Latino individuals accounted for only 9% of the U.S. STEM workforce, despite making up nearly 19% of the overall population (NSF, 2019). This disparity is even more pronounced among Latinas, who face additional challenges and underrepresentation, despite having similar aspirations as their male counterparts for obtaining advanced degrees (SHPE-LDC Report, 2023).

The Society of Hispanic Professional Engineers (SHPE) is at the forefront of addressing this underrepresentation by fostering a sense of belonging and identity among Hispanic/Latino students and professionals in STEM. SHPE’s efforts include measuring constructs such as STEM identity and sense of belonging, which are crucial for understanding the factors that influence retention and success in these fields. Previous research has highlighted the importance of these constructs in shaping academic and career outcomes (NSF, 2019). Recognizing the significance of accurate and reliable measurements, SHPE has revised its methodology to include constructs with stronger internal consistency, as indicated by higher Cronbach alpha values in the 2023 survey.

Furthermore, longitudinal studies play a vital role in capturing changes over time, allowing for a deeper understanding of trends and the long-term impact of interventions. By comparing data from 2022 and 2023, SHPE aims to provide insights into the evolving experiences and challenges faced by Hispanic/Latino individuals in STEM. This approach not only enhances the reliability of the findings but also informs the development of targeted programs and policies to support this underrepresented community.

Methodology

This study utilizes constructs from SHPE's annual Needs Assessment survey, focusing on the 2023 results and offering a comparison with the 2022 constructs to provide a 2-year comparison. A detailed account of the Needs Assessment methodology and framework is provided in a previous paper, with updates incorporated here (Martínez et al., 2024). As a reminder, the primary goal of the Needs Assessment is to gain a comprehensive understanding of the needs, issues, and challenges faced by SHPE members, and to identify ways in which the organization can enhance their personal and professional success. Further, results are published in order to inform the community and help others design effective strategies.

The information obtained from the survey is instrumental in designing and refining programs and services that effectively support SHPE members' growth and achievements. By analyzing survey responses, the organization's initiatives are tailored to better address the specific needs of its members. The analysis of survey data involves both descriptive and inferential statistical methods. Descriptive statistics are employed to summarize and characterize the data, while statistical inference is used to examine differences between various groups within the survey population. To ensure the reliability of the constructs related to STEM belonging and identity, Cronbach's alpha coefficients are calculated to assess internal consistency. Following this, the constructs are analyzed both individually and across different groups. Further details of these analyses are provided in the subsequent section.

As stated in the previous paper, SurveyMonkey is used as the data collection tool (Martínez et al., 2024). In addition to the construct-related questions, the survey includes items on demographics, needs, preferences, and recommendations. This comprehensive approach ensures that a wide range of relevant information is captured, providing a more complete picture of SHPE members' experiences and requirements. In the 2023 Needs Assessment, the organization gathered a total of 2,529 responses, achieving an 81.5% completion rate. Figure 1 presents the distribution of respondents across different member types.

Figure 2 shows the gender identity composition of respondents and Table 1 provides a detailed breakdown of racial and ethnic identities among the survey respondents, with a significant 73.8% and 64.3% identifying as Hispanic and/or Latino/a, respectively.

Some other important demographics worth reporting include that 54.4% of respondents were first-generation college students. This was determined by inquiring about the highest level of education attained by the mother and father of the respondent. Additionally, 71.2% of respondents were born in the United States and were not immigrants themselves.

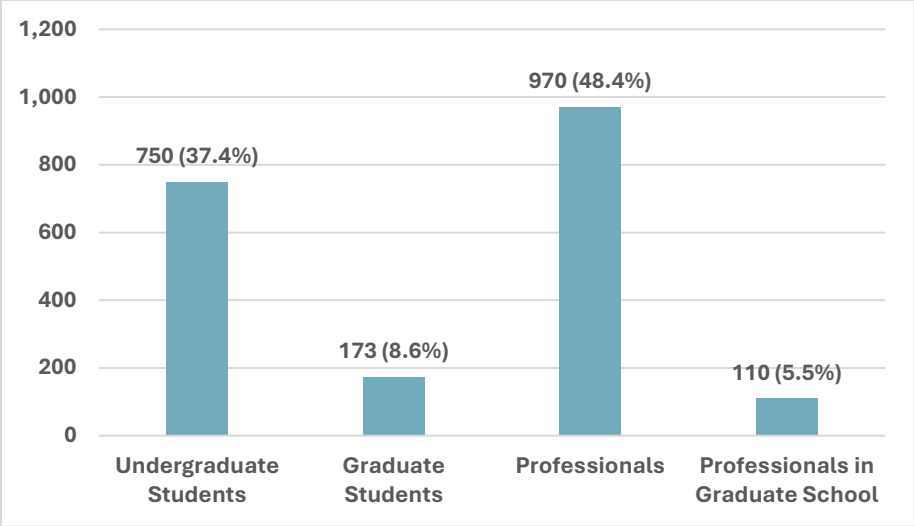

Figure 1 2023 Needs Assessment Subgroups (Sample Size: 2,003)

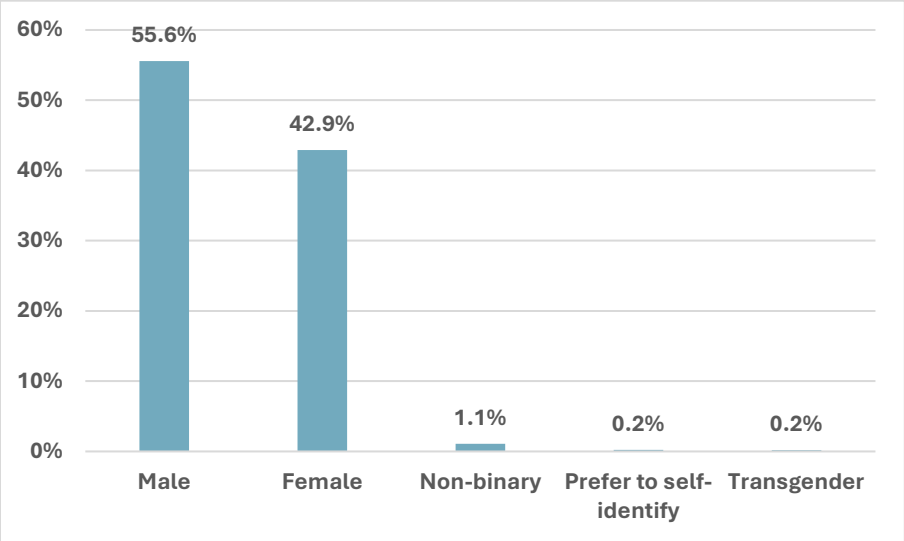

Figure 2 Gender Identity (Sample Size 2,176)

Table 1 Race/Ethnicity Composition (Sample Size 2,185, "Select All That Apply" Question)

Race/Ethnicity	Responses	Percentage
Hispanic	1612	73.8%
Latino/a	1404	64.3%
White or Caucasian	423	19.4%
Latinx/e	280	12.8%
Spanish Origin	223	10.2%
Asian or Asian American	120	5.5%
Black or African American	99	4.5%
American Indian or Alaska Native	95	4.4%
Other (please specify)	54	2.5%
Middle Eastern or North African	41	1.9%
Prefer not to report	23	1.1%
Native Hawaiian or other Pacific Islander	10	0.5%

Regarding STEM fields, Figure 3 illustrates that 65.1% of respondents identified engineering as their primary discipline, with technology-related fields, particularly computer science, following closely. Additionally, 55.8% of respondents had earned college credits from a community college, highlighting the diverse educational backgrounds within the sample.

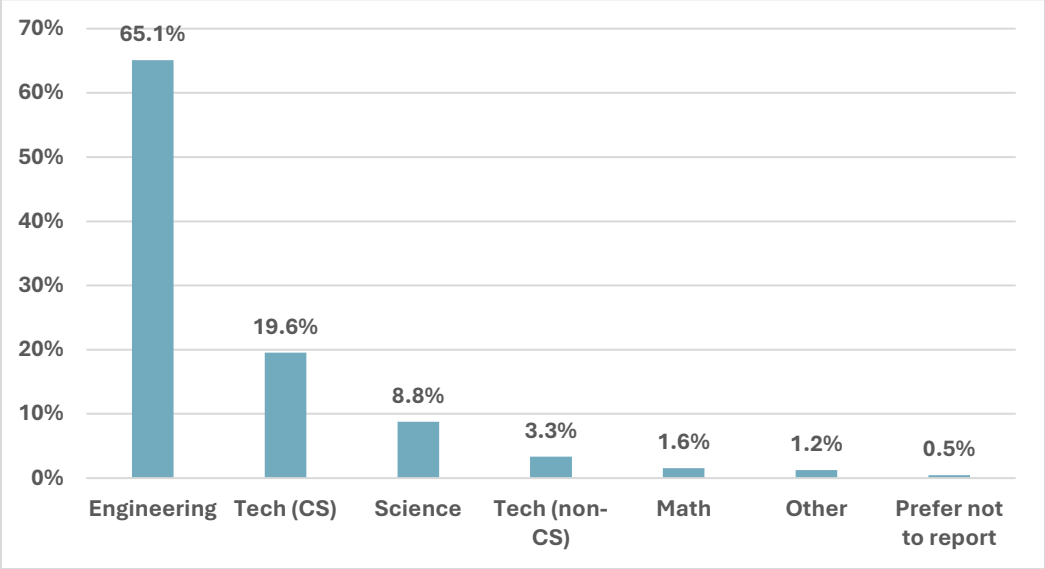

Figure 3 Field of Study (Sample Size 2,193)

To further analyze the survey results, the focus shifted to the constructs related to STEM belonging and identity. These constructs were assessed for reliability and validity, with particular attention given to those from the 2022 survey that had previously exhibited low Cronbach's alpha values. Constructs that were not valid in 2022 were revised or substituted with new ones that demonstrated validity in 2023. Additionally, a comparison was made with the 2022 constructs to examine any changes or trends over the past year. This longitudinal analysis provided insights into the evolving needs of members and helped to evaluate and refine the effectiveness of ongoing initiatives.

Constructs

A summary of the constructs with a brief description is provided in Table 2. A detailed description of all constructs used in this study has been provided in a previous paper (Martínez et al., 2024). However, some changes were made this year to improve the reliability and accuracy of the constructs.

One significant change involved the construct measuring Cultural Perspective. In 2022, this construct had a low Cronbach's alpha value of 0.536, indicating poor internal consistency. To address this, the construct was revised by deleting one item that was contributing to the low alpha. After this adjustment, the Cronbach's alpha improved to 0.720, which is above the threshold for assuming internal consistency among the items.

Additionally, the construct that previously measured Recent Events was replaced by the Satisfaction with Life Scale, developed by Ed Diener, Robert A. Emmons, Randy J. Larsen, and Sharon Griffin, as detailed in their 1985 article in the *Journal of Personality Assessment*. This change was made to better capture respondents' overall well-being. The construct measuring Underrepresented Status was also updated. To reduce bias in responses, the scale was flipped, allowing for more accurate data collection.

Table 2 Constructs Used and Descriptions

Construct	Description
STEM Identity	Individual's sense of belonging, satisfaction, and professional identification within the STEM community. Likert Scale from 1 (Strongly Disagree) to 5 (Strongly Agree).
Cultural Perspective (Revised)	How people see the alignment of their ethnic and cultural background with their choice of a STEM career. Likert Scale from 1 (Strongly Disagree) to 5 (Strongly Agree).
Recent Events Replaced with Satisfaction with Life Scale	Consisting of five statements that respondents rate based on their level of agreement using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The statements are general in nature and reflect a person's overall satisfaction with life.
Underrepresented Status (Revised)	Impact of one's minority status within the STEM discipline. Likert Scale from 1 (Almost Always) to 5 (Never).
Perspectives on Micro-Affirmations	How frequently participants experienced micro-affirmations related to their academic and career journeys in STEM. Likert Scale from 1 (Never) to 4 (Daily).
Perspectives on Classes/Work	Participants' perspectives on their academic experiences, specifically their classes and work within the STEM field. Likert Scale from 1 (Not at all) to 5 (Very much).
Perceptions on Feelings of Belonging	How participants perceive their acceptance, recognition, and inclusion within their STEM major or work. Likert Scale from 1 (Never) to 10 (Always).

In the next section, results are presented for 2023 and compared to findings from 2022 (Martínez et al., 2024). For the purpose of this paper, the results are presented as a general overview without division by subgroups, as the primary focus is on the longitudinal analysis. A more detailed comparison of results among different subgroups will be addressed in a separate paper.

Results and Discussion

Cronbach Alphas

Table 3 presents the Cronbach's alpha values obtained for all constructs in the 2023 survey. Calculating Cronbach's alpha is important because it assesses the internal consistency of a set of items within a construct. In other words, it measures how closely related the items are as a group, providing an indication of the reliability of the construct. A higher Cronbach's alpha value suggests that the items in the construct are consistently measuring the same underlying concept (Cronbach, 1951).

In this study, all the constructs achieved Cronbach's alpha values above the 0.7 threshold, which is generally considered the minimum acceptable level for internal consistency. This means that the constructs used in the analysis are reliable and that the items within each construct are well-aligned, providing confidence in the validity of the findings derived from these constructs.

Following this, the results of all constructs are presented, along with a comparison of the values obtained in 2022 and 2023. This comparative analysis allows us to examine changes over time and identify any trends or significant shifts in the constructs, contributing to a deeper understanding of the evolving experiences and perspectives of our members.

STEM Identity

For the construct measuring STEM identity, Table 4 shows an overall increase from 2022 to 2023 across most groups. However, this increase was only statistically significant for undergraduate and graduate students. The change in STEM identity was not significant for professionals and professionals in graduate school.

The significance of this increase among students as shown in Figure 4 suggests that our undergraduate and graduate members are experiencing a stronger sense of belonging, satisfaction, and professional identification within the STEM community. Several factors could contribute to this, such as enhanced support programs, more targeted engagement efforts, or improved community-building initiatives specifically aimed at students.

Table 3 Cronbach Alphas

Construct	Group	Cronbach Alpha
STEM Identity	Undergraduates	0.892
	Graduate Students	0.894
	Professionals	0.904
	Professionals in Graduate School	0.914
Underrepresented Status	Undergraduates	0.889
	Graduate Students	0.864
	Professionals	0.899
	Professionals in Graduate School	0.980
Perspective (Class/Work)	Undergraduates	0.869
	Graduate Students	0.909
	Professionals	0.907
	Professionals in Graduate School	0.864
Perspective (Micro-Affirmations)	Undergraduates	0.911
	Graduate Students	0.916
	Professionals	0.910
	Professionals in Graduate School	0.983
Perspective (Feelings)	Undergraduates	0.937
	Graduate Students	0.943
	Professionals	0.940
	Professionals in Graduate School	0.890
Cultural Perspective	Undergraduates	0.778
	Graduate Students	0.748
	Professionals	0.721
	Professionals in Graduate School	0.748
Satisfaction with Life	Undergraduates	0.857
	Graduate Students	0.853
	Professionals	0.884
	Professionals in Graduate School	0.850

Table 4 Results for the Construct Measuring STEM Identity

Group	Variable	2022	2023	P-Value
Undergraduate Students	Mean	4.04	4.13	0.010
	Sample Size	2131	697	
Graduate Students	Mean	4.08	4.21	0.043
	Sample Size	440	166	
Professionals	Mean	4.17	4.15	0.685
	Sample Size	1251	918	
Professionals in Graduate School	Mean	4.18	4.30	0.175
	Sample Size	120	107	

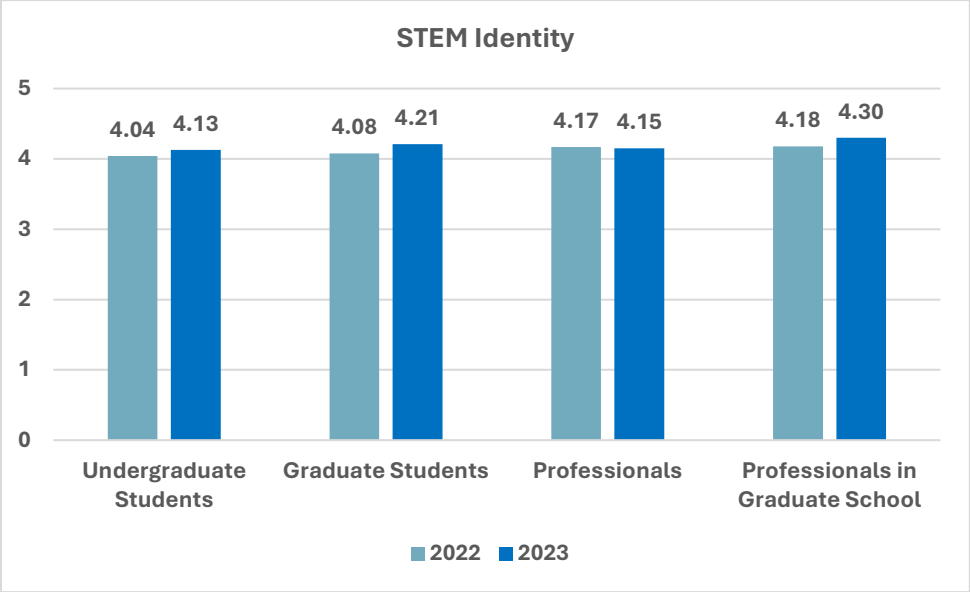

Figure 4 STEM Identity 2022 and 2023 Results

Interestingly, in 2023, the mean STEM identity scores of professionals and undergraduates were very close, whereas in 2022, these two groups had the most divergent scores. This narrowing of the gap is encouraging, as it indicates that our student members are increasingly identifying with the STEM field, aligning more closely with the professional community. This trend could be reflecting the positive impact of SHPE initiatives aimed at fostering a stronger STEM identity among students, and it underscores the importance of continuing these efforts to support their professional growth and development.

Underrepresented Status

For the construct of underrepresented status, the Likert scale was flipped in 2023 to reduce response bias. To ensure consistency and enable a direct comparison, the 2022 results were adjusted by flipping them as well, facilitating a direct comparison.

As shown in Table 5, there were no statistically significant differences between the results of 2022 and 2023. This indicates that there was no measurable change in how SHPE members perceive the impact of their minority status within the STEM discipline. Several factors could explain this stability, such as ongoing challenges in the STEM field that continue to affect underrepresented groups, or perhaps the initiatives aimed at addressing these challenges have not yet led to a noticeable change in perception.

Table 5 Results for the Construct Measuring Underrepresented Status

Group	Variable	2022	2023	P-Value
Undergraduate Students	Mean	3.34	3.38	0.582
	Sample Size	2070	681	
Graduate Students	Mean	3.45	3.40	0.629
	Sample Size	432	157	
Professionals	Mean	3.49	3.59	0.064
	Sample Size	1216	896	
Professionals in Graduate School	Mean	3.64	3.56	0.634
	Sample Size	116	110	

It remains unclear what effect the scale order reversal may have had on these results. Even though Figure 5 shows some increases and decreases across groups, because the scale was flipped, it is difficult to determine whether the lack of significant difference is a true reflection of our members' perceptions or if the change in scale order masked any potential variations that might have been observed had the original scale been maintained. This uncertainty highlights the complexity of measuring perceptions and the need for careful consideration in survey design.

Moving forward, this revised scale will be used in future assessments. By maintaining the same scale in subsequent surveys, the organization will be better positioned to detect any real changes in perception and provide clearer insights into how members' views on underrepresented status evolve over time. From this consistency, more definitive conclusions may be drawn in future analyses.

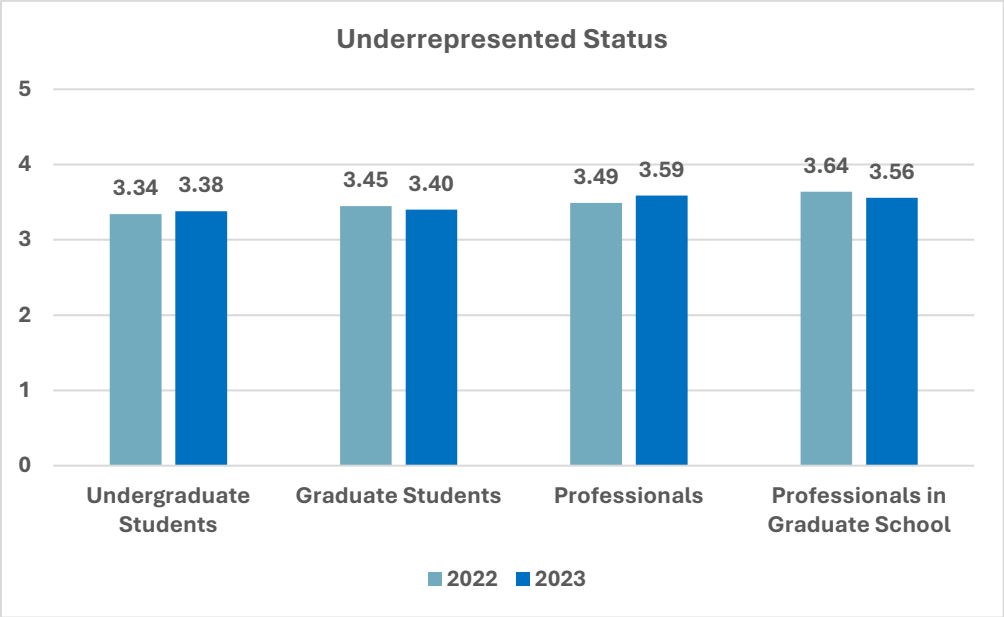

Figure 5 Underrepresented Status 2022 and 2023 Results

Perspectives on Micro-Affirmations

For the construct measuring microaffirmations, there were no statistically significant differences between the results from 2022 and 2023 as shown in Table 6. This indicates that the frequency with which participants experienced microaffirmations related to their academic and career journeys in STEM remained relatively stable over the past year.

Table 6 Results for the Construct Measuring Perspectives on Micro-Affirmations

Group	Variable	2022	2023	P-Value
Undergraduate Students	Mean	3.51	3.25	0.055
	Sample Size	1992	667	
Graduate Students	Mean	3.40	3.48	0.074
	Sample Size	414	153	
Professionals	Mean	2.98	2.73	0.677
	Sample Size	1159	869	
Professionals in Graduate School	Mean	3.31	3.09	0.936
	Sample Size	111	9898	

Notably, professionals reported experiencing microaffirmations less frequently than any other group, including undergraduate students, graduate students, and professionals in graduate school. This lower score among professionals could suggest that they encounter fewer instances of positive recognition or support in their work environments, which might be reflective of less inclusive or affirming workplace cultures. The lack of microaffirmations could also be tied to the challenges professionals face in navigating complex work dynamics or integrating their STEM expertise into their roles.

Although the differences between 2022 and 2023 (shown in Figure 6) were not statistically significant, the general trend observed in this short longitudinal study is slightly downward for most groups, indicating a potential decrease in the frequency of microaffirmations experienced by participants. While this trend is not definitive and should be interpreted with caution due to the limited data points, it does raise concerns about the consistency of positive reinforcement and recognition within the STEM community over time.

Given that there is only two years of data, it is important not to overgeneralize these findings. However, the observed trend underscores the need for continued monitoring and efforts to foster environments where microaffirmations are more prevalent, especially for professionals who seem to be receiving fewer of these positive experiences. Future assessments will help clarify whether this downward trend persists and whether targeted interventions might be necessary to enhance the frequency of microaffirmations across all groups.

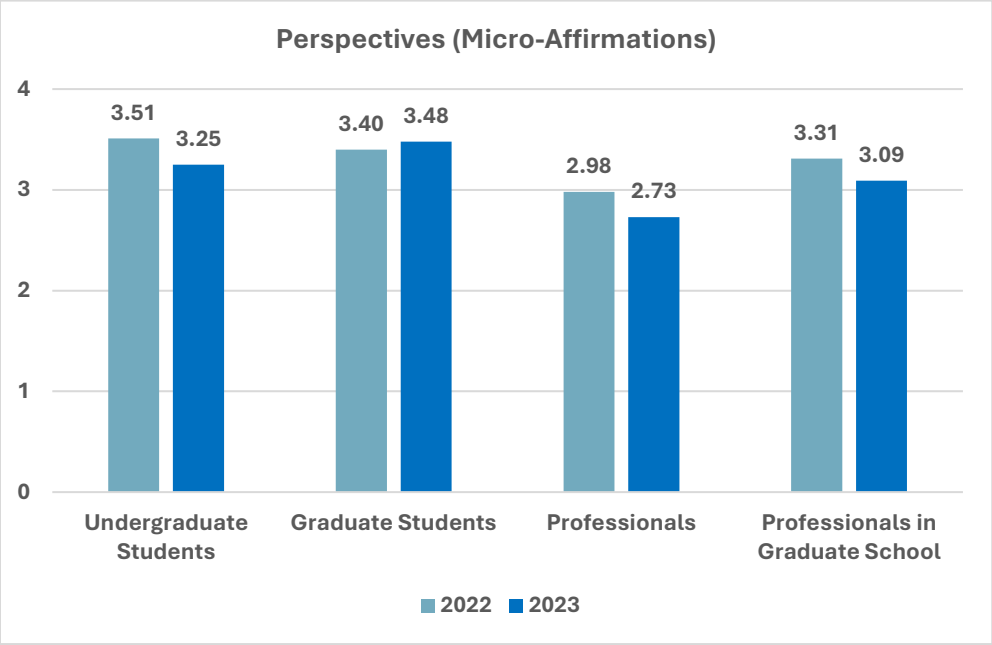

Figure 6 Perspectives Micro-Affirmations 2022 and 2023 Results

Perspectives on Classes or Work

For the construct measuring perspectives on classes and work, both undergraduate students and professionals in graduate school showed statistically significant changes from 2022 to 2023, as shown in Table 7 and Figure 7. The increase seen for undergraduate students suggests that this group viewed their academic experiences, particularly their classes within the STEM field, more positively in 2023 compared to the previous year. This increase may reflect improvements in the quality of STEM education or better alignment between coursework and career aspirations.

For professionals, the data indicated a slight decrease in their perspectives on work from 2022 to 2023. This decline suggests that professionals may be experiencing challenges in their educational experiences or ongoing work environments. This shift could imply a growing disconnect between their expectations and the realities of their roles, highlighting potential areas for development and support within the professional landscape.

Table 7 Results for the Construct Measuring Perspectives (Class/Work)

Group	Variable	2022	2023	P-Value
Undergraduate Students	Mean	4.44	4.51	0.017
	Sample Size	1997	660	
Graduate Students	Mean	4.24	4.36	0.101
	Sample Size	406	152	
Professionals	Mean	3.72	3.70	0.027
	Sample Size	1169	866	
Professionals in Graduate School	Mean	4.67	4.85	0.083
	Sample Size	110	98	

Furthermore, professionals still had the lowest score among all groups, including undergraduate and graduate students, and professionals in graduate school. This could indicate that professionals may still face challenges or dissatisfaction in their work environments or with the alignment of their job responsibilities with their STEM training. The lower score might also suggest that professionals experience more significant pressures or constraints in their work compared to students, affecting their overall perspective.

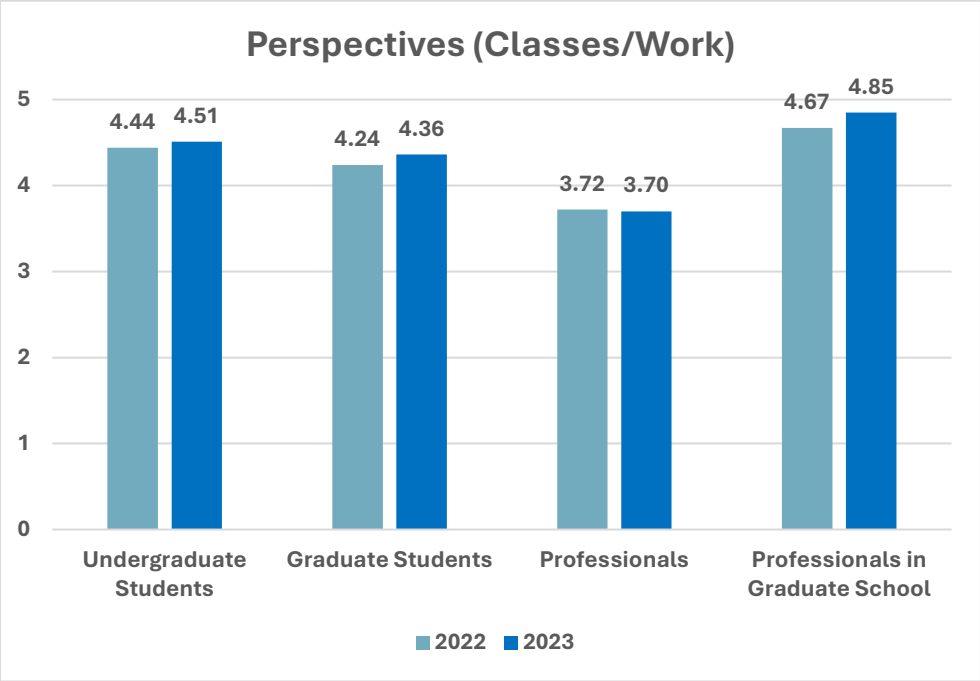

Figure 7 Perspectives on Classes/Work for 2022 and 2023 Results

On the other hand, professionals in graduate school had the highest score on this construct. This could imply that those who are both working and pursuing advanced degrees find a greater sense of fulfillment or alignment between their work and academic endeavors. The higher score may also suggest that these individuals benefit from the dual support systems provided by both their academic programs and their professional environments, contributing to a more positive outlook on their experiences within the STEM field.

Overall, these results highlight the importance of continuing to address the specific needs and challenges of professionals, while also recognizing the positive experiences of those who are simultaneously engaged in graduate studies and professional work.

Perspectives on Feelings

The only statistically significant difference observed in this construct, which measures how participants perceive their acceptance, recognition, and inclusion within their STEM major or work, was among undergraduate students, as shown in Table 8 and Figure 8. This may suggest that undergraduates experienced a change in their sense of acceptance and inclusion within their

STEM fields compared to the previous year. The slight increase in this construct for undergraduates might indicate improvements in campus climate or departmental support, which could be contributing to their enhanced feelings of belonging and recognition.

Table 8 Results of the Construct Measuring Perspectives on Feelings

Group	Variable	2022	2023	P-Value
Undergraduate Students	Mean	7.01	7.12	0.026
	Sample Size	1960	636	
Graduate Students	Mean	7.12	6.93	0.738
	Sample Size	411	145	
Professionals	Mean	7.29	7.16	0.788
	Sample Size	1159	869	
Professionals in Graduate School	Mean	7.56	7.42	0.705
	Sample Size	109	98	

Unlike other constructs, this one did not exhibit a clear trend across the two years analyzed. This variability could be due to the dynamic nature of how individuals perceive acceptance and inclusion, which may be influenced by a wide range of factors including institutional changes, evolving peer dynamics, or shifts in personal confidence and engagement within their fields. Interestingly, professionals scored slightly higher on this construct than both undergraduate and graduate students. This result could imply that professionals, possibly due to more established roles and networks within their work environments, feel a stronger sense of acceptance and recognition. Their greater experience and professional status may also contribute to a heightened sense on how participants perceive their acceptance, recognition, and inclusion within their STEM major or work.

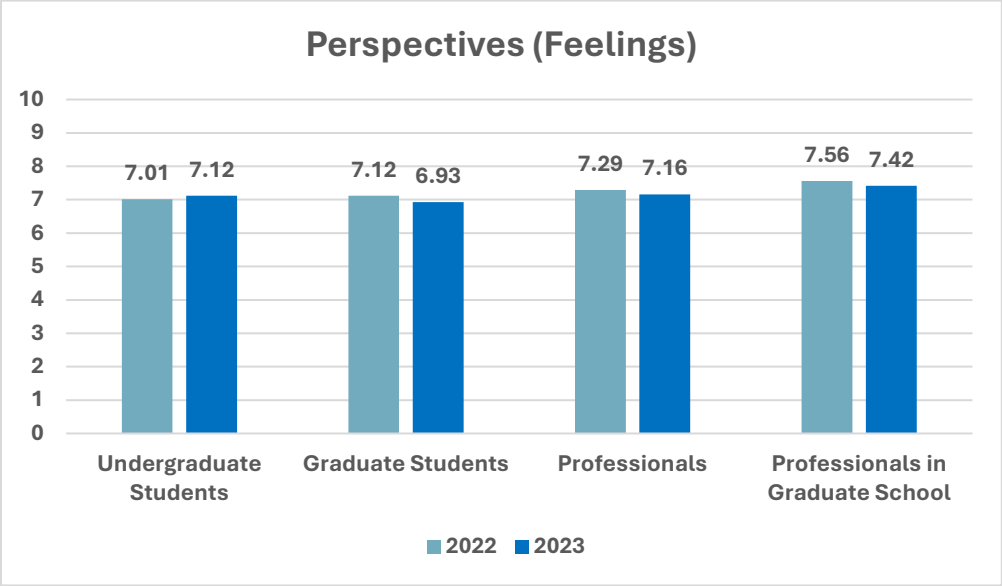

Figure 8 Perspectives on Feelings 2022 and 2023 Results

In conclusion, while the data for this construct does not reveal a consistent trend across all groups, the statistically significant improvement among undergraduates is a positive sign, a move toward the right direction. It highlights the importance of continued efforts to foster inclusive environments, especially for students who are still developing their professional identities. The higher scores among professionals also suggest that as individuals progress in their careers, their sense of acceptance within STEM may solidify, underscoring the value of long-term support and mentorship in building a lasting sense of inclusion. Moving forward, it will be crucial to monitor these perceptions to ensure that all members, regardless of their career stage, feel recognized and valued within the STEM community.

Cultural Perspective

Table 9 and Figures 9 and 10 display the results for the construct measuring cultural perspective in the 2023 survey. Figure 10 shows the results from the Tukey test which is a statistical method used to identify significant differences between the means of multiple groups after a significant ANOVA result. It performs all possible pairwise comparisons while controlling for the family-wise error rate, reducing the likelihood of false positives. By calculating confidence intervals for the differences in means, the Tukey test provides valuable insights into which specific groups differ from one another (Tukey, 1949).

Table 9 Results for the Construct Measuring Cultural Perspective

Item	Mean			
	Undergraduate	**Graduate Students**	**Professionals**	**Professionals in Graduate School**
I know many people who share my ethnic culture in STEM.	3.71	3.41	3.44	3.43
I believe that a career in STEM is compatible with my cultural values.	4.04	3.95	4.03	4.16
My family / elders support my pursuit of a professional career in my STEM field.	4.36	4.25	4.31	4.29
I feel that I can be authentically myself in my STEM field.	3.96	3.96	3.82	3.92
Average	**4.02**	**3.89**	**3.90**	**3.95**

This year marks the first time that the cultural perspective construct produced valid results with appropriate Cronbach alpha values, as the 2022 data did not meet the necessary threshold for internal consistency. Consequently, a direct comparison between 2022 and 2023 is not possible for this construct, limiting our analysis to the 2023 results alone.

In 2023, the analysis revealed that there were no statistically significant differences in cultural perspective across the different groups surveyed, as evidenced by the Tukey test results displayed in Figure 10. This suggests that perceptions of cultural perspective were relatively consistent among undergraduates, graduates, and professionals in the STEM field.

One of the most notable findings within this construct is the low rating given to the item regarding knowing people who share their ethnic culture. Across all groups, this item was rated the lowest, indicating a common experience among participants: many individuals in the STEM community do not have a strong network of peers who share their ethnic background. This finding could suggest that individuals might feel a sense of isolation or lack of cultural connection within their academic and professional environments, which could influence their overall sense of belonging and identity within STEM.

On the other hand, the highest-rated item in the cultural perspective construct was related to family and elder support for pursuing a professional career in STEM. Participants across all groups felt strongly that their families and elders were supportive of their professional aspirations in STEM fields. This high rating underscores the critical role that familial and community support plays in fostering the ambitions of Hispanic/Latino students and professionals in STEM, potentially acting as a buffer against challenges they might face in environments where they lack cultural peers.

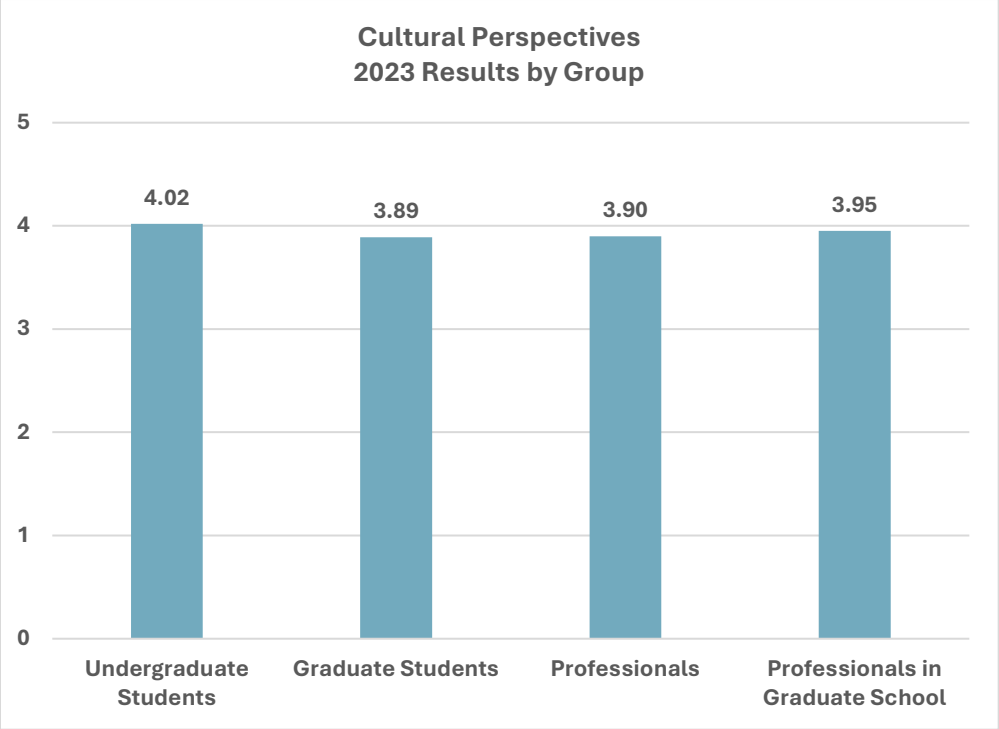

Figure 9 Cultural Perspective 2023 Results by Group

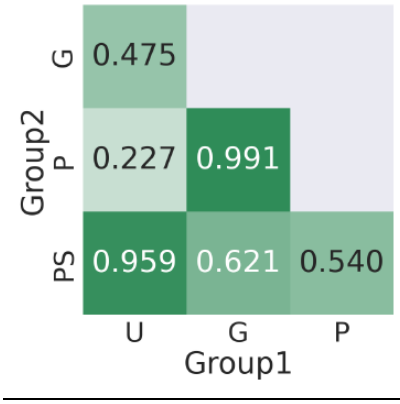

Figure 10 Tukey Test for Cultural Perspective

These insights from the 2023 data provide a nuanced understanding of the cultural dynamics at play within the STEM community for Hispanic/Latino individuals. While there is strong support from families, the lack of cultural representation and connections within their professional circles remains a challenge that needs to be addressed to improve the overall cultural perspective for these individuals in STEM.

Satisfaction with Life

The Satisfaction with Life Scale (SWLS) is a well-established measure that assesses an individual's overall satisfaction with life (Diener, 1985). It uses a 7-point Likert scale, where respondents rate their agreement with statements ranging from 1 (strongly disagree) to 7 (strongly agree). This scale offers valuable insights into a person's subjective well-being, providing a broad understanding of how content they are with their life as a whole. Results are shown in Table 10 below.

Table 10 Results of the Construct Measuring Satisfaction with Life

Item	**Mean**			
	Undergraduate	**Graduate**	**Professionals**	**Professionals in Graduate School**
In most ways my life is close to my ideal.	4.59	4.70	5.02	5.26
The conditions of my life are excellent.	4.70	4.76	5.23	5.24
I am satisfied with life.	4.91	5.08	5.30	5.51
So far**,** I have gotten the important things I want in life.	4.87	5.32	5.38	5.45
If I could live over, I would change almost nothing.	4.18	4.40	4.40	4.62
Average	4.65	4.85	5.07	5.21

In this study, notable differences emerged between undergraduate students, professionals, and professionals enrolled in graduate school as evidenced by a Tukey test shown in Figure 12. Among these groups, undergraduate students reported the lowest levels of life satisfaction, as indicated by their scores on the SWLS. This lower score among undergraduates might reflect the unique challenges they face during their academic journey, including the pressures of academic performance, uncertainty about future career paths, and the process of adjusting to adult life. These factors can contribute to a less favorable view of their overall life satisfaction.

When looking at students in general, which includes both undergraduates and graduate students, they tended to score lower on the SWLS compared to professionals. This trend may suggest that students, who are often navigating a period of significant personal and professional development, experience more fluctuations in their life satisfaction. The demands of academic work, coupled with the uncertainties of the future, could explain why students, as a group, report lower life satisfaction.

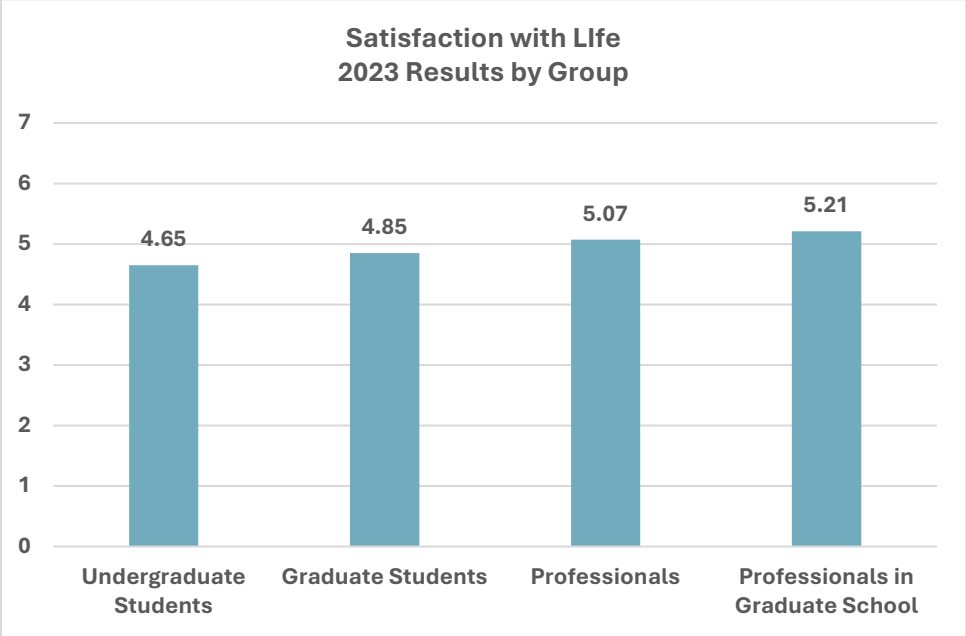

Figure 11Satisfaction with Life 2023 Results by Group

On the other hand, professionals, including those enrolled in graduate school, generally reported higher life satisfaction scores. This finding may be attributed to several factors. Professionals typically have more stability in their lives, including established careers and possibly more financial security, which can contribute to a greater sense of life satisfaction. Furthermore, professionals might have more clarity and confidence in their life choices, leading to higher satisfaction with their current life circumstances.

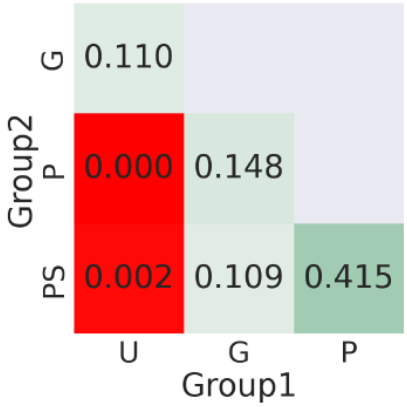

Figure 12 Tukey Test Results for Satisfaction with Life Scale

Overall, the differences observed in SWLS scores between students and professionals highlight the varying stages of life and the different challenges faced by each group. These findings underscore the importance of considering life stage and context when evaluating subjective well-being across different populations.

Next Steps

Building on the insights and findings from this longitudinal study, several next steps are essential to further understand and support the identity constructs among Hispanic engineering students and professionals. These steps will involve refining our methodologies, addressing identified shortcomings, and expanding the research scope to ensure a comprehensive understanding of the evolving experiences of the organization's members.

1. Refining Survey Instruments and Methodologies

One of the primary next steps is to continue refining the survey instruments to ensure they accurately capture the constructs of interest. Although the revised constructs in 2023 showed improved internal consistency, there is still room for enhancing the precision of these measurements. For instance, the Cultural Perspective construct, while improved, could benefit from additional qualitative research to identify potential new items that better reflect the cultural nuances of Hispanic/Latino STEM identities. Incorporating focus groups or in-depth interviews with a diverse subset of respondents could provide richer data to inform future revisions.

2. Expanding the Longitudinal Scope

While this study provided valuable insights by comparing two consecutive years, extending the longitudinal scope to cover a more extended period would allow for a deeper analysis of trends and shifts in STEM identity and other related constructs. A multi-year study spanning at least

five years could reveal more about the long-term impacts of SHPE's interventions and broader societal changes on the STEM experiences of Hispanic/Latino individuals. This extended timeline would also help in identifying any cyclical patterns or emerging challenges that may not be evident in a shorter study period.

3. Addressing Sampling Bias and Representation

One of the shortcomings identified in the current analysis is the potential sampling bias due to the overrepresentation of certain groups, such as professionals, in the survey sample. This imbalance could skew the results, particularly when analyzing constructs such as STEM identity and underrepresented status. To mitigate this, future surveys should aim for a more balanced representation of all member types, especially undergraduates and graduate students. Stratified sampling techniques could be employed to ensure proportional representation across different demographics, enhancing the generalizability of the findings.

4. Enhancing Construct Validity

Although Cronbach's alpha values indicated strong internal consistency for most constructs, construct validity—whether the survey items truly measure the intended constructs—remains a critical area for improvement. Some constructs, such as Underrepresented Status, may require additional validation studies, perhaps through triangulation with external data sources or parallel surveys that measure similar constructs in different contexts. This would help ensure that the survey results accurately reflect the experiences and perspectives of Hispanic/Latino STEM professionals and students.

5. Integrating Qualitative Data

The inclusion of qualitative data could significantly enrich the understanding of identity constructs. Future studies could incorporate open-ended survey questions, interviews, or focus groups to capture the nuanced experiences and perspectives of respondents that are not fully expressed through quantitative measures alone. This mixed-methods approach would provide a more holistic view of the factors influencing STEM identity, belonging, and underrepresented status among Hispanic/Latino individuals.

6. Monitoring the Impact of Interventions

It will be crucial to monitor the impact of specific SHPE interventions over time to determine their effectiveness in enhancing STEM identity and reducing the underrepresentation of Hispanics in STEM fields. This could involve setting up a feedback loop where program outcomes are continuously assessed and refined based on survey findings. Additionally, conducting case studies on successful interventions could offer valuable insights into best practices that can be scaled across SHPE's programs.

7. Expanding Analysis to Subgroups

The current study primarily focused on the overall results without delving deeply into subgroup differences. Future analyses should explore the experiences of specific subgroups within the Hispanic/Latino community, such as first-generation college students, Latinas, or individuals from different geographic regions. This disaggregated analysis could uncover unique challenges and needs within these subgroups, leading to more targeted and effective support strategies.

Analysis Limitations and Possible Solutions

Several potential limitations were identified during this study, along with corresponding solutions to address them in future research:

Overreliance on Cronbach's Alpha

While Cronbach's alpha is a useful measure of internal consistency, it should not be the sole determinant of construct reliability. The danger lies in assuming that a high alpha value automatically equates to a valid construct, which may not always be the case.

Solution: Complement Cronbach's alpha with other validity tests, such as exploratory factor analysis (EFA) or confirmatory factor analysis (CFA), to ensure that the constructs are both reliable and valid.

Limited Longitudinal Data

The short two-year span of this study may not capture the full range of longitudinal trends, particularly those influenced by external factors like economic shifts or policy changes.

Solution: Extend the study to cover a longer period, as previously suggested, and consider including control variables that account for external influences, thereby isolating the effects of SHPE interventions.

Potential Non-Response Bias

With an 81.5% survey completion rate, there is a possibility that non-respondents may differ significantly from respondents, potentially introducing bias into the findings.

Solution: Implement follow-up surveys or non-response analysis to identify and mitigate any potential biases. Offering incentives or simplifying the survey process could also help increase response rates.

By addressing these shortcomings and implementing the proposed next steps, future research can continue to build a robust understanding of the identity constructs that shape the experiences of

Hispanic/Latino engineering students and professionals. This will ultimately contribute to more effective strategies for supporting their success in STEM fields.

Conclusions

The longitudinal analysis presented in this study offers valuable insights into the evolving identity constructs among Hispanic engineering students and professionals. By comparing data from 2022 and 2023, statistically significant trends and changes have been identified that underscore the impact of ongoing initiatives aimed at fostering a stronger sense of belonging and identity within the STEM community.

One of the most notable findings is the statistically significant increase in STEM identity among undergraduate and graduate students. This may suggest that SHPE's targeted engagement efforts and community-building initiatives are effectively resonating with these groups, enhancing their sense of belonging and professional identification within STEM. The narrowing gap in STEM identity scores between professionals and undergraduates further highlights the positive trajectory of the organization's student members, who are increasingly aligning with the professional community. This alignment is crucial for their long-term success and integration into the STEM workforce.

The improvements in the reliability and validity of constructs, as evidenced by the higher Cronbach alpha values in 2023, also reflect the research team's commitment to refining measurement tools that capture the experiences of SHPE members more accurately. The revisions made to constructs such as Cultural Perspective and the introduction of the Satisfaction with Life Scale have contributed to a more robust and reliable analysis, providing a clearer picture of the factors influencing retention and success in STEM.

While the findings are encouraging, they also underscore the need for continued efforts to support underrepresented groups within STEM, particularly Hispanic/Latino individuals and Latinas. The persistence of disparities in STEM identity and the unique challenges faced by these groups call for sustained and targeted interventions. Moving forward, it will be essential to build on the progress made and to further tailor SHPE programs to address the specific needs and aspirations of their diverse membership.

In conclusion, this study not only provides a snapshot of the current state of identity constructs among Hispanic engineering students and professionals but also highlights the importance of longitudinal analysis in understanding the dynamic nature of these constructs. The insights gained from this research will inform the development of future programs and policies, ensuring that SHPE continues to effectively support and empower Hispanic/Latino individuals in STEM.

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