

International mobility for enhancing leadership in women engineering students: a case study connecting Colombia and Spain

Alicia García-Holgado^{1,*†}, Sonia Verdugo-Castro^{1,†}, Vilma V. Ojeda-Caicedo^{2,†} and Sonia H. Contreras-Ortiz^{2,†}

¹GRIAL Research Group, Instituto Universitario de Ciencias de la Educación (IUCE), Universidad de Salamanca (<https://ror.org/02f40zc51>), Salamanca, Spain

²Universidad Tecnológica de Bolívar, Parque Industrial y Tecnológico Carlos Vélez Pombo Km 1 Vía Turbaco, Cartagena, 130010, Colombia

Abstract

The gender gap in STEM is a problem that occurs at different career stages. In this context, W-STEM project arose to make changes in the strategies and mechanisms of higher education institutions for engaging and retaining more women into STEM programs. The project, funded by the European Union, is a capacity-building project aimed at implementing good practices to achieve gender equality in STEM programs. When the project ended, in 2022, a network of Latin American and European universities was created to continue developing strategies to contribute to the reduction of gender gaps in STEM fields. This network includes a mentoring program where advanced students in STEM programs lead first-year female students. Under this scenario, Universidad Tecnológica de Bolívar (UTB) in Colombia and Universidad de Salamanca (USAL) in Spain, implemented an international mobility for mentors. At UTB, the mentors received training to strengthen their leadership, multicultural, inclusion, and research competencies. This training was developed in their home university and then, they participated in international mobility in Spain to finish their training through different activities developed at USAL. Focus groups were conducted, with a methodology that allowed to evaluate the strengthening of leadership, multiculturalism, inclusion, and research competencies.

Keywords

STEM, Higher Education Institutions, mentorship, women, gender gap, Latinamerica, mobility program

1. Introduction

The market trends are transforming the industry, not only in favor of the development of technical skills but also the need for transversal skills, such as critical thinking, problem-solving

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*Corresponding author.

†These authors contributed equally.

✉ aliciagh@usal.es (A. García-Holgado); soniavercas@usal.es (S. Verdugo-Castro); vojeda@utb.edu.co (V. V. Ojeda-Caicedo); scontreras@utb.edu.co (S. H. Contreras-Ortiz)

🌐 <https://produccioncientifica.usal.es/investigadores/57596/detalle> (A. García-Holgado);

<https://produccioncientifica.usal.es/investigadores/148133/detalle> (S. Verdugo-Castro)

🆔 0000-0001-9663-1103 (A. García-Holgado); 0000-0002-9357-1747 (S. Verdugo-Castro); 0000-0002-8636-482X (V. V. Ojeda-Caicedo); 0000-0003-2461-2100 (S. H. Contreras-Ortiz)



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and innovation [1], all of which are closely linked to STEM (Science, Technology, Engineering and Mathematics). Moreover, there are not enough workers to meet the needs of the STEM workforce. The number of students enrolled in STEM programs is decreasing, although the number of jobs requiring STEM skills is increasing. This problem is exacerbated if we analyze the figures on the basis of gender, the lack of women in these areas is a global issue [2, 3, 4, 5, 6]. This problem starts in the early stages of education due to different internal and external factors, not only social norms or stereotypes [7, 8], but also issues related to self-perception, self-efficacy, support received, etc. [9].

There are many initiatives focused on reducing the gender gap based on working and primary and secondary educational levels [10]. However, solving the problem requires an holistic approach, involving processed, entities and stakeholders with different backgrounds and objectives. In this context, we developed the W-STEM project and, specifically, the W-STEM Network, created as a result of the project to ensure its sustainability and knowledge transfer.

This work describes a particular experience developed between two institutions of the W-STEM Network, Universidad Tecnológica de Bolívar (UTB) in Colombia and University of Salamanca (USAL) in Spain, to search new mechanisms for fostering internationalization through the mentoring programs. This Network is the result of a European-funded project focused on engaging more women into STEM programs in Higher Education institutions in five Latin American countries (Chile, Colombia, Costa Rica, Ecuador and Mexico). The aim is to find out the impact of international mobility as part of gender mainstreaming mentoring through the participants' satisfaction and perception of the experience. A focus group was conducted to answer the following research questions:

- Q1. What is the usefulness of international mobility in a gender-sensitive mentoring program?
- Q2. What is the impact on the institution?
- Q3. How does international mobility in mentoring programs contribute to the promotion of STEM degrees for girls and women?

The paper is organized into six sections. Section 2 presents the main features of the W-STEM Network. Section 3 describes the case study at UTB. Section 4 describes the training program implemented for female STEM mentors at USAL. Section 5 describes the focus group for analyzing the experience. Finally, the last section summarises the main conclusions.

2. W-STEM Network

W-STEM Network arose during the last year of the W-STEM project (Building the future of Latin America: engaging more women into STEM) [11]. The project, funded by the European Union through the capacity building call, aims to improve the mechanisms and strategies that higher education institutions have for attraction, access, retention and guidance of students in STEM programs to focus on engaging more women into those programs, with a particular effort in programs with a wide gender gap. The project developed and piloted the W-STEM model [12], a framework to transfer the knowledge created during the project to other institutions. The project's first year was focused on self-assessment to get information about the situation in

each institution and the definition of the Gender Equality Action Plan for STEM programs. The second year was devoted to attraction and access actions, so each institution was working with secondary schools to increase the number of women applying to STEM programs.

Finally, the last year was focused on developing the mentoring network [13]. Each Latin American institution created a local W-STEM chapter to support the guidance and mentorship of female students in their first year of studies. Although the local chapters were planned for the second half of the project, some partners started the implementation of the local chapters at the beginning of the project to support attraction campaigns and involve women students from the beginning.

The creation of the local chapters was related to implementing the mentoring programs in each Latin American institution involved in the project. Some institutions have created a local chapter from scratch, as in the case of Universidad Técnica Particular de Loja (Ecuador), UTB (Colombia) or Universidad del Norte (Colombia). In other cases, such as Tecnológico de Monterrey (Mexico) or Universidad Federico Santa María (Chile), local chapters have joined existing initiatives, this has allowed synergies between the established initiative and the new one. Both approaches have focused on ensuring the sustainability of mentoring within each institution.

All local chapters follow the same objectives, based on the framework for defining the mentoring programs. The framework collected the agreements between the partners and the feedback received from the European partners as experts. However, each institution has defined its own identity, rules, etc. The aim of having heterogeneous chapters is to ensure that the chapter considers the characteristics of each institution. The connection between the local chapters is the W-STEM Network.

Moreover, the project coordination in Spain, the University of Salamanca, also implemented the mentoring program to strengthen the connection between Europe and Latin America in the Network. The mentoring program at USAL was funded by the Instituto de las Mujeres (Spanish Government) in the 2021-2022 academic year for piloting experience and continue in 2022-2023 [14]. Among the activities organized during the Spanish mentoring program, there was an international activity in which mentors, mentees and tutors from the mentoring W-STEM network participated.

The good practices developed in each mentoring program among the different Latin American institutions involved in the project were shared in Open Access to facilitate other institutions to provide other institutions with sufficient tools and knowledge to implement gender-sensitive mentoring in STEM programs [15][16].

3. The mentoring program at UTB

The Faculty of Engineering is the largest Faculty of UTB. There are 2896 students in 11 undergraduate programs. Since 2019, the Faculty has been measuring gender equality indicators. Gender gaps have been observed in most engineering programs [17], and in the whole Faculty, the percentage of female students has reduced from 32% in 2018 to 26% in the first semester of 2023. Aware of this problem, several strategies have been implemented to promote the participation of women in engineering programs. One of these strategies is a mentoring program with

a gender perspective. The program started in the second semester of 2021 and is currently in its third version. It consists of mentoring first-year engineering students by advanced students of the faculty. There are two mentor leaders who support the coordination of activities and communication with the students and two professors who lead the mentors' call and training activities.

3.1. Mentors' training

In the first weeks of each semester, a call is opened to students from the third year and above interested in being mentors. A meeting is organized where mentors receive information about the W-STEM project, what is expected from the mentoring program, the code of ethics, resources on inclusive language, women's leadership in STEM, and how to avoid gender bias, among other aspects. Reference and support resources are shared. A census of first-semester female students is done and they are assigned to mentors according to their academic program. Each mentor can have up to three mentees. Participation in the program is voluntary for both mentors and mentees.

3.2. Dissemination activities

During the development of the mentoring program, several activities such as round tables and talks are held to share the life experiences of women engineers with successful careers in academia or industry. Most of these engineers are graduates of the faculty and some are outstanding scientists living abroad. The purpose of these activities is to present role models to inspire students who are starting their careers. Students from the W-STEM group also participate in this event, sharing their experiences as students.

3.3. Evaluation of the mentoring program

We applied a qualitative methodology to evaluate the experience. In-depth research was carried out on the participants' opinions, perceptions, and impact of the experience employing the phenomenological method. For this purpose, the focus group was used as a study technique. For some authors, the focus group data collection technique is a group interview in which reality is approached through debate and group discussion of reality. The technique aims to generate and analyze the interaction between the participants in the approach to the topic of study. Likewise, the aim is also to discover how the group constructs the meanings of the topic discussed [18].

The focus group was conducted on 26 October 2022. Signed informed consents were collected with the focus group.

3.4. Student selection for international training

With the support of ICETEX, from the Ministry of Education of Colombia, six female engineering students, five mentors and one mentee, participated in a training program in USA. The main purpose of the program was to strengthen leadership, multiculturalism, and inclusion skills in female engineering students. ICETEX defined some requirements to provide funding: the students need to have a low socioeconomic background, be the first person in their families to

attend higher education, and not have traveled abroad. All students from the W-STEM group were asked to register and submit evidence of socioeconomic status, belonging to minority groups, being the first generation, participation in student groups, research groups, and the W-STEM group.

4. Specialized training of female STEM mentors

The training program for international mobility was divided into two main activities: participation in an international conference and a training week for junior researchers.

First, the conference was the international conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2022). This event brings together researchers and postgraduate students interested in combining different aspects of the technology applied to knowledge society development. This edition was organized in 16 thematic tracks that cover research areas such as Educational Assessment and Orientation, Human–Computer Interaction, Computers in Education, Communication Media and Education, Medicine and Education, Learning Analytics, Engineering Education, Robotics in Education, Diversity in Education, Gamification and Games for Learning, Smart Learning and Laboratory-Based Education [19].

The international conference took place for three days. The Colombian students actively participated in the conference sessions, including round tables, keynotes and networking activities.

On the other hand, during the second week, the students participated in the training program organized by the Doctoral Program on Education in the Knowledge Society. The objective of the training week was to foster relationships between students who wish to start or are starting their research careers. Throughout this edition, seminars, workshops and various activities were held where national and international experts shared their knowledge with the students. Students from Colombia participated in all the activities of the doctoral week, acquiring basic knowledge about research as well as interacting with other students from Spain and different Latin American countries. Among the activities planned, the students attended the following seminars and workshops:

- Gender mainstreaming in research.
- The importance of support networks for doctoral students.
- Elaboration of questionnaires: how to avoid biases and distortions in the answers.
- The importance of the image in scientific communication.
- Exploratory and confirmatory factor analysis with JASP software.
- Introduction to qualitative research and its data analysis with NVivo.
- The importance of using a good reference manager such as ZOTERO.
- How to develop a research data plan.

5. Focus group

5.1. Participants

The focus group consisted of six participants, all of whom had lived international mobility in Spain. As previously indicated, they were engineering students; five were mentors, and one was a mentee. All of them belong to minority groups, being the first generation studying for an undergraduate degree.

5.2. Results

The focus group was audio-recorded with prior informed consent. In addition to being recorded, notes of comments that arose during the discussion session were taken. Subsequently, the focus group questions were organized by categories for analysis, and the content was reduced for coding into categories, i.e., questions [20]. To guarantee anonymity, each participant was assigned an identifier consisting of the letter P and a number.

5.2.1. Activities during the mobility

The data were analyzed to measure different aspects of the experience, including impact and satisfaction. Regarding the lessons learned from the experience, first, we asked about the main activities developed during the mobility, the international conference and the training week.

What is your opinion about your participation in an international conference? In what ways do you think you have benefited from it in terms of your education and your academic and professional future?

- P2: As an undergraduate student, it is an honor to participate in it, as it opens up a world of possibilities for the future.
- P4: Many of the articles were related to my degree. They can be applied to different fields of research. Asking questions gave clues about quality and how to reflect it.
- P5: I felt that I had a gap in the topics related to my degree, and it helped me to get excited. In Colombia they don't deal with these different topics; they focus on one theme. You can work on certain lines of research, they are themes that I have dealt with, but I didn't have the vision that I could do it.
- P1: In my case, I am just starting my undergraduate degree, and it is very motivating to have this experience, especially because of the work methodology. I have had experience, but not at this level and I can raise the level. It is an opportunity for me and other colleagues.

What aspects of the training you received during the training week would you highlight?

- P3: During the training, we did different survey activities, and it was very useful; it helped me to broaden my ideas on how to apply the surveys. In addition, it was also interesting to work on gender mainstreaming because we don't do it in our courses.

- P6: In the gender mainstreaming course, there was a very interesting experience; there was a dynamic on how to include the perspective in your field. And yes, there is a way to include it in every field and it is very important to do it and talk about it to see how gender mainstreaming can be included. I find it interesting to be able to transfer it to other W-STEM colleagues. It is one of the few times that I have been on a gender mainstreaming course, and I feel that I can address how to contribute.
- P4: The gender mainstreaming course was very enlightening; how to respect both sides and have both sides represented.

What are the main lessons you would highlight from the activities you participated in?

- P2: In my case, what I focused on and learned the most, I have always thought about what I want to specialize in when I finish my undergraduate degree and about the training we have received on gender mainstreaming, how it can be taken and assumed in my field, how to use it so as not to discriminate.

5.2.2. The mentoring program

The second part of the focus group was about the mentoring program at UTB and their experience as mentors and mentee.

If you were to participate in a mentoring program as a mentee, which of the contents that you have learned and worked on during the international conference and the training week would you like to be transferred to you? Why?

- P1: I am mentored; I would like the gender perspective to be transferred. Many girls have the closed idea that the intention is that women see each other more than men, and it is not like that, it is necessary to reach a union, a balance where to create things together.
- P3: I would like how to give my ideas in a very short time. Many of them during TEEM had 3 minutes to explain a work of years, how to explain in a reduced way a great work.
- P6: It is very important. In my country, they don't talk about it. It needs to be part of everyone's education. Not everyone has the knowledge to express it. You have to know how to differentiate between sex, identity and orientation. I wasn't clear about it, and other people weren't either.

Now, assuming you are a mentor, in what way, through what strategies, would you transfer this content to your mentees?

- P5: You have to consider that they come from a high school with inculcated values. You have to put together a strategy to transmit these concepts in the best possible way. Not everyone is open-minded. You have to listen to them.
- P6: A survey should be carried out on what they think. We need to know what they think to know what we are dealing with.
- P4: In these programs, there is resistance because it seems that we are forcing a mentality, an indoctrination.

5.2.3. Impact

We also asked about the impact of the experience on other people and on themselves, on their competencies.

How do you think this experience can impact colleagues who have not been able to travel to Salamanca?

- P6: I definitely think that seeing that we were able to come here and what we learned will motivate them to want to come here. It will make them want to continue with the W-STEM mentoring. Seeing that we have come here, that after so much effort, we have been able to get here, is going to make them want to try harder.
- P2: I want us all to get involved in this. This is a huge step. Achieving this is thanks to the project. I want more motivation, incorporation, to be seen more at the university.

How do you think the experience can impact the institution you are part of?

- P2: The university has looked for ways to make women more visible, but I think that with what we have achieved, the university has to try to make it more visible. That there are more resources, more support and professors who are interested. I think that now the role of women is more visible in the institution.
- P5: I think we are starting new courses, showing them a different vision of this great experience that we are taking with us. The fact that there are courses on things we have learned, that I have learned one thing and my colleague has learned another, is a great contribution to the institution. In the case of the papers, it would benefit the university.

How has the experience you have been part of contributed to developing your leadership competence?

- P1: It also influences how others start to see me because I am here. They start to see you as a leader and they are accepting what you are doing, and that process becomes better. The leadership process has to be a two-way process.
- P4: These reinforcing capacities reflect positively on how we act. They see us as someone to follow and we have the sensitivity to know how to guide and lead.

Do you consider that these experiences promote multiculturalism and inclusion?

- P6: Living together has helped us all to learn, to listen, to understand that, even if it is not my opinion, we can live with that difference. It promotes multiculturalism of everyone.
- P4: And also with other people at the event, with other people from other countries, with whom we can live and talk. You have to respect and understand that gestures and languages can represent different things. This experience gave us multiculturalism to talk to different people.

5.2.4. Gender gap in STEM

Later, participants shared their experiences and thought about the gender gap in STEM.

How do you see the experience you have had as contributing to the promotion of STEM degrees for women?

- P6: I think it is very necessary. At school, I never valued being an engineer. My father is sexist, so I thought I couldn't do engineering. When I started, I saw women engineers, which made me confront my father's macho thoughts.
- P5: I was afraid because I entered a week late, and we were five women and the rest were men. I was the only woman and they were all men. And the women had little participation. I was afraid that they were right and that I wouldn't be able to. But I saw that there were female engineering teachers, and they were good and that motivated me to leave that feeling of fear of being unable to.
- P2: As women, we have always been destined to meet expectations. We don't have to fulfill expectations. We have to fulfill our own expectations. We are the advertisement that if we can do it, they can do it.

Do you think these experiences are useful in reducing the gender gap in STEM?

- P2: The simple fact that six women are here, learning about how to make more women visible, hopefully in time... Just by being here, we have already done a lot.
- P6: In the semester I started, there were very few mentors and volunteers, and this semester, all of them were enrolled. It is a good strategy to see that we have achieved so much, that they think about where they could go with this project, and that they don't give up and continue with it.

How do you think these experiences contribute to generating new opportunities?

- P2: When you presented your project and people were surprised. This opens up more opportunities for us with the people who listened. Just by coming here, we open up a world of opportunities.
- P1: Something curious that I heard is that everyone here is leaving the country for the first time. With that first little stamp, opportunities open up for us.

5.2.5. Satisfaction

Finally, the last questions focused on identifying the general opinion on satisfaction with international mobility.

What positive aspects do you draw from the experience of the training scheme?

- P2: There are many positives and a huge list of everything we have learned. The knowledge we take with us, the knowledge we have learned and can share. We want to spread the word as soon as we get off the plane and arrive at the university. In our personal life project, there are many positive elements, we are getting more involved in our career, we are falling in love with our career.

- P6: Looking at the possibility of doing a graduate degree here, we looked at the price and the location. But I wouldn't have known what it's like if I hadn't come here. Without knowing, it is difficult.
- P5: The new vision I have, I am a different person than the one who got on the plane.
- P1: It's a huge list of positive things, both academically and educationally, and personally.

What negative aspects do you draw from the experience of the training scheme?

- P2: To see the presence of shortcomings in our university.
- P1: Being able to walk from where we live to school without being robbed.
- P4: Seeing that we can go out at night without anything happening.

6. Discussion

The mentoring program with a gender perspective was created at the UTB with the purpose to offer support to female first-year students of engineering programs. The student mentors were highly motivated to participate and highlighted the importance of these spaces. The university developed several strategies to foster self-confidence, leadership, and intercultural skills in these students.

The objective of the qualitative study applied through a focus group was to measure satisfaction with international mobility as part of the mentoring program at UTB. Based on the results obtained through the participants' discourses, it can be concluded that they found numerous benefits to this experience. They indicated that it has helped them to connect their studies with their careers and feel more confident. Likewise, attending the international conference has put them in contact with other researchers in their fields. It has allowed them to identify the fields of study they would like to advance.

All the benefits mentioned above are combined with others, such as learning to socialize with other people, listening to new accents and learning about new cultures, leaving their country and appreciating the experience as an opportunity to gain more knowledge and also to transfer this learning in their country and at their university when they return.

Regarding the training they have received, they highlighted the usefulness of getting technical knowledge, such as the handling of surveys, and knowing social and pedagogical approaches, such as gender mainstreaming in engineering. They emphasized that they enjoyed working on the gender issue because, in their environment, they felt discriminated against by family members because of their studies; however, having other references has helped them to gain self-confidence.

The participants stressed the importance of mentoring in demystifying STEM studies and helping other female colleagues not to drop out. In this sense, they appreciate the usefulness of giving visibility to mentoring programs. Regarding the best strategies for the development of mentoring, they emphasized working from the point of view of proximity and conveying a message on positive values that motivate.

Finally, they consider that the experience may encourage other students to participate in similar programs. Regarding satisfaction with the experience, it is concluded that promoting

these international initiatives benefits university institutions and students. It is especially valuable to connect the different institutions through synergies and involve them in the process of active change.

7. Conclusions and future work

The usefulness of international mobility for gender-sensitive mentoring programs can be summarized in five aspects.

- Inspiration and role modeling. Students could meet successful female engineers and scientists from different cultural backgrounds.
- Awareness and inclusion. Students have been exposed to gender mainstreaming concepts and the importance of gender equality in research. This awareness has fostered a more inclusive perspective that can be integrated into the mentoring program.
- Cross-cultural competence. Interacting with diverse individuals from different countries has developed students' cross-cultural competence. This skill can be leveraged to create a more inclusive and welcoming mentoring environment that respects and appreciates cultural diversity.
- Network expansion. The international mobility experience has expanded students' networks to include mentors, peers, and professionals from around the world
- Skill development. Students have learned how to communicate their research and ideas more effectively and boost their self-confidence and self-efficacy.
- Research skills. Development of skills to participate in international events.
- Recognition of international mobility as a strategy to further develop their studies.

Regarding the impact on the institution, The students' achievements through international mobility can raise the visibility of the mentoring program within the university. This visibility can lead to increased support, resources, and recognition for the program's efforts to promote gender equity.

This international mobility experience contributes to reducing the gender gap in STEM by demonstrating that women can excel in STEM fields regardless of their background. Their success stories can motivate young women to enter and persevere in STEM fields.

The main limitations of this type of intervention are limited impact due to financial constraints, sustainability if the resources are not consistently available, and lack of male engagement, as men may be excluded to participate in gender-sensitive programs, perpetuating the idea that gender equality is a women's issue. The second phase of the project will be developed in 2023. A group of 11 students from UTB will visit USAL to participate in activities to promote research skills. They will attend a conference and present a paper describing the mentoring program's experiences.

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