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Mentoring women in STEM: empowering through social technologies for enhanced inclusivity and professional growth. A case study

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The use of social technologies for on-line training of women in STEM (Science Technology Engineering and Mathematics) areas was explored for empowering women. Here, a case study on the implementation of a mentoring program focused on fostering the professional careers of women from the Juarez Autonomous University of Tabasco (UJAT), at the southeast of Mexico is presented. By means of an international initiative from the British Council, 32 participants were trained as mentors and mentees at UJAT, and further matched to accomplish a 3 months mentoring relationship. Throughout the sessions, the participants' advances in soft skills (assertiveness, networking, leadership, active listening, self-confidence, ability to set SMART objectives, among others) were analyzed, showing how the use of social technologies promoted the professional development of women through empowerment as a strategy for reducing the gender gap in scientific and technological careers in Latin America.

KEYWORDS

mentoring, STEM, networking, mentees, mentors, social technologies

1 Introduction

Thanks to advances in communication tools, people can now be connected globally, transcending physical and cultural boundaries. Platforms such as Friendster, MySpace, and, eventually, Facebook and Twitter pioneered creating digital spaces for sharing, networking, and collaboration. Under this context, social technologies evolved from static information-sharing systems to dynamic, interactive platforms. The definition of social technologies remains unclear, but we recognize them as the product of years of technological evolution designed to benefit people. Social technologies are "digital technologies used by people to interact socially and together to create, enhance, and exchange content" (Chui et al., 2012). Social technologies reshaped industries, empowered grassroots movements, and redefined how societies interact, paving the way for a more interconnected world, becoming relevant in the last few years mainly because they help to increase women's connection, communication and empowerment (Hagen and Robertson, 2010; Nord et al., 2017; Nord et al., 2016). For instance, online training has opened new opportunities for people to interact, increasing knowledge and sharing information in all fields. Social technologies help support career development networks for women because they increase their ability

to communicate, produce, publish, and share (Jarrahi and Sawyer, 2013). It has been widely accepted that through social technologies, the development of countries could be accelerated, impacting the economy and well-being of citizens (Nord et al., 2016). In a digital era, the simultaneous use of different strategies for improving employee development in companies and organizations provides additional advantages such as better alternatives for training, motivation, and a sense of belonging for the employees.

Science Technology Engineering and Mathematics areas have been traditionally for men all over the world. However, several policies have been established in the last decade to decrease the gender gap in such areas. Women face a significant underrepresentation in STEM careers worldwide, being more noticeable in Latin America (Inés et al., 2023). Several studies revealed that the gender gap is one of the challenges in gender and diversity that organizations are facing and is not being reduced as expected, especially in STEM areas (Beroíza-Valenzuela and Salas-Guzmán, 2024; Meoli et al., 2024; Verdugo-Castro et al., 2023). In this regard, mentoring programs for women represent an excellent strategy to reduce the so-called gender gap (Aufschläger et al., 2023). This gap is driven by cultural, structural, and social barriers that limit their access, development and leadership in these areas (García et al., 2023). It begins with the low access to undergraduate studies in STEM areas, which consequently tends to decrease even more when women join the workforce.

In this regard, academia is not the exception since women on the faculty face several obstacles that limit their professional development, causing dissatisfaction or frustration, which sometimes even leads them to resign due to a lack of growth opportunities (Casad et al., 2020). The impostor syndrome, glass ceiling, and glass cliff are among the most common situations that women need to overcome during their careers, but unfortunately, most of the time, these phenomena make their progress difficult. According to the British Council, reducing the gender gap in Higher Education Institutions is needed to improve the economic development of countries (British Council, 2022).

It is important to mention some statistics related to gender differences in the state. In Mexico, there is a national program called SNII (*Sistema Nacional de Investigadores e Investigadoras*- National System of Researchers) that evaluates the quality and performance of researchers based on their scientific production, academic achievements, science dissemination and internationalization and categorize into four levels: candidate, Level I, Level II, Level III and Emeritus. According to the National Council for Humanities, Science and Technology (CONAHCYT, 2024), there are 302 researchers active in STEM areas recognized in the SNII that are currently ascribed at Tabasco, but only 103 of them are women, representing the 34% of the total number of researchers in STEM.

Tabasco is located southeast of Mexico and possesses abundant natural resources such as water, oil and gas, and a wide agricultural variety. Historically, most of the middle to upper positions in such areas have been dominated by men, and recently, it has been reported that it is the only state of Mexico in which the gender gap in STEM increased in a study from 2012 to 2022 (IMCO, 2023). However, in recent years, Mexican government policies are promoting the inclusion of women in STEM through the launch of specific programs and recognizing successful women who have entered in these fields (Gobierno de México, 2022, 2024), which

TABLE 1 Academic staff and undergraduate and graduate students in Juarez Autonomous University of Tabasco (UJAT) educational programs in Science Technology Engineering and Mathematics (STEM) areas (Narváez Osorio, 2024).

Level of participation	Women	Men
Undergraduate students	1,903	3,892
Graduate students	162	201
Academic staff*	260	475
Total	2,325	4,568

*Includes tenures, temporary, and part-time professors.

may inspire and motivate young women from this region of the country.

The UJAT, being the most important academic Institution in the state, contributes to this statistic with 218 researchers, but only 77 of them are women (35%), which agrees with the local statistics. But more important is the fact that until July 2024, from the 24 researchers with higher SNII levels of the UJAT (Levels II and III) only seven are women (29%) (CONAHCYT, 2024), which reflects the low access of women from the entity to high levels of recognition.

According to data from UJAT (Narváez Osorio, 2024), the number of women working in STEM areas within the UJAT (Universidad Juárez Autónoma de Tabasco) is lower than the number of men (Table 1). In postgraduate and undergraduate programs, the data are very similar. This can be interpreted as the need for incorporating more women in these areas.

Since the UJAT offers careers according to the needs of the state, it is necessary to promote higher participation of women in STEM areas. However, other factors such as customs and traditions from the region which are related to the historical belief that women should stay at home and take care of children and husband, low family incomes, long commutes because transportation routes are not well-developed and there many people live in remote communities, and the lack of awareness of opportunities have a detrimental effect on such enterprises. As a strategy to contribute to diminishing the gender gap, the UJAT implemented the Institutional mentoring program for women in STEM, which recruited 30 participants to boost the professional goals of students and teachers from the UJAT, with the collaboration of the British Council. In this work, the role of social technologies such as online training, virtual meetings, and social networks is crucial. These technologies facilitate communication, knowledge sharing, and goal reinforcement, thereby advancing and achieving the mentee's goals and reinforcing leadership in mentors.

2 Methods

2.1 Social technologies used

The social technologies employed for this study were social media (Facebook, X, Instagram, and WhatsApp) for dissemination of the program and to establish the network for direct communication between the participants and the research group in charge of the study, collaborative online tools (Jamboard,

mentimeter and Microsoft Teams), and an e-learning platform (*Vincúlate*).

2.2 Selection of the participants

Recruitment of the participants was performed through an open call, which was disseminated through social media, and using UJAT's radio and TV channels. To reinforce this, on-site visits to the different campuses of the university were carried out with the support of the authorities, where all the information related to the call was provided and to recruit potential candidates. Inclusive language as used in the call. The applicants filled in an online form that included the following aspects: privacy notice, general information of the participant, interest in participating, expectations of the program, and experience. The criteria for selecting the applicants were the following: (i) to be women working on STEM areas, (ii) to be members of the university either full-time or mid-time professors or enrolled students in undergraduate or postgraduate studies, (iii) to be willing to take the training, and (iv) to meet the expectations of the program. An additional criterion for mentors was the experience in calls for getting funds, and the recognition in their fields, which was confirmed by their CVs and the corresponding evidence. After selection, the applicants were asked to confirm their participation by email. Thirty participants (14 mentees and 16 mentors) confirmed their participation and were selected and split into two groups (mentors and mentees) according to their needs, experience, and objectives.

2.3 Mentoring training

Once selected, the participants were trained in mentoring for 2 months. The training consisted of an online course (MOOC) integrated into five modules and four sessions of accompaniment with a duration of 90 min each. All the topics revised in the MOOC, were provided by the British Council though the *Vincúlate* platform, and were in Spanish, although some of the complementary materials (videos, webinars and readings) were in English but translation to Spanish was available. During the training, virtual meetings, social media, videos, and collaborative apps were used to encourage participants to increase their communication skills as well as their tools for developing the mentoring process. Two instructors carried out the accompanying tasks using the virtual Microsoft Teams platform. Collaborative tools used during the meetings included Jamboard (google), whiteboard (Teams), and mentimeter. Communication was accomplished using instant messaging.

2.4 Matching

A matching process was performed using a questionary to find as many coincidences as possible between mentor-mentee regarding professional objectives, experience, availability, willingness and hobbies. To avoid biases, the pairs were formed avoiding matching participants that belonged to the same campus or educational program. With this, 14 mentees were matched up with 14 experienced mentors. The number of pairs was limited by the number of mentees. The mentors that were not matched (two), were considered as substitutes if needed, after asking them for willingness to do so. The results of the match were communicated via e-mail and a further brief person-to-person meeting to establish the rapport between the mentor-mentee dyad.

2.5 Mentoring relationship

The mentoring process took place over a period of 12 weeks, where one-on-one meetings took place once a week. In between sessions, mentees worked on the objectives that they had established at the first meeting. All mentees were asked to establish their own objectives using the SMART (Specific, Measurable, Achievable, Relevant, Time-based) approach. The progress of the objectives was monitored through a personal diary during the mentoring sessions, and the performance of each participant was assessed using a feedback form. This feedback form included general data such as date, and the name of the counterpart in order as evidence of that the meeting took place. The evaluation of soft skills was estimated using a self-assessment form before and after the conclusion of the mentoring. During this stage of the program, a drawback took place between one of the pairs and did not conclude the relationship.

2.6 Assessment of the program

Finally, after the mentoring relationship concluded for the 13 pairs, mentors (15, considering the un-matched mentors) and mentees (13) evaluated the program through an assessment questionnaire filled in online that included the following sections:(i) staff's performance, (ii) the suitability and opportunity of the call, (iii) the program's contribution to achieving the objectives established by the mentees, and (iv) the benefits obtained as participants. The questionnaire used for the assessment of the program was bases on the evaluation form used by the British Council and Inova Consultancy during the training of the staff prior to the implementation of this program, with modifications to align it with the needs of UJAT. For the analysis of the results, four key questions related to the main objective of the program and social technologies were selected.

3 Results

3.1 Training phase

It is worth mentioning that from the selected applicants, not all of them completed the confirmation for taking the training, without providing any reason, this was an expected result as the schedule of applicants and priorities may change during the process. The program's population included participants from different locations in the state. Therefore, the use of virtuality, social media, and instant messaging played a key role in the communication and dissemination of the program results during the training.

Since the accompaniment sessions were used as a strategy for reinforcing and discussing the topics revised in the online course, the use of collaborative applications allowed us not only to obtain information about the progress of the participants but also to gain knowledge on the compromise and particular obstacles that were faced by the participants regarding their everyday activities, which will imply further modifications to avoid work overload. Taking the training online and asynchronously allowed the participants to keep their own pace and progress according to their schedules. The overall result was the completion of the training by 100% of the participants in 8 weeks ± 5 days.

3.2 Mentoring relationship

One key activity was to establish the goals that the mentee wanted to achieve, and the use of SMART objectives methodology was promoted. At the end of each meeting, each participant filled out the feedback form for their counterparts about their performance as mentor/mentee, and the forms were sent by e-mail. At the end of the mentoring, 100% of the participants filled out the forms, although just 50% sent them on time (during the first 2 days after each meeting), whereas the other 50% of the participants had delays in the sending from 1 to 14 days. During session 12, each mentee was asked by her mentor to evaluate the achievement of their objectives.

The mentoring relationship lasted approximately 3 months with periodical meetings once a week. Despite the general advice for the participants was to have meetings with enough time to allow the reaching of weekly planned activities, it was observed that as the end of the semester approached, which coincided with the last month of the relationship, the meetings were re-scheduled, or the period was different (larger or shorter than at the beginning). This information was collected from the feedback forms sent to the participants.

3.3 Assessment of the program

To assess the effectiveness of the program, surveys were conducted among mentors and mentees, which included sections on their overall opinion about the program, this included whether the call was clear, suitable and properly scheduled, how they felt about the mentoring relationship, and general perception of the program and they were asked to leave any additional suggestions or comments to improve the program. It should be mentioned that during the mentoring stage, one dyad experienced lack of rapport after the third meeting and they decided not to continue, then only 13 pairs completed this stage. Regarding the launch, suitability and schedule of the call, as well as the kickoff ceremony, the results (Figure 1) showed a favorable reception, for both mentors and mentees.

Even though no unfavorable responses were obtained in the first part of the questionnaire, it is observed that some opinions differ between mentees and mentors. For example, mentees noticed less clearly the criteria for selection whereas according to mentors, the dates established in the call were not completely adequate or met. These aspects can be improved in further calls.

Figure 2 shows the opinions provided for the participants with the role of mentors. According to their responses about the training, 100% were favorable options ("Strongly Agree" and "Agree"). Despite the encouraging of these results, it should be noted that the number of sessions and the contents revised are areas for improvement in further calls, as the participants responded not to be totally convinced. Regarding the platform where the contents of the training are allocated, most participants considered it easy to use.
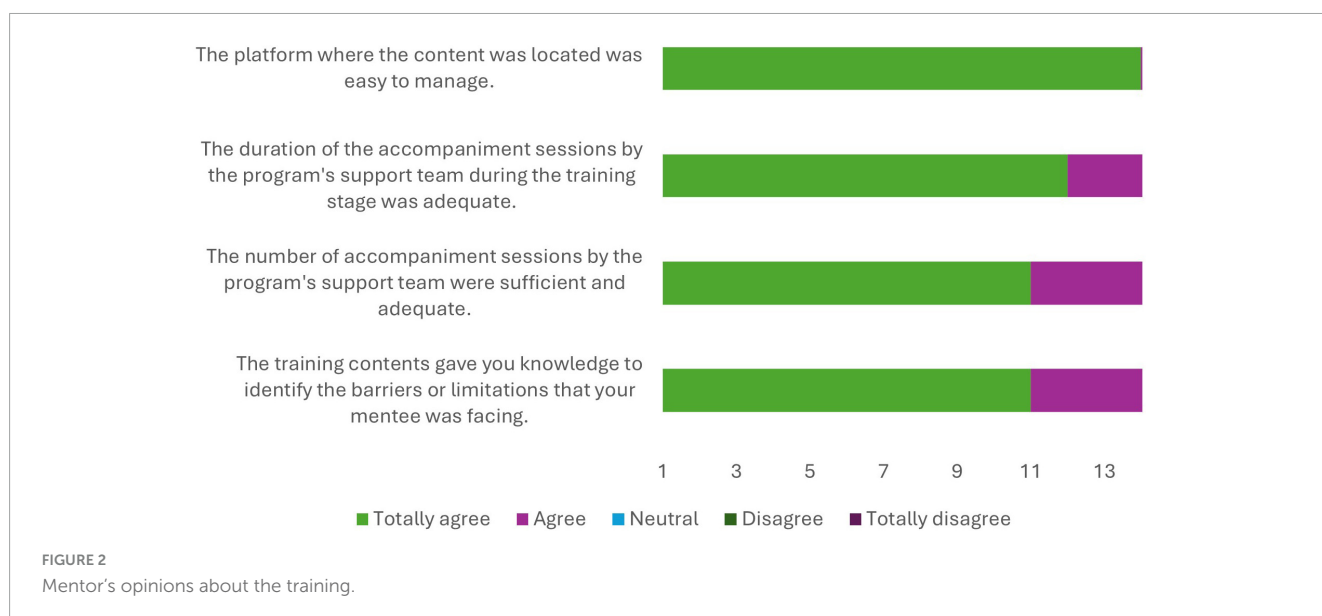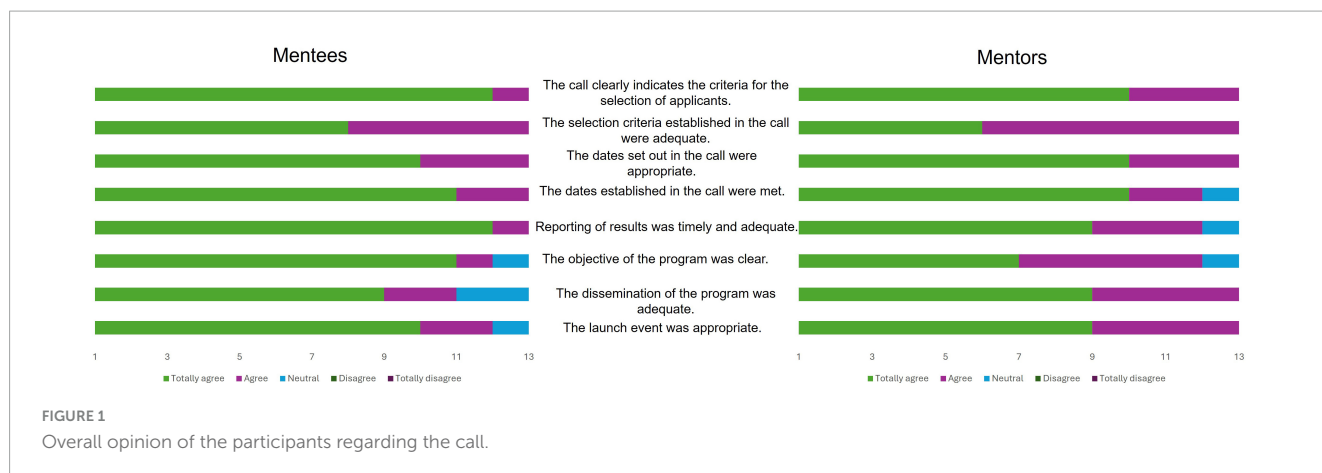
On the other hand, the responses for this topic provided by mentees (Figure 3) showed that for mentees the number of accompaniment sessions needs attention, since responses were more varied than those provided by the mentors.

During the training period, mentees were provided with two accompanying sessions, each lasting 90 min. Most of the participants indicated that they totally agreed on the duration (84%), with a variation of opinions in the number of sessions (69%). It is noted that for the mentees, the number of accompaniment sessions could be increased or improved in further calls. Also, it was observed that as for mentors, the use of the e-learning platform was easy to manage for the mentees too. Interestingly, regarding the tools provided during the training, considering "Totally agree" responses, almost half of the mentees agreed that they were enough to identify the limitations or barriers that they face by being involved in STEM areas, since half of the mentees responded just as "Agree," this may indicate that it is needed to develop additional tools for helping mentees to identify their own limitations needs in further trainings.

One of the main objectives of the program was the achievement of the professional goals of the participants. In this regard, they were asked about in what degree they considered their SMART objectives were accomplished. The results are shown in Figure 4, and there it can be observed the differences in perception. Whereas the mentees felt more optimistic as most of them considered to reach more than 80% of their SMART objectives, mentors did not share the same opinion in two cases. Just one of the mentees considered to achieve their established objectives in a low percentage.

The last result that is worth discussing is related to the obtained benefits after conclusion of the program. Here is needed to say that for mentors, this was a multiple-choice question because there were well-established skills that will be reinforced for the mentors, but for mentees their opinion about the benefits was an open question to get more information about their point of view. The results are displayed in Figure 5 as a word cloud.

Interestingly, most of the mentors agree that their mentoring skills were improved, followed by the reinforcement of leadership, while the active learning was also among the most common responses. As can be observed in Figure 5B, mentees felt benefited because the mentoring helped them to organize their time and improve their ability for planning, which also contributed to the achievement of their goals. At the end of the program, some of the participants were asked to volunteer to create short videos about their experience as part of the program, as most of the volunteers declared, significant improvements in active listening skills (mentors) and greater clarity in setting career goals (mentees) were achieved at the end of the relationships.

FIGURE 1
Overall opinion of the participants regarding the call.

FIGURE 2
Mentor's opinions about the training.

4 Discussion

Gender gap is remarkably noticed in the southeast of Mexico, where customs and manners still limit women's development. Besides cultural beliefs, women in this region of the country must overcome difficulties such as harassment, economic and social limitations for having access to higher academic degrees that allow them to get well-remunerated jobs.

According to the overall impression of the participants, the launch of this mentoring program helped the participants in different areas of their life. The use of online platforms is an alternative tool for women for training. Nevertheless, the lack of funds and awareness of opportunities limits women in Tabasco. As observed from the recruiting stage, where on-site meetings with potential participants took place, one common concern arose: this type of programs should be available not only for women but also for men, since the lack of opportunities is generalized due to centralization in Mexico.

The use of social media helped to disseminate the call, nevertheless due to the high number of activities at the University, the information is lost among so many advertisements. This is

probably one of the reasons why the participants noticed that the call was not as good as it should be in terms of schedule, dissemination and general information. In this regard, it is advisable to search for additional strategies such as the creation of media allusive to the program that can be broadcast on TV and radio. One additional strategy to reach more potential applicants could involve the participation of mentors and mentees from the first call to share their experiences through short videos, interviews and in-person conferences.

It was observed that training was a key stage for the success of the program, but there were different scenarios that should be considered for further calls. According to the assessment questionnaire, the use of MOOC was not difficult either for mentees or for mentors, but the need to schedule more and longer accompaniment sessions arose. This may be due to the lack of knowledge of what mentoring is. UJAT offers "academic mentoring" which is provided by students to students for specific topics, and offers "tutoring" also, where professors provide guidance to students during freshman and sophomore. Even though the objective of those programs is different to the mentoring for women in STEM, some strategies and actions are shared among the three programs, which facilitates the transition to mentoring

FIGURE 3
Mentee's opinions about the training.
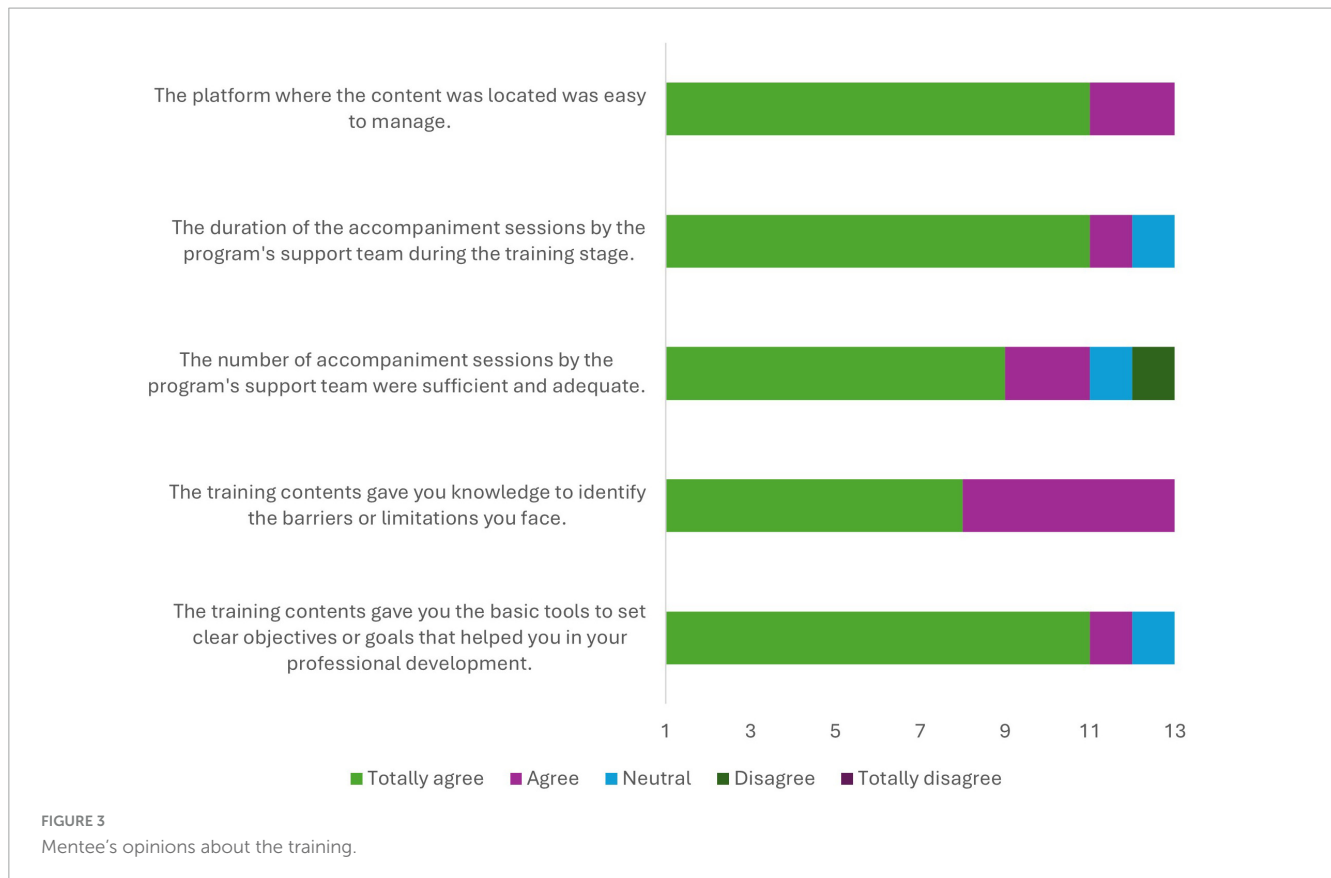
for achievement of professional goals. This was reflected in the use of asynchronous platforms, social media and other tools for establishing good communication and scheduling meetings for mentoring. It was observed that those pairs that met more than twice in person, experienced better rapport as the participants externed during the accompaniment sessions.

It is worth noticing that the achievement of the SMART objectives was differently perceived by mentees and mentors. This could be explained by two different scenarios observed during the accompaniment sessions during training with the mentees: (i) the mentees noticed a significant change in their organizing and planning activities which lead them to consider that they made a lot of progress in achieving their objectives, or (ii) the improvement in their skills to establish clear goals making them to be more focused and thus they may perceive this as an approaching to the objective. Either way, this lets us think about the need to develop a quantifiable and unbiased tool or instrument that allows us to measure the real achievement of the objectives soon.

In Tabasco, development opportunities are lower compared to northern and central Mexico, besides the lack of awareness about application procedures, and how to get financial support, significantly reduce women's opportunities of aspiring to higher positions, scholarships, and resources. In the Academy, participation in funded projects, collaborative scholarships, and scientific products are critical to accessing the National System of Researchers and federal scholarships that impact women's income. In this sense, the UJAT mentoring program was focused on addressing these and helping women learn about and strengthen their skills in specific areas that help them advance their careers,

mainly as researchers. As stated in the assessment questionnaire, some of the participants in the role of mentees concluded personal projects after the mentoring (enrolling in postgraduate studies, finish a paper or concluding their experiments for theses) that were boosted by the accompaniment of their mentors. We expect this success will help to promote future calls, increasing the number of applicants and thus the number of participants.

At the beginning of the training, the lack of self-confidence was the common characteristic among the mentees, but once concluded, most of the participants felt more confident not only at personal level but also as professionals since they are now aware of their strengths and weaknesses, but more important they are willing to change their situation by acting and stepping out of their comfort zone.

The UJAT mentoring program emphasizes the importance of unity and empowerment among women. In addition, networking was promoted not only by providing a space for technical knowledge sharing but also by creating a trusting environment in which women can freely discuss the specific obstacles they face and work together to overcome them.

Creating these networks is vital to breaking down the barriers of isolation that many women experience in STEM in the southeast of the country. By having a mentor who understands common STEM challenges, mentees can feel empowered to advance in their careers. This support is essential to increasing the retention of women in technology and science careers at UJAT, where dropout rates are high due to a lack of support.

Mentoring through social technologies has a transformative impact on creating a culture of support among women, especially
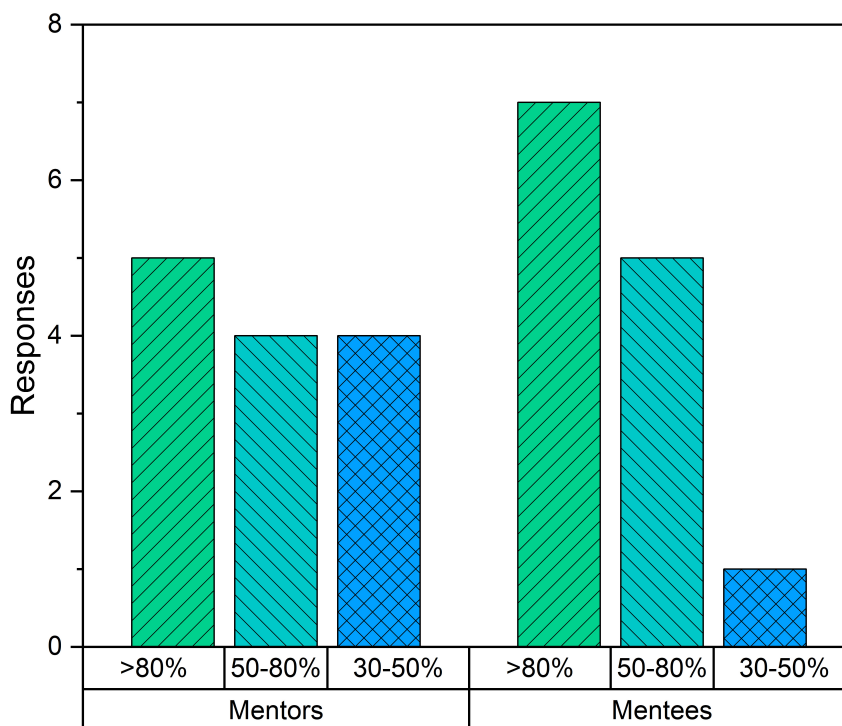
FIGURE 4
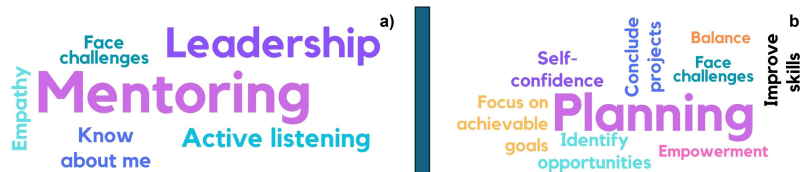Achievement perception of the SMART objectives by mentees and their corresponding mentors.

FIGURE 5
Benefits obtained by the participants after the conclusion of mentoring relationships. **(A)** Mentors and **(B)** Mentees.

those beginning their professional careers (Brizuela et al., 2023). As these women advance in their careers, they can become mentors, creating a virtuous circle of inclusion and support within STEM careers.

The UJAT mentoring program, and its alignment with social technologies, understood not only as social media but also as all type of technologies used for women in this program such as collaborative applications, videos, vlogs, and repositories, generates a supporting infrastructure designed to drive women's inclusion and professional development in STEM. This takes significance because as previously described, in Tabasco the insufficiency of transportation directly affects the mobility, and limits the opportunities for specialized training, and improvement of skills in women. Through social technologies, the participants of this program learn synchronously and at their own pace fundamental concepts not only for mentoring, but also to understand the context in which a mentoring program is needed. Technology tools have opened a wide range of opportunities, but it is needed to establish programs for women to use these tools for their own benefit and to increase they collaboration through networking.

By providing a network of mentors, this program not only trains participants in technical skills but also provides them with the tools to face and overcome structural barriers that have limited their participation in these areas.

According to the observed results, the implementers have noted that the accompaniment was effective in most cases, as the mentees are now aware of their skills and must continuously work to improve themselves. The second finding is related to the necessity of setting clear objectives based on a previous evaluation of the mentees' professional status and priorities. In addition, the use of social technologies to increase their collaborative network will be a milestone in their careers.

The program has revealed the potential for a hybrid model, where face-to-face sessions and social technologies play a key role in effective training and communication. This innovative approach opens new possibilities for the program's future, making it more adaptable and accessible. In addition, areas for improvement have been identified, such as the need for more training tools and periodical meetings for the participants to get feedback from their partners.

5 Conclusion

The UJAT mentoring pilot program has proven effective for promoting women's inclusion in STEM careers, improving their professional skills, and expanding their network. Mentors consolidated their positions, felt empowered, and were proud to promote the growth of mentees. Most mentees left their comfort zone and achieved their goals; some even surpassed themselves.

The pilot program yielded good results, and improvements such as extended mentoring sessions, additional training with an emphasis on soft skills, and a focus on including more areas of knowledge are proposed. Accompaniment is crucial during training, but also continuous supervision of the progress of each dyad is needed. This case study highlights the critical role of social technologies for inclusion in sectors where women have traditionally been under-represented. The mentoring approach used in the program can provide a basis for future policies and programs at the regional level. Before implementation in other locations, institutional/organizational support is the first goal for the team, and it is also essential to link with NGOs or local sponsors to get fundings and support. Fundings will be needed for organizing in-person meetings for the participants, whereas support provided for any other actor of the society will increase visibility and dissemination of the program. Another critical requirement is to align the objectives of the mentoring program with the priorities and needs of the Institution/Organization, so it is recommended to perform a SWOT analysis. As those needs evolve and the results of the mentoring program contribute to reach institutional goals and objectives, the program will become part of the Institution/Organization's policies. Another recommendation is to hold in-person meetings once or twice during the process for mentors and mentees separately, because it will encourage peer-to-peer feedback while at the same time this will be an additional strategy for monitoring the mentoring relationships.

Since this manuscript describes the first institutional approach to a mentoring program for women in STEM, some limitations regarding the staff arose. Even though this program was designed for women in STEM, experts from social sciences are needed. It is suggested that the staff be reinforced by including personnel with experience in gender and inclusion affairs, for supervising the contents of the training materials and the further reports that will be generated. Psychologists are also required to modify the evaluation instruments to obtain more information related to personal challenges that the participants face in their role as housewives, mothers, and/or heads of family, psychologists can be helpful also to design tools used during the training. Because one of the aims of the mentoring is to give visibility to women and their achievements, its is necessary to incorporate also specialists in communication for attracting more participants by designing visually attractive, impactful materials for social technologies and clearly communicates the objectives and results of the program.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in this article/supplementary material.

Ethics statement

The requirement of ethical approval was waived for the studies involving humans because personal data of the participants is reserved. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin because data were obtained for statistics only and no sensitive information of the participants is disclosed.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

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