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Mentoring model in LATAM for women in stem, lessons learned from design to implementation

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Abstract– ***The current demand for professionals in STEM areas, aligned with the Sustainable Development Goals, specifically gender equity, has moved higher education institutions to generate initiatives that increase the presence of women in STEM areas from their education to the workplace. Gender gaps are still present in Latin American countries, and it is more visible in STEM areas. This is why the Matilda Chair was formed in an alliance between universities, which seeks to make this situation visible but also to reduce the gap with initiatives such as Mentoring Programs. The objective is to share the case study of the design and implementation of the model as a mentoring program, from the perspective of mentors, mentees and the process itself, with a qualitative methodology, considering the lessons learned during its development. This seeks to support other institutions interested in promoting and strengthening the STEM vocations of women in all stages of their lives, mainly during their education. The findings inspire us to continue with these initiatives because of the impact on the lives of all involved, those who seek to inspire, guide and motivate, and those who seek that guidance that empowers them in their decision making and development in STEM careers.***

Keywords—Women in STEM, Mentoring, Higher Education, Innovational Education

I. Introduction

Gender Equity is one of the Sustainable Development Goals, integrating efforts that governments, institutions, civil society and organizations have already been developing to create this culture. There are several reasons to focus efforts on promoting and strengthening this culture in the countries of Latin America. The fields of science, technology, engineering and mathematics (STEM) are experiencing a shortage of certified and highly skilled workers, yet these areas are experiencing great technological development. In addition, the STEM education sector suffers from a lack of representation of the female sector, whose participation rate is still well below the average [1]

To reduce the gender gap and its consequences in industry and academia, it is necessary to focus on the influences of the family, the educational environment and the peer group, as well as the culture itself. And while the gender equity perspective in education and the workforce has advanced in recent decades, where women have gained some important representation and recognition, the differences are persistent in STEM fields. While gender equity is becoming more widely available and the representation of women in STEM even in high-status positions is increasing, as such, the issue of "gender in STEM" is no longer about whether women have the capacity to succeed, but rather about the costs to STEM fields that will occur without them. Thus, gender diversity is indispensable to meet the demands of innovation and productivity in the complex environments of our highly technologized society [2]

In order to encourage the participation of more women in STEM careers at the higher education level, initiatives have been undertaken to support this cause. Among the initiatives being implemented are mentoring programs and support networks to encourage and strengthen the participation and retention of STEM vocations in women [3]. The objective of this paper is to share lessons learned from the design and implementation of a mentoring program for women to promote vocations and retention in stem areas with the humanistic approach of the organization.

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II. Literature Review

A. Gender equity in stem

The deficiency of women in STEM careers is a problem present in the higher education institutions in Latin America, Europe and other regions. According to a recent study conducted by UNESCO (2020), in Latin America, the participation of women in university careers related to ICTs (Information and communication technologies programs), engineering, manufacturing and construction is around 35% and several countries exceed the world average percentage of 27% - 28% [4]. This situation begins in childhood due to different factors related with self-perception, self-efficacy, support received, social standards and stereotypes [5]. The environment during the university studies can influence the desertion level, being the first year the most critical one. The mentoring, adaptation to the university, teacher support, and accompaniment in the first year increase the chances of success [6].

Over the world the proportion of female and male graduates is similar for bachelor and master degrees, however the percentage of women diminishes at doctoral level, and even more in occupational fields such as researchers. In particular, the gender gap for the research field diminishes in Latin America and Central Asia, both are the two regions in the world where parity regarding female and male researchers is almost achieved (45%-48% of researchers are women). In particular, seven countries in LATAM have already reached parity (Argentina, Cuba, Guatemala, Panama, Paraguay, Trinidad and Tobago, and Uruguay), while Venezuela has crossed the threshold and has more than 60% of female researchers. Costa Rica, Ecuador, Honduras, El Salvador, Bolivia and Colombia have percentages between 37 to 42%, while in Chile, Mexico and Peru the percentage of female researchers is below 34% [7]. Even if the gender gap in LATAM has good results, segregation continues to be high because stereotypes regarding men more capable of occupying high working levels still remain. Female researchers continue to be, then, underrepresented at senior levels in their professional careers. For example, in Panama, women account for less than 40% of total members in Academia of Science, and this situation is worse for Bolivia having less than 9% [8].

Additionally, to this problem, research grants and possibilities to obtain capital for science and technology startups, are fewer than those obtained by their male colleagues [9]. This underrepresentation could become more marked in emerging jobs formed in the Fourth Industrial Revolution; in fact, nowadays, around the world, only 22% of all professionals working in artificial intelligence and 12% on machine learning research are women [10]. So, it is crucial to reinforce the stem of politics to consider these new jobs to correctly prepare women for the new industrial revolution.

B. Mentoring initiatives

One of the actions most frequently found to be applied in organizations that seek not only to create a culture of gender equity, but also to ensure the empowerment and presence of women in them, are mentoring programs. The low presence of women in careers, positions and development of stem areas is a serious problem for several countries, especially for Latin America. In order to increase the presence of women in stem areas, several initiatives related with mentoring programs have been presented that seek to empower and promote the participation of women in science and technology areas. Examples of these initiatives are shared below.

Case 1. The W-STEM project is a mentoring network with the purpose of establishing strategies to empower women to participate in STEM programs. For this mentoring program six countries (Chile, Colombia, Costa Rica, Ecuador, Spain and Mexico) and eleven educational institutions joined forces to ensure that more women interested in science, technology, engineering, or mathematics areas. The W-STEM program defines three types of participants in mentoring programs: mentor (teacher/tutor), student and mentee and each spanish-speaking university has established their own mentoring program following the methodology. The objective of the mentoring program is to train mentors, accompanying female students in STEM areas and evaluate the mentoring program in each university [11].

Case 2. The mentoring program called IT Women created by LACNIC (Registro de Direcciones de Internet de América Latina y Caribe), an international non-governmental organization, established in Uruguay, seeks to promote the participation and leadership of women in the internet ecosystem. The mentoring program includes the assignment of a mentor for technical work, a coach for professional development and a guidance in networking abilities [12].

Case 3. Another successful example of mentoring program is the Executive Women Development Program (EWDP) by the American Chamber Mexico, with the purpose of pair emerging leaders (mentees) with established leaders (mentors) with extensive experience, in order to foster development through real-life experience, expand their network of contacts and reinforce their self-confidence, in order to lead their careers and/or businesses. [13]

Case 4. In Mexico several educational institutions have designed local mentoring programs to contribute to increasing the development of women in STEM areas. A private higher education institution in Mexico developed several programs focused on mentoring: Alliance with the Carlos Elizondo Foundation that promotes scholarships for girls interested in STEM areas; Women mentoring in STEM, Innovation & Entrepreneurship that is a mentoring program on engineering, science and entrepreneurship for professional and high school students from any educational institution; SACBÉ STEM Social Service were undergraduate STEM students give mentoring weekly sessions to public school students, and Pepsico-Ingenia Mentoring, where engineering students benefit from one-on-one mentoring with high-level managers from Pepsico.[14]

Case 5. A university from Buenos Aires designed a mentoring program for students, graduates, co-teachers and professors of the University. Women from all over the country will be able to develop leadership skills, generate a networking network and obtain tools to enhance their purpose [15].

Case 6. The program for Women Leaders of Educational Institutions of the Americas (Emulies) of the Inter-American Organization for Higher Education (OUI), in coordination with the Pontifical Catholic University of Peru (PUCP) and the UNESCO Regional Chair for Women, Science and Technology in Latin America (Argentina), developed a mentoring program for establishing the right tools to pass on to other women their experiences in decision-making positions. The 2018 Mentoring Program represents an innovative strategy in the field of EIs in Latin America. After an instance of formation of twelve mentors from seven countries (Argentina, Colombia, Costa Rica, Chile, Ecuador, Mexico and Peru), carried out mentoring experiences, which resulted in information, materials and

conclusions that feed new developments of this strategy in other institutions and in other countries [16].

A large number of successful examples of mentoring programs are presented annually in Latin American countries with the purpose of reducing the gender gap and supporting the development of female students and professionals.

C. Matilda Latin American Chair and Women in Engineering

Matilda, the Matilda Latin American Open Chair, is an academic space to share ideas, reflections, best practices, and work together to design and organize activities to promote new vocations and equal opportunities for women in engineering and sciences in Latin America and the Caribbean. Matilda adopted its name from the "Matilda Effect", a bias that attributes the achievements of female researchers and scientists to their male colleagues. The Matilda Chair was born as a joint effort of three institutions: 1) ACOFI - Colombia (Asociación Colombiana de Facultades de Ingeniería - Colombian Association of Engineering Faculties), 2) CONFEDI - Argentina (Consejo Federal de Decanos de Ingeniería - Federal Engineering Deans Council), and 3) LACCEI (Latin American and Caribbean Consortium of Engineering Institutions).

These non-profit institutions connect engineering universities in Latin America and the Caribbean to promote global collaboration to foster engineering, innovation, research, technology, and education. The Matilda Open Chair is organized into an executive board and six different committees: Communication, Education, Mentoring, Professional Practice, Vocations, and Research. People join Matilda to volunteer their work and time with the same purpose in mind, contributing to this cultural change towards gender equality. The committees organize different activities to attract, retain and develop women in STEM, ranging from conferences, panels, debates, workshops, mentoring programs, podcasts, inspiring books, to a research conference. More information about Matilda and its activities can be found in its website (www.catedramatilda.org).

III. METHODOLOGY

The methodology is qualitative [17], with a case study describing the creation and development of the mentoring program, the perspectives of mentors and mentees, and reflections on lessons learned for the improvement of the program and its impact on fostering, retaining and empowering women in STEM fields.

The case study steps to be developed are: a) Program design process, b) Design of short mentoring workshops, c) Implementation of pilot mentoring program in Latin America, d) Lessons learned from the process.

The Mentoring Committee is one of the six committees that constitute the Matilda Chair. The main objectives of this committee are: a) to accompany students of any level of studies, work or business, through mentoring actions, b) to inspire their minds to reflect, provide them tools and accompany in the construction of an image of a possible future, c) and to promote communication channels between the members of the committee and the target population.

The Committee is composed of a team of professors and researchers from different universities in Latin America, with the following characteristics:

- 13% men, 87% women.
- 33% from Argentina, 27% from Colombia and 40% from Mexico.
- Representing different STEM areas: Mechatronics Engineering, Industrial Engineering, Mechanical Engineering, Computer Technology Engineering, Information Technology, Chemical Engineering and Food Engineering.

The design phase of the mentoring model consisted first of a workshop to raise awareness and share experiences of mentoring models with the Matilda Chair community. Following this, the basis of the Mentoring Model of the Chair was designed with a humanistic theme and with a focus on the development of women in STEM areas.

Short mentoring workshops were held to identify potential mentors interested in participating, as well as to support their training in this function.

Once we had a base of mentors, we proceeded to design the first mentoring program, consisting of the elements that were established from the design: inspirational, person-focused and comprehensive according to the mentee's needs. The results are analyzed from three perspectives: mentoring process, the mentor and the mentee.

IV. RESULTS

In the analysis of results, the creation of the Program was shared as case study with perspectives from different universities and countries, the perspective of mentors, and the perspective of mentees to join this program.

The first step was to design the mentoring model of the Matilda Chair with the characteristics that distinguish it from other models. The agreement of the Mentoring Committee was that it should be based mainly on the following principles (see Figure 1):

- Humanistic, person-centered model
- Designed primarily to inspire women, it is a model that can be developed for everyone.
- Model that considers the cultural differences between LATAM and other regions of the world.
- Holistic model that considers the different life stages of vocation development in STEM careers.

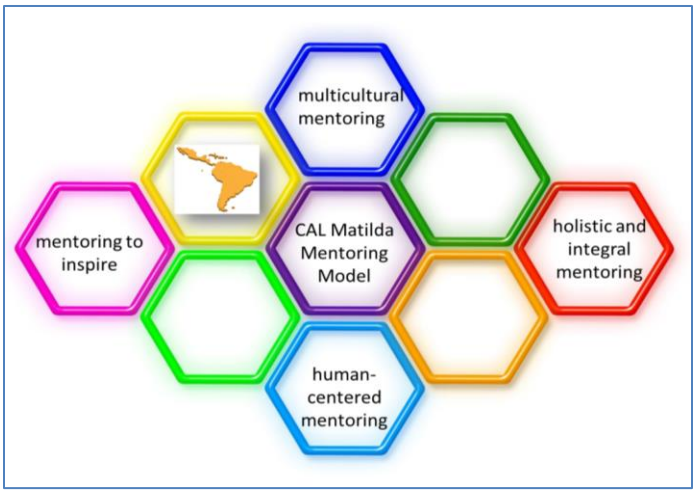

Fig. 1 Matilda Chair Mentoring Model

As part of the mentoring process the elements that were present are:

- Awareness of the current context in Latam in relation to STEM areas, unconscious biases, and life stages in order to provide a broad vision of women in these areas.
- Mentor profile.
- Mentee profile considering their needs.
- Matching process.
- Communication process.
- Agreement of mentoring expected results.
- Mentees´ communities.

Related to the mentors, their profile is shared as well as interests in the areas where they committed to mentor. In relation to the age of the mentors it is shown in Figure 2 that more than 70% are over 41 years old, with the smallest population being under 30.

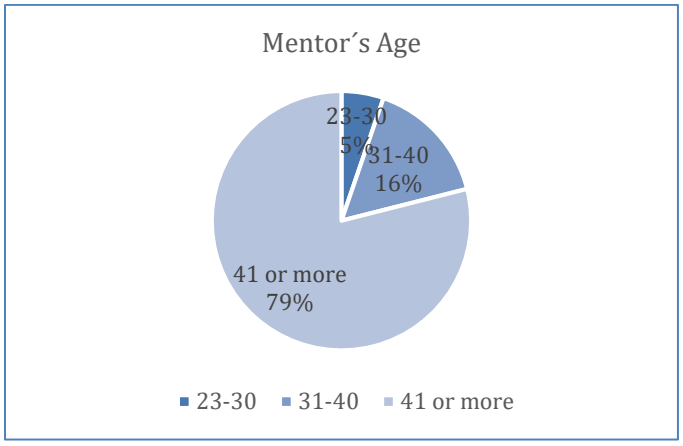

Fig. 2 Mentor´s Age

Part of the process with the mentors was to propose mentoring topics that could be tailored to the mentees' needs that they expressed in a consultation. Two topics proved relevant: life and career balance and mentoring techniques. Derived from this need, the mentors selected the topics where they felt most confident and experienced to share with the mentees. Since the greatest interest was related to mentoring techniques, the mentors decided to support this area more to meet the mentees' demand (see Figure 3).

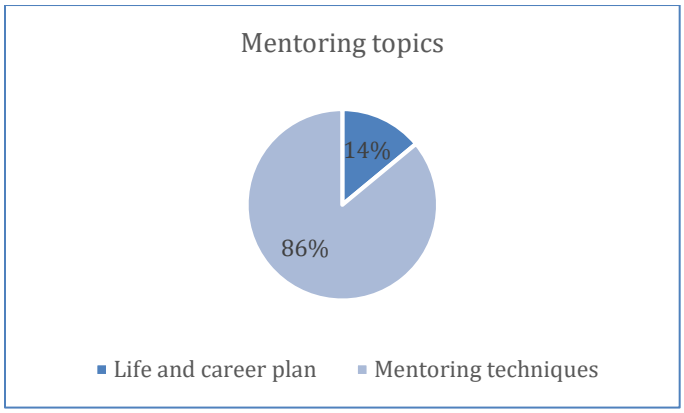

Fig. 3 Topics selected by Mentors

As part of the reflection of the participants in the mentoring preparation workshops, they shared the words and ideas they took away from these events. These insights are shown in Figure 4 with key words linked to mentoring.

Fig. 4 Word Cloud related with mentoring

The mentee's profile is relevant in the mentoring process, in order to focus the accompaniment according to his or her needs and stage of life. It is interesting to note that the participants in the first mentoring program were in the 41+ age range (See Figure 5). This is due to the interest in learning about the

mentoring process to support adolescents and young people in their vocation process or in their life and career plan.

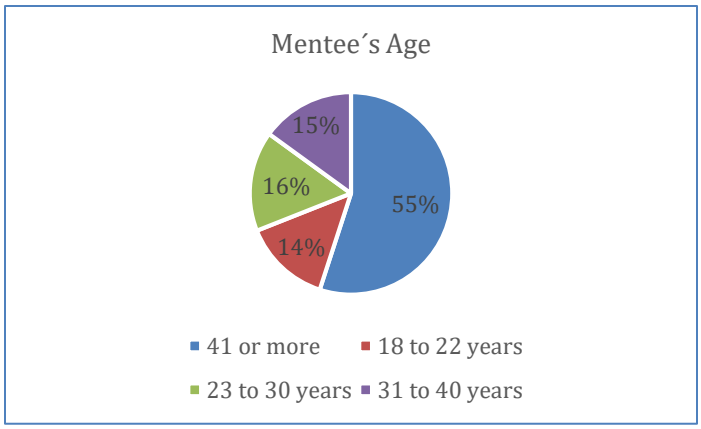

Fig. 5 Mentee´s Age

Of the engineering areas, there was a high percentage that I did not indicate which area of study it was in, or the population was too small to separate it out. They were mainly from the areas of Computer, Industrial, Civil, Electrical, Mechanical and Chemical Engineering. (See Figure 6).

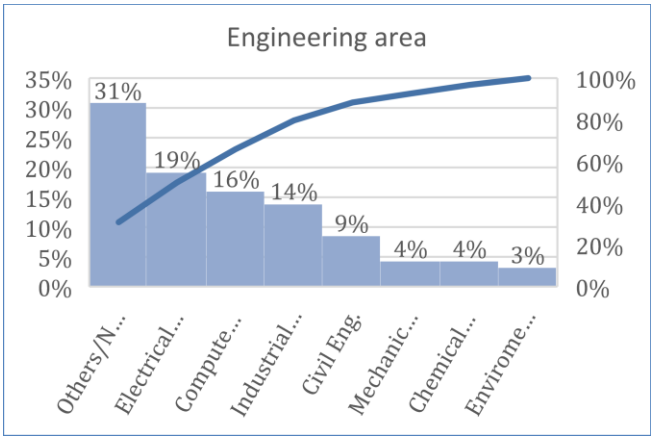

Fig. 6 Mentee´s Engineering Area

Among the main interests that mentees shared in relation to participating in the mentoring process were:

- Learning how to become a mentor, to engage in mentoring women in stem.
- How to help teachers and students
- As support and guidance
- To support scientific vocations and life projects.
- For self-evaluation, vocational support.
- To support and empower more women

Finally, the mentoring program has mentors and mentees from Latin America countries such as: Argentina, Bolivia, Colombia, Ecuador, Mexico, Peru, and from more than 50 different universities.

In addition, an analysis is provided of the objectives to be achieved for the mentoring sessions. As part of the mentoring process, agreements were established with mentoring objectives per mentee. These agreements are individual and discussed between mentor and mentee. General themes are shared that align the objectives that were established to be achieved during the program:

- More confidence in front of an audience
- Strategies for finding employment
- Proper communication about STEM areas with young people
- Basic methodology on how to approach the topic and contract they will be performing.
- Mentoring programs and how to integrate students.
- Networking with other universities

It is interesting to find throughout the process of designing and implementing the mentoring program, that the awareness and empathy generated by the visibility of the long way to achieve greater participation of women in STEM areas is the driving force that guides the interest in mentoring issues [4,5,6,7]. This gap is observed in all phases of life: in professional programs, graduate programs, research areas and even in the workforce, where there is a strong demand for specialized engineers [1,2,3].

The need to prepare mentors is not only a demand of the environment, but also a very personal interest, in order to impact lives in their decision-making process during their training and during their professional stage. This is observed both in the shared cases of the mentoring programs as well as the case study that is shared [11,12,13,14,15,16].

The main difficulties that arose were more of an operational nature of the program, as the interest, will and encouragement was already present in mentors and mentees. Among the difficulties encountered were:

- The integration of new mentees during the process, although it is good to be flexible, the logistics are complicated particularly the matching process once the program has started.
- Follow-up sessions between mentors and mentees, who is looking for whom.
- The timing of both mentees and mentors, dates also aligned with work periods and not vacations.
- There was a need for a resource library for both mentors and mentees to access readings and videos on topics of interest related to mentoring engagements, which were made available for mentors to share with mentee

IV. CONCLUSIONS

There is a demand for professionals specialized in STEM areas globally, and in our Latin American countries. In addition, there is an awareness of the lack of representation of women in STEM programs at both the undergraduate and graduate levels. This lack of greater participation of women in STEM areas has different causes and factors, however, society, governments, companies and educational institutions are making efforts to encourage these programs as a life option for women when deciding their vocation.

A mentoring program is one of the most commonly seen initiatives in higher education institutions to foster vocations, retain students and increase female graduates in STEM fields. Sensitive to the situation of the countries that are part of Latin America, where the gap is more evident, an international organization (Matilda Chair) was created, involving universities from different countries, whose purpose is to promote women in STEM areas. This is how mentoring model and programs are designed, with professors and researchers from different universities and countries. Sharing these mentoring initiatives with their processes, benefits and difficulties, seeks to facilitate their development in institutions that are interested in promoting these efforts, finally it is by sharing knowledge that we can grow.

The interest in increasing the vocations of women in STEM, and strengthening the presence of women in these areas, engages both women and men, who seek to support young people in training, and it is through mentoring that they seek to inspire and to empower, and thus impact our organizations and societies, with a more equitable and inclusive culture that generates a change that we need so much our countries.

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