

Empowering Latin American Women Engineers: Bridging the Gender Gap Through a Network of Change

Dr. Vianney Lara-Prieto, Tecnologico de Monterrey

Vianney Lara graduated as Mechatronics Engineer from Tecnologico de Monterrey, Monterrey Campus and holds a PhD in Smart Materials from Loughborough University in the UK. She worked in GE Healthcare as Manufacturing Process Engineer and Advanced Projects Engineer for Magnetic Resonance Imaging equipment. She joined Tecnologico de Monterrey as Program Head for the Mechatronics Engineering Program. Then, she was Academic Projects Director, Division Director, National Head of Higher Education of the School of Engineering and Sciences, and her current role is Academic Services Director.

Vianney belongs to the executive committee of the Matilda Latin American Chair for Women in Engineering and belongs to the mentoring and research groups. She belongs to the LACCEI executive board. She is a founding member of Ingenia Women in Engineering and Sciences participating in the linkage, mentoring and dissemination committees. Vianney is a founding member of the OWSD Mexico's Chapter. She is an IEEE, WIE (Women in Engineering) and IEEE-HKN member. Vianney is a CB Coach certified by the Conscious Business Center.

She belongs to the National System of Researchers (SNI). Her research lines are Challenge-Based Learning, Educational Innovation in Engineering, Interdisciplinary STEM Education, and Women in STEM. She is an adjoint member of the SOI – STEM Socially Oriented Interdisciplinary STEM Education Research Group at the Institute for the Future of Education.

Maria Ileana Ruiz-Cantisani, Tecnologico de Monterrey

Maria Ileana Ruiz-Cantisani has a PhD in Educational Innovation and Master of Science in Engineering with specialization in Systems and Quality, and Industrial Engineer. She is Associate Professor at the School of Engineering and Sciences, and professor in Capstone Courses on industrial engineering. She leads projects in the areas of educational innovation, virtual reality and student engagement, active learning and women in stem. She is member of Catedra Abierta Latinoamericana Matilda (as member of the board that leads the chair,), and leader of Women in STEM Committee of the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI). She is member of Ingenia, Women in Engineering and Sciences of the School of Engineering and Science. Ileana is Director of Liaison and Educational Partners of the School of Engineering and Sciences of Tecnologico de Monterrey

Marcela Paola Bentin

Maria Haydée Peralta, National University

Laura Romero, Tecnologico de Monterrey

Empowering Latin American Women Engineers: Bridging the Gender Gap Through a Network of Change

The global gender gap in engineering represents a significant challenge to society. While numerous initiatives have been launched to tackle this challenge, achieving true gender equity remains a complex task. Latin America is no exception to this reality. The pressing need for female representation in STEM professions and leadership roles cannot be overstated. In response, a group of educational institutions and individuals has come together to establish the Matilda Latin American Open Chair for Women in Engineering. The main goal of this network is to enhance the visibility of women in Engineering and Sciences, inspire new generations to pursue STEM vocations, and support the growth and retention of women at various stages of their STEM careers. Employing a mixed methods approach, this study seeks to evaluate the individual impact of participation in a women's network committed to fostering a culture of gender equality and celebrating the accomplishments of recent years. Some initiatives organized by the Matilda Chair include books featuring the inspiring journeys of women, expert panels, conferences, webinars, mentorship programs, social media campaigns, and research publications. This joint effort hopes to serve as an inspiration and to encourage other institutions to embark on similar journeys, advocating for equal rights and opportunities for women in both academic and professional areas. Together, we strive to create an equity environment where gender no longer serves as a barrier to success and fulfillment in engineering.

Keywords: Educational Innovation, Women in STEM, Higher Education, Women networks, Gender Equality

Introduction

Half of the world's population is comprised by women and girls, which represent half of the world's potential. However, gender inequality persists across the globe and is hindering social advancement. The Sustainable Development Goal (SDG) #5 is therefore looking into achieving gender equality and empowering women and girls. The main targets of SDG 5 are eliminating all forms of discrimination and violence against women, promoting women empowerment by enabling their access to education, health, and technology, strengthening policies and legislation for the promotion of gender equality, and ensuring women participation in leadership roles and decision-making positions in political, economic, and public life. [1]

These gaps are significant depending on the sectors that can be analyzed: by geographic region, by culture, by education, by place where one lives (city or country), by field of study, by type of work, etc. This research addresses this gap in STEM (Science, Technology, Engineering and Mathematics) environments in Latin America.

UNESCO shows the gap by reporting that in the world 35% of those pursuing higher education in STEM areas are women. When analyzing LATAM countries, it is observed, for example, that "in Mexico, for every 100 men enrolled in engineering, there are 45 women", while in areas such as computer science, only 31 women study in this field. [2] On the employment side, for every 4 men who get jobs in STEM fields, only 1 woman does. [3] This reality is made up of varied factors that influence its continuation, even with the efforts of private, public, social, and educational initiatives to reduce this gap.

In most countries in the world, women in STEM areas are in the minority, however, in some countries (Sweden, UAE, Kuwait, and Iran), women have a higher presence due to factors such as “high ability learners, where they develop more abilities, interests, and psychological maturity than men” and confidence in women is another factor that affects their ability to stay in this field. [4,5] In LATAM, there is a different reality and is characterized by varied factors that influence this gap to continue, even with the efforts of private, public, social, and educational initiatives to reduce it. Among the factors are the preconceptions in relation to STEM careers, gender stereotypes, family attitudes, lack of women leaders in these areas who are an example to inspire or to mentorship. The lack of gender equity for women in engineering is a global problem that has implications for society, as it means losing the opportunity to have this talent that is in such high demand today. [6]

This context that gives us the environment leads us to reflect on the initiatives that are being carried out globally to further promote and create this culture of gender equality, where public policies, associations, private sector initiatives, student initiatives or universities, arise in order to strengthen the culture of gender equality, create safe spaces and opportunities for the development of women, and particularly convinced of the positive impact that this generates in organizations and society in general. For this reason, this year UN Women is proposing a reflection on the theme "Investing in Women: Accelerating Progress". [7]

Another important reflection, in addition to understanding the current context of gender equity in engineering, is the involvement of men in general in shaping this culture, who, being sensitive and aware of this reality, create spaces, opportunities and even policies that favor equity and opportunities for the development of women, considering their skills and knowledge. [8] The most important thing is the collaborative construction where men and women jointly carry out equity initiatives, which ultimately enrich institutions, organizations, and families. Finally, being part of networks inspires the development of plans and projects in the same institutions or organizations that the members are part of. [9]

In this context of gender gap in STEM areas and in a time of complexity due to the pandemic that generates a setback in the reality of women in society, an initiative of three organizations with presence in Latin America is born: the Latin American Open Chair Matilda and Women in engineering, and the organizations behind it are:

- The Latin American and Caribbean Consortium of Engineering Institutions - LACCEI is a non-profit organization of Latin American and Caribbean institutions that offer academic programs in Engineering and Technology.
- Federal Council of Engineering Deans of Argentina-CONFEDI, they work in the continuous improvement of engineering education, being the main protagonists in the development of educational policies that position Argentine engineering in a place of reference at regional level.
- Colombian Association of Engineering Schools –ACOFI is a private non-profit organization that works for the quality of engineering education provided by the faculties, schools and programs of the country that conform it.

The Matilda Chair was founded in 2020 with this joint effort and with the purpose of being an academic space where debate, reflection, research, and development of initiatives are present to promote gender equity both in opportunities and spaces for women in the academic and professional environment, and to encourage the increase of vocations for engineering and science in girls and young women in LATAM. This chair is composed of 120 members, 9 percent of whom are men and the rest are women. [10] Reflecting on the need for both men and women to become involved in the creation and strengthening of this culture of gender

equity in STEM fields, this study is generated. This study seeks to evaluate the individual impact of participation in a women's network committed to fostering a culture of gender equality and celebrating recent accomplishments.

Methodology

The methodology is presented in three phases: its description and steps, how the Matilda Chair is integrated and the main initiatives of the Chair.

Description

This research analyzes how the involvement of the members of the Chair impacts on a personal level, their participation in the initiatives that are developed, the events that are held, the research that is carried out, their participation in committees, as well as the dissemination of this culture, to mention a few. Employing a mixed methods approach, this study seeks to evaluate the individual impact of participation in a women's network committed to fostering a culture of gender equality and celebrating the accomplishments of recent years.

First, a brief introduction to the history and context of the Matilda Latin American Open Chair for Women in Engineering is presented. Then, the Matilda Chair main initiatives are described.

An instrument is developed and applied because of the ending of the 2022-2023 cycle of activities, in which members are invited to participate, as well as their authorization so that the results can be analyzed for two purposes: to contribute to strategic planning and for research on the topic of gender equity in STEM. The questionnaire is composed of the following sections:

- General data such as gender, country, age, and stage of their professional life.
- Regarding their participation in the Chair, they are asked: how they got to know the Chair, what they have participated in, and their motivation to be part of this network.
- In relation to the impact on their life due to their participation, the questions related were: what impact has being part of the Chair had on your personal or professional life, what have you done differently at a personal or institutional level as a result of your participation in the Chair, and what are you most proud of in relation to the Chair.
- From their personal approach, questions related with which initiatives have had the greatest impact, what does the Chair mean in 3 words, and which of the actions carried out favor the visibility of the gender gap in the areas of engineering, science, and technology.
- And a section for the future with proposals from the members.

Finally, the questionnaire results are presented and discussed showing the members' impact on their personal and professional lives.

Matilda Latin American Open Chair for Women in Engineering

As previously mentioned, the Matilda Chair was born in 2020, in a joint effort of 3 organizations LACCEI, CONFEDI and ACOFI in LATAM, to visualize the gender gap in areas of engineering, science and technology, and promote a culture of equity through collaboration between universities and organizations, as well as the members themselves with initiatives, events, and research. It has 120 active individual members (91% women, 9% men), from 18 countries: Argentina, Bolivia, Brazil,

Canada, Chile, Colombia, Costa Rica, Ecuador, El Salvador, France, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, the United States and Venezuela.

It is composed by 6 committees (see Table 1):

Table 1. Chair Matilda´s Committees [9]

Committees	Objectives
Research	This is the most recently created committee. It conducts research with a scientific focus on topics relevant to the chair, allowing the visibility and social appropriation of knowledge. Constantly promotes reflection and dissemination of research findings.
Mentoring	It is concerned with helping to reduce the gender gap in the personal, school and work environment and thus improve the quality of education and work performance, with accompanying programs that inspire and guide women's growth.
Vocations	Promotes interest in the study and promotion of engineering activities in young female university candidates.
Professional Practice	Promote actions in the professional sphere that encourage women to be considered in an equitable manner. Because of their technical capabilities, professional training, and competence.
Education	Emphasize and contribute to the development of capabilities and competencies of the engineering, scientific and technological culture. And it generates spaces for debate, critical reflection, and the collective construction of knowledge.
Communication	To disseminate the activities organized by the Committees that make up Matilda Chair in the academic and professional environment related to engineering.

Initiatives for Gender Equality in Engineering

Some initiatives organized by the Matilda Chair include books featuring the inspiring journeys of women, expert panels, conferences, webinars, mentorship programs, social media campaigns highlighting a variety of role models, and research publications.

Among the main initiatives developed annually are:

- Publication of the Book Matilda and Women in Engineering (it already has 5 books published in Spanish for free), which seeks to share the reflections and life experiences of women in STEM areas.
- Research Symposium, which seeks to share and disseminate research on gender, engineering, and science.
- Mentoring programs and workshops, preparing mentors in interested institutions, and mentoring women students interested in engineering.
- Webinars, lectures, conferences on diversity, gender equity and inclusion.
- Capsules of reflection and knowledge, and podcasts sharing inspiring experiences of women in STEM areas.

Individual impact of belonging and participating in a network of change – Results and Discussion

All the members of the Matilda Latin American Chair are volunteers, committed to put on service their talent, their work, and their time to contribute towards the Chair objectives. As part of the continuous improvement and strategic planning strategies of the Matilda Chair, a questionnaire was designed as an instrument to gather the members’ insights, feedback, satisfaction, and improvement suggestions. 43 people participated in the questionnaire giving their input for this valuable exercise. Figure 1 shows the sample population characteristics relevant to defining and delimiting the context from which the responses come from. In terms of gender, 91% of the participants are identified as women and 9% as men. This gender distribution represents the overall distribution of Matilda Chair members. In this sense, the responses are representative. However, given the fact that there are few responses from men, the analysis will not differentiate between men and women responses. Regarding the age groups, the most predominant are people between 40 – 49 years old with 37% of the participants and 50 – 59 years old, which represent 35% of the respondents. There are a variety of nationalities in the Matilda Chair. However, there is more representation of the countries where the three founding institutions are based or have their main operations (ACOFI, CONFEDI and LACCEI). With this context, the sample population has a relevant representation from Argentina (35%), Colombia (35%) and Mexico (19%).

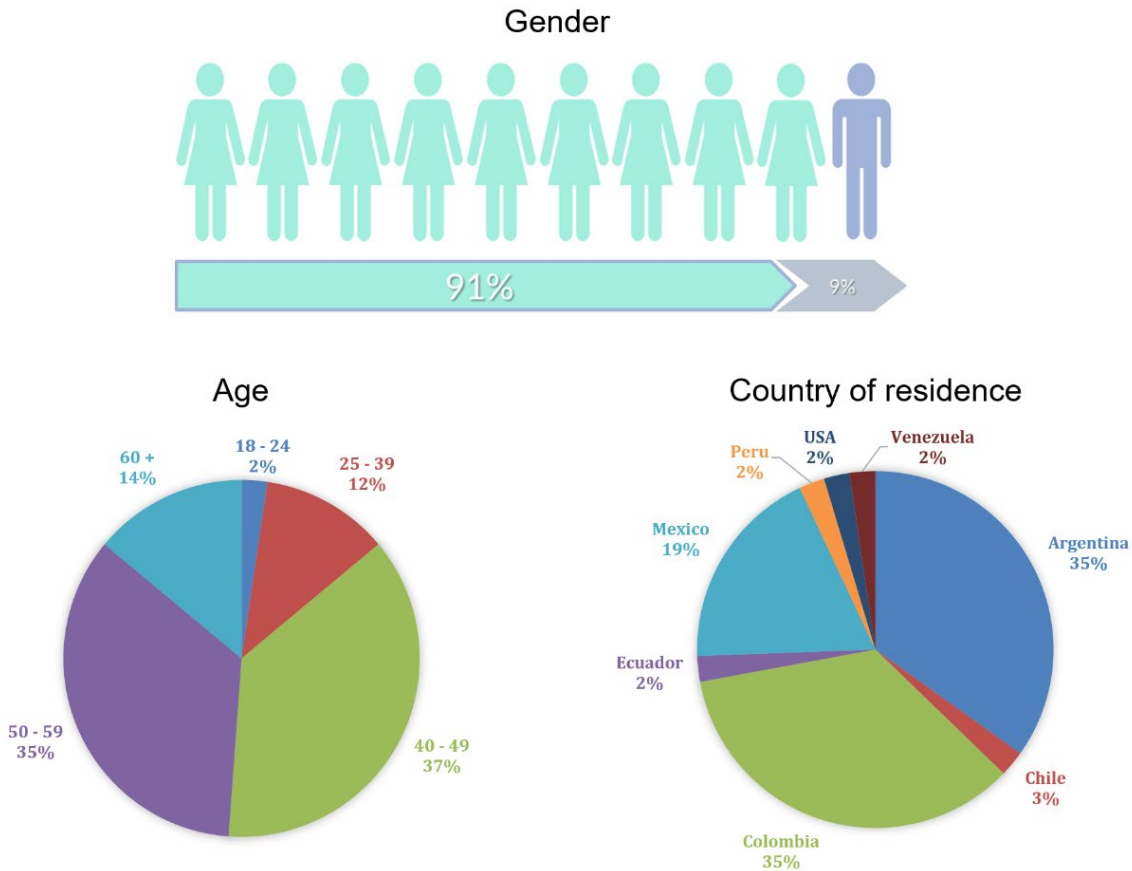


Figure 1. Sample population characteristics

Enhancing the diversity of perspectives among Matilda Chair members is the varied professional stage of their careers. Most of the members, and therefore most of the survey respondents, come from the academic world, holding key positions as faculty members, leaders within academic institutions, and researchers. Figure 2 shows the professional stage of the sample population. Each person may hold multiple roles at the same time.

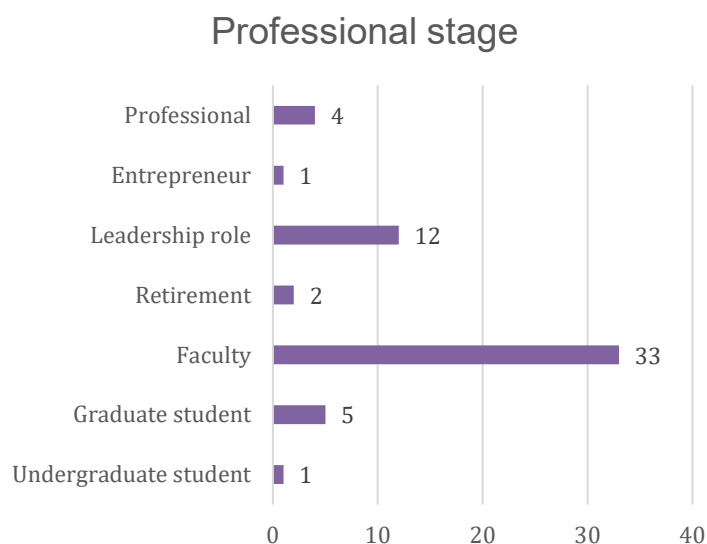


Figure 2. Sample professional stage

The respondents were asked in an open-ended question to describe their main motivation to belong to the Matilda Chair and contribute to its various initiatives. The responses were analyzed and categorized to represent the main idea. In general terms, the responses were summarized as follows: the opportunity and the experience to belong to a women network; find new research collaborations and work together on particular research projects; engage in the Chair initiatives either as organizers, speakers or participants; promote women empowerment; contribute to reduce the gender gap in STEM careers; be able to reach young girls and women and have a meaningful impact on their lives so that they do not live with the same bias and obstacles that other generations did; and was invited by a colleague to form part of the Matilda Chair. Figure 3 shows the frequency of these responses. The main motivations are to reduce the gender gap in STEM careers and fostering women empowerment [2,3,5].

Main motivation to belong to the Matilda Chair

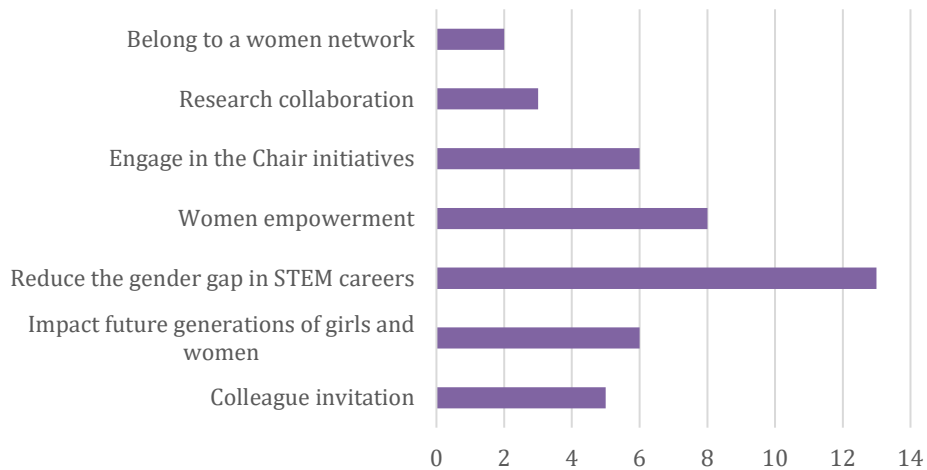


Figure 3. Main motivation to belong to the Matilda Chair

The Matilda Chair has engaged in different initiatives since its foundation, with the leadership and support of the different committees. Some of these initiatives are well established and are emblematic for our community, such as the Matilda Book with 5 published editions so far, with inspiring stories and reflections such as those required to promote this culture of gender equity and women's growth in STEM areas [4], and the Research Symposium which has been held twice. Figure 4 shows the initiatives that the Matilda Chair members consider as valuable and that have the most impact. The top responses include the Matilda Books, seminars and forums, and the Research Symposium. The communication platforms are also considered quite relevant. The WhatsApp group serves as the primary communication channel among members, while the social media accounts (Facebook, Instagram, LinkedIn and X) serve to disseminate information and invitations to the general public.

Initiatives

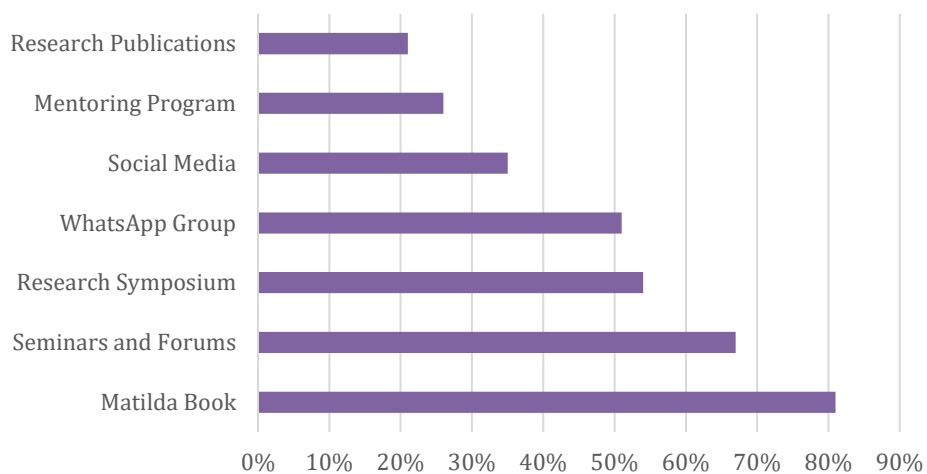


Figure 4. Initiatives with the most impact

It is important to identify the impact that the active participation on the Matilda Chair has had on the lives of its members. Regarding the impact of belonging to this group and work on their professional lives, the participants shared a range of ideas, since it was an open-ended question. The answers were categorized, and the most frequent responses are the ones illustrated in Figure 5. Most of the respondents agree that their belonging to this women network has resulted in some way of professional growth. Secondly, the respondents value the networking that the Matilda Chair has provided in their professional context. Moreover, the respondents highlight the awareness and knowledge they have acquired in terms of gender and the sense of professional sorority. The Matilda Chair has members from around 18 different countries, from a variety of ages and professional contexts, all committed and working together towards the same goals.

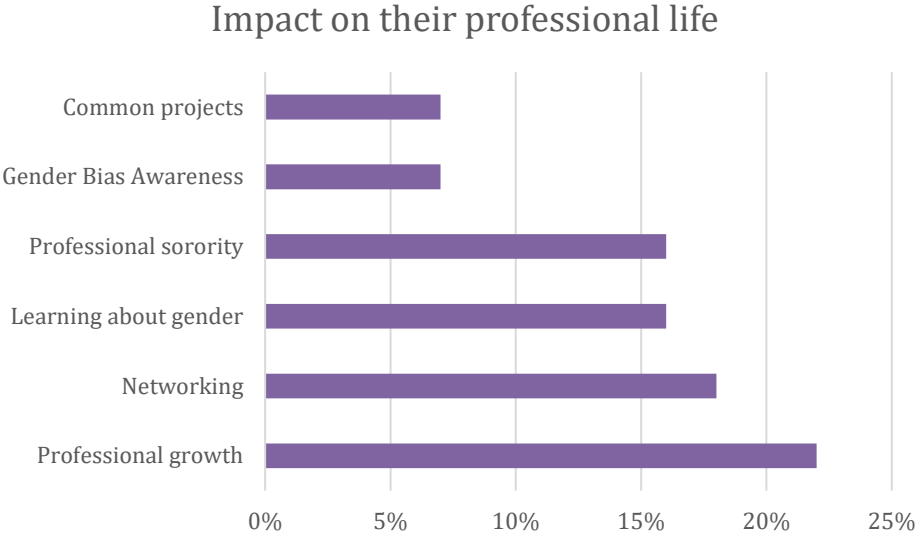


Figure 5. Impact on their professional life

Taking it a step further, the survey invited the respondents to reflect on how their engagement and experience within the Matilda Chair has influenced them, whether personally or professionally. Being such a subjective question, it was open-ended to give them space to share freely. After an analysis of the responses, the main ideas were summarized as follows: engaging actively in the different initiatives organized by the Matilda Chair; dissemination of the different Matilda events, initiatives, and campaigns as ambassadors committed with the cause of promoting gender bias awareness and women empowerment; engaging on research projects focused on gender and women in STEM; participating in training and implementation of mentoring (formally or informally) to help others to advance on their careers and reach their goals; being more conscious about gender bias; promoting teamwork convinced of the benefits of synergy; collaborating with people from different countries and backgrounds; inviting other people to integrate to the Matilda Chair; replicating similar efforts in their home institutions, either academic or professional organizations; and one person responded that nothing has changed yet.

Changes in personal / professional life

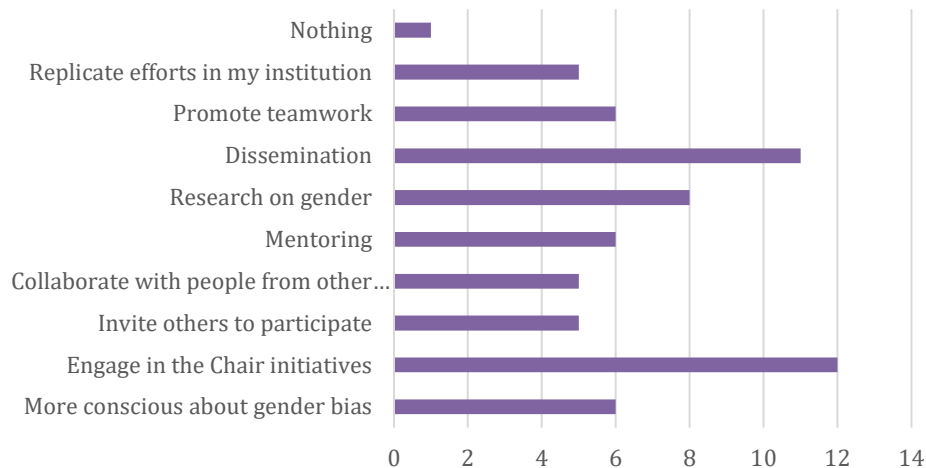


Figure 6. What have you changed in your personal/professional life due to your participation in the Matilda Chair?

To the question what Matilda Chair mean to you in one word does, their focused on the following:

- Equality
- Sorority
- Community
- Empowerment
- Mentoring
- Collaboration
- Commitment
- Friendship
- Networking

These words reflect the sense of community, mutual support, common growth, collaboration, commitment, and even friendship, that leads to impactful results in the universities where the members belong.

The survey also collected improvement suggestions to be considered on the planning and continuous improvement of the women network. Numerous interesting ideas came out from this exercise and were incorporated into the formulation of short-term and medium-term goals. Some of these suggestions are:

- Liaison with industry, other organizations with presence worldwide such as UNESCO, and partnership with other women networks.
- Apply for funding and scholarships to support women interested in pursuing STEM careers.
- More casual interactions between the different committees, both virtual and in-person.
- Establish a formalized research symposium and collaborate with a conference hosted by one of the founding institutions to attain Scopus indexation. This will result in a robust platform for the researchers, elevating the impact and visibility of their work.
- Include a broader perspective on different genders in the books and podcasts, providing a platform for their stories to be heard.
- Work together with other committees on a common project.

- Make a more coordinated effort focused on presenting and publishing research articles at relevant indexed conferences and journals.
- Strengthen the mentorship training.
- Initiate actions designed for primary education to engage both students and teachers.
- Strengthen social media.
- Obtain resources from national and international funds for mobility, in-person events or projects.
- Create impactful audiovisual materials.
- Engage in projects related to public policies.
- Establish indicators to measure impact (initiatives, universities participation, etc.) and provide a report to the members, the founding institutions, and the partner universities.

One of the most interesting results is how this is integrated into a strategic planning process, updating and strengthening the objectives of the Chair, as well as action and operation strategies, in order to have a greater impact on the youth of our countries as well as the culture of our institutions and society.

Conclusion and Future Work

As a network of women and men who collaborate in communities to visualize a reality that affects our communities and countries, we seek to promote concrete actions such as research, training and mentoring projects and initiatives to increase vocations in STEM areas, but above all to strengthen a culture of equity with safe and fair spaces, where the capabilities of both men and women are developed and valued equally.

The environment shows us that there is work to be done, gaps to be closed, realities to be transformed. The loss of talent prevents us from growing as societies and as countries. That is why collaborative networks, as well as the initiatives that are being carried out, help little by little to reduce this gap. Much has been reflected in the spaces created by the Matilda Chair, through its books and life stories, its symposiums and research, through its workshops and conferences, have generated a change of perspectives and the desire to continue growing and replicating the initiatives.

Acknowledgements

The authors would like to acknowledge the financial support of Writing Lab, Institute for the Future of Education, Tecnológico de Monterrey, Mexico, in the production of this work.

References

- [1] Goal 5 Gender Equality. Sustainable Development Goals. United Nations. Available: <https://www.un.org/sustainabledevelopment/gender-equality/> [Accessed Jan. 21, 2024].
- [2], “Necesitamos más mujeres en carreras STEM,” *ONU Mujeres – América Latina y el Caribe*. [Online]. Available: <https://lac.unwomen.org/es/stories/noticia/2022/02/necesitamos-mas-mujeres-en-carreras-stem>. [Accessed: 08-Jan-2024].
- [3] “Reduciendo la brecha de género en STEM en América Latina: ¿Pasando a la acción?” *UNESCO Office Montevideo and Regional Bureau for Science in Latin America and the Caribbean*. [Online]. Available: <https://unesdoc.unesco.org/ark:/48223/pf0000386465>

- [4] S. Malallah, S. Alfaiakawi, T. Y. Alkhurafi, and J. L. Weese, *Reversing Gender Stereotypes in STEM Education in a Gender-Segregated Region*. 2021 ASEE Virtual Annual Conference Content Access, July 2021.
- [5] T. J. Weston, W. DuBow, and A. Kaminsky, *Women in Computing and Engineering: Differences between Persisters and Nonpersisters*. 2018 CoNECD - The Collaborative Network for Engineering and Computing Diversity Conference, Crystal City, Virginia. April, 2018.
- [6] L. G. Oka, and K. Stillmaker, *The Role of Female Engineering Faculty in Female Student Success and Belonging: A Case Study at California State University, Fresno*. 2018 CoNECD - The Collaborative Network for Engineering and Computing Diversity Conference, Crystal City, Virginia. April, 2018.
- [7] “Invertir en las mujeres: acelerar el progreso” *Naciones Unidas-Día Internacional de la Mujer, 8 de marzo*. [Online]. Available: <https://www.un.org/es/observances/womens-day#:~:text=La%20tem%C3%A1tica%20para%20el%20D%C3%ADa, trav%C3%A9s%20de%20la%20financiaci%C3%B3n%20adecuada>. [Accessed: 15-Jan-2024]
- [8] “Men’s Accountability for Gender Equality” *United Nations Human Rights Special Procedures*. [Online]. Available: <https://www.ohchr.org/en/special-procedures/wg-women-and-girls/mens-accountability-gender-equality> [Accessed: 20-Jan-2024]
- [9] R. M. C. F. Vasconcelos, V. F. A. Barros, L. A. M. Amaral, E. R. Araújo, and I. Ramos, *Gender Equality in the Information Systems and Technology Fields: A Comprehensive Diagnosis at the School of Engineering of the University of Minho*. 2019 ASEE Annual Conference & Exposition, Tampa, Florida. June, 2019.
- [10] “Catedra Matilda,” *Catedramatilda.org*. [Online]. Available: <https://catedramatilda.org/>. [Accessed: 01-Feb-2024].