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Continuing education of academic women in STEM: perspectives on mentoring and professional roles

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Despite ongoing efforts towards gender equity, the gender gap in STEM (Science, Technology, Engineering, and Mathematics) remains significant today. This article explores the motivations and perceptions of women in different professional roles within STEM fields regarding the importance of mentoring in fostering interest and participation in STEM careers, thus contributing to continuing engineering education. Based on qualitative data from 19 semi-structured interviews with women in managerial, research, teaching, and external academic and professional roles, the study delves into their motivations for pursuing STEM careers, their interest in promoting diversity, and the role of mentoring in supporting their professional development. The thematic analysis results are grouped into a hierarchical structure comprising one meta-theme, four primary, and six subthemes. The participants emphasized that their primary motivation for STEM involvement was contributing to society and promoting economic growth. Additionally, they advocated for greater diversity and challenged traditional gender roles in these areas. The participants highlighted the importance of closing the gender gap and recognizing the capabilities and new perspectives that women brought. Although these women faced obstacles such as glass ceilings, having a mentorship opportunity was identified as a critical tool for women's empowerment and training. The insights contribute to advancing strategies for promoting gender equity and diversity in STEM fields, with implications for researchers, universities, and organizations seeking to support women's participation and advancement in STEM careers. Further research is recommended to explore the perspectives of women in other roles and the effectiveness of mentoring programs in fostering gender diversity in STEM.

KEYWORDS

mentoring program, female mentors, women in STEM, higher education, educational innovation, mentorship, continuing engineering education

1 Introduction

Today, the gender gap in STEM (Science, Technology, Engineering, and Mathematics) is still prevalent. Despite the progress and efforts toward gender equity, women are still underrepresented in these fields (UNESCO, 2024). The underrepresentation of women in STEM fields can be attributed to various complex factors that intersect with societal norms, educational systems, and workplace cultures. Charlesworth and Banaji (2019) describe that the debates surrounding the causes of gender disparities in STEM often settle around three

interrelated hypotheses: "(1) innate and/or socially determined gender differences in STEM ability, (2) innate and/or socially determined gender differences in STEM preferences and lifestyle choices, and (3) explicit and implicit biases of both genders in perceptions of men's and women's work."

Even with the increased emphasis on diversity, equity, and inclusion in STEM fields, gender disparities persist in participation and advancement. While efforts have been made to attract and retain women in STEM, the representation of women in these fields needs to be more robust. Research highlights the need for comprehensive strategies to address the barriers that hinder women's progression in STEM careers and emphasizes the importance of retaining and actively promoting women in their STEM positions (Bilimoria et al., 2014). Moreover, fostering a supportive and inclusive environment is essential to encourage women's active engagement and leadership in STEM disciplines. Achieving gender equity in STEM requires sustained commitment and concerted actions from various stakeholders across academia, industry, and government.

Being motivated entails feeling driven to act; someone lacking this impetus or inspiration is deemed unmotivated, while an energized or directed toward a goal is considered motivated (Ryan and Deci, 2000a). In self-determination theory (Deci and Ryan, 1985), intrinsic motivation refers to engaging in an activity for the sheer joy and satisfaction it brings, without any external rewards or incentives. Personal interests, curiosity, and a sense of fulfillment drive this type of motivation. In contrast, extrinsic motivation involves engaging in an activity to obtain external rewards or avoid punishment. This type of motivation is driven by external factors such as praise, money, or recognition. Locke and Schattke (2019) describe intrinsic and extrinsic motivation. They define intrinsic motivation as "liking or wanting an activity for its own sake divorced from any specific outcome level" (p. 279–280) and suggest confining the meaning of extrinsic motivation to "involving means-ends relationships; it is doing something to get some future value (or avoid some future disvalue)" (p. 282). The motivation to pursue a STEM major and sustain a career within these fields is influenced by a complex interplay of intrinsic and extrinsic factors. Research highlighted by Luttenberger et al. (2019) suggests that male students often exhibit higher motivation levels than their female counterparts. This finding is particularly intriguing given that average gender differences in academic performance in science and math subjects are minimal or even favor girls and women. National Science Foundation (2020, Marzo 6). The ADVANCE Journal recently devoted an issue (vol 4, no.2) on transforming institutions from within towards diversity, equity, and inclusion. This is particularly relevant since this journal "publish peer-reviewed scholarship related to institutional transformation concerning inclusion, equity, and justice in higher education… Institutional transformation research related to NSF ADVANCE projects is especially welcome" (The ADVANCE Journal, 2024). This journal emerges as a product of an NSF project on diversity and inclusion in STEM fields. This journal and many others dedicated to diversity, equity, and inclusion offer critical insights into the intersectionality phenomenon that underrepresented or vulnerable groups face for their development and their input and contributions to be recognized. Despite achieving similar or sometimes better academic results, female students may encounter additional societal or cultural barriers (Wilkins-Yel et al., 2019), intersectional invisibility (Sparks et al., 2023), that dampen their motivation to pursue STEM fields with the same vigor as their male counterparts (OECD, 2015).

One potential solution to address the gender gap in STEM fields is through mentoring programs for women to promote collaboration among female academic members by sharing their experiences, supporting each other, and facilitating collective learning (UNESCO, 2024). Mentorship is a collaborative relationship that significantly impacts personal and professional growth by providing career guidance and psychosocial support (Tal et al., 2024). It typically involves a more experienced individual partnering with a less experienced one based on trust, reciprocity, and shared responsibility. Effective mentorship includes role modeling, advising, and sponsorship, focusing on self-reflection, clear expectations, trust, and feedback as key components for success (National Academies of Sciences, Engineering, and Medicine, 2019).

Mentoring programs for women in STEM have shown promise in addressing the gender gap by providing support, guidance, and role models for aspiring female professionals and have been identified as an essential catalyst for performance, success, and career advancement (Hund et al., 2018). These programs offer opportunities for women to connect with experienced individuals in their fields, gain valuable insights, and receive encouragement to pursue their career goals. The impact of mentoring goes beyond skill development; it can also help women navigate the challenges and biases they may face in the male-dominated STEM industries (Hernandez et al., 2020). Additionally, mentors can serve as role models, showcasing successful trajectories for women in STEM, thereby improving their confidence and self-efficacy (Moghe et al., 2021). By fostering a supportive and inclusive environment, mentoring programs contribute to breaking down some of the barriers that hinder women's advancement in STEM (Hund et al., 2018; Zhang, 2024). Mentoring alone does not fix structural bias; however, it plays an important role in mitigating some of its effects. Structural bias in STEM fields is deeply rooted in institutional practices, policies, and cultural norms that disadvantage women and underrepresented groups (Meschitti and Lawton Smith, 2017; Washington and Mondisa, 2021). While mentorship provides critical support, guidance, and opportunities for these individuals, it is only one piece of the puzzle in addressing systemic inequities (Dawson et al., 2015; Hernandez et al., 2020). Mentorship helps individuals navigate biased environments, providing role models, expanding networks, and increasing identity, motivation, and self-efficacy (Hernandez et al., 2017; Torres-Ramos et al., 2021; Amador-Campos et al., 2023). These benefits can empower individuals to persist in STEM and overcome the challenges posed by structural biases (Eby and Robertson, 2020). However, institutional changes are needed to truly eliminate structural barriers, such as policies promoting equal opportunities in hiring, transparent promotion criteria, anti-bias training, and an inclusive culture that values diversity at all levels. Therefore, mentorship is a valuable tool for supporting those affected by structural biases, but it must be combined with broader systemic changes to address and rectify these inequities fully.

Closing the gender gap benefits individuals and society. Research has consistently shown that gender diversity in STEM increases innovation, creativity, and problem-solving abilities (Charlesworth and Banaji, 2019). Concurrently, studies indicate that increased female participation, not limited to STEM fields, has positive repercussions on the economy, contributing by expanding the talent pool and filling skill gaps in high-demand sectors (Duflo, 2012). In essence, achieving

gender equity in STEM fields is not just a matter of social justice but a vital catalyst for progress and prosperity on a global scale.

The STEM fields are integral for driving innovation and enhancing various aspects of our lives while providing avenues for business growth and job opportunities. These fields utilize scientific and technological advancements to uncover new possibilities, tackle challenges, and influence the creation and evolution of innovative products and production methods (Bilimoria et al., 2014). It is evident that achieving gender balance and ensuring the active participation of both women and men in STEM professions is crucial for strengthening and expanding competitive advantages in the foreseeable future, leading to sustained economic benefits for nations in the long term (OECD, 2015). The integration of diverse perspectives in STEM fields fosters innovation and addresses global challenges more effectively. Research indicates that gender diversity in STEM can lead to improved organizational performance and enhanced problem-solving capabilities, which are essential for tackling complex global issues such as climate change and public health crises (Benavent et al., 2020; Sraieb and Labadze, 2022). Understanding the factors contributing to the underrepresentation of women in STEM fields necessitates a closer examination of their interests. As evidenced by Su and Rounds (2015), research consistently indicates that interest plays a significant role in shaping career decisions and outcomes as a critical psychological determinant influencing gender disparities within STEM fields. Moreover, these findings underscore the importance of exploring and addressing the underlying factors that shape women's interests and aspirations in STEM domains. Moreover, assembling mentoring programs with female mentors (role models) has a positive influence on preparing their mentees (students) to study a science program (Moghe et al., 2021). By gaining deeper insights into the role of interests in career selection, interventions can be developed to promote more significant gender equity and diversity in STEM disciplines, ultimately fostering a more inclusive and thriving scientific community.

The objective of this paper is to explore and categorize perceptions about the importance of pursuing a career in STEM and the role of mentoring based on the professional roles occupied by women. The study was conducted with prospective participants from a mentoring one-to-one model at a private institution that has yet to be implemented. The participants' insights are based on their previous experiences with mentorship throughout their careers, providing valuable perspectives on the potential impact of structured mentoring on professional growth and leadership development. This analysis is guided by the research question: How do women in managerial, research, teaching, and external academic and professional roles perceive the impact of mentoring in a STEM career? This research seeks to contribute to the knowledge about the importance of mentoring programs as a fundamental tool to promote interest in STEM areas. This research provides valuable insights from women in managerial, teaching, research, and external professional roles in STEM. Thus, it contributes to women's professional development as part of continuing engineering education.

2 Methodology

A qualitative methodology was employed to investigate and delve into the role of mentoring in STEM and engineering from the participants' perspective. Semi-structured interviews were conducted to explore women's perspectives in various roles in STEM fields (such as directive managers, external professionals, researchers, and university teachers) regarding the role of mentoring in these areas. Under this method, the participants became critical informants whose narratives provided the relevant data. For this study, thematic analysis was used to examine the data collected and to structure the result section (Guest et al., 2014; Braun and Clarke, 2021, 2024).

2.1 Participants

Nineteen women from a higher education institution who had training in STEM areas, mainly engineering and science, were interviewed. Specifically, the number of participants per area: 11 from engineering, four from sciences, three from health, and one from leadership; four participants were external to the institution but were part of the program for their experience in mentoring. Regarding the academic degree, 14 of the participants had obtained a doctoral degree and five a master's degree (Table 1). Diversity in age, career stage, main academic activity, and sector of expertise was sought to obtain a broad view of perspectives on mentoring in STEM careers. To ease the area in which each participant works, the first letter of the nicknames of the participants coincides with the first letter of the area (Table 1). Names in bold indicate that the participant obtained a doctoral degree.

2.2 Semi-structured interviews

A semi-structured interview script was designed and validated before implementation. The interview script collected the participants' perspectives on mentoring in STEM careers, covering aspects such as motivation, interest, and encouragement towards these areas. To ensure the validity and reliability of the instrument, the interview script was reviewed and validated by a panel of experts in qualitative

TABLE 1 The participants' composition in terms of their area, number of working years, range of working years, and highest academic degree obtained.

Area	# of participants	Participants' pseudonyms (bold indicates doctorate)	Working years (average)	Working years range (min-max)	Doctoral Degree	Master's degree
Engineering	11	**Edith**, Elaine, **Eliza**, **Ella**, **Emily**, Emma, **Erin**, Esme, **Esther**, **Eva**, **Evelyn**	16.5	1 to 29	8	3
Science	4	**Sara**, **Sienna**, **Sofia**, **Stella**	19.3	13 to 25	4	0
Health	3	**Hazel**, Heidi, **Hope**	16.5	13 to 22	2	1
Leadership	1	Lucy	9.0	NA	0	1

methodology and gender and STEM issues. Nineteen interviews were conducted face-to-face, while two were done through the Zoom platform, following the necessary ethical and security protocols. Before each interview, informed consent was obtained from the participants, assuring them of the confidentiality and anonymity of their responses. All interviews were audio and video recorded, which allowed us to capture both the verbal narratives and the participants' expressions and gestures. Subsequently, the interviews were transcribed verbatim, accurately preserving the perspectives and narratives of the 19 participants. After transcription, a preliminary theme map was created to guide subsequent qualitative data analysis. This rigorous and systematic process identified the main themes in the participants' speeches.

2.3 Data analysis

Thematic analysis was used for data analysis. Thematic analysis is primarily used for analyzing qualitative data. It is described as the method for identifying and examining various patterns within the data (Braun and Clarke, 2006; Clarke and Braun, 2017). In particular, the codebook approach helps us to draw the developing analysis, and as a team of researchers, we were able to code independently (Braun and Clarke, 2021). Finally, codes and themes help to analyze the data collected from interviews (raw data). The thematic analysis identifies and describes implicit and explicit ideas within the data (themes). At the same time, the codes mark points in the raw data that connect to the identified themes (Guest et al., 2014, p. 9). The purpose of the thematic analysis was to identify the participants' perceptions about the relevance of pursuing a career in the STEM area and the role of mentoring based on the different roles occupied by the participating women. This answered the research question: How do women in management, research, teaching, and external academic professional roles perceive the impact of mentoring on a STEM career? In the following section, the themes guide the structure and discussion of the results.

3 Results

The result section divides into three subsections: Mentoring theme system for women's engagement in STEM, perceived impact of mentoring from women in STEM roles, and trends in the perception of mentorship impact among women in STEM careers.

3.1 Mentoring theme system for women's engagement in STEM

The main results of the analysis are grouped into a theme system consisting of four themes, and six subthemes. Each section was defined after an exhaustive review of the participants' discourses. The motivations' theme analyzes the main reasons these women work in STEM areas. It is divided into two main subthemes: contribution to society and promotion of diversity, encompassing eliminating the gender gap. The second theme, encouraging STEM careers, addresses the importance of increasing women's participation in these areas and recognizing their skills, abilities, and approaches to thinking that generate innovative new ideas. The third theme focuses on interest, highlighting the role of support, soundness, learning space, training, and leadership. Finally, the mentoring theme is presented as a fundamental tool to encourage and motivate more women to pursue scientific careers. Figure 1 illustrates the theme system.

3.1.1 Motivation

The main motivations for pursuing a STEM career are not limited to individual benefits but transcend into supporting the community and society within a country.

Participant Hazel mentions that her decision to choose a career in science was motivated not only by the "*desire to acquire knowledge*," but also by the purpose of "*understanding the world and contributing to the development of cities, organizations, and projects*." This idea is complemented by the perspective of participant Emma, who mentioned that everyone has the potential to "*drive advancement in*

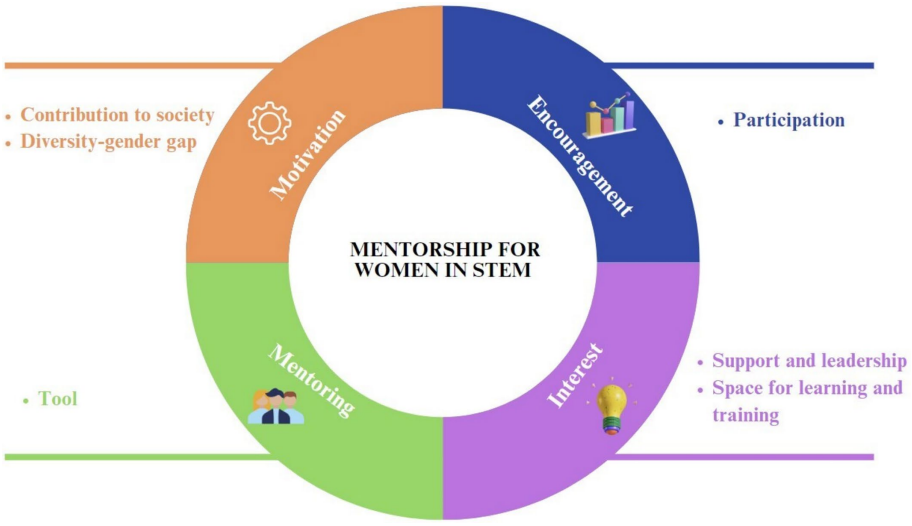

FIGURE 1
Mentoring theme system for women's engagement in STEM.

society." Furthermore, in the observation of Erin, it is highlighted that STEM careers offer the opportunity to "*address complex situations in diverse areas such as companies, industries, projects and governments*." Likewise, it is emphasized in the contribution of Evelyn that "*these careers are important in many economies, with very high economic rewards*." On the other hand, participant Edith alludes to the importance of "*understanding how the world works and seeking its transformation towards a better society,*" finding fulfillment in contributing with a positive impact on her environment. Participant Eliza highlights "*the relevance of contributing to the development of the country*." For her part, Sienna points out that her motivation to study science lies in the "*desire to change the world and improve existing conditions*"; likewise, Lucy highlights the capacity of STEM areas to "*offer solutions to global problems*," while Esme underlines the importance of working towards "*building a more livable world for all*."

In line to improve society is the fight against the gender gap and the promotion of diversity in STEM areas. Participant Hazel points out that STEM areas significantly impact the "*social context and the direction of individual efforts*." On the other hand, participant Emma highlights the importance of gender equity, arguing that "*men and women complement each other, and that society requires a balance*." In line with this idea, participant Sofia stresses the importance of "*closing the gender gap and empowering all women to pursue their goals regardless of their gender or career choice*." Participant Evelyn mentions that STEM careers historically did not align with traditional gender roles but emphasized that women have the potential to perform in any profession that interests them and fits their abilities and talents. From another perspective, participant Edith advocates freedom of career choice for women without being limited by gender bias or cultural stereotypes. Participant Ella highlights the importance of continuing to promote gender-diverse teams. Participant Lucy emphasizes that "*gender is central to all activities and decisions*" and highlights the importance of supporting projects that foster the participation of more women in STEM. Finally, participant Esme reflects on the importance of surrounding herself with people committed to equity, sustainability, and progress as a fundamental basis for moving toward a more just and equitable society.

3.1.2 Encouragement

Regarding the importance of encouraging women to pursue and STEM careers, the emphasis on increasing female participation in these areas stands out. This drive not only seeks to close the gender gap that persists in these fields but also recognizes and leverages the unique capabilities, skills, and thinking perspectives that women bring to the table.

For example, participant Hazel mentions, "*More women must develop in the STEM area because of their sensitivity to understand the mechanisms that lead us to organize ourselves in a certain way. Women have much to contribute to this, broadening our perspective for the better.*" Additionally, participant Stella comments, "*Women always bring a difference or sensitivity in the development of these areas. Therefore, it is essential to have different positions and approaches to flow effectively and diversely.*" Likewise, participant Ella highlights, "*Our thinking structures and skills allow us to combine mathematical aspects uniquely.*" On the other hand, the lack of female participation is a driving factor to continue promoting these areas, as participant Emma points out, "*Seeing the statistics of the scarce presence of women in STEM, especially after learning about the impact of mentoring on future students, motivates me, even more, to participate in this work.*" Additionally, participant Erin comments, "*We need more people in engineering and STEM areas to transform and improve our world. This includes both men and women.*" However, challenges persist regarding female representation in these areas, as participant Sara mentions, "*We have a considerable deficit of women in STEM areas, which is evident even in cases such as Mexico, where we barely reach 30% participation. More women must develop in various areas of engineering.*" Participant Evelyn adds, "*STEM careers are considered non-traditional due to pre-established gender roles. It is essential to overcome these perceptions to encourage female participation in these areas.*" Participant Heidi highlights, "*Women have a key role in science, research, and health.*" Regarding female representation in these areas, participant Edith comments, "*It is disappointing to see the lack of female representation in STEM despite being half of the population. This underscores the importance of promoting inclusion in these areas from an early stage.*" Finally, participant Lucy concludes, "*It is crucial to increase the presence of women in STEM, as we know that 75% of the future jobs will be in these areas. Without women, these areas will not reach their full potential.*"

3.1.3 Interest

About the interest in being part of an intra-academic mentoring program, its fundamental character as a space for learning and training that promotes leadership is highlighted. In addition, it functions as a platform to foster solidarity among participants, generating an environment of mutual support that strengthens confidence and self-confidence. Participant Hazel mentions: "*STEM careers are crucial areas for the development of all people. The Intra-Academic Mentoring project is extremely valuable, as it helps us to empower ourselves individually.*" In agreement, participant Emma emphasizes, "*We women must have equal opportunities in salary, ability, and leadership. I decided to focus on a STEM career to show that women can lead and innovate.*"

On the other hand, participant Eliza adds, "*It is essential to show that women can lead and contribute innovative solutions in STEM fields, which motivated me to embark on this area.*" Participant Sofia mentions, "*Having the guidance of someone with a similar career path to yours is invaluable to resolve doubts and receive useful advice.*" In addition, participant Esther adds, "*It is enriching to share experiences during the mentoring process, which creates an even stronger bond.*" For her part, participant Elaine expresses, "*I am motivated by the possibility of inspiring and accompanying female teachers and young professionals, as well as girls who are exploring their interests and vocations.*" Participant Eva comments, "*It is crucial that, as academics, we come together to form a strong network and work as a team, as we women can maintain unity and achieve effective and lasting results.*" Participant Heidi emphasizes, "*The participation of women as leaders in STEM areas has a positive impact on the effectiveness of teamwork and the sustainability of organizational changes.*" Participant Evelyn emphasizes, "*Mentoring is a valuable tool beyond technical training, as it contributes to the advancement of the academic community.*" In addition, participant Emily adds, "*Mentoring opens a relationship of mutual learning and growth, where time, experiences, and strategies for moving forward are shared.*" Participant Edith comments, "*I strongly believe in the power of mentoring as a powerful tool for personal and professional growth, regardless of age or background.*" Participant Sienna notes, "*Mentoring is an opportunity to improve my work and*

become a better mentor for future generations." Participant Lucy highlights, "*Training women mentors and linking them with young female researchers is an effective way to boost development and progress in academia*." Finally, participant Esme expresses, "*I am excited about the possibility of participating in diverse conversations and meeting interesting people in different fields and spaces*."

Several participants offer enriching perspectives regarding the individual support and confidence strengthened in mentoring spaces: Participant Emma highlights: "*It is fundamental to support the personal and professional growth of every woman, not only in STEM areas. This type of support helps us grow and generates a positive impact on the lives of others*." For her part, participant Sofia shares, "*In my personal experience, having someone to help, support and guide me has been extremely beneficial. Mentoring is a valuable tool in this regard*." Participant Erin states, "*I strongly believe we can change a person's life. Mentoring helps mentees grow and enables the growth of both mentors and mentees*."

Additionally, participant Esther complements, "*We still need this kind of accompaniment more. Sometimes, we feel alone, especially when we are few women in certain fields. Feeling that support and connection with someone who has gone through similar experiences is invaluable*." Participant Elaine says: "*I believe that it is our responsibility to share our experiences and knowledge with those women who already have a professional career. Teaching and university life offers us the privilege of contributing in this way*." Participant Eva adds, "*Seeing the progress of those we have mentored is rewarding. As a teacher and researcher, accompanying, teaching, and sharing knowledge is truly enriching*." On the other hand, participant Evelyn emphasizes, "*It is crucial to promote STEM careers for women from an early age. Generating a support network among professionals in these fields is fundamental to fostering inclusion and growth*." Participant Emily reflects, "*Pushing, motivating, and inspiring other women is essential to increase female representation in STEM fields*." Participant Heidi notes, "*Helping more women in science is an opportunity to contribute to the development of the community and oneself*." Participant Stella adds, "*Mentoring is a way to support other people's personal development, while also providing feedback and personal growth for both mentor and mentee*." For her part, participant Edith suggests, "*Teamwork and continuous learning are key to growth and development. Collaboration and strategy allow us to keep moving forward together*." Participant Eliza reflects, "*It would have been beneficial to have mentoring in my professional development. Now that we have the opportunity, it is important to offer our help to those who need it*." Participant Sienna finds motivation in knowing that it is possible to achieve goals with support and perseverance. Finally, participant Esme emphasizes: "*Mentoring is an opportunity to recognize and value our abilities while expanding our support networks among women*."

3.1.4 Mentoring

Mentorships are much more than simple encounters between mentors and mentees; they are sacred spaces where learning, support, and growth are intertwined meaningfully. For the Hazel, they represent a safe space where she feels listened to and learns from the experience of others. They are an opportunity to make better decisions and consolidate efforts. On the other hand, Emma highlights that they imply sharing experiences and obstacles faced in life, offering a valuable perspective to overcome them personally and professionally. In addition, it is recognized in the idea of Sofia that mentoring helps carry out projects together, which could be more difficult to achieve individually. Erin describes mentoring as a process of growth and accompaniment, where the mentor's experience is used to help the mentee achieve his or her goals and dreams. In this process, listening is crucial, as highlighted by Esther, where the mentee trusts the mentor to find solutions to his or her problems, and the relevance of sharing experiences is emphasized.

On the other hand, Elaine and Edith consider them a gift, while Sara highlights their potential to create networking networks. Eva describes them as an act of empathy and admiration, encouraging others to move forward and recognizing the importance of not being alone in the process. From a more professional perspective, Evelyn defines them as a support tool among colleagues, while Emily sees them as a guide or inspiration. For Heidi, they represent progress; and for Hope, they are a source of inspiration. Stella highlights that they are a life experience that promotes the growth of both the mentor and mentee, and Eliza sees them as a commitment and a responsibility to make others shine. Finally, their ability to transcend is highlighted, according to Ella, and to drive transformation, as indicated by Sienna. Lucy sees them as fundamental support, and Esme highlights their ability to foster sonority in the mentoring process. In summary, mentoring is a valuable tool for personal and professional growth, where listening, empathy, and sharing experiences create an environment conducive to self-improvement and success.

3.2 Female roles in STEM: mentorship impact

Women hold various crucial roles in STEM, from leadership to research and teaching. Each of these roles plays a unique role in advancing scientific and technological progress, as well as in shaping the next generation of STEM professionals. However, despite advancements in gender equity in these areas, significant challenges persist regarding female representation and participation. In this context, mentorship has emerged as a powerful tool to support and empower women in their STEM careers. In this section, we will explore the perspectives of interviewed women according to their professional roles (directive managers, external professionals, researchers, and university teachers), examining how their testimonies and experiences may vary depending on the role they occupy and how they can contribute to the professional and personal development of women in STEM (Table 2). As in Table 1, the first letter of the nicknames indicates the first letter of the area (E for engineering, H for health, S for science, and L for leadership); whereas names in bold indicate that the participant obtained a doctoral degree.

In the following subsection, perspectives are analyzed according to the themes (Figure 1) based on the participants' roles at the time of the interview. Figures 2–5 depict the perceptions of women in various professional roles (directive manager, external professional, researchers, university teachers) regarding the impact of mentorship on a career in STEM.

3.2.1 Directive managers

Hazel, Emma, Sienna, Sofia, and Erin hold leadership positions. They see mentoring as a critical tool for driving societal progress and equity and an indispensable tool for personal growth and advancement. Regarding the motivation theme, the directive

TABLE 2 The participants' composition in terms of their academic role in the institution, number of working years, range of working years, and highest academic degree obtained.

Academic role	# of participants	Pseudonyms (bold indicates doctorate)	Working years (average)	Working years range (min-max)	Doctoral Degree	Master's degree
Directive manager	5	**Hazel**, Emma, **Sienna**, **Sofia**, **Erin**	23.2	16 to 29	4	1
External	4	Lucy, Esme, **Eva**, **Evelyn**	16.8	9 to 23	2	2
Researcher	5	**Edith**, **Eliza**, **Ella, Emily, Stella**	12.8	7 to 22	5	0
Instructors	5	Elaine, **Sara**, Heidi, **Hope**, **Esther**	10.8	1 to 15	3	2

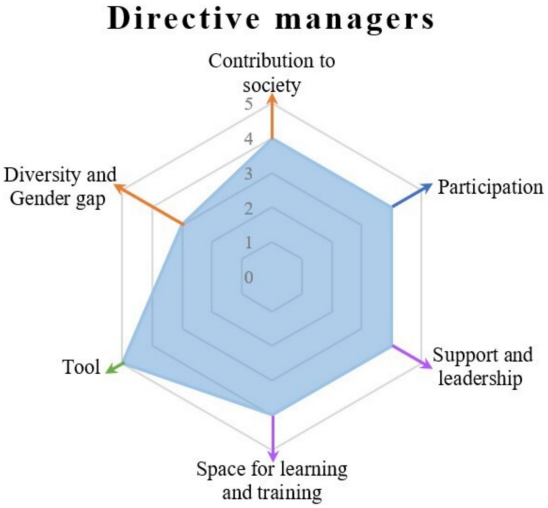

FIGURE 2
The enclosed area considers the six subthemes for directive managers.

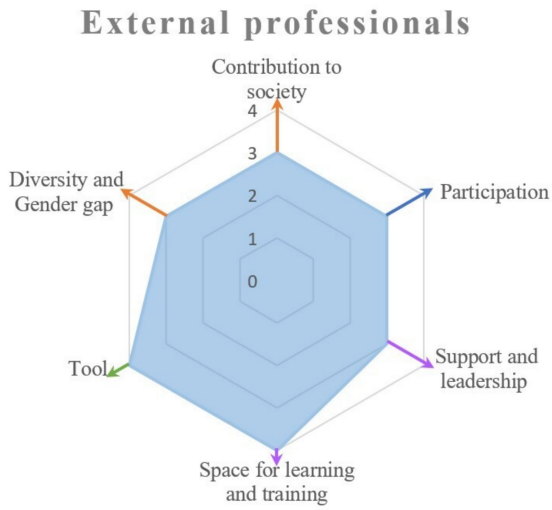

FIGURE 3
The enclosed area considers the six subthemes for external professionals.

managers stated that mentorship dramatically contributes to society and highlighted the systemic and social impact of mentorship programs beyond individual benefit. Most of these women consider mentoring important for promoting diversity and addressing the gender gap in STEM; as leaders, they understand that closing gender gaps is crucial, but they may also focus on other goals. These women also believe that mentorship provides solid support in their careers. They know how crucial it is to have that guidance and feedback to advance their careers. Under the interest theme, we found that these female managers believe that mentorship provides a crucial space for learning, training, and leadership. As women in managerial positions, they understand that mentorship provides a unique and valuable space for learning and training future leaders. They see mentorship as a critical pathway for cultivating and strengthening leadership (see Figure 2), where the six subthemes enclose an area that can be interpreted as how much these directive managers value mentoring as a tool that promotes participation, contributes to society, fosters diversity, and provides support for professional development for developing knowledge, skills, and leadership.

3.2.2 External professionals

Lucy, Esme, Eva, and Evelyn hold external positions in the educational institution where the study took place; that is, they work in non-governmental organizations or the private sector. Like the directive managers, they also view mentoring as a valuable tool for personal and professional development. For them, mentoring contributes to society and is essential for promoting diversity and addressing the gender gap in STEM. Additionally, these women believe that mentorship provides a crucial space for growth and leadership. Being outside the organization, they possibly value the safe space and learning opportunities mentorship provides. Lastly, these women consider that mentoring could be a way to encourage women's participation in STEM careers. In all the themes, these participants have an opinion as strong as directive managers. Considering that there was one less external professional than directive managers, the enclosed area in Figure 3 is similar to Figure 2, indicating how strongly these external professionals advocate for mentoring in the themes we analyzed.

3.2.3 Researchers

Compared to other professional roles, researchers (Edith, Eliza, Ella, Emily, and Stella) have as strong positive opinion on the importance of mentoring as a tool as the directive managers and the external professional. These researchers recognize the solid support provided by mentorship and its role in providing a space for learning and leadership, similar to the position

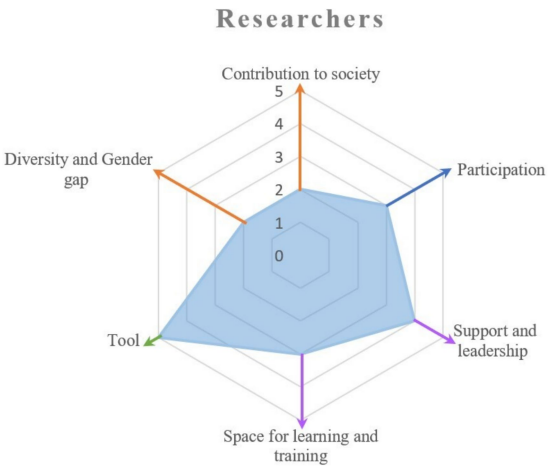

FIGURE 4
The enclosed area considers the six subthemes for researchers.

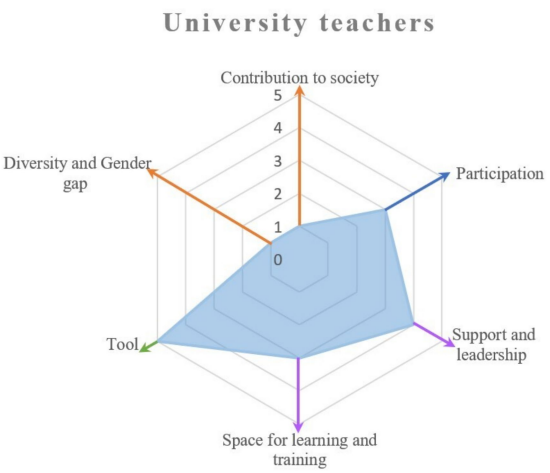

FIGURE 5
The enclosed area considers the six subthemes for university teachers.

manifested by the managerial or external professional, suggesting that researchers recognize the valuable support mentorship provides for encouraging participation in STEM areas. However, they see less impact on contributing to society, promoting diversity, and addressing the gender gap. It seems they hold a skeptical or critical perspective when evaluating the social reach or promotion of gender diversity. These women may have a more pragmatic perspective or consider other relevant factors to address this challenge. Figure 4 depicts the resulting area enclosed for the six subthemes for the researchers. We consider the enclosed area smaller for the researchers than for the directive managers. While researchers recognize the importance of mentoring in promoting interest in supporting leadership, they may perceive it differently in terms of priority than other subthemes.

3.2.4 University teachers

Women in teaching roles (Elaine, Sara, Heidi, Hope, and Esther) exhibit a low perception of the impact of mentorship on contributing to society, promoting diversity, and addressing the gender gap. The percentage obtained for contributing to society is significantly lower than that reported for other professional roles. This suggests that university teachers have an even more skeptical view of the social impact of mentoring and do not perceive mentorship as crucial for addressing the gender gap in their fields. Most of the university teachers who participated in the study believe that mentorship provides a space for learning and training and even more for support and leadership. In these two subthemes, their responses are like the researchers. This indicates that university teachers recognize the importance of this subtheme but do not perceive it as fundamental as women in external professions do. This may be because, as academics, they have a more knowledge and teaching-focused approach and do not see leadership as their main priority. However, these women value the solid support that mentoring brings to leadership. As women in managerial positions and researchers, these university teachers widely recognize mentorship as a valuable tool for STEM careers. It seems to be an aspect in which all professional roles agree in a positive perspective (see Figure 5).

3.3 Trends in the perception of mentorship impact among women in STEM careers: an analysis of professional roles and perspectives

It is important to note that all participants, regardless of their professional role (100%), recognize mentoring as an essential tool for their professional development in STEM. However, how they value its impact may vary depending on their role and work context. Given the results obtained in describing how different professional roles of women in STEM careers perceive mentorship and its impact, we can explore these perceptions in a broader context:

- Varied perception based on role. The data reveals significant variation in the perception of mentorship among different professional roles held by women in STEM careers. While women in managerial positions and external professionals view mentorship more positively and acknowledge its impact on contributing to society and promoting gender diversity, researchers and university teachers show a more moderate perception of these aspects. This finding suggests that the position held within an organization can influence the perception of the effectiveness of mentorship.
- Importance of support and leadership. Although perceptions vary, all participants recognize the importance of mentorship as solid support in their careers. This highlights the universal need for support and guidance in the professional development of women in STEM, regardless of the role occupied. Additionally, all roles value mentorship as a crucial space for learning, training, and leadership, underscoring the importance of mentorship in professional growth and leadership in the STEM field.
- Perspectives on contributing to society and gender diversity. Differences in the perception of mentorship regarding its contribution to society and the promotion of gender diversity among different professional roles may reflect unique work experiences and responsibilities associated with each position.

Women in managerial positions and external professions, who likely have a broader scope of influence and responsibility, are possibly more aware of the vast impact of mentorship on society and gender diversity in STEM than researchers and university teachers, whose focus may be more on research or teaching.

- Need to address differences and promote equity. These findings highlight the importance of recognizing and addressing differences in the perception of mentorship among different professional roles held by women in STEM careers. To promote gender equity and improve the effectiveness of mentorship in STEM, it is crucial to implement inclusive strategies catering to each group's unique needs and perspectives. This may include creating specific mentorship programs for certain roles or training mentors to address the concerns of each theme.

The differences in opinions about the impact of mentorship in STEM careers among different professional roles can be attributed to a combination of factors, including work experience, organizational context, specific professional needs, and organizational culture. Understanding these differences can be crucial for designing more effective mentorship programs tailored to the needs of each group. Mentorship programs can focus on vital aspects of professional roles, such as leadership, communication, and self-management, thereby providing comprehensive support for the growth and success of participants.

4 Discussion

This study addresses a significant gap in the literature by investigating the specific motivations of women in non-traditional roles in STEM, such as managerial and external positions, compared to research and educational roles. The findings suggest that persistence factors vary by role type, and support programs must be tailored to these differentiated motivations, providing a more comprehensive framework for STEM retention. The data reveal distinct motivational patterns among women in managerial and external professional roles, who are strongly oriented toward social impact and economic growth; in contrast, researchers and educators focus more on technical or academic goals. According to role congruity theory (Eagly and Karau, 2002), these differences may stem from the alignment of personal values with the specific demands of each role. Our study extends this theory by providing evidence that social and economic impact values are critical motivators in leadership roles within STEM, suggesting a need for tailored mentoring programs that address these specific motivations.

The participants who played managerial roles (Hazel, Emma, Sienna, Sofia, and Erin) and those with the role of external professionals (Lucy, Esme, Eva, and Evelyn) highlighted that their primary motivation for pursuing a career in STEM was to contribute to society and promote economic growth through projects. The OECD recognizes the insertion of women in the productive sector as a fundamental element for economic development, which promotes policies oriented toward the STEM model (OECD, 2015). These women aimed to impact society, transcending personal benefit positively. Moreover, they actively advocated for greater diversity in STEM areas, challenging traditional gender roles and confronting gender prejudices and stereotypes that historically limited women's participation in these fields. This aligns with findings by Blickenstaff (2005), who argued that the underrepresentation of women in STEM is often linked to conformity with traditional gender roles and cultural pressures. Additionally, Martínez Gómez et al. (2022) and Musso et al. (2022) highlighted that gender stereotypes significantly limit women's STEM engagement. By challenging these stereotypes, participants in our study sought to foster a more inclusive environment that encourages women to enter and thrive in STEM fields.

Regarding promoting women's participation in STEM, female managers, and external professionals have emphasized the importance of closing the gender gap and recognizing women's capabilities and new perspectives to generate innovative ideas. The participation of women in senior management or leadership positions in science, research, academia, or other vital sectors strengthens the social and economic development of countries. Despite offering significant advantages for the participation of women, in the senior management positions, women face the "glass ceilings" (López-Bassols et al., 2018), a factor of inequity that prevents the ascent of women scientists and has nothing to do with experience, training, or skills. This low participation of women in high academic spheres is due to the phenomenon of vertical segregation.

Encouraging women to pursue STEM careers remains crucial, as their perspectives and skills in mathematics and science enrich all fields (Oliveros Ruiz et al., 2016; Segovia-Saiz et al., 2020). To that end, mentoring programs are a sound strategy. However, the findings underscore the importance of mentoring programs tailored to different roles within STEM. While previous studies (Rosser, 2004; Settles et al., 2007; Meschitti and Lawton Smith, 2017) support the value of mentorship in STEM, this study introduces a differential approach: women in managerial and external roles benefit from mentorship that emphasizes social impact, whereas researchers and educators may require support aligned with technical objectives. This perspective offers a practical improvement in designing role-specific mentoring programs (Hund et al., 2018; Washington and Mondisa, 2021).

About mutual support and sonority, managers, researchers, and university teachers have expressed their conviction that peer support favors individual and collective growth. Women can create collaborative networks to achieve more impactful results (Miller et al., 2015; Segovia-Saiz et al., 2020).

Concerning the learning and leadership space, external participants (all with mentoring experience) agreed that mentoring effectively helped women's empowerment and training, supported by the majority opinions of managers, researchers, and university teachers. In the work of Müller and Kenney (2014), it is reflected how, in the areas of life sciences, individualism, and competition hinder collaboration and teamwork, which leads to the exclusion of certain groups, hence the importance of creating these spaces for collaboration and mentoring. On the other hand, it is necessary to make visible that more women are in these areas since the androcentric vision of science based on stereotypes and the absence of role models of women scientists are factors that are related to the loss of women in science in general (Segovia-Saiz et al., 2020). Finally, in the mentoring theme, all participants, regardless of their roles, highlighted its importance as a fundamental tool for personal and professional growth and a space for exchanging experiences and mutual help. This is corroborated by the study conducted by Settles et al. (2007), who mention that mentoring among women in academia and departmental leadership is effective for the retention and success of women in male-dominated fields (Moghe et al., 2021).

The testimonies of the participants have relevant implications for psychology, sociology of science, and talent management in these fields. Motivation towards STEM careers has been of interest in various disciplines, especially in psychology and sociology. Beyond individual benefits, such as income potential and job stability, motivations towards STEM often focus on social impact and the desire to contribute to the common good. Self-determination theory suggests that individuals are intrinsically motivated to seek activities that satisfy their basic psychological needs, such as competence and relatedness (Ryan and Deci, 2000b). In the context of STEM, this can translate into a desire to understand the world, address global issues, and generate positive societal change. This intrinsic motivation drives women towards STEM careers. It can influence their long-term commitment and persistence in these areas—the persistent gender gap in STEM concerns scientific research and society. Even with the advances in gender equity, women continue to be underrepresented in science, technology, engineering, and mathematics (Nimmesgern, 2016; Campos et al., 2022). However, the value of women's unique perspectives and skills in STEM is increasingly recognized. Gender diversity is a matter of equity and has significant implications for innovation and progress in these areas (Nielsen et al., 2017; Potvin et al., 2018; Greider et al., 2019).

Research in psychology and sociology of science has highlighted how including women enriches scientific and technological development by diversifying thought and creativity. Academic mentoring programs are recognized as a fundamental tool to support the development and retention of women in STEM careers (Dawson et al., 2015; National Academies of Sciences, Engineering, and Medicine, 2019; Saffie-Robertson, 2020; Torres-Ramos et al., 2021). From a psychological perspective, mentoring provides a space for guidance, emotional support, and the exchange of knowledge and experiences. Attachment theory suggests that the secure connection between mentor and mentee can foster self-confidence and empowerment in participants (Yip et al., 2018; Robertson and Zhang, 2024). Additionally, creating support networks and solidarity among women in STEM can have positive implications at the social and organizational levels, promoting a more inclusive and collaborative culture (Hall et al., 2023; Pillay-Naidoo and Vermeulen, 2023). From a psychological and managerial perspective, mentoring is perceived as a safe space for listening, empathy, and mutual support (Dawson et al., 2015; Eby and Robertson, 2020; Sera and Johnson, 2022). Trust and constructive feedback are crucial in effective mentoring processes, helping mentees overcome challenges and grow personally and professionally. In addition to conveying specific knowledge and skills, mentoring facilitates the integration and retention of women in STEM careers by providing them a sense of belonging and support. From a systemic approach, mentoring can create a more inclusive culture in STEM by fostering a diversity of perspectives and experiences.

The implications of this analysis of categorization by roles of women in STEM fields and the role of mentoring are aimed primarily at researchers, universities, or organizations interested in promoting more women's interest in STEM areas. This work emphasizes mentoring as a fundamental tool to generate synergies and support for professional development in different areas, regardless of roles.

5 Conclusion

In response to the research question of this study: How do women in managerial, research, teaching, and external academic, and professional roles perceive the impact of mentoring in a STEM career? it is observed that the perspectives of the women interviewed from different roles in STEM areas and mentoring are quite similar. There are converging points regarding the motivation that led them to pursue these careers, the interest in encouraging greater female participation, and the valuation of mentoring programs as tools for personal and professional development and to contribute to the growth of others. The results highlight that the main motivations that drove women to pursue a career in engineering or science include the desire to contribute to society, overcome the gender gap, promote diversity, and increase female participation in these areas. This aligns with the perception of the role of mentorships, considered spaces for support, learning, fostering entrepreneurship, and leadership, becoming fundamental tools for female development in these areas.

In terms of the objective, after categorizing the participants' discourses, it was concluded that it is crucial to create mentoring spaces that include women from diverse roles and work environments as part of their continuing education. Their experiences and approaches can serve as an impetus for other women facing similar situations or who may face them in the future. On the other hand, it is essential to continue to advocate for diversity and fight against gender stereotypes, as well as to give visibility to women scientists so that they can inspire future generations and become references that encourage more women to pursue STEM careers. In terms of contribution, the analyzed discourses provide valuable information on the perceptions of women in managerial, external, faculty, or researcher roles on how mentoring can motivate more women to pursue STEM careers. This may be useful for researchers, universities, or organizations promoting female participation in STEM fields (Dominguez, 2023). More extensive and comparative analyses regarding the opinions of women in other roles who have participated in mentoring programs are recommended for future studies.

Data availability statement

The datasets presented in this article are not readily available because confidentiality and anonymity. Requests to access the datasets should be directed to Angeles Dominguez, angeles.dominguez@tec.mx.

Ethics statement

The studies involving humans were approved by Instituto Tecnologico y de Estudios Superiores de Monterrey. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

EG-S: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing – original draft. SP-S: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – review & editing. AZ-P: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – review & editing. FM-A: Conceptualization, Data curation,

Investigation, Project administration, Resources, Writing – review & editing. AD: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – review & editing.

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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.

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