An initiative for collaboration and participation in the professional field: "Women Engineers"

Una iniciativa de colaboración y participación en el ámbito profesional: "Mujeres Ingenieras"

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Abstract

The Sustainable Development Goals (SDGs) are a call for all of us to act to end poverty, care for the planet, and help people live better lives and have more opportunities around the world. Specifically, Sustainable Development Goal 4 establishes the guarantee of inclusive education. In this regard, this study proposes a qualitative investigation aimed at identifying studies of network initiatives, groups, or communities of support and collaboration for women in engineering education programs in Mexico. A documentary analysis method with a descriptive and exploratory approach is used, where a literature review is conducted, and the case study of Women Engineers is presented. The results show that various studies have documented the challenges women face in their entry and retention in STEM disciplines; only a few results focus specifically on engineering. Inclusion, gender equity, and interculturality are holistic aspects of the role of women in higher education. However, a new line of research remains open in the field of sisterhood and the culture of peace, focusing on STEM disciplines and engineering.

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Resumen

Los Objetivos de Desarrollo Sostenible (ODS) constituyen un llamado a la acción global para poner fin a la pobreza, salvaguardar el planeta y promover una mejor calidad de vida y mayores oportunidades para las personas a nivel mundial. Es así como el 4º ODS se centra en garantizar una educación inclusiva. Motivados por este último objetivo, el presente estudio plantea una investigación cualitativa cuyo fin es identificar estudios sobre iniciativas de redes, grupos o comunidades de apoyo y colaboración para mujeres inscritas en programas de ingeniería en México. Se adopta una metodología de análisis documental con un enfoque descriptivo y exploratorio, que comprende la revisión de la literatura especializada y la presentación del caso de estudio Mujeres Ingenieras. Los hallazgos evidencian que una variedad de investigaciones ha documentado los desafíos que experimentan las mujeres en su incursión y permanencia en las disciplinas STEM; no obstante, solo un número limitado se centra particularmente en las ingenierías. La inclusión, la equidad de género y la interculturalidad son aspectos holísticos propios del papel de la mujer en la educación de nivel superior. Sin embargo, queda abierta una nueva línea de investigación en el ámbito de la sororidad y la cultura de paz enfocadas a las disciplinas STEM o las ingenierías.

Palabras clave: mujeres, ingeniería, comunidad, colaboración.

Introduction

Throughout history, women have faced discrimination in numerous contexts, including education. Undeniably, a notable inequality between men and women persists in the 21st century. The United Nations (UN) has proposed a strategy known as the 2030 Agenda, outlining specific goals to be achieved globally. Notably, "Sustainable Development Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" is highlighted (United Nations, 2025a).

It is important to emphasize two of the targets defined for the 4th SDG proposed by the UN concerning vocational education and gender equality (United Nations, 2025b):

- 4.3: By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.
- 4.5: By 2030, eliminate gender disparities in education and ensure equal access 1 at all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations.

The Autonomous University of Campeche (UACAM) is a higher education institution located in the state of Campeche, Mexico. Dr. José Alberto Abud Flores, Rector of UACAM, through the 2022-2026 Institutional Development Plan, affirms: "I ratify the institution's commitment to the Sustainable Development Goals of the 2030 Agenda, recognizing that universities are a fundamental part of the endeavor to achieve a better world for all humanity" (Universidad Autónoma de Campeche, 2022, p. 25).

UACAM's mission is:

> To be a public and autonomous university serving society, providing excellent, humanistic, secular, and inclusive upper secondary and higher education for the well-being, development, and comprehensive training of professionals, researchers, and university professors who contribute to the transformation of their environment as drivers of the changes that the community and their peers demand to improve their quality of life, through knowledge, science, technology, art, culture, sports, and national and international solidarity cooperation (Universidad Autónoma de Campeche, 2025a).

In this context, "Mujeres Ingenieras" (Women Engineers) is a research project originating within the Faculty of Engineering at UACAM, Mexico, registered under code 11/UACAM/2024 with the General Directorate of Postgraduate Studies and Research (Universidad Autónoma de Campeche, 2025b) .

The primary objective of this project is to encourage, empower, promote, and train girls and young women in the field of Engineering, fostering the participation of women in educational programs with a STEM (Science, Technology, Engineering, and Mathematics) focus through the community of the same name.

STEM disciplines are gender-neutral, yet they possess significant potential, demand, and future prospects. If women identify with certain areas of study, if stereotypes are countered, and if more information is available regarding the future of work and the challenges to be addressed in this century, more inclusive societies can be built where young women are encouraged to pursue their vocation, develop new skills, and contribute their talent (AMIIF, 2021). Achieving gender equality in science, technology, engineering, and mathematics is fundamental to achieving each of the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda set by the United Nations (UN). It is the responsibility of all countries to dismantle the obstacles that prevent women from accessing education in these disciplines (Recio, 2021). Choosing a bachelor's degree is a decision influenced by three groups of factors: intrinsic (personal interests, self-efficacy, expectations, and professional development opportunities), extrinsic (salary, job stability, professional prestige, and job accessibility), and interpersonal (family, teacher, and peer influences, and social responsibility) (Vázquez-Hernández, 2025).

The Mujeres Ingenieras community, as its motto states, "Empowered to inspire, united to transform". It offers a space for support and motivation where women can develop both professionally and personally. The main objectives of the Mujeres Ingenieras community are:

- To promote the education of girls and young women in engineering educational programs.
- To create a space for support, mentorship, and professional growth for its members.
- To organize events, workshops, and conferences to strengthen technical and soft skills.
- To generate networking opportunities with professionals, companies, and institutions related to engineering.
- To foster gender equity in the academic and professional spheres.

The Mujeres Ingenieras community is an inclusive and diverse environment where every woman feels comfortable and safe to explore her potential in the field of engineering. Through projects and workshops, knowledge and skills are developed. Each member of the community is key to strengthening collaboration and sisterhood.

Method

This study employs a documentary analysis method with a descriptive and exploratory approach.

1. Para acceder a la constancia de registro consulte el enlace: https://drive.google.com/file/d/11j5xDVp-jhu5tviCMBI_o25Me4xFhijzh/view?usp=drive_link

The first stage involves a literature review focused on identifying the progress, initiatives, and inclusion strategies for women in engineering educational programs in Mexico, contextualizing the study from a current perspective. The second stage will involve a case study centered on the "Mujeres Ingenieras" (Women Engineers) community, promoted by the research project of the same name at UACAM, Mexico. This case study will present the main activities and strategies implemented to foster the participation of women in engineering, providing concrete evidence and best practices that can be replicated in other educational settings. These two stages are detailed below.

Stage 1: Literature Review

- The literature review analyzed the question: How have support and collaboration networks, groups, or communities for women in engineering educational programs in Mexico evolved between 2022 and 2025? The objective was to identify progress, institutional and academic initiatives, as well as collective strategies that promote the participation and retention of women in engineering from a gender equity perspective. To delimit and structure the documentary corpus, inclusion criteria focused on thematic relevance, source type, and the currency of the information were defined. Only scientific documents—books, book chapters, and articles—that directly addressed the participation of women in engineering or the development of collaborative spaces aimed at their strengthening in this field were considered. Additionally, publications written in Spanish or English were accepted, provided their publication date fell between 2022 and 2025. Complementarily, exclusion criteria were established to ensure the relevance of the analysis. Works unrelated to the topic, duplicate documents, and those published before 2022 were discarded. This refinement allowed for the selection of current, relevant, and coherent sources with the research objectives. A total of 490 documents related to the topic were reviewed, from which 9 directly related to the review question were extracted.

Stage 2: Case Study "Mujeres Ingenieras" (Women Engineers)

- Regarding the presentation of the case study, the activities presented are focused on the following four impact strategies and mechanisms: female role models, professional support, mentorship, and equal participation.

Development

The literature review began with the search and collection of scientific sources in the bibliographic management tool Mendeley (Mendeley, 2025) and the scientific information system Redalyc (Redalyc, 2025). The initial search string was broad to maximize the scope of results. Specifically, the keywords "mujeres AND ingeniería AND México" and "women AND engineering AND Mexico" were used, yielding 59 and 1040 results in Mendeley, and 3551 and 324 in Redalyc, respectively (prior to the validation of inclusion and exclusion criteria). Subsequently, all inclusion and exclusion criteria were applied, except for the direct relationship with the review question, to segment the set to a manageable number of scientific sources. As a result, 497 documents were identified, of which 35 were in Mendeley (13 in Spanish and 22 in English) and 455 in Redalyc (389 in Spanish and 66 in English). Next, the coincidence or relationship between the titles and abstracts of the articles with the research question was evaluated, finally yielding 7 documents in Mendeley (2 in Spanish and 5 in English) and 2 in Redalyc (2 in Spanish and none in English).

Based on the literature review, an initial approach to the analysis of gender conditions in engineering educational programs is offered by Mata-Santel (2023), who studies how spatial practices at the Benemérita Universidad Autónoma de Puebla (BUAP), within the university environment, particularly in the Faculties of Engineering and Law, contribute to the reproduction of gender representations that place women in peripheral positions. The author emphasizes that social and sports activities tend to reinforce male centrality, while women are relegated to marginal spaces,

affecting their sense of belonging and full participation in university life.

Aragón-Macías, Arras-Vota, and Tarango, J. (2023) state that studying the social role that women and men have been playing from a gender perspective reveals a myriad of traditional traits composed of a set of customs, rites, duties, and obligations, in which a patriarchal, androcentric, and traditional character predominates.

Martínez-Huerta et al. (2024) analyze gender differences in motivation, procrastination, and academic performance at a private university in northeastern Mexico. Their results conclude that female students showed greater intrinsic motivation compared to their male peers, which translated into better academic performance for women at the end of the course. Although the study does not directly focus on support networks or communities, its findings underscore the need for institutional strategies that foster the motivation and academic performance of women in engineering. This suggests that the evolution of support networks could play a crucial role in improving the educational experience of women in engineering programs in Mexico.

Regarding the evolution of networks, groups, and support communities for women in engineering educational programs, Ortiz-Martínez et al. (2023) highlight the implementation of mentoring programs and digital platforms that favor the creation of collaborative networks. These spaces allow interaction between students and professionals in the field, providing emotional support, academic advice, and strengthening the female professional identity. Peer mentoring initiatives and programs have proven effective in improving the retention of women in STEM, reinforcing their sense of belonging.

Similarly, a mentoring model for indigenous women in Oaxaca has been designed to promote their inclusion in STEM disciplines (García-Silva, García-Holgado, & Sánchez-Gómez, 2023). The study by Loría-Lizama and Villagómez-Valdés (2023) examines the challenges and opportunities faced by women for their permanence in engineering careers in technological institutions in the state of Yucatán, from a gender perspective. It is found that, despite the increasing access of women to higher education, profound inequalities associated with gender stereotypes, traditional roles, sexism, and discriminatory practices persist, which create glass ceilings in their academic trajectory. Among the main challenges identified are economic difficulties, insecurity, gender-based violence, and the limited availability of family support. However, their permanence has been favored by governmental and institutional support, as well as by the development of personal skills related to the discipline, resilience, and empowerment. Likewise, models in Mexican institutions with processes for the attraction, access, guidance, and retention of women have been identified (García-Holgado & García-Peñalvo, 2022).

Complementarily, the importance of strategies aimed at fostering STEM vocations among women is underscored, such as the early promotion of these disciplines without gender bias, the sensitization of families, the creation of safe school environments, and the promotion of female role models in the field of engineering (Loría-Lizama & Villagómez-Valdés, 2023).

Nevertheless, perceptions of gender inequality persist among engineering students, in differences in treatment and job opportunities, reflecting the need to continue strengthening support strategies (Aguilar, Habib-Mireles, & Ancira, 2022), where the difficulty of women's insertion into the labor market of STEM disciplines prevails (Hernández-Herrera & Hernández-Herrera, 2023).

Finally, in this first phase, after the literature review, it is observed that there is no substantial line of research addressing the specific challenges faced by women in engineering. However, other open and interesting lines of research are examined that interrelate with the role of women from various perspectives, such as educational inclusion and interculturality in higher education (Roncal-Vattuone, X., 2023), and the leadership of women in STEM disciplines as a key to promoting inclusion and diversity (Vega-Osuna, L. A et al., 2025).

Intrinsically linked to Phase 1, the case study "Mujeres Ingenieras" (Women Engineers) is presented. This research project, bearing the same name as the "Mujeres Ingenieras" community, emerged as a strategy to encourage girls and young women in engineering. The leader of this initiative, Dr. Luz María Hernández Cruz (Hernández-Cruz, 2025), a professor and researcher at the Faculty of Engineering of the Autonomous University of Campeche, Mexico, has spearheaded various academic, scientific, and cultural activities that promote women's interest in STEM disciplines.

Next, some significant activities of the Mujeres Ingenieras community aimed at:

- Strengthening equal participation through inclusion and gender equality activities.
- Recognizing female role models, highlighting the achievements of women who inspire in the professional, work, and/or scientific fields of engineering.
- Forming support and mentorship networks for the development of knowledge, capacities, skills, and attitudes of women in the academic, professional, and/or work spheres of engineering.
- Providing training, tutorials, and research activities offered by professors and/or community members.

The "Altar de Muertos" (Day of the Dead altar) created by Mujeres Ingenieras was a cultural activity to preserve our traditions, in which the community chose to participate to pay tribute to outstanding women in STEM disciplines. Students from various engineering degrees at the Faculty of Engineering (UACAM), such as Computer Systems Engineering, Software Engineering, and Mechatronics Engineering, participated in the creation of a thematic altar. The altar was dedicated to Marie Curie, Janice Louri, Margaret Hamilton, and Sofia Kovalevskaya, women who have left a significant impact on STEM, with the aim of remembering their legacy as motivation for other students, as shown in Figure 1.

From a scientific perspective, the inclusion of women promotes scientific excellence and enhances the quality of outcomes in STEM disciplines, as diverse perspectives add creativity, reduce potential biases, and foster more robust knowledge and solutions. Women have already demonstrated their abilities in these disciplines, contributing, for example, to advancements in the prevention of cholera and cancer, expanding the understanding of brain development and stem cells, and other discoveries. Maximizing the catalytic role of STEM disciplines requires drawing on all available talent to promote excellence, and excluding women is a loss for everyone (UNESCO, 2019).

The community identity contest served to foster participation and creativity in constructing the identity of Mujeres Ingenieras, through proposals for selecting the name, slogan, and logo that would represent the community of women in the Faculty of Engineering, recognizing the talent and effort of the winners. Students and graduates from various degree programs participated in this activity, including Software Technology Engineering, Computer Systems Engineering, Civil Engineering and Management, Mechatronics Engineering, Electrical Mechanical Engineering, and Energy Engineering, who contributed their talent and vision to give identity to the project, as shown in Figure 2.

Mentoring has proven to be an effective strategy to support women in STEM degrees, providing role models, safe spaces, and skills development (Navarrete-Sánchez, Rosales-Escobar, & Garcés-Rodríguez, 2024). Through the Mujeres Ingenieras community, Eugenia de los Ángeles Fuentes Caraveo, a student in the Computer Systems Engineering program, received tutoring for her research entitled "MnlC-029 El Liderazgo en la formación profesional de Ingenieros en Sistemas Computacionales" (Leadership in the Professional Development of Computer Systems Engineers) for her participation in Mujeres en la Ciencia 2024 (Women in Science 2024) https://cierqueretaro.org.mx/ciermmi-2024/.

Figure 1.
Female referents to inspire new generations. Altar of the Dead Activity

Figure 2.
The Women Engineers community

See Figure 3 for the book chapter published by ECORFAN Mexico (Hernández-Cruz et al., 2024): https://www.ecorfan.org/handbooks/Handbook_T-XXIII_CIERMMI_Women_in_Science_Engineering_and_Society/Handbooks_Engineering_and_Society_TXXIII.pdf

Furthermore, female students from the Computer Systems Engineering educational program received advisory support for the Scrum Fundamentals certification in software project management, as shown in Figure 4.

The video "Mujeres Ingenieras: A Community that inspires in the Faculty of Engineering" aims to raise visibility and highlight the impact of this community within the Faculty of Engineering. Through this, we seek to inspire young women in high school to consider a career in engineering by showcasing real-life examples of students and professionals who have found support and motivation within the community. This video illustrates the visibility and impact of the "Mujeres Ingenieras" community within the Faculty of Engineering. Through testimonials and real experiences, we aim to inspire young women in high school by showing them a space where they will find support, motivation, and opportunities for growth.

It emphasizes the fundamental role of women in engineering, promoting equity and the importance of their participation in STEM degree programs. More than an informative video, this production seeks to evoke emotion and inspire, strengthening the path towards a future with more women leaders in engineering, as shown in Figure 5.

Another factor affecting their motivation is how the gender perspective is addressed in the classroom. If we do not foster equal participation, the appropriate use of language, and female role models in the classroom, it is difficult to generate the necessary interest for girls to become motivated towards science and technology (UNESCO, 2023). In this regard, various activities have been carried out that allow for the inclusion of both female and male engineering students in the Faculty of Engineering. We also highlight the participation of authority figures such as the Director, Mtro. Francisco Javier Barrera Lao; the Academic Secretary, Mtro. Guadalupe Manuel Estrada Sego-

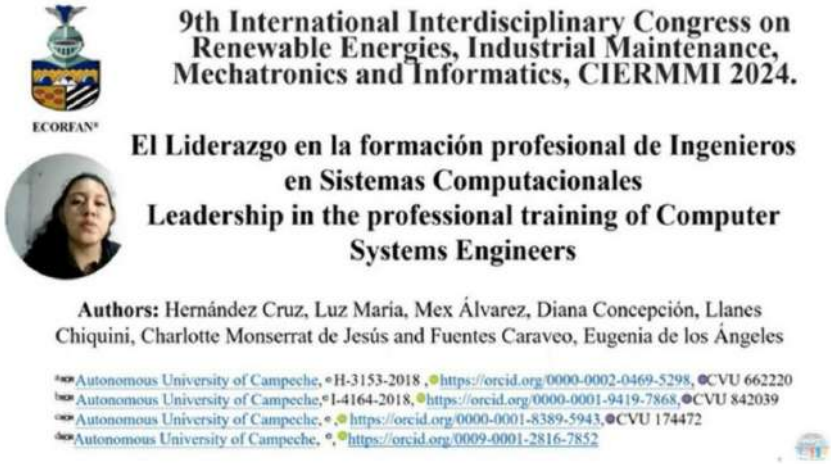

Figure 3.
Academic Support. Tutoring in the scientific production of a book chapter and participation in an International Congress https://youtu.be/9Xq847lij3k?si=lgvzapnxzWWnyBCu

Figure 4.
Academic Support. Scrum Foundation Professional Certification (SFPC) accrediting their competencies in agile project management (CertiProf, 2025).

Figure 5.
Establishing mentoring networks that connect students with professionals in the sector. Women Engineers community identity activity.

via; and the Academic Coordinator, Dr. Heribé Felipe Uribe Santiago, as shown in Figure 6.

Conclusions

Various initiatives seek to close this gap, such as training programs and educational campaigns that promote the interest of girls and young women. However, gender stereotypes and structural barriers that hinder the full inclusion of women in these fields still persist. The main findings of the documentary research clearly indicate significant action strategies.

Mujeres Ingenieras represents a transformative initiative that directly responds to and aligns with Sustainable Development Goal 4, focused on ensuring inclusive and equitable education through a comprehensive approach. This community has successfully created safe, inclusive, and enriching spaces for girls and young women to develop in the field of engineering and other STEM disciplines. Today, the strategy of this project not only considers the academic aspect but also the strengthening of personal, academic, and scientific skills; mentorship; tutoring; inclusion; and the promotion of cultural identity. All of this is with the purpose of empowering participants and transforming educational environments. In this sense, Mujeres Ingenieras positions itself as an inspiring model that today, from the Autonomous University of Campeche, Mexico, emerges to actively contribute to closing the gender gap, driving towards a more just, inclusive, and equitable society.

There is still much to do. Mujeres Ingenieras is just beginning, and with it come many possibilities for growth over time, a project with soul and heart. May this study serve to take decisive actions in achieving gender equity in engineering degree programs.

It is clear that inclusion, gender equity, and interculturality are holistic aspects of interest for continuing scientific studies on the role of women in higher education. At the same time, new lines of research are opening up, such as sorority and a culture of peace. Similarly, addressing the limitations of the study is a path to continue research. Primarily, these limitations are the dependence on the results obtained by the bibliographic manager Mendeley and the scientific information system Redalyc in the literature review, and the scope of the collaboration and support strategies in the case study.

Figure 6.
Equal Participation. Inclusive coexistence activities with the entire community (Mujeres Ingenieras, 2025)

Authors' Contributions

Luz María Hernández Cruz: conceptualization, curation, initial writing, formal analysis, and final writing.

Roselia Lorena Turriza Mena: methodology, initial writing, and curation.

Sandra Lizette Sánchez Ramírez: conceptualization, curation, and formal analysis.

Mayra Deyanira Flores Guerrero: methodology and formal analysis.

Brenda Bravo Díaz: formal analysis and final writing.

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