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Article

Women mentor program in science in the state of Mexico. experiences and results at the Universidad Politécnica del Valle de México

Programa de mujeres mentoras en la ciencia en el estado de México. Experiencias y resultados en la Universidad Politécnica del Valle de México

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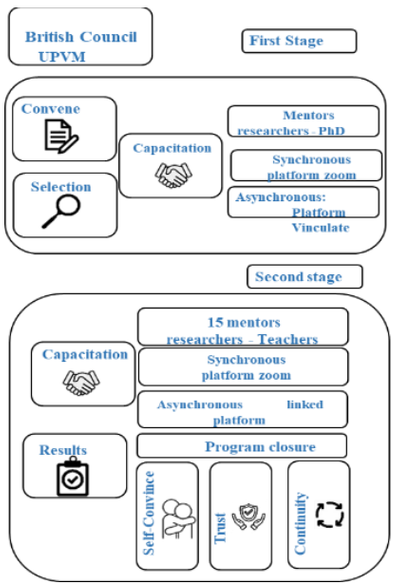
Abstract

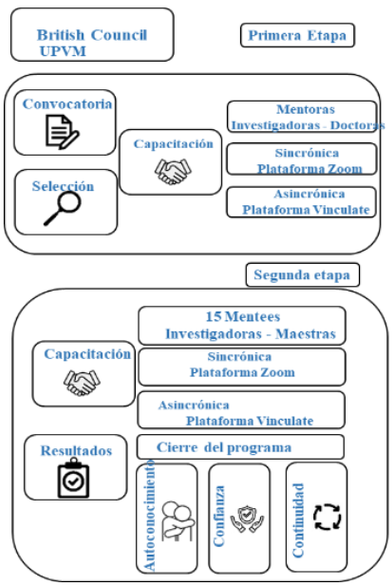
In this work presents the results of the application of the Women in Science Mentoring program in the State of Mexico, as part of the British Council – CONAHCYT program at the Universidad Politécnica del Valle de México (UPVM). The program had the participation of 15 women with a doctorate degree as mentors and 15 women with a master's degree as mentees. The program was developed with the training of synchronous and asynchronous sessions (MOOC). The results of the application of the program show that the participants obtained greater self-knowledge of themselves, greater confidence to continue their scientific and/or academic work, and finally obtained training to support women in STEM areas.



Mentoring Women, STEM, Gender Gap

Resumen

En el presente trabajo se presentan los resultados de la aplicación del programa de Mentoría Mujeres en la Ciencia en el Estado de México, como parte del programa del British Council – CONAHCYT en la Universidad Politécnica del Valle de México (UPVM). El programa tuvo la participación de 15 mujeres con grado de doctorado como mentoras y 15 mujeres con grado de maestría como mentees. El programa se desarrolló con la capacitaón, a partir de sesiones síncronas como asíncronas (MOOC). Los resultados de la aplicación del programa muestran que las participantes obtuvieron un mayor autonocimiento de sí mismas, mayor confianza para dar continuidad a su labor científica y/o académica, y finalmente obtuvieron una capacitación para el acompañamiento de mujeres en las áreas STEM.



Mentoría de mujeres, STEM, Gender Gap

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Introduction

Women's participation in science, technology, engineering and mathematics (STEM) is low globally. Although in recent years there has been increased participation of women in STEM fields, inequality is still present. The under-representation of women in STEM, in addition to being a social justice issue, also has economic and scientific implications.

The lack of equity in STEM limits the potential to solve complex issues such as climate change, inclusive technological development and technological innovation in various areas. Minimising women's participation in these disciplines means missed opportunities to achieve the goals of the 2030 Agenda (UNESCO, 2019). For example, 1.5% of climate change-related aid recognised gender equality as one of the main objectives and only 0.2% of aid is through women-led organisations. Yet 80% of people displaced due to climate change are women and girls (The lancet, 2024).

The low participation of women in STEM fields is due to factors of gender discrimination, race, class, socio-cultural factors, institutional bias, etc. Underrepresentation of women's participation in STEM may be due to the influence of male-dominated environments, stereotypes that STEM fields are masculine. The metaphor of the leaky pipeline explains the gender gap in STEM. The STEM pipeline lets women interested in STEM escape, or when they are in university, they change their major before finishing their studies or if they graduate, they have jobs that do not correspond to STEM fields (Meolli *et al*., 2024).

The gender gap in STEM is caused by cultural, educational and institutional factors. From an early age, women are confronted with stereotypes that keep them away from STEM areas, because of stereotypes that women have neither the physical capacities, such as strength, nor the intellectual capacities to belong to these areas. Moreover, at the professional level, women face systematic barriers, such as lack of leadership opportunities, unequal pay, and unconscious biases that affect their recruitment and promotion.

Another factor that has decreased women's participation in STEM fields is the belief that care and domestic tasks are women's responsibility (Abuwatfa *et al*., 2021). Squazzoni *et al*. (2020) report that the effects of the pandemic caused women scientists to decrease the number of manuscripts submitted to journals during the COVID-19 pandemic.

This gap not only represents a loss of talent, but also perpetuates structural inequities. Several studies have identified factors such as gender stereotypes, lack of role models and insufficient support networks as key barriers for women in STEM.

Strategies to promote women's participation in STEM include: a) Mentoring and Support Networks, through the creation of mentoring networks and institutional support specifically for women, enabling them to access resources and advice to facilitate their progress in their academic careers. b) Inclusive institutional policies, this involves institutions implementing measures that balance teaching, research and service responsibilities, ensuring that they do not fall disproportionately on women. c) Awareness and training on unconscious bias, as well as fostering an inclusive culture in academic institutions (Dobele *et al*, 2019).

Mentoring programmes in STEM targeting women have emerged as a strategy to break down gender gap barriers and foster greater inclusion. One of the key factors contributing to widening this gap is the lack of role models and support networks.

This is where mentoring programmes play a crucial role. By connecting students and emerging professionals with experienced female mentors, these programmes help overcome barriers of trust, access and perception. The benefits of STEM mentoring programmes are:

1. **Personal and Professional Empowerment**: Mentorships enable women to develop technical and soft skills, such as problem solving, leadership and communication. They also provide a safe space to discuss challenges and strategies for overcoming them (Corbett et Rose, 2010).

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2. **Reducing the Confidence Gap**: Many women face **impostor syndrome**, especially in male-dominated fields. A female mentor can offer emotional support and share personal experiences to help overcome these insecurities.

3. **Professional Networking**: Mentoring programmes not only connect mentors and mentees, but also foster the creation of broader networks that can be crucial for career advancement (Chuco-Aguilar, 2023).

Programmes such as Million Women Mentors in the United States and INWES (International Network of Women Engineers and Scientists) have demonstrated the positive impact of these initiatives. These organisations have created global platforms to connect women in STEM, promoting development opportunities and removing cultural and educational barriers.

The British Council's Women in Science Programme, is also another successful programme, which aims to promote more diverse and gender-representative science by: increasing the presence of girls in STEM; supporting women scientists in STEM with training; strengthening networks of female researchers in collaboration with the UK; and developing policies to promote greater access and influence for women in science (UNESCO, 2022).

Since 2018, the British Council Americas Women in Science programme promotes the strengthening of links and capacity building of girls and women scientists in the Americas and the UK. The programme is based on three pillars: Inspiration, Performance and Recognition, from which strategic priorities are developed, such as: attracting more girls and women to STEM careers, strengthening capacities to support the development of professionals in the field, generating networks and partnerships that promote a positive transformation towards a more diverse science, impacting the political and institutional spheres (TLRHWP, 2024). This paper shows the results of the application of the Women Mentors in Science programme in the State of Mexico, as part of the British Council - CONAHCYT programme at the Polytechnic University of the Valley of Mexico (UPVM).

Methodology

The programme consisted of two stages: the first was a training course to train mentors, which lasted 11 sessions, based on the accompaniment of experts and certified in the subject, at the same time as the candidates took the course: Training for Mentors: Women in STEM, from the CONCYTEC's Vincúlate platform.

The second part was the assignment of a mentee to each mentor, the purpose of this action was to exercise her role as a mentor and evaluate her role through the progress of her mentee. At this stage, the mentees also took the Training Course for Mentees: Women in STEM of the Vincúlate platform of CONCYTEC. The number of participants was 15 women with a doctorate degree in science and 15 mentees, women with a master's degree.

Box 1

Figure 1
Inauguration of the Women in Science Programme in the State of Mexico at UPVM
Source: Own Elaboration

The synchronous sessions conducted for the mentoring training were designed in such a way that the participants acquired the tools for mentoring and matching with their mentee. The sessions were divided into: a) Conceptual tools for mentoring, b) Soft skills, c) Female leadership in science, d) Technological entrepreneurship, as well as providing them with tools for better self-awareness and introspection through mindfulness sessions.

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Results

Box 2

Figure 2

Synchronous sessions held in the Women in Science Programme in the State of Mexico at UPVM

Source: Own Elaboration

The training provided to the mentors was evaluated through the application of a survey with the following questions:

1.- Why did you decide to study a career in STEM? Some of the answers to the question are: 'Because since middle and high school I was genuinely attracted to science and although I still did not have great mathematical skills, it was not a limitation and I put myself at a level to achieve it', 'My main reasons for studying a STEM career were the interest in understanding and solving complex problems through science and technology, as well as the curiosity to explore how this knowledge can be applied in the real world', 'In order to seek solutions and address challenges that provide solutions to problems that benefit society', 'I like technology'. These responses show that, even knowing the challenges and difficulties in studying any of the STEM areas, the interviewees answered that they like their area of knowledge out of conviction, despite the difficulties inherent to the area, as well as the stereotypes formed.

The above responses are consistent with a study carried out by Hernández-Herrera (2022), to find women's perceptions of their transition in the STEM area, which indicates that the women participants indicated that the motivations that led them to study STEM careers are related to: becoming the first woman in their family to obtain a university degree; studying something related to mathematics in an innovative field; Applying the knowledge acquired for the benefit of society; and that they have envisioned becoming researchers.

2.- Did you have a female teacher or professional role model in STEM who motivated you to study? 50% of the interviewees answered that they did not. The lack of STEM professionals and teachers is a multifaceted problem that affects both educational institutions and companies. In education, the shortage of qualified teachers reduces the ability to inspire new generations in science and technology disciplines, which in turn affects student interest and retention in these fields (Diekmaan et Benson-Greenwald, 2018).

The lack of role models or inspirational role models is one of the major barriers that women face for entry into STEM fields. López Navajas (2016), who analysed the presence of female characters in the books of Santillana and Oxford Publishers (ESO) for 48 subjects from 1st to 4th grade (secondary-preparatory in Mexico), found a significant bias in the contributions of women in all areas in the published books of these publishers.

This implies a deficient cultural transmission in education by neglecting the contributions of women in the area of science, conditioning them to a low motivation to participate in STEM areas. Another example is that, currently 28% of researchers are women and only 17 women have won the Nobel Prize in Physics, Chemistry or Medicine, as opposed to 572 men (UNESCO, 2019). The low recognition of women in science makes women invisible, leaving a huge gap in inspirational female role models.

3.- What are the main barriers to overcome in your professional field? The vast majority of the responses focused on the words shown in Figure 1. Some of the female mentors mentioned pregnancy, family care, job change, financial problems as personal problems. The vast majority of the female mentors mentioned the following as the main barriers in their work environment: lack of job and professional recognition, lack of confidence to access leadership positions and one of the biggest barriers, institutional machismo (Figure 3).

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Dobele et al (2019) explain that in academia, sticky floors and glass ceilings are metaphors that represent, respectively, the difficulty of progressing from the initial levels of an academic career and the impossibility of reaching higher positions.

Among the main findings that the authors found were: a) Under-representation in Leadership Positions, suggesting that the glass ceiling is a significant barrier. b) Gender Expectations and Roles: Women are relegated to caring, mentoring and teaching tasks, limiting their time and ability to research and publish, activities that are paramount for academic promotion and recognition. c) Work Environment and Microaggressions:

Microaggressions and lack of institutional support create a hostile environment for women, perhaps leading them to leave academia. d) Impact on Professional Development: Work overload, lack of support networks, lack of funding opportunities and collaboration were identified as key factors limiting women's advancement and perpetuating sticky floors keeping women in an unadvanced position. It is recognised that employment favours men and that the required profiles maintain a preference for men in the majority of cases, in addition, situations that cause discrimination against women continue to prevail, as well as various manifestations of gender-based violence in the difficult road they have had to travel (Henández-Herrera, 2023)

Box 3

Figure 3

Main professional barriers of participants as Women Mentors in the Mentoring programme

Source: Own Elaboration

4.- Why would you like to be a mentor and what do you hope to gain from participating in the mentoring programme? To this question they answered that being a mentor would give them the opportunity to guide and empower other women in their personal and professional development. They also commented that in order to achieve women's empowerment, it is crucial for women to mentor others, as they face unique barriers in the work environment.

Finally, the interviewees felt that training as mentors would provide them with the necessary tools to gain experience, empathy with other women scientists and give other women the opportunity to motivate them to get others increasingly into STEM fields. Mentoring offers a safe space to discuss challenges and strategies for overcoming them, as well as providing role models who inspire young women. This support creates collaborative networks that benefit not only the women, but the entire community. In addition, mentoring can contribute to building a more equitable future (Figure 2). In the context of mentoring, women scientists acting as role models have been shown to have a significant impact on the development of new generations of women scientists.

These inspirational role models not only foster technical skills, but also the development of self-confidence and resilience, key qualities in disciplines where women are often under-represented. Research shows that the involvement of female leaders in STEM mentoring programmes increases the retention of female students in these areas by reducing the deterrence effect that can arise in predominantly male environments (Diekman *et al*, 2017). (Alexander *et al*, 2016).

Exposure to female role models can increase girls' interest and confidence in their ability to succeed in STEM, especially when the role models are seen as accessible and representative of qualities they value. Role models that emphasise both STEM competence and femininity tend to have a more positive impact on younger girls, who are still developing their personal identity (Bamberger, 2014).

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5.- One of the final questions asked of the participants as mentors was to learn about their barriers overcome, as well as their strengths gained at the end of the programme. The results of the mentoring training in Women Researchers at UPVM were: 1) Strengthening the strategies used to orient, direct and guide people (Figure 4), 2) Organisation and gaining time for their training, 3) Gaining greater confidence, 4) Achieving collaborative work and forming inter-institutional networks, 5) Empathy and improved listening skills, 6) Better self-knowledge and recognition as women and researchers, 7) Motivation to give continuity or resume their scientific work, 8) Recognition of their entrepreneurial capacity (Figure 5).

The mentoring programme seeks to provide women students in the STEM fields, through other women whose life experience and professional careers in STEM inspire and share their experiences. One of the main impacts of mentoring is the professional guidance that mentors provide to participants. UNESCO (2017) mentions that mentoring helps women identify their career goals, understand the specific challenges of STEM disciplines and develop strategies to overcome institutional and cultural obstacles. Mentoring is crucial at key stages such as the transition from academia to the workplace.

On the other hand, mentoring also fosters the building of strong professional networks. These networks allow participants to access collaboration opportunities, resources and visibility within their fields (IFE, 2022). Another benefit is the strengthening of women's confidence in their ability to succeed in STEM. Many STEM women face impostor syndrome, which they sometimes do not even perceive, therefore, through mentoring programmes, participants report a significant improvement in their professional self-efficacy and their perception of belonging in STEM disciplines.

Box 4

Figure 4

Podcast of the interview of the work done with the Mentoring Programme between participants Judith Ruby Sánchez García (mentor) and Belén Itzel Solano (*mind*)

Source: Own Elaboration

Box 5

Figure 5

Opening of the Laboratory for Scientific and Technological Innovation and Entrepreneurship in the State of Mexico

Source: Own Elaboration

On the other hand, the achievements of *mentees* were rated through the evaluation of skills obtained by mentees at the beginning and end of the programme.

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Figure 6 shows that the mentoring programme achieved an increase in the recognition of mentees' skills, results that also demonstrate an effective empowerment of women mentors. These results show that the different skills and strengths acquired by the mentors were permeated to the *mentees*, achieving a match by achieving an improvement in the skills of their *mentees*.

Box 6

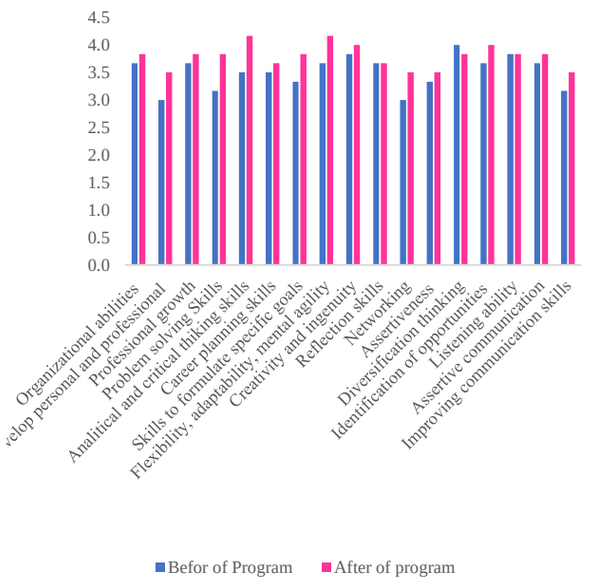

Figure 6
Skills assessed to participants as mentees before and after the Mentoring programme
Source: Own Elaboration

Conclusions

The application of the Women in Science programme in the State of Mexico enabled the women participating as mentors to acquire tools such as organisation and planning for training in the field of mentoring, as well as gaining strengths such as confidence, self-knowledge and self-recognition, which led them to break with the impostor syndrome.

At the end of the programme, some of the participants were able to continue their scientific work by publishing some of their research results, as well as considering technological entrepreneurship as an option for their professional growth. On the other hand, the women participants as *mentees*, achieved an improvement in their skills and recognised the work of their mentors as inspirational role models.

The results of the programme applied with this small population of women researchers at UPVM, also makes the reflection and motivation to give continuity to the programme and reduce the gender gap in the STEM area.

Statements

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' contribution

Martínez-Pérez, Beatriz, carried out the methodological development as well as the writing of this research paper.

Hernández-Acosta, Humiko Yahaira and *Sánchez-Vázquez, Elizabeth reviewed* and provided editorial corrections.

Availability of data and materials

Data are available for consultation and review.

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Abbreviations

IFE: Institute for the Future of Education

MOOC: Massive Open Online Course.

RENIECYT: Registro Nacional de Instituciones y Empresas Científicas y Tecnológicas.

SPWM: Science Programs for Women Mentorship.

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STEM: Science, Technology, Engineering and Mathematics.

UNESCO: United Nations Educational, Scientific and Cultural Organization.

UPVM: Polytechnic University of the Valley of Mexico.

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