

# Definition and Implementation of W-STEM Mentoring Network

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## Abstract

The lack of women in STEM careers is a problem that affects all higher education institutions, not only in Latin America but also in Europe and other regions of the world. Improving access, retention, and orientation mechanisms in universities is fundamental to ensure that more women interested in these areas effectively pursue a degree in science, technology, engineering, or mathematics. The W-STEM project seeks to establish strategies to improve these mechanisms in Latin American institutions. Since 2019, it has addressed the improvement of attraction, access, retention, and orientation mechanisms. The W-STEM Mentoring Network is part of these strategies. Specifically, it aims to empower women and encourage their active participation in STEM programmes. The mentoring model implemented uses a three-way relationship: a mentor teacher, a mentor-student and the mentee. The Network provides guidelines for the implementation of mentoring programmes, but each institution involved has adapted them to their contexts and needs according to their Gender Equality Action Plan. This paper describes the guidelines developed through a collaborative co-creation process involving all project institutions under the coordination of the Universidad Técnica Particular de Loja (Ecuador) and the University of Salamanca (Spain).

## Keywords

Gender Gap, STEM, Latin America, mentorships, gender mainstreaming, women in STEM.

## 1. Introduction

The 2030 Agenda for Sustainable Development (SD) and its Sustainable Development Goals (SDGs) are based on the concept of sustainability, addressing global challenges from climate change, environment, poverty, social and gender inequalities, and peace [1, 2]. Each SDG has specific targets requiring actions at different levels, involving public entities, regulatory agencies, controllers, private companies, civil society, and higher education institutions. Higher education has the power to generate competences in society that will enable it to face global changes [3]. Science, Technology, Engineering, and Mathematics (STEM) careers are crucial to respond to the needs of today's society.

Low participation rates of girls and women in STEM are a problem both for girls and women and for society as a whole. Women whose career trajectories reflect these unequal participation rates suffer considerable disadvantages [4], such as not being considered a decision-making group, unequal pay and workload. On the other hand, it has been shown that increasing gender diversity in STEM can lead to more effective problem-solving and improved innovations [5], and can have long-term effects not only on gender equality but also on economic development [6]. According to Quirós et al. [7], more women in digital jobs would benefit Gross Domestic Product (GDP) by up to 16 trillion euros per year in the European context.

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This problem starts in the early stages of education due to different internal and external factors, not only social norms or stereotypes but also issues related to self-perception, self-efficacy, support received, etc. [8-10]. Furthermore, according to Verdugo-Castro et al. [11] "as one evolves and progresses through the academic and professional trajectory in STEM domains, the number of women decreases, due to social stereotypes and other factors that indicate that these sectors are masculinised and cannot be easily reconciled with family and motherhood projects". This loss of women throughout their careers is represented by the leaky pipeline metaphor [12].

A holistic approach is needed to help policymakers close the gender gap in STEM [13]. Many factors contribute to this problem, such as self-perception, self-efficacy, interest in science, expectations of outcomes, previous educational experiences, family and social context [14]. According to the SAGA project (STEM and Gender Advancement) [15, 16], the gender gap in STEM must be addressed through seven macro-objectives covering social norms and educational and career pathways, research and decision-making. According to García-Holgado and García-Peñalvo [17], in this holistic approach, higher education institutions are crucial elements, as they impact directly or indirectly on the macro-objectives identified by UNESCO, with particular attention to education from an early age through teacher training.

At the European level, many initiatives focused on encouraging STEM vocations so that more women opt for higher education in these areas [18]. However, not so many actions work on the presence of women in STEM once they have entered higher education. According to the theory of the leaky pipeline [12], a high number of women dropout of STEM studies. During their studies, the university context can influence dropout rates, elements such as adaptation to the university environment [19], teacher support [20] or the support received from the institution [21] are some of the factors identified in previous studies.

Most dropouts occur in the first year of university, a critical time [22-25]. Follow-up and accompaniment in this first year increase the chances of success [26]. For this reason, there are several initiatives focused on mentoring as a tool to prevent dropouts in the early stages of higher education. For example, in the European context, the Mediterranean Network of Engineering Schools (RMEI) has developed a series of actions to achieve greater institutional readiness to identify, reflect and address gender bias in engineering higher education institutions through the TARGET project (Taking a Reflexive Approach to Gender Equality for Institutional Transformation). In particular, one of the strategies adopted is developing a mentoring and tutoring network for women academics [27].

The W-STEM project was created in response to this global problem. W-STEM is a project funded under the Erasmus+ Capacity-building in Higher Education Programme of the European Union [28, 29]. The project addresses three processes - attraction, access and retention/guidance - to increase the number of women in STEM programmes in higher education institutions in Latin America. In the third year of the project, one of the goals has been to stimulate the role of women in STEM programmes, empowering and ensuring long-term actions to make the project sustainable, through a mentoring network aimed at first-year women in STEM careers.

The W-STEM Mentoring Network aims to empower women and encourage their active participation in STEM programmes. The mentoring model implemented uses a three-way relationship: mentor teacher (tutor), mentor-student and mentee [30]. In order to establish the Mentoring Network, each Spanish-speaking university involved in the project has set up its mentoring programme. The guidelines for implementing the programmes are common to the whole Network, but each institution has adapted them to its context and needs according to its Gender Equality Action Plan [31]. In particular, the Network is made up of six countries (Chile, Colombia, Costa Rica, Ecuador, Spain and Mexico) and eleven institutions:

- Pontificia Universidad Católica de Valparaíso (PUCV)
- Universidad Federico Santa María (USM)
- Universidad del Norte (UNINORTE)
- Universidad Tecnológica de Bolívar (UTB)
- Universidad de Costa Rica (UCR)
- Tecnológico de Costa Rica (TEC)
- Universidad Técnica Particular de Loja (UTPL)
- Universidad Técnica del Norte (UTN)

- Universidad de Salamanca (USAL)
- Tecnológico de Monterrey (ITEMS)
- Universidad de Guadalajara (UDG)

The process of defining the Network followed a collaborative approach based on co-creation [32], so that all the institutions that are part of it were involved in defining the guidelines and the implementation process. This paper aims to present the W-STEM Mentoring Network.

The paper is organised into four sections. The first section presents an introduction from a theoretical point of view that allows us to identify the need for mentoring from a gender perspective. The second section describes the proposal for the implementation of mentoring with the guidelines common to all mentoring programmes. The third section presents the actions carried out to consolidate the Network with the active involvement of women mentors. Finally, the last section summarises the main conclusions and future lines of work.

## 2. Proposal

Mentoring has a vast field of action and can be qualified with tutoring actions. Mentoring is a "relationship between an experienced and knowledgeable person and a younger person seeking assistance, guidance and support for career, personal and professional development" [33]. Rhodes [34] proposed that mentoring relationships affect mentees through three processes: (1) improving their social relationships and emotional development, (2) improving their cognitive skills through dialogue and listening, and (3) promoting positive identity development by presenting a role model and advocate in the person of the mentor. According to this model, people who mentor and influence improvement in more than one of these three areas are likely to have a more significant impact on their mentee. Therefore, the success of mentoring projects lies in establishing a close and long-lasting relationship [35].

### 2.1. The objective of the mentoring

The W-STEM Mentoring Network aims to develop skills in the mentees that will enable them to perform better in their student life, acquire good behaviours for their professional life, and foster their personal growth. It is necessary to establish the following specific objectives to achieve this objective:

- a) Train mentors (who can be male or female teachers or students from last semesters) through short videos on mechanisms and strategies to develop skills that enable them to develop gender-sensitive mentoring. The videos will be available on the project platform for open access.
- b) Accompanying incoming female students in STEM programmes through mentoring. Each university will decide whether they will be carried out individually or in groups of a maximum of 3 mentees under the responsibility of at least one mentor. The methodology for organising the call for applications or the activities must be adapted to each university, in terms of timing, regulations, etc.
- c) Evaluate mentoring in each institution through a standardised instrument to produce indicators for feedback and improvement of the process.

### 2.2. Launching the mentorships

A set of guidelines are proposed to develop this proposal. The mentoring programme involves three roles. First, the female mentees will be first-year undergraduate students. Although gender-sensitive mentoring can involve people of all genders, the focus of the activity is on reducing the dropout of women in STEM programmes as a measure towards reducing the gender gap in these areas. For this reason, it is recommended that the mentees should be female students only.

Second, mentors should be final-year students. The participation of upper-year mentors enables a better relationship between young women of closer ages to ensure effective mentoring, as well as to empower future female professionals about the importance of their participation in STEM careers by

fostering their leadership. In addition, these students will meet minimum training requirements to become role models for first-year students. Each student mentor will be assigned one or two first-year students (never more than 3) and their task will be to provide informal guidance and advice to stimulate and assist first-year students' academic and social integration.

The third role is tutors, teachers from each STEM programme who will supervise the mentors and mentees. On the one hand, the aim is to monitor the peer mentoring processes to support the mentors. On the other hand, the tutors must ensure that the principles of gender equality are met and build inclusive spaces where a coeducational approach goes beyond the classroom and encompasses other areas of the centre. However, this role is recommended, it is not compulsory, so each institution can decide whether to develop a process based on three or two roles.

Regarding the selection of participants, although the process can be carried out in different ways depending on the institution, it is recommended that the following steps be followed:

- Identify tutors to involve them in the selection process of mentors and mentees. At least one person should be identified in each STEM programme where mentoring will be implemented.
- Attract first-year female students. The team can work with the offices responsible for student access, identify them through the first-year professors, or launch an open call for applications through the institution's media. In addition, the selected tutor can come to some first-year classes to promote the programme and invite women to participate.
- Select male and female students to act as mentors. A call for volunteers can be launched or identified through student clubs or student associations. In addition, in order to stimulate their participation, scholarships can be offered, if the institution has the resources to do it, or some other type of incentive in order to raise awareness of positive volunteering and to be able to guarantee the fulfilment of the tasks during the mentoring.

### **2.3. Initial training**

One main objective of the Mentoring Network is to train mentors and tutors. This training can be aimed at both teachers and students who act as mentors. Short videos and materials will be created on topics focused on gender, women's rights, gender-based violence, and prevention, so that there is empowerment with the topics to be addressed focused on university students. The objective is that mentors to provide support to improve the skills or performance of the mentees in their student life. Each institution can develop the training in the format that is most suitable for them. Among the contents addressed in training, the following are established as the basis for the training:

- Basic concepts. Introductory videos on concepts such as gender, stereotypes, mansplaining, and coeducation, as well as selected supplementary material such as the coeducational dictionary [36, 37].
- Women's empowerment and leadership.
- Gender violence. Identification of sexism, sexist microaggressions, mistreatment, harassment in classrooms/centres, etc., as well as tools for reporting it. This type of content exists in most institutions involved, so they will be used. There is also another series of supplementary materials, such as the I Workshop on Gender Violence in Higher Education Institutions developed by the University Network for Gender, Equity and Sexual Diversity (RUGES) and the Union of Universities of Latin America and the Caribbean (UDUAL) [38]. In addition, each university incorporates information on its complaint and support services, as well as information on informal mechanisms in contexts where no institutional-level processes exist.
- Inclusive language. The use of inclusive language is a key element in creating egalitarian spaces. In addition to the development of specific materials, a set of supplementary materials such as the UN resources on the gender-inclusive language are identified [39] or the Practical Guide for Inclusive Language produced by COCEMFE (Confederación Española de Personas con Discapacidad Física y Orgánica) [40].
- Soft skills.
- Intra-personal skills with particular emphasis on assertive communication.

- Stories of women in STEM. Throughout the W-STEM project, interviews have been generated with women in STEM from different countries, cultural backgrounds, ages and career stages (not just senior positions). These videos aim to show diversity in STEM and to reduce stereotypes in these areas. The interviews are between 3 and 7 minutes long, and the original language is English or Spanish with subtitles. [41, 42].

## 2.4. Development and evaluation

Once the people involved in the programme have been identified, the working groups should be organised. It is recommended that the relationship between mentees, mentors and tutors should belong to the same STEM programme.

Regarding the development of the programme, the guidelines include indications for organising a series of face-to-face meetings to strengthen the relationship between the people involved in the mentoring programme. There should be at least one joint kick-off, one follow-up and one end-of-programme meeting. In addition, each programme can establish its own guidelines for mentors and mentees, although fortnightly meetings between mentees and the assigned mentor are recommended to ensure adequate and timely mentoring.

Concerning the monitoring and evaluation of mentoring, the following guidelines are proposed:

- Information will be collected using two instruments, a questionnaire at the beginning of the mentoring and another one at the end to compare expectations with final satisfaction.
- Two initial questionnaires will be elaborated, one for the mentees and one for the mentors. These questionnaires will collect motivation towards STEM studies and needs and attitudes towards the mentoring process.
- Three final questionnaires adapted to mentees, mentors and tutors will be prepared. These questionnaires will collect satisfaction with the individual mentoring methodology, time invested in the programme, perception of the mentoring programme, and overall satisfaction with the mentoring programme.
- Conduct a focus group with the participation of all the people involved in the mentoring programme to identify the programme's strengths and weaknesses.

The information gathered through the mechanisms mentioned above will allow for improved programme implementation in the following semester or academic year.

## 3. Consolidation of the Network

The W-STEM Mentoring Network is developed in each institution in a semiautonomous format, although follow-up meetings are held throughout the implementation process to share experiences and lessons learned.

The W-STEM International Conference (<https://wstemproject.eu/es/conferencia-w-stem-chile/>) was held in Valparaíso (Chile) to consolidate the Network. This event, which had a hybrid format, had as one of its main objectives to know the mentoring programmes from the point of view of the mentors who have participated in them. Two mentors from each institution participated in the conference activities in person.

The Columbus Association, the external evaluator of the W-STEM project, collaborated as an external agent within the Mentoring Network to define mentoring 3.0 in a co-creation process in which only the mentoring students participated. More than 20 mentors worked on an action plan to ensure the sustainability of the Network based on the mentoring network that emerged from the face-to-face event.



Figure 1. Presentation of the plan developed by W-STEM mentors.

The women mentors worked over two days to present a viable plan to the other project partners (Figure 1). The plan consists of the following:

- Self-governance mechanisms through a board with the participation of one student per institution and a professor who will have a passive role and serve as a contact element for issues related to the institution.
- Short-term strategies: mentoring, dissemination and creation of strategic alliances.
- Long-term strategies: social entrepreneurship, development of multidisciplinary projects, and mentoring mobilities between institutions in the Network.
- A wish list was requested from the project consortium to support the short- and long-term strategies.

It is essential to highlight the importance of human resources for the Network's sustainability according to the analysis carried out by the mentors. Firstly, they identified the need for technical, administrative, institutional and logistical support, as well as the network of contacts established through W-STEM, so that these people can act as catalysts in the affiliated institution to facilitate the development of mentoring. Secondly, they highlight the need to make the Network visible in institutional communication channels and through creating content on social networks. Lastly, they consider training as a critical element to ensure the proper development of mentoring.

#### 4. Discussion and conclusions

This paper describes the guidelines developed in the W-STEM project for implementing the mentoring programmes of the W-STEM Mentoring Network. This Network serves as a tool to improve retention and guidance for women in STEM programmes in higher education institutions.

Although the mentees are the primary beneficiaries of the process, the mentors improve their decision-making, leadership, planning and communication skills, and increase their commitment to the university and the other participants in the activity [43] and develop technical (knowing), social, participatory (knowing how to be) and methodological (knowing how to do) competences [44].

Implementing the W-STEM Mentoring Network has empowered first-year female students and female students who have played the role of mentors. This empowerment has enabled the creation of gender mainstreaming spaces and laid the foundations for continuing mentoring programmes in future academic years. It also highlights the need to establish mentoring processes that are fully adapted to

each institution. The initial proposal addressed a more stricter guidelines for establishing mentoring programmes. However, it was necessary to look for more flexible guidelines that would facilitate implementation according to the unique characteristics of each institution. For example, some programmes had to be integrated with mentoring processes already established in the institution; others were integrated with student groups.

On the other hand, concerning the resources needed to implement mentoring, depending on the institution, a greater or lesser amount of economic resources have been invested. However, the requests identified by the mentors highlight the need for support at the institutional level to use spaces, organise activities and continue the mentoring processes. They only identified the need of funding to strengthen the links within the mentoring network through mentoring mobilities between programmes. The Mentoring Network is a sustainable proposal from an institutional point of view if human resources are invested in maintaining the transition between academic years, so the mentees play the role of mentors in subsequent years.

In future steps, it is proposed to establish mechanisms to ensure the Network's sustainability over time so that its implementation does not depend on a small group of people but is part of the institutional mechanisms. Likewise, the mentors expressed their interest in continuing their relationships with the programme by taking on the role of professional mentors and working on the sustainability of the Network.

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