

Diversity in STEM: Strategies of Professional Engineering Organizations in Recruiting and Retaining Women from Minority-Serving Institutions

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Strategic Insights into Recruiting and Retaining Women in STEM at Minority-Serving Institutions

Introduction

The culture in science, technology, engineering, and mathematics (STEM) is often perceived as a welcoming and inclusive environment—where success is believed to be the result of objectively determined merit, training, and hard work [1], [2]. A space where if we have the knowledge, training, and skill set coupled with enough ambition to do the job—and do well at our job—we will naturally progress up the ladder of success via promotions and other forms of recognition commensurate with such achievements and contributions [1], [2]. However, this belief is often overly idealized and may not always reflect the complexities of reality, as it fails to fully account for the barriers, biases, and inequalities that impact who succeeds and how recognition is distributed. [3], [4], [5]. For many, in particular women and underrepresented and minoritized (URM) students, the STEM space—the early stages of pursuing an engineering degree or later in their professional careers—frequently experience overt sexism, gender bias, racism, discrimination, stereotyping, and isolation [4], [6], [7].

National concern and acknowledgment of barriers faced by women in STEM is longstanding and well-documented [1], [3], [8], [9]. According to the National Science Foundation, despite making up nearly half of the overall workforce, women represented about 35% of the science and engineering workforce in 2021 [10]. Moreover, Harvard Business Review (2014) found that 52% of highly qualified women working in STEM fields left their jobs at mid-career, citing a hostile work environment and a lack of support as the primary reasons [11]. Additionally, the American Association of University Women (AAUW) (2015) found that approximately 50% of women who start their higher education studies in STEM fields switch to non-STEM majors or drop out altogether [12]. Previous research shows that the feeling of not belonging in engineering programs is the primary reason students switch to non-engineering majors (as well as non-STEM majors) before graduation [13], [14], [15].

Still, despite these challenges and statistics that underscore the ongoing trends that contribute to lower retention rates for women—who often leave STEM due to such experiences—there remains a pressing need to reform the STEM culture to increase the engagement and retention of diverse talent pool in the STEM workforce [1], [16]. To better understand how STEM professional societies recruit and retain students from underrepresented universities, such as MSIs—the Society of Women Engineers (SWE) aims to explore the challenges women in STEM experience and better understand strategies that promote participation in STEM societies. Research shows that STEM professional societies (Societies) are uniquely positioned as agents for diversity, equity, and inclusion (DEI) reform via shaping and maintaining the STEM culture and provide critical levers for systems change [17]. In particular, Societies, members and supporters from diverse STEM influencers across academia and industry, government, and non profits provide ‘multiple levers’ for DEI reform by shaping disciplinary culture and serving a wide range of stakeholders [3], [18]. Academic literature often defines the role of STEM professional societies as multifaceted—spanning across varied disciplinary functions—frequently collaborating with other STEM system gatekeepers, (i.e., corporate entities,

laboratories, and academic organizations) to optimize the engagement of all STEM talent and foster inclusive and equitable spaces [17]. Scholars found that Societies that offer critical support via mentoring and networking significantly improve the persistence of women and underrepresented undergraduates in engineering degree programs [3], [18]. Moreover, when Societies focus on members' experiences and implement person-centered strategies that consider participants' diverse backgrounds and identities, retention in STEM fields improves [19].

Despite the clear benefits that Societies offer to STEM students, there is limited understanding of how Societies can effectively recruit students who attend Minority-Serving Institutions (MSIs), in particular at Hispanic-Serving Institutions (HSIs), Historically Black Colleges and Universities (HBCUs), and Tribal Colleges and Universities (TCUs). While efforts to increase diversity in STEM through SWE engagement have been made, we don't fully know how effective these strategies are in recruiting and retaining women from MSIs. Specifically, it's clear that person-centered strategies can help, but more research is needed to understand how these efforts can be tailored to support women enrolled in HSIs, HBCUs, and TCUs. Therefore, our study asks two overarching questions:

- Part A: What are effective strategies for recruiting and retaining MSI students in SWE programs?
- Part B: How do key stakeholders tailor and implement recruitment strategies to align with MSI students' unique experiences, and what challenges do they encounter?

In line with the National Academies of Sciences Engineering Medicine (2018) and other scholars conclude that many Societies want to better understand the experiences of underrepresented students and professionals and incorporate meaningful strategies to address inequities, but they lack critical information. “We can't solve the problems in a vacuum.... We want to identify what kinds of challenges our members are facing and what [we] can do to be a partner and an educator in helping to create actionable steps toward solutions” (p. 5) [1], [3], [17].

Conceptual Framework

Social capital, rooted in the early works of Sociologist Karl Marx (1818–1883), Max Weber (1864– 1920)—and later extended by (Bourdieu (1986), and Korte and Lin (2011)—is a complex multidimensional phenomenon often applied in social science research used incorporate socio cultural factors to explain economic and social outcomes [20]. Despite the voluminous literature and the multi-faceted nature of social capital, which has been repeatedly refined over the years to reflect the diverse interests of various scholars, it remains challenging to pinpoint a single, definitive definition of social capital [21]. However, it serves as a conceptual framework rooted in the notion of informal social networks, and it is believed that “social relations are valuable resources” that provide connections and access to opportunities via “relationships, networks, friends, memberships, civic engagement, information flows, and institutions that foster cooperation and collective actions for mutual benefits and contributes to economic and social development” [20].

According to scholars “the concept of social capital has been increasingly employed by researchers and practitioners in STEM education to understand and design new

programs/practices for enhancing students' STEM learning, motivation, and participation" [22]. For example, Weber's concept of *status groups* refers to how social and cultural capital function in educational spaces and how certain groups maintain their privileges via shared cultural practices and networks that influence access to education and professional opportunities [20]. In the context of MSIs, understanding Weber's framework centered on social stratification could shed light on the barriers women of color face in navigating educational and career pathways—which are often dominated by status groups with greater cultural and social capital. Whereas Lin's (2001) concept of social capital "is captured in social relations and that its capture evokes structural constraints and opportunities as well as actions and choices on the part of the actors" (p. 3) [23]. In essence, it centers on how students actively use their social connections (e.g., mentoring, networking) to overcome barriers and succeed in their educational pursuits [23]. Moreover, Bourdieu posits that social capital via "memberships in a group" is linked to the resources and advantages that certain individuals or groups have based on their position within a social hierarchy [24]. For MSI students from underrepresented and marginalized backgrounds, their social networks might not provide the same level of access to opportunities and resources as those from more privileged backgrounds. Bourdieu's framework argues that the structure and composition of social networks—shaped by factors such as class, race, or institutional affiliation—affect access to opportunities and resources—potentially perpetuating inequality [24].

Therefore, to study meaningful efforts via recruitment and retainment of women and ways Societies can better support their persistence in STEM fields, we adhere to Lin's (2001) and Bourdieu's (1986) frameworks to understand how social networks influence educational outcomes by accounting for both the resources MSI students can mobilize and the structural inequalities that shape these networks [23], [24]. We argue that applying a multi-faceted approach to social capital will provide Societies with a nuanced understanding, thereby enabling them to implement meaningful and effective strategies to better address inequities and increase the retention and recruitment of women into STEM societies and, ultimately, into the STEM workforce. Moreover, despite research suggesting there is a growing interest in and use of social capital for improving STEM education—research specifically focused on social capital in STEM contexts remains notably absent [22].

Literature Review

The Role of Social Capital in STEM

STEM fields traditionally dominated by men—coupled with the social relations with 'insiders' who control access to resources and information—can be particularly detrimental to women of color. Research indicates that these insiders act as gatekeepers to various academic and professional opportunities (i.e., research collaborations, internships, and career advancement), thereby making it challenging for those outside of such networks to gain traction to similar advantages [25]. Scholars posit that this exclusionary dynamic can be especially more pronounced for women of color, who often experience compounded challenges stemming from the intersectionality of race and gender. Ong, Smith, and Ko (2018) noted that women of color frequently encounter microaggressions and systemic bias, which significantly impact their

persistence and success in STEM fields [26].

Ultimately, the STEM workforce should reflect the population it serves. However, research by the National Science Foundation finds “Hispanic, Black, and American Indian or Alaska Native persons collectively account for 37% of the U.S. population ages 18–34 years in 2021, and 26% of S&E bachelor’s, 24% of S&E master’s, and 16% of S&E doctoral degrees earned by U.S. citizens and permanent residents in 2020” [27]. In addition, women earned 51% of S&E bachelor’s, 51% of S&E master’s, and 47% of S&E doctoral degrees in the U.S. in 2020, but despite women’s high levels of representation in S&E (which includes the life sciences and social sciences), women of color earned only 14.9% of all S&E bachelor’s degrees [27] (NSF, 2023). In engineering and computer science, women’s representation among bachelor’s degree earners is 25%, while women of color earn only 5% of degrees in these fields, highlighting the fact that certain STEM fields continue to struggle to reflect the diversity of the U.S. population [27]. Moreover, previous research shows that exclusion from informal networks further exacerbates similar challenges faced by women of color in STEM. For instance, a study by Hurtado et al. (2017) found that women of color attending an HSI who experienced exclusion from informal networks due to racial and gender biases were 35% more likely to persist in STEM majors when they participated in a structured mentoring program compared to those who did not participate [28].

The Role of Social Capital Structures

Broadly, students who cultivate relationships with faculty, peers, and professionals are more likely to acquire the social capital necessary for success and persistence in STEM fields [3]. Similar findings imply that formal programs that facilitate networking and mentorship opportunities have been found to help women of color at MSIs via persistence in STEM majors compared to those who do not participate [29]. These “resource-rich networks” matter—especially when it comes to providing women with access points to information and resources, and these networks particularly influence their academic and professional trajectories [30]. The AAUW (2015) indicates that women of color experience feelings of isolation in academic spaces, noting that over 60% reported feelings of exclusion from a STEM-related informal network [31].

Even for women of color who do not actively seek out these resources, being part of a network where they are exposed to valuable information, opportunities, and support can help in their journey [32]. The exposure itself acts as an access point and is crucial for leveling the playing field [33]. Moreover, mentorship and networking show to be an integral component of social capital—often offering guidance, advice, and emotional support that are otherwise difficult to obtain—and necessary to navigate in one’s academic and professional journey [34]. Social relationships and the resources that are embedded within the social networks are accessed and used by the actors for actions [23]. Mentorship and networking (i.e., social networks) is an investment in social connectedness through which other actors (i.e., mentees) navigate and borrow from [23].

Research shows that the presence of these formal networks helps foster a sense of belonging,

which is an essential factor for retention in STEM fields. Estrada et al. (2018) found that women of color who reported strong mentorship relationships were twice as likely to remain in their STEM programs compared to those without experience with such relationships [35]. This support is not only academic but also emotional, thereby providing a buffer against the isolation and marginalization that can lead to attrition. Additionally, scholars find that MSIs that adopt a well-rounded support system for women of color in STEM, which includes peer mentoring and faculty advising, have seen retention rates improve by 25% over a five-year time period [36].

While helpfully highlighting the importance of social capital in academic success, there remains a notable gap in the literature that explores women of color at MSIs and their access to social capital. Most research in this area has either generalized findings across diverse racial groups, failing to account for the unique experiences of women of color, or has focused primarily on Predominantly White Institutions (PWIs) [29]. This gap in the literature is important to address because the dynamics of social capital within MSIs, where many students are from underrepresented groups, may differ from those in PWIs. Additionally, there is limited research exploring how formal and informal networks at MSIs might potentially contribute to the persistence of women of color in STEM fields [36]. Addressing these gaps is crucial for understanding how targeted recruitment interventions at MSIs can better support this demographic, particularly retention in STEM disciplines where they remain underrepresented.

Methods

To respond to the two research questions, a qualitative methodology was utilized, involving focus groups and interviews with students, SWE staff, and leaders involved in recruitment efforts. The process for recruiting study participants included (1) recruitment of collegiate student members via emails and social media posts and (2) recruitment of key Societies recruitment and member engagement stakeholders through the SWE's existing networks. Researchers were particularly interested in recruiting SWE stakeholders who had strong collaborations with MSIs and partnerships with organizations with strong engagements with MSIs.

One initial email and one follow-up email were used to recruit student participants for virtual focus group interviews. The sample population included six focus groups with students. However, two of these resulted in one-on-one interviews with MSI students due to low turnout. In total, 15 MSI students participated in the study, including fourteen women and one man. For stakeholder interviews, four women involved with SWE recruitment efforts participated in one-on-one interviews.

Sample

Part A of the study involved recruiting collegiate student members attending MSIs who had been involved in SWE for more than a year, as well as those who had recently joined. Special efforts were made to include women of color to ensure a diverse range of perspectives. Per IRB recommendation—and to ensure compliance with local laws and regulations concerning consent and research participation—the current study encompassed a national sample, with participants

classified as adults based on the age of majority (AOM) in their respective states rather than the standard age of 18. For example, participants in Nebraska and Alabama were considered adults at age 19, while in all other states, the age of 18 served as the threshold. Part A SWE Program Collegiate Student Members participants included 15 students recruited from first-year engineering programs at 11 universities across three states; see Table 1 provides a list of participants from MSI universities, while Table 2 outlines the focus group questions. Part B of the study included interviews with key stakeholders who play significant roles in the SWE's recruitment and member engagement efforts.

To protect anonymity, Part B participants were categorized as follows: (i) Membership & Data Management Expert—this individual oversees member recruitment and engagement at the local level, providing valuable insights into how the SWE manages membership data and recruitment strategies; (ii) Leader from an Affinity Group—this leader, representing one of the SWE's affinity groups, plays a crucial role in implementing recruitment initiatives tailored to their specific community, offering a unique perspective on targeted recruitment efforts, (iii) Outreach and Engagement Leader—this individual is responsible for overseeing the SWE's broad recruitment strategies and operational aspects, providing a strategic perspective on outreach and engagement initiatives; (iv) Collegiate Engagement Leader—Specializing in outreach and engagement with college students, this participant focuses on efforts to attract undergraduate students to SWE through collegiate chapters, mentorship programs, and related initiatives; see Table 3 for one-on-one interview questions.

Analytic Strategy

To gather insights on retention and recruitment strategies, this study utilized a combination of virtual focus groups and one-on-one interviews with MSI students and Stakeholders. Focus groups and interviews with MSI students were semi-structured and featured open-ended questions that focused on participants' experiences and perceptions about SWE. These interviews accommodated time zones in the U.S. and were held virtually via Zoom approximately for 45 minutes. All participants were recruited through purposive sampling to ensure representation of different MSI institutions and diverse student demographics. The one-on-one interviews were conducted with key stakeholders and followed a similar semi-structured format, which included open-ended questions and additional questions that prompt questions aimed to explore individual experiences and capture nuanced recruitment experiences.

The study's protocol was submitted for Institutional Review Board (IRB) review and was exempt from full review. To ensure the confidentiality of all participants in this study, the researchers explained the interview's purpose and format, obtaining consent for recording, and consent to participate in the study. Moreover, a direct line of contact information was provided for follow-up inquiries, and participants were given the verbal option to omit or add any information within two months from the start of the interview. Adhering to ethical standards and privacy laws, all participants were fully informed about the terms of their participation and the study's goals, with the option to opt out of any questions during the interview process. Proper documentation of all verbal consents was maintained via audio and transcription. In line with

other scholars in this line of research the analyses that was used in this study were based on the frequency, patterns, and “keyness” (i.e., the extent to which the data captured concepts that are essentially related to our research questions) [3]

Thematic Analysis

All sessions were recorded, transcribed via the platform Zoom. The transcriptions were analyzed via the Dedoose software. Thematic coding was employed to identify key trends and recurring themes across the transcriptions. During this phase, the transcripts were read multiple times to ensure familiarity with the content and context of the interviews. Moreover, open coding was employed, which included areas where data segments were labeled with initial codes based on the participant responses. For instance, participant statements about challenges in the recruitment process were tagged under "challenges to recruitment," while comments on effective retention methods were labeled "best practices and recommendations." Subsequently, axial coding was used to establish whether there were any overarching themes and sub-themes that stemmed from the transcriptions. This process narrowed down the selective coding process which captured direct quotes from the student and stakeholders. Moreover, data from focus groups and one-on-one interviews were cross-checked to identify consistencies and whether discrepancies in the themes emerged. To ensure reliability and validity, the analysis incorporated two key steps: (i) audit conducted by a colleague not directly involved in the project to review a subset of the coded themes, and (ii) cross-checking against qualitative insights to ensure depth and reduce potential bias.

Results

Our analysis examines the influence of effective recruitment and retention strategies on MSI students, in particular women of color. Through a qualitative approach, we engaged with various participant groups via tailored interviews and focus groups to uncover practical and effective recruitment and retention strategies as well as what possible factors contribute to challenges and barriers with recruitment and retention. Results from prior research emphasize that the role of social capital extends beyond just access to resources—it includes the cultivation of a supportive community [24]. In this context, we find that a supportive space where women of color connect, and network is an important factor in helping women navigate and succeed in traditionally exclusive or unwelcoming environments. In line with other scholars who posit that community support is important for overcoming systemic barriers that often hinder these students' academic and professional progress [37].

For instance, our interviews with stakeholders shed light on the importance of personalized communication, leveraging relationships with affinity groups, and creating a strong sense of belonging to resonate with MSI students and contribute to sustained engagement (see Table 4 for Stakeholder Effective Strategies and Best Practices). Equally (if not more) important is that this active use of one-on-one communication and tailored messaging has shown to be particularly successful in connecting with students on a more personalized level, which in turn fosters a deeper commitment to the organization—and more meaningful connections—similar to a reciprocal relationship process. As one stakeholder observed, "We've been able to more clearly

communicate that value across all platforms, social media...so that we could curate content that was specific for collegiates."

Our findings also indicate that MSI students repeatedly felt that the value placed on peer mentorship and networks, in particular for students who felt isolated in traditionally male-dominated STEM spaces, helped students feel less alone and more connected. In some instances, students reported that having peer relationships within SWE bridged gaps that were left by formal programs, which in turn, created a sense of community that felt genuine and empowering. One student shared, "My friends in SWE who had more experience were like unofficial mentors—helping me navigate STEM challenges." Another student reflected, "It's not just about the academic help. It's about having people [mentors] who truly understand what you're going through and who genuinely want to see you succeed—it's about feeling seen and understood by someone who has walked a similar path." This shared reflection of support suggests that intentional modes of mentoring does not only create a sense of belonging, but recreates a space—a community that extends beyond SWE events. Moreover, within such spaces, students are able to build their confidence and self-efficacy—enabling them to thrive in STEM traditionally male-dominated fields—both on and off campus.

By contrast, several barriers appear to influence the effectiveness of retention and recruitment of MSI students. In particular, the distribution of resources via grant funds and challenges in maintaining engagement beyond the initial recruitment phase (see Table 5 for Stakeholder Challenges and Lessons Learned). At the same time, a few key systemic and structural obstacles contribute to decreased retention, such as a lack of awareness about the existence and value of certain programs in and around MSI spaces. These barriers suggest a need, in part, for more targeted outreach and tailored response strategies to better support MSI students. As one stakeholder vividly put it, "That sense of belonging and inclusion is, like, the primary factor... Even if you're super interested in the mission, if you don't feel like you belong... it's hard to stay enthusiastic about, you know, being active."

These findings suggest that while some strategies are effective, other areas, such as continuous evaluation and adaptation, are equally important in addressing the evolving challenges in recruiting and retaining URM students. In addition, stakeholders spoke of the general need for ongoing community building, inclusive outreach, and persistent communication. Intuitively, one might assume that the three variables (i.e., community building, inclusive outreach, and persistent communication) are effective strategies and that the nuances of their implementation reveal a one-size-fits-all approach, but this was found to be far from the truth. Each variable—whether it be community building, outreach, or communication—requires careful tailoring to address MSI students' unique challenges and needs.

However, discussions with MSI students revealed several barriers to current Societal practices in recruitment and retention practices. First, the perception that SWE is exclusive to certain disciplines and genders and that there is limited support for graduate students were identified as reoccurring challenges. One student shared, "It's challenging to join because I'm not directly related to engineering, but I believe SWE can be helpful for my professional development." Second, students reported having financial constraints that prevent them from receiving funding

to participate in SWE events. Some students reported that (i) their attending University is not large enough to provide funding; and (ii) they were unaware of available funding for travel and networking opportunities through SWE. This disconnect presents a paradox: while stakeholders' express frustration that MSI students are not taking advantage of readily available funding, the students themselves posit that the lack of awareness or access to these resources is a significant barrier to their retention and engagement.

Discussion

While such findings from this study may strike some as counterintuitive, it remains possible that there might be gaps in communication or structural challenges at play. It is possible that some schools serving higher concentrations of minority students or students who attend MSI universities are not made aware of these funding opportunities despite SWE's communication efforts. Additionally, the turnover in university staff responsible for overseeing these programs could result in important information not being disseminated effectively across their campuses. As a result, students may miss out on funding opportunities to make those connections happen—and facilitate the recruitment and retention needed to increase persistence in STEM fields, thereby hindering their full participation in SWE initiatives.

Moreover, stakeholder's experiences surrounding community-building efforts suggest the need to go beyond simply creating spaces for women of color to connect and interact; they should do so in an environment where students feel genuinely valued and supported. These strategies might involve, as students have elaborated in the interviews—initiatives, including mentorship programs that connect students with alumni or professionals who share similar backgrounds or creating a social platform where all students can openly voice experiences and, equally important, the barriers they experience to overcome unique barriers. Moreover, the unique perceptions and experiences stemming from our focus group interviews with MSI students offered valuable insights into the effectiveness of various strategies (see Table 6, MSI Student Experiences on Effective Strategies).

A key theme emerging from these discussions was the importance of personalized communication, robust mentorship networks, and targeted outreach in building social capital. For example, students reported that inclusive programs have played key roles in attracting MSI students and provided the space for sharing their unique experiences with other students of similar backgrounds or lived experiences. Relatedly, these efforts suggest fostering a sense of belonging and the space for valuable networking opportunities which, in turn, highlight the need to develop spaces that support student engagement and retention.

Consistent with prior research, our findings align with the broader literature, which indicates that similar strategies are important in establishing a sense of belonging and connection among students, which is crucial for their persistence in STEM fields [38] [39]. As one participant noted, SWE's mentorship and professional development programs have been instrumental in helping them "build confidence and improve my resume and LinkedIn profile." This not only underscores the importance of social capital in providing tangible career benefits but also highlights how intentional modes of mentoring impact students— in particular underrepresented

STEM students to combat feelings of isolation, imposter syndrome, while fostering confidence and self-efficacy [40] [41]. By institutionalizing these networks through formal programs, organizations can recreate equitable and inclusive spaces that support the persistence and success of women of color in STEM [42]. These findings align with Museus et al. (2015), who indicated that the presence of strong social capital is linked to higher levels of student engagement and success, particularly for students from underrepresented groups [43]. Therefore, social capital not only facilitates access to both information and emotional support— but also offers emotional support and the platform for students to overcome the barriers inherent in higher education and STEM careers [22].

Limitations and future directions

Both data and research design restrictions contribute important limitations to our overall empirical strategy. On the data front, this study research design used focus groups and one-on-one interviews, with a particular focus on women from Minority-Serving Institutions (MSIs). Despite outreach efforts to 2,447 potential participants, including 247 participants attending HBCUs— the actual number of MSI student participants was lower than anticipated. The low response rate, particularly as only a small fraction of those contacted responded— may not be fully representative of capturing the diverse experiences, perceptions, and perspectives of the target population. Survey instruments might be more beneficial, potentially (i) increasing response rates, (ii) reflecting potential barriers to recruitment and/or retention that were not fully explored in this study, (iii) allowing a fuller understanding of the experiences and needs of women of color from MSI institutions, and (iv) increasing the opportunity to gather a larger racially diverse sample.

Further limitations flow from the research design— Participants in the study were self-selected, which means that participants who volunteered to participate might have different experiences or motivations compared to those who did not, thus potentially leading to results that may not be fully representative of the broader population of MSI students or SWE members. We remain mindful of the lingering ambiguity concerning this motivation to participate. For example, the participants who volunteered may potentially have positive experiences with SWE and potentially refrain from any preexisting perceptions or experiences with MSI retention and recruitment. At the same time, it is also plausible that those who have more negative experiences or barriers may not willingly participate or lend their voice to this space.

Future research can benefit from integrating a quantitative analysis alongside qualitative insights for a more comprehensive understanding of such trends and patterns, potentially leading to more robust and generalizable findings. Moreover, additional research is needed to better capture and explain what specific factors influence participation and engagement numbers among students from MSIs. Finally, future studies need to more directly examine links between barriers and motivators for these students— helping to determine whether these factors have a causal impact on student involvement in participating in such spaces to further develop directions for retainment and recruitment.

Conclusion

Limitations notwithstanding, the present research underscores the importance of understanding key strategies surrounding the recruitment and retention efforts of MSI students, in particular women of color. The findings of this study contribute to the literature on what possible strategies are most and least effective for recruiting and retaining MSI students to STEM societies. We feel that by underscoring the nuanced experiences of stakeholders and MSI students, we can gain a better understanding of how to implement a best practice approach that better resonates with MSI students—such as personalized communication, tailored mentorship programs, funding, and inclusive networking opportunities. Moreover, our study contributes to not only educational research but also research on DEI within STEM education to help support those in the field in being more informed about the decisions concerning educational leadership, strategic planning, and implementation of recruitment and retention initiatives. Findings from this study can help STEM Societies better support MSI students, ultimately leading to a more diverse and inclusive STEM workforce.

Table 1. MSI Universities—Student Participants (HSI, TCU, HBCU, AANAPISI)

<i>MSI Universities</i>	<i>HSI</i>	<i>TCU</i>	<i>HBCU</i>	<i>AANAPISI</i>
California, Los Angeles, University of	✓			✓
*Fisk University – Nashville			✓	
California, Los Angeles, University of	✓			✓
Saginaw Chippewa Tribal College		✓		
California, Irvine, University of	✓			✓
San Jose State University	✓			✓
San Diego State University	✓			✓
Texas at Arlington, University of	✓			✓
San Diego State University	✓			✓
California, Los Angeles, University of	✓			✓
Bluefield State College			✓	
*University of Arkansas at Pine Bluff - Pine Bluff			✓	
Howard University	✓		✓	

*Denotes: 2 participants from the same University participated.

Table 2. Part A: Student Focus Group and One-on-One Interview Questions

Topic	Question
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Awareness and Recruitment	How did you learn about SWE?
Motivation and Interest	Why did you choose to join SWE?
Program Evaluation and Impact	Can you describe your experiences with SWE programs and any other STEM-related initiatives you've been involved in? What aspects stood out to you as particularly impactful or challenging?
Career Perception and Aspirations	How do you perceive a career in STEM, and in what ways has your involvement with SWE or other educational experiences influenced this perception?
Challenges and Support	What barriers or challenges have you faced in pursuing education or a career in STEM, and how have these impacted your decisions? Do you feel that these challenges are adequately addressed by professional societies like SWE?
Support Systems and Improvement	What kinds of support systems (e.g., mentorship, networking, educational resources) have you found most helpful during your STEM journey? How could these support systems be improved to better assist women from MSIs?
Inclusivity and Improvement	SWE is aiming to create a more inclusive environment for all members. In what ways do you feel SWE does this well? Where do you see room for improvement?
Future Goals and SWE's Role	Looking towards the future, what are your aspirations within the STEM field? How do you think organizations like SWE can assist in achieving these goals, especially for women from diverse backgrounds?

Table 3. Part B: Key Stakeholder One-on-One Interview Questions

Research Objective	Topic	Question
Research Objective 1: Effective Strategies for Recruiting and Retaining MSI Students	Innovative Recruitment and Retention Strategies	Can you share specific examples of innovative and/or inclusive strategies beyond traditional methods in recruiting and retaining MSI students in SWE programs?

	Strategy Customization	How do you tailor these strategies to better resonate with the unique experiences and backgrounds of MSI students?
	Recruitment Challenges	What obstacles or challenges have you encountered in recruiting MSI students into SWE programs?
	Retention Strategies	Once MSI students are recruited, what measures beyond initial recruitment do you take to ensure their continued engagement and participation within SWE?
Research Objective 2: Impact of Diverse Recruitment Strategies	Measuring Recruitment Effectiveness	How do you assess the effectiveness (i.e., measurement tools) of your recruitment strategies in increasing the representation of MSI students within SWE?
	Successful Diverse Recruitment Strategies	Can you share examples of successful diverse recruitment strategies implemented and how they have contributed to increased recruitment of MSI students and sustained engagement within SWE?
	Best Practices and Recommendations	Based on your experience and observations, what best practices and/or recommendations would you offer to other organizations seeking to improve recruitment and retention of MSI students?
	Lessons Learned	Could you share any valuable lessons learned from past initiatives or strategies that were not effective in retention and recruitment?

Table 4: Key Stakeholder Effective Strategies and Best Practices

Stakeholder	Effective Strategies	Best Practices	Direct Quote
1	<p>One-on-one communication to Engage MSI students.</p> <p>Leveraging relationships with affinity groups.</p> <p>Tailoring strategies to fit MSI students' experiences.</p>	<p>Ensure communication resonates with MSI students.</p> <p>Maintain engagement through community building.</p>	<p>"We've been more successful if we have one to one communication... The organization is able to do more focused, one-to-one communications, more follow up, more you know, hand holding, if you will, throughout the process to engage students and section leaders from MSI."</p>
2	<p>Targeted initiatives for minority students in community colleges.</p> <p>Connect individuals' roles to their purpose in the organization.</p> <p>Inclusive outreach programs for underrepresented groups.</p>	<p>Provide transparent and constructive feedback.</p> <p>Recognize and retain volunteers through a structured program.</p>	<p>"We've been able to more clearly communicate that value across all platforms, social media...so that we could curate content that was specific for collegiates."</p>
3	<p>Tailored messaging and inclusive programming.</p> <p>Targeted outreach and personalized approaches for leadership development.</p> <p>Word-of-mouth recruitment.</p>	<p>Create a sense of belonging and inclusion.</p> <p>Address lack of awareness in minority-serving institutions.</p>	<p>"That sense of belonging and that sense of inclusion is, like, the primary factor... Even if you're super interested in the mission, if you don't feel like you belong... it's hard to stay enthusiastic about, you know, being active."</p>

4	<p>Innovative recruitment strategies for HBCU students.</p> <p>Constant communication and resource availability.</p> <p>Follow-up on implemented strategies to assess their effectiveness.</p>	<p>Identify and maintain the right point of contact at MSIs.</p> <p>Ensure university support and funding for new initiatives.</p>	<p>"It's essential to keep the lines of communication open and ensure the right point of contact is identified and maintained at MSIs to overcome barriers and support new initiatives."</p>
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Table 5: Key Stakeholder Challenges and Lessons Learned

Stakeholder	Challenges	Lessons Learned	Direct Quote
1	<p>Difficulty in distributing grant funds to support MSI groups.</p> <p>Ensuring continued engagement beyond initial recruitment.</p>	<p>Tailored support and ongoing community building are crucial for sustained engagement.</p>	<p>"Once they get on site, if they're not there with a group, they feel lost...so we've started finding more ways to increase that sense of community."</p>
2	<p>Systemic and structural barriers limit access to STEM for marginalized groups.</p> <p>Difficulty in effectively reaching minority students in non-traditional schools.</p>	<p>Inclusive outreach and targeted programs can overcome barriers and better support minority students.</p>	<p>"It's important to connect individuals to the purpose of their roles within the organization."</p>

3	<p>Lack of awareness about the SWE's existence in minority serving institutions.</p> <p>Difficulty in retaining minority students due to a lack of belonging.</p>	<p>Creating a strong sense of belonging and tailored outreach efforts are key to improving retention and engagement.</p>	<p>"That sense of belonging and that sense of inclusion is, like, the primary factor... Even if you're super interested in the mission, if you don't feel like you belong... it's hard to stay enthusiastic about, you know, being active."</p>
4	<p>Securing university funding and support for new sections at MSIs.</p> <p>Finding and maintaining the correct point of contact for sustained engagement.</p>	<p>Persistent communication and tracking the right contacts are essential for overcoming barriers and ensuring continuity in new initiatives.</p>	<p>"It's essential to keep the lines of communication open and ensure the right point of contact is identified and maintained at MSIs to overcome barriers and support new initiatives."</p>

Table 6: MSI Student Experiences on Effective Strategies

Key Insights	Details	Direct Quotes
Networking and Community Building	SWE programs are highly valued for fostering a sense of community among women in STEM, offering opportunities for networking and career growth.	"Being part of the SWE really opened up opportunities for networking and professional development that I wouldn't have had otherwise."
Mentorship and Professional Development	SWE's mentorship programs improve communication, leadership, and professional skills.	"My mentor kind of grabbed me and encouraged me to go to our events... I ended up making a lot of new friends who I feel are really cool people."
Inclusivity in Programs	SWE events are seen as inclusive and welcoming, even to international students and those from diverse backgrounds.	"The emphasis on diversity at SWE events was really positive. It made me feel more confident and represented."

Increased Accessibility and Confidence	SWE's support makes STEM careers more accessible, inspiring participants to pursue their goals.	"Seeing women in high-level positions at conferences inspired me to keep going despite the challenges."
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Table 7: MSI Student Experiences on Challenges and Barriers

Key Insights	Details	Direct Quotes
Navigating a Male Dominated Field	Participants face challenges in male dominated environments, with SWE providing support to counter these experiences.	"I think for me, it would definitely be imposter syndrome... just that feeling of not being good enough."
Challenges for International Students	Difficulty in securing employment due to visa restrictions was a common challenge, with SWE's networking opportunities being valuable.	"As an international student, it's hard to find a job, and having more networking opportunities with employers would really help."
Room for Growth in Chapters	There is a need for more active and continuous engagement within local SWE chapters throughout the year.	"Our chapter does a good job, but sometimes it feels like there could be more frequent and engaging activities beyond the main events."
Enhanced Mentorship and Alumni Networks	Developing a more structured mentorship program involving alumni could provide ongoing support beyond the University.	"If the SWE could establish a stronger alumni network and provide more continuous support beyond just events, it would really help in achieving our career goals."
Increased Inclusivity and Outreach	Expanding reach to include graduate students, men, and non-engineering STEM fields would help build a more diverse community.	"I feel like the SWE could do better at reaching out to the male population... There's this perception that it's only for women, which is not true."
More Frequent and Interactive Engagements	More frequent video conferencing and interactive sessions could help maintain engagement throughout the year.	"Arranging more video conferencing is very helpful... It helps us connect and learn from each other in ways that emails just can't."

References

- [1] Leibnitz, G. M., Peters, J. W., Campbell-Montalvo, R., Metcalf, H., Lucy Putwen, A., Gillian-Daniel, D. L., ... & Segarra, V. A. (2022). Refining a DEI assessment tool for use in optimizing professional STEM societies for gender equity. *Frontiers in sociology*, 7, 755372.
- [2] Taylor, L. S. (2022). The myth of meritocracy in the pharmaceutical sciences. *Molecular Pharmaceutics*, 19(3), 729-730.
- [3] Smith, C. A., Wao, H., Kersaint, G., Campbell-Montalvo, R., Gray-Ray, P., Puccia, E., ... & MacDonald, G. (2021). Social capital from professional engineering organizations and the persistence of women and underrepresented minority undergraduates. *Frontiers in Sociology*, 6, 671856
- [4] McGee, E. O. (2020). *Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation*. Cambridge, MA: Harvard Education Press.
- [5] Bird, S. R., and Rhoton, L. A. (2021). Seeing isn't always believing: gender, academic STEM, and women scientists' perceptions of career opportunities. *Gender Soc.* 35, 422–448. doi: 10.1177/08912432211008814
- [6] May, G. S., and Chubin, D. E. (2003). A Retrospective on Undergraduate Engineering Success for underrepresented Minority Students. *J. Eng. Education* 92 (1), 27–39
- [7] Brown, S., Flick, L., and Williamson, K. (2005). Social Capital in Engineering Education, Proceedings of the 35th ASEE/IEEE Frontiers in Education Annual Conference. Indianapolis
- [8] National Academies of Sciences Engineering and Medicine (2018). *Engineering Societies' Activities in Promoting Diversity and Inclusion: Proceedings of a Workshop—in Brief*. Washington, DC: The National Academies Press
- [9] Faulkner, W. (2007). Nuts and bolts and people: gender-troubled engineering identities. *Soc. Stud. Sci.* 37, 331–356. doi: 10.1177/0306312706072175
- [10] National Science Foundation. (2023). *The STEM workforce: Representation in the STEM workforce*. National Center for Science and Engineering Statistics. <https://nces.nsf.gov/pubs/nsf23315/report/the-stem-workforce#representation-in-the-stem-workforce>
- [11] Hewlett, S. A., Sherbin, L., Dieudonné, F., Fagnoli, C., & Fredman, C. (2014). Athena Factor 2.0: Accelerating Female Talent in Science, Engineering & Technology. Harvard Business Review. <https://hbr.org/2014/03/athena-factor-20>
- [12] AAUW. (2015). *Solving the Equation: The Variables for Women's Success in Engineering*

and *Computing*. https://www.aauw.org/app/uploads/2020/03/Solving-the-Equation-report_nsa.pdf

[13] Seymour, E., and Hewitt, N. M. (1997). *Talking about Leaving: Why Undergraduates Leave the Sciences*. Boulder, CO: Westview Press.

[14] Fink, A., Frey, R. F., & Solomon, E. D. (2020). Belonging in general chemistry predicts first-year undergraduates' performance and attrition. *Chemistry Education Research and Practice*, 21(4), 1042-1062.

[15] Rainey, K., Dancy, M., Mickelson, R., Stearns, E., and Moller, S. (2018). Race and Gender Differences in How Sense of Belonging Influences Decisions to Major in STEM. *Int. J. STEM Educ.* 5 (1), 10.

[16] Bilimoria, D., Lord, L., & Marinelli, M. (2014). An introduction to women in STEM careers: international perspectives on increasing workforce participation, advancement and leadership. In *Women in STEM Careers* (pp. 3-15). Edward Elgar Publishing.

[17] Leibnitz, G. M., Gillian-Daniel, D. L., Greenler, R. M. C. C., Campbell-Montalvo, R., Metcalf, H., Segarra, V. A., ... & Sims, E. L. (2022). The inclusive professional framework for societies: changing mental models to promote diverse, equitable, and inclusive STEM systems change. *Frontiers in sociology*, 6, 784399.

[18] Campbell-Montalvo, R., Kersaint, G., Smith, C. A., Puccia, E., Sidorova, O., Cooke, H., et al. (2022a). The influence of professional engineering organizations on women and underrepresented minority students' fit. *Front. Educ.* 6, 1–16. doi: 10.3389/feduc.2021.755471

[19] Campbell-Montalvo, R., Cooke, H., Smith, C. A. S., Hughes Miller, M., Wao, H., Puccia, E., et al. (2022c). “Now I'm not afraid”: The influence of identity-focused STEM professional organizations on the persistence of sexual and gender minority undergraduates in STEM. *Front. Educ.* 7, 1–8. doi: 10.3389/feduc.2022.780331

[20] Bhandari, H., & Yasunobu, K. (2009). What is social capital? A comprehensive review of the concept. *Asian Journal of Social Science*, 37(3), 480-510.

[21] Robison, Lindon J., A. Allan Schmid, and Marcelo E. Siles. 2002. “Is social capital really capital?” *Review of Social Economy* 60: 1-24.

[22] Saw, G. K. (2020). Leveraging social capital to broaden participation in STEM. *Policy Insights from the Behavioral and Brain Sciences*, 7(1), 35-43.

[23] Lin, N. (2001). *A Theory of Social Structure and Action*. Social Capital. Cambridge: New York: Cambridge University Press. doi:10.1017/cbo9780511815447

[24] Bourdieu, P. E. (1986). *The Forms of Capital. Handbook of Theory and Research for the*

Sociology of Education. New York, NY: Greenwood Press.

[25] McGee, E. O., and Martin, D. B. (2011). You Would Not Believe what I Have to Go through To Prove My Intellectual Value!” Stereotype Management Among Academically Successful Black Mathematics and Engineering Students. *Am. Educ. Res. J.* 48 (6), 1347–1389.

[26] Ong, M., Smith, J. M., & Ko, L. T. (2018). Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of Research in Science Teaching*, 55(2), 206-245. <https://doi.org/10.1002/tea.21417>

[27] National Science Foundation. (2023). *The STEM workforce: Representation in the STEM workforce*. National Center for Science and Engineering Statistics. <https://nces.nsf.gov/pubs/nsf23315/report/science-and-engineering-degrees-earned>

[28] Hurtado, S., Alvarado, A. R., & Guillermo-Wann, C. (2017). Moving from deficits to assets: Incorporating an asset-based lens in retention theories for underserved students of color. *New Directions for Higher Education*, 2017(180), 91-103. <https://doi.org/10.1002/he.20260>

[29] Nkrumah, T., & Scott, K. A. (2022). Mentoring in STEM higher education: a synthesis of the literature to (re) present the excluded women of color. *International Journal of STEM Education*, 9(1), 50.

[30] Martin, J. P. (2015). The Invisible Hand of Social Capital: Narratives of First Generation College Students in Engineering. *Int. J. Eng. Education* 31 (5), 1170–1181.

[31] AAUW. (2015). *Solving the Equation: The Variables for Women’s Success in Engineering and Computing*. <https://www.aauw.org/app/uploads/2020/03/Solving-the-Equation-report-nsa.pdf>

[32] Ong, M., Smith, J. M., & Ko, L. T. (2018). Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of research in science teaching*, 55(2), 206-245.

[33] McGee, E. O., and Martin, D. B. (2011). You Would Not Believe what I Have to Go through To Prove My Intellectual Value!” Stereotype Management Among Academically Successful Black Mathematics and Engineering Students. *Am. Educ. Res. J.* 48 (6), 1347–1389.

[34] Beals, R., Zimny, S., Lyons, F., & Bobbitt, O. (2021, September). Activating social capital: How peer and socio-emotional mentoring facilitate resilience and success for community college students. In *Frontiers in Education* (Vol. 6, p. 667869). Frontiers Media SA.

[35] Estrada, Mica, Myra Burnett, Andrew G. Campbell, Patricia B. Campbell, Wilfred F. Denetclaw, Carlos G. Gutiérrez, Sylvia Hurtado et al. "Improving underrepresented minority student persistence in STEM." *CBE—Life Sciences Education* 15, no. 3 (2016): es5.

- [36] Museus, S. D., Ledesma, M. C., & Parker, T. L. (2015). *Racism and racial equity in higher education: AEHE Volume 42, Number 1*. John Wiley & Sons
- [37] Stanton-Salazar, R. D. (2011). A social capital framework for the study of institutional agents and their role in the empowerment of low-status students and youth. *Youth & Society*, 43(3), 1066-1109.
- [38] Shortlidge, E. E., Gray, M. J., Estes, S., & Goodwin, E. C. (2024). The Value of Support: STEM Intervention Programs Impact Student Persistence and Belonging. *CBE—Life Sciences Education*, 23(2), ar23
- [39] Strayhorn, T. L. (2018). College students' sense of belonging: A key to educational success for all students. New York NY: Routledge.
- [40] Beals, R., Zimny, S., Lyons, F., & Bobbitt, O. (2021, September). Activating social capital: How peer and socio-emotional mentoring facilitate resilience and success for community college students. In *Frontiers in Education* (Vol. 6, p. 667869). Frontiers Media SA.
- [41] Moschetti, R. V., Plunkett, S. W., Efrat, R., and Yomtov, D. (2017). Peer Mentoring as Social Capital for Latina/o College Students at a Hispanic-Serving Institution. *J. Hispanic Higher Educ.* 17 (4), 375–392. doi:10.1177/1538192717702949
- [42] Vasquez-Grinnell, M. (2019). *Persistence of vision: Factors influencing the retention of women of color in STEM programs*. Northeastern University.
- [43] Museus, S. D., Ledesma, M. C., & Parker, T. L. (2015). *Racism and racial equity in higher education: AEHE Volume 42, Number 1*. John Wiley & Sons