Chapter 6
Promoting the Participation of Women in STEM: A Methodological View

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Abstract The low participation of women in engineering fields is a common problem worldwide. As a result, universities are starting to create plans to attract more female students. However, there are no documented methodologies to guide institutions in this process. Hence, this chapter describes a method to attract more women to STEM programs, using one Latin American university as a case study. The procedure starts by establishing a baseline of the student population, using specific metrics to determine possible biases in admissions or graduations. The results show a small number of registered female students; thus, the method suggests different strategies to improve this situation. The next step is proposing activities to empower young girls to study engineering, describing indicators developed to evaluate the effectiveness of the activities. The case study includes participation from elementary, middle, and high school students. Results show that girls and boys participated in the proposed activities, and they maintained or improved their motivation to study a STEM program.

Keywords Gender · Equity · STEM · HIE · Methods · Institutional practices · Empowering

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6.1 Introduction

The low participation of women in STEM careers has been a problem for several decades. Reports illustrate this situation since the 1960s (Rossi, 1965; Goldman & Hewitt, 1976; Crowley 1977; Rossiter, 1993). Consequently, between 1966 and 1978, at least 300 projects were designed in the United States to increase the participation and status of women in science, engineering, and mathematics (Aldrich & Hall, 1980).

Furthermore, in recent years, the attention devoted to this situation has increased due to the relevance of science and technology in daily life and the search for solutions to contemporary problems. An example of this relevance is the increase in jobs in the STEM area compared to non-STEM areas, where growth is much higher in positions related to Computer Science (Zilberman & Ice, 2021). Additionally, STEM salaries are higher than other non-STEM careers (Funk & Parker, 2018).

STEM disciplines play a significant role in creating strategies, policies, and actions to achieve sustainable development. Thus, STEM education is vital at all levels, especially in primary and secondary education, to develop the capacities that future generations require to solve the complex problems they will face (Pahnke et al., 2019). However, despite this panorama, professionals in STEM careers are very scarce in some specialties such as Computer Science, Engineering, and Mathematics (NSF 2020).

Some studies try to determine the reasons for this phenomenon at secondary and tertiary education and entering the workforce (Cantillo & García, 2014). Other studies, rather than determining the causes of this situation, focus on developing strategies, projects, and actions to reverse it at the same levels (Charlesworth & Banaji, 2019; General Directorate of Communication Networks, Content & Technology of the European Commission, 2013).

Concerning the causes of this problem, (Charlesworth & Banaji, 2019) provides evidence on how gender differences in STEM careers have been explained based on individual characteristics, and specific differences in aptitude in mathematical competencies (Geary, 1996; Halpern, 1989). On the other hand, some authors argue that the historical gender divergences in average mathematical aptitude can be explained more by social barriers, especially considering the activation of gender stereotypes (Else-Quest et al., 2010; Gray et al., 2019; Hyde & Mertz, 2009; Penner & Paret, 2008). However, evidence from recent years indicates that the gender gap in performance in mathematics has been narrowing to reach tiny statistical differences (Feingold, 1988; Hyde, 2014, 2016; Lindberg et al., 2010; Zell et al., 2015). Thus, it is not a question of biological differences, but beliefs regarding mathematics, what influences performance in mathematical competencies (Hyde, 2016; Ceci et al., 2014). Women face barriers related to societal beliefs and expectations for women, especially in male-dominated STEM disciplines such as engineering, computer science, or the physical sciences (Swafford & Anderson, 2020).

On the contrary, there is increasing consensus that the factors related to the low participation of women in STEM careers are due to psychosocial and cultural factors such as gender roles, values, and lifestyle preferences (Ceci et al., 2014). These factors, in turn, are shaped by the sociocultural context in which people live and study. From early childhood, people receive social pressures about what roles are appropriate. For example, parents expect boys to be competitive, while girls prefer community and helping activities (Diekman et al., 2010; Eagly, 1987; Ferriman et al., 2009; Su et al., 2009; Weisgram et al., 2011). On the other hand, STEM careers seem like highly competitive and individualistic environments that value status and power. These particularities make women avoid these fields because they are contrary to female values (Diekman et al., 2011, 2015).

Sociocultural characteristics greatly influence all levels of society, specifically female high school students who want to start a STEM career. The underrepresentation of women in decision-making and STEM-related patents creates a bleak picture. It is common to see women in STEM fields in inferior positions, lower salaries, or earning the same wage as men but twice the responsibilities. These situations prevent improving the quality of employment for females in STEM areas (General Directorate of Communication Networks, Content & Technology of the European Commission, 2013; ECLAC, 2014). In other words, the imaginaries about women's performance in science, engineering, and mathematics make it difficult for women to start jobs in these fields (World Economic Forum, 2016).

Consequently, different studies proposed various models of inclusion and social representation of women in STEM fields to avoid prejudice or barriers (Aldrich & Hall, 1980; General Directorate of Communication Networks, Content & Technology of the European Commission, 2013). The initiatives start from preschool (Harris, 2020), primary (Milgram, 2011), secondary (Kang et al., 2019; Mosatche et al., 2013; Prieto-Rodriguez et al., 2020), and tertiary education at undergraduate (Cantillo & García, 2014; Smith et al., 2018) and graduate levels (Bekki et al., 2013). Other initiatives addressed the problem from the perspective of the organizational culture of higher education institutions (HEI) (Furst-Holloway & Miner, 2019) or as part of inclusion in the workforce (ASCE, 2021; Matthews nd). Other studies point to strategies, policies, or programs at the state level (Foundation, 2008) or directed to protecting the rights of underrepresented minorities in STEM careers (Syed & Chemers, 2011) such as the Afro-Latino population (1977; Morton & Parsons, 2018) indigenous (Stevens et al., 2016) or LGBTQI+ (Farrell et al., 2018; Yang et al., 2021), among others.

The recommendations for developing similar initiatives are diverse. For example, several experts emphasize the importance of collaboration between STEM programs at HEI and schools (González-Pérez et al., 2020; Milgram, 2011; Quigley et al., 2017). Additionally, some authors point to the importance of making role models visible (Herrmann et al., 2016; Math et al., 2012; Olsson & Martiny, 2018) to minimize the disagreement between the roles in STEM professions and sociocultural assumed appropriate roles for women.

Additionally, some ideas from the guidelines of General Directorate of Communication Networks, Content and Technology of the European Commission (2013) include using attractive STEM topics for young people and women in particular. These topics should be exciting, diverse, challenging, full of opportunities, and profitable. More ideas involve creating role models through the visibility of influential women in the sector, promoting a diversity approach and using inclusive terms, involving more men in the solution of this issue, and prioritizing STEM activities as not exclusive to one gender to avoid the bias.

The literature shows very different initiatives; however, there is no clarity in the methodological approach applied in these strategies. Thus, it is difficult to replicate them, creating limitations to solve the problem. Therefore, this chapter aims to describe the methodological approach developed during the execution of the project "Building the future of Latin America: engaging women into STEM (W-STEM), from here on called Project W-STEM. The project is funded by the European Union, under the ERASMUS + call: "Capacity Building in Higher Education Call for proposals EAC / A05 / 2017". The project aims to promote the participation of women in STEM careers. Section 6.2 shows a brief context of the W-STEM project. Then, the chapter illustrates the methodological approach in Sect. 6.3. Section 6.4 describes the execution of each stage in the Universidad del Norte. Section 6.5 shows the main lessons learned and the elements contributing to the project's sustainability. Finally, Sect. 6.6 concludes the chapter.

6.2 Brief Description of the W-STEM Project

The problem described in the previous section is a challenge to HEI in Latin America (LA). Thus, the situation leads to implementing a cooperation strategy among institutions in different regions. The goal of the ERASMUS+ call is to promote the development of capacities in HEI through transnational cooperation projects led by university networks. These projects strive to strengthen HEI's management, innovation, and internationalization capabilities. The primary strategy uses the funding priority "Equity, access and democratization of higher education" (García-Holgado et al., 2020).

The W-STEM project built a consortium of five European (Spain, Finland, Ireland, Italy, United Kingdom) and 10 LA universities (two for each country: Chile, Colombia, Costa Rica, Ecuador, Mexico). The University of Salamanca in Spain coordinates the project and interfaces between the EU Commission and the consortium. The project established the Universidad del Norte (Uninorte) in Colombia as support coordinator to facilitate management and communication between the LA partners. There is a steering committee with one representative for each partner, in which the project coordinator acts as a non-voting secretary.

The project includes different Work Packages (WP), and each one has a university leader and a co-leader. They assign tasks to the partners who participate in each WP and organize technical discussions, documents, and deliverables. The project also includes Columbus, an association for cooperation between universities in Europe and LA, as an external evaluator to guarantee the quality and success of the project.

The project has partners that receive no funding and play an essential role. One of these partners is UNESCO that supports national and international dissemination. Additionally, the participant LA universities have partners in high schools that support the campaigns for attracting and recruiting women to STEM careers.

The project established communication methods and instruments presented in periodic management meetings. The meetings allow for verifying the implementation of the action plans, preparing the respective minutes, and sending them to the entire consortium.

6.3 Methodological Approach

The methodological approach proposed in this section uses the conceptualization of the WP as a systematic process. Figure 6.1 shows that inputs and outputs aim to achieve the project's main objective. The figure illustrates four significant stages: definition of the baseline, information analysis, planning, and development. The results of each step constitute products that serve as input for the subsequent stage and allow for feedback and improvement of the process. The products related to the final stage define the project's results, including the analysis of indicators, lessons learned, and the sustainability of the actions. The following is a description of the methodological stages of the project.

6.3.1 Baseline

This stage determines the status of the member institutions regarding women's participation in STEM programs. The stage employs a quantitative self-assessment procedure and maps the critical processes of this study: attraction, access, advising, and retention. Furthermore, each university determines the starting point and defines strengths and weaknesses based on this diagnosis. Thus, universities define the opportunities for change that will lead to developing action plans to increase the participation of women in STEM careers.

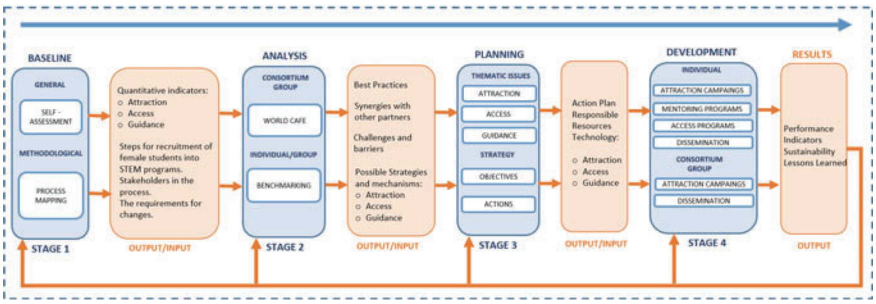

Fig. 6.1 Methodological approach

6.3.1.1 Self-Assessment

In this activity, each institution must collect all the quantitative information relevant to the processes under study to obtain data showing a gender gap. Therefore, the project designed an evaluation questionnaire (W-STEM Consortium, 2019a), based on a subset of the indicator matrix of the SAGA working document developed by Ernesto et al. (2018). The application of this questionnaire should result in the self-assessment matrix for each institution to help define the baseline indicators for each university and the consortium.

6.3.1.2 Mapping Process

This activity, which can develop in parallel with the self-assessment, aims at mapping the internal processes of attraction, access, advising, and retention of students in STEM programs. This mapping will help the institution determine all the steps involved in recruiting female students into STEM programs, the main stakeholders in the process, and the requirements for introducing changes.

For this purpose, the project designed a spreadsheet template (W-STEM Consortium, 2019b). Each institution must record the information associated with every process under study, defining the associated sub-processes, the activity description, and the responsible offices.

6.3.2 Analysis

After each institution determines the current state of women's participation in STEM programs, the institution analyzes the information collected to identify the gap, which actors are involved, and how to close it. This analysis considers two different scenarios. First, within each institution to identify strengths and opportunities for improvement. Second, to establish the barriers and challenges to the project as a group. Here it is essential to define, through a shared exercise, the guides to establish lines of action to achieve the objectives set by the consortium. This stage consists of two main activities.

6.3.2.1 Benchmarking

The objective of benchmarking is to identify the policies, procedures, and mechanisms considered good practices in attraction, access, and advising for women in undergraduate STEM programs so that other institutions can replicate them.

The project followed the methodology designed by Columbus for benchmarking clubs. Thus, the project created a questionnaire (W-STEM Consortium, 2019c) with four sections: description of the good practice, institutional strategies and policies, implementation and sustainability, and future improvements. After identifying the good practices, the institutions will socialize them in a group session.

The project has three Benchmarking sessions. The first one will be during the project's first year to socialize the good practices identified in the baseline stage. Additionally, this session will guide the elaboration of the action plan of the institutions. The other two benchmarking sessions will take place in the second and third years of the project.

6.3.2.2 World Café

This activity aims to identify policies, strategies, mechanisms, and actions to increase the participation of women in STEM programs. The World Café includes a collaborative dialogue and a group reflection with all consortium members. The institutions first share their experiences, then evaluate the main challenges faced in the processes of attraction, access, retention, and advising. Moreover, they define the ecosystem of strategies, mechanisms, and actions that aim to close the gender gap in STEM careers.

6.3.3 Planning

At this stage, each university defines the action plan to increase the participation of women in STEM programs. The institutions should explain actions to improve the processes of attraction, access, retention, and advising. Moreover, it is essential to ensure that these actions become policies to guarantee the sustainability of the objectives, even after the project ends. The action plans will adjust to the context of each participating institution, which will determine the mechanisms and how they will measure their achievements. For this purpose, the project designed a format to write the action plan for each consortium member.

6.3.4 Development

This stage executes all the mechanisms and actions defined in the planning stage. Baseline, Analysis and Planning occur in the project's first year. Thus, during the following two years, the institutions must develop the activities in the action plan, aiming to improve the processes of attraction, access, retention, and advising. Hence, specific actions as a consortium point to the design of attraction campaigns, mentoring programs, and other efforts to facilitate women's access to STEM careers. In addition, the project includes actions to disseminate the activities and the achievements obtained.

6.4 Engaging Women into STEM: The Case of Uninorte

The proposed methodology sets out a systematic process with guidelines, instruments, tools, and procedures whose application guarantees the achievement of objectives. Each institution seeks mechanisms and resources according to its context to implement the stages based on the proposed structure. This section presents a case study of how Uninorte approaches the execution and implementation of the W-STEM project from the previously described methodological approach.

6.4.1 Baseline

The definition of the current situation proposes implementing two activities that can execute simultaneously. The research group at Uninorte decided to perform them sequentially, starting with the self-assessment. After achieving significant progress, the group developed the process mapping. The main reason for this setup was that the first activity required more preparation and a more exhaustive review. The execution of these activities is explained below, showing the obtained results.

6.4.1.1 Self-Assessment

The first step in developing the self-assessment was defining the STEM programs participating in the study. In general terms, STEM programs stand between categories 5 and 7 of the "ISCED Classification" (Instituto de Estadística de la UNESCO, 2013). Therefore, Table 6.1 defines the undergraduate programs offered by the Uninorte with their respective ISCED code, name, and institution code.

The next step is to collect the information to fill out the self-assessment matrix proposed by the project consortium. The matrix has 26 sections to obtain quantitative indicators to measure the gender gap in the STEM programs for 2018 and 2019.

When analyzing the strategies for constructing the matrix, the first difficulty was that information was scattered in various university departments. Hence, the research group analyzed the different sections and questions of the matrix to identify 11 major categories of questions associated with almost 20 departments that could provide the required data. Then, the group requested the information from the graph of relationships related to the required information (see Table 6.2). At that time, another difficulty emerged because there were historical records of the information requested in most cases, but sometimes this information was not disaggregated for each program. Therefore, the group reprocessed the data, requiring more time and resources to complete the self-evaluation matrix. Some of the most relevant results of this activity are:

Table 6.1 Definition of STEM programs-Uninorte

Name ISCED	Code ISCED	Name Uninorte	Code Uninorte
Earth sciences	0532	Geology	GEO
Mathematics	0541	Mathematics	MAT
Electricity and Energy Engineering	0713	Electrical Engineering	IEL
Electronics and Automation Engineering	0714	Electronic engineering	IEN
Motor vehicles, ships, and aircraft Engineering	0716	Mechanical engineering	IME
Architecture and town planning	0731	Architecture and urban planning	ARQ
Building and civil engineering	0732	Civil and environmental engineering	ICI
–	–	Industrial Engineering	IIN
–	–	Systems Engineering	IST

Table 6.2 Relationships associated with the required information

Required information	Office	Required information	Office
Students and Alumni	Planning Office Alumni Office Academic programs	Mobility	OCI Academic programs Register Office
Attraction, access, and enrollment	Planning Office Admission Office Student Financing Office	Faculty	Faculty development Human resources Planning Office
Orientation, retention, and dropout	CREE Academic programs University wellness Register Office Planning Office	Student Financing	Student Financing Office Academic programs
Scholarships and financial aid	Student Financing Office Alliances and Corporate Relations	Awards and Recognition	Academic programs Register Office University wellness
Discrimination and sexual harassment	Human resources		

34.2% of the STEM population are women. IEL, IME, IST, and MAT programs have a women population smaller than 20%. The IEN program has female participation below 30%. STEM programs have a higher rate of male enrollees and admissions; thus, the situation is similar in the enrollment phase in seven of the nine STEM programs. Additionally, in six of the nine programs, the absorption rate (the ratio between enrolled and registered) is higher for men than for women. Nonetheless, the conditional probability of enrollment in a STEM program at Uninorte in 2018 does not depend upon gender. Therefore, the strategies to be implemented should be aimed mainly at the attraction mechanisms to raise the admission numbers to such programs.

Moreover, the process of access to an HEI in Colombia depends on external factors such as economic resources, obtaining scholarships, and admission to other Universities. Furthermore, the number of female professors teaching first-year STEM students is 26.7% of the teaching population at the university, which shows the lack of role models or references for girls in their first academic semester.

The achievements of this activity were first to establish the initial indicators that define the gender gap in STEM programs at Uninorte. Second, it created the need to conduct similar studies at least every two years to monitor the gap. Currently, the group is repeating this first step to obtaining the leading performance indicators for 2020 and 2021. Finally, although the university has a robust department that oversees the data and relevant information, the managers of these processes suggest handling centralized gender statistics allowing them to perform the data analysis more naturally and fluidly.

6.4.1.2 Mapping Process

The next activity at Uninorte was to map the processes associated with attraction, access, recruitment, retention, and advising developed within the institution. To this end, the research group designed a template to identify the sub-processes, activities, and responsible personnel. This process was simple because all the information resides in an easily accessible repository. Additionally, a flow chart documents the process and indicates every detail of the activities within each sub-process.

The process also identifies the stakeholders and their relationships. The responsibilities belong to a few departments such as Admissions, Marketing, The Office of the Registrar, Student Financing Office, academic programs, CREE (Spanish acronym for Center of Resources for Academic Success), and Student Affairs.

The research group identified robust processes for attraction, access and recruiting, and retention and advising. The institution has activities to strengthen the attraction processes, but there are no different activities for males and females.

The attraction processes encompass several mechanisms directed toward large high school populations, presenting all undergraduate programs differently. Nonetheless, the tools do not show elements to foster more extensive participation of women in STEM programs.

Even with all efforts in access and recruitment, the main obstacle to entering a STEM program is the cost of tuition. Thus, the group identified policies for obtaining scholarships and financial aid but did not find specific actions to increase women's participation.

The group also identified vital processes for retention and advising, but only related to obtaining good academic performance, regardless of gender. Additionally, the university provides workshops and other activities to foster professional skills in students. However, these activities do not consider the students' programs or their main gender problems.

The mapping process allowed the team to know the processes under study in detail. The section also defines the strengths and opportunities for improvement to create courses of action. Additionally, by reaching out to the people responsible for these processes, the team obtained support to develop activities related to the project. Thus, the team expects to achieve future sustainability to get longer impacts.

6.4.2 Analysis

This stage includes analyzing all information to define the actions for the following stages of the project. Therefore, each institution must analyze and socialize the results in the second consortium meeting. This meeting occurred before the end of the project's first year at the W-STEM International Leadership Summit. The stage was crucial to identifying the strengths and learning how to face the challenges. The following sub-sections describe the associated steps.

6.4.2.1 Benchmarking

Benchmarking includes identifying the good practices that can inspire other institutions. For this activity, the Uninorte team had previous experience as leader and moderator of U-Benchmarking Club: Improving the participation of women in STEM programs, organized by Columbus. The team already knew the methodology; thus, it could lead the first benchmarking round for the consortium.

Consequently, the team developed a form based upon the methodology created by Columbus. The document has four sections: description of the good practice, institutional strategies and policies, implementation and sustainability, and future improvements. The first section describes the type of practice and the expected goals. The second section shows if the practice results from an institutional policy or strategy; in this case, how the practice contributes to achieving the goals and what resources are available. The third section determines how to measure the success of the practice and the obtained results regarding learning and improvement. Finally, the last section describes how the institution visualizes the practice in the future and the actions planned to solve possible obstacles.

This document was socialized and sent to all the consortium universities; thus, they provided all information. The first round of the project benchmarking included presenting all this information at the W-STEM International Leadership Summit. A total of nine universities (seven LA and two European) presented their good practices during this session. Furthermore, another three (all European) presented them during the event aimed at university leaders. Finally, three universities (all in LA) expressed that they did not have good practices in these areas.

The good practice presented by the Uninorte team was the W-STEM Uninorte Student Group, a student community devised at the beginning of the project and founded in the summer of 2019 as a mechanism of attraction and retention of young women in STEM fields. The main objectives of this group are: creating a broadcast channel for the W-STEM project, attracting young women to STEM careers, providing pertinent information about STEM programs to young women in high schools, and raising awareness in the community about the importance of gender equity in STEM fields. Additionally, the student group develops the following activities: high-school attraction campaigns; robotics, programming, and data analysis hotbeds for college and high school students; conferences with local/national/international role models; tutoring programs for college and school students with former students and teachers; and activities where college students share their experiences as STEM students with high school girls.

As a result of this Benchmarking, the research group concluded that there is no statistical difference between LA and European universities regarding the participation of women in STEM programs. However, European Universities have a long way to go in studies and progress. Additionally, these countries have governmental and institutional policies that support these initiatives and actions. On the other hand, LA universities socialized robust initiatives that, in most cases, were isolated acts not supported by any institutional or governmental policy. Furthermore, this activity displayed good practices to replicate in different contexts.

The project conducted a second round of benchmarking in the second year. For this session, the Uninorte team presented the activities developed during the second year to promote the attraction of more women to STEM careers. The development stage will explain these activities in detail. Moreover, the consortium plans to do a final round to socialize good practices at the end of the project.

6.4.2.2 World Café

The second activity at the W-STEM International Leadership Summit was the "World Café", a group analysis that uses a brainstorming exercise to establish strategies and actions that the consortium institutions can develop to achieve the objectives from the Erasmus + W-STEM project. This activity follows a methodology based on sharing knowledge to establish possibilities for creative actions through a collaborative dialogue. Therefore, for guiding the conversation, the team prepared four tables with the following subjects:

1. Public policies and institutional initiatives to promote the participation of women in STEM fields.
2. Institutional policies and strategies to promote the participation of women in STEM fields.
3. Strategies and mechanisms for ATTRACTION and ACCESS of young women to STEM careers.

4. Strategies and mechanisms for GUIDANCE, RETENTION, AND PROMOTION of scientific careers for women.

The detailed description of the methodology used in the World Café and the main results are described in García Peñalvo et al. (2019). The Uninorte team reflected on and appropriated the results of this activity to plan the activities. Some of these are:

- The importance of
  - Developing long-term policies and plans requires creating mechanisms to include gender and STEM components in institutional policies.
  - Measuring the impact of the activities, analyzed, and executed with a gender perspective.
  - Raising awareness of the issue. Teach and prepare future leaders to be aware of the importance of having greater participation of women in STEM programs.
  - Reaching different stakeholders through social networks.
- Technological platforms can also help transform policies into actions, especially during the pandemic.
- Economic factors strongly impact women's access to STEM careers. Therefore, more targeted awards, scholarships, and long-term policies are needed.
- Teachers and families play a crucial role. They should be included in activities to promote women in STEM, to eliminate stereotypes and the perception that STEM fields are male-dominated.
- Creation of Groups/Communities and support groups for women in STEM, so members participate in seminars, talks, and gender awareness meetings.

6.4.3 Strategic Planning Process

For developing action plans aimed at the attraction, access, retention, and orientation processes, Uninorte included individual and collective information analysis. The analysis encompassed all WPs such as the Self-Assessment on Gender Equality in STEM, the Process Mapping of Attraction, Access and Guidance, the Application of Self-Assessment Tools, the Analysis report, and the Benchmarking rounds on strategies and mechanisms.

For planning, the team employed the methodology established by the project to formulate the plan, including creating improvement objectives and the actions for achieving them. The first step was to analyze the current state of the three processes in the institution and discuss macro strategies that served as inspiration for the formulation of the objectives. The second step was defining actions to achieve the goals, displaying them in a matrix that mapped the activities to the purposes. Finally, the team assigned the people responsible for each step.

The research group formulated the action plan to achieve the following goals focused on STEM programs.

Attraction: To increase the number of female students, the team established the following actions.

- Develop awareness days with directors of partner schools about the problem of participation of women in STEM careers to obtain a commitment to support the campaigns to be carried out within their institutions.
- Develop a training session with vocational counselors and science and technology teachers from partner schools to show STEM careers and their importance in the development of society.
- Design and implement campaigns aimed at senior students at the partner schools, particularly women, to recognize STEM programs as options for university study and professional life.
- Access: To create mechanisms for assuring recruitment, the actions were:
- Hold meetings with administrative offices (admissions, graduates, fundraising, among others) to discuss, reflect, and propose strategies to facilitate and support women's access.
- Analyze the structure required (financial and operational) to propose a scholarship in STEM undergraduate programs aimed at candidates who need funding.

Retention and Guiding: to establish mechanisms for monitoring and to advise students from the first year, including:

- Develop a focus group with students of the primary cycle to know the main academic barriers for their student success.
- Design and implement an activity to support students' success in their basic cycle.

6.4.4 Development

6.4.4.1 Attraction and Recruitment Campaigns

According to the methodological approach, the next stage consisted of developing the attraction campaigns following two principles according to the literature: Joint university-school work and visualization of female STEM role models.

The target population of the attraction campaigns was senior secondary education students in the region, so they know the women who work in STEM and their contributions to the industry, academia, and civil society (García-Ramos et al., 2021). Additionally, the campaigns provided information on the different possibilities for women when choosing a STEM career and the skills and abilities required. Although the attraction campaigns were designed for girls, due to the COVID pandemic, the participation was open to all students. The main campaign subjects were W-STEM Cinema, Computer Workshops, and Role Models in STEM.

W-STEM Cinema

The first activity consisted of a cinema forum; a space created to reflect on the role of women in STEM through the film industry. The sessions included:

Hidden Figures: This activity highlighted the qualities and attitudes of the lead characters, which allowed them to succeed despite the double discrimination in the 60 s.

Shakuntala Devi, "The Human–Computer": This work recounts the exciting life of the Indian mathematician and writer who, without any formal education, achieved multiple feats by performing mathematical calculations.

Let's talk about the girls of The Big Bang Theory: The stereotypes about men and women were analyzed, especially the evolution of the central female character who starts as the stereotype of a dumb blonde girl and later becomes an empowered woman and friend of female scientists.

Interstellar: the activity analyzed the protagonism of science and technology and the varied and positive female roles.

Programming Workshops

The research group organized several workshops to motivate students to develop and strengthen their computational skills because they are essential in any work, especially in STEM fields. The workshops were:

Code.org: the activity presented the Code programming learning platform that uses a didactic and playful format to fulfill the educational needs of primary and secondary students.

PSeInt: this workshop introduces this educational tool, very popular in universities in LA and Spain, to learn programming fundamentals in a pseudo interpreter.

Java: this seminar introduced the programming language and its importance in the software industry through didactic and straightforward examples.

Python + Colab: this workshop introduces the Python programming language on the Colaboratory platform.

Role models and empowerment

One good practice was to promote empowerment through role models in STEM to show students a greater diversity of a woman's roles. In addition, this campaign aims to empower STEM women in their different fields of action. The campaign includes the following presentations:

Investigating Biomass energy to mitigate climate change: The presenter was a female researcher with the Biomass Energy with Carbon Capture and Storage (BECCS) line of the Tyndall Centre for Climate Change Research (United Kingdom). She shared the results of her doctoral thesis.

Renewable Energies, management of a photovoltaic solar energy project: a young female engineer presented this webinar, showing her role as manager in constructing a self-generating solar farm.

From girl to engineer: This activity consisted of a series of talks to highlight the work of several award-winning STEM women in their areas. Each woman presented her life stories from childhood to her professional life, showing the skills that allowed her to achieve her goals.

Women in Engineering W-STEM + WIE: Four female engineers presented their perspectives and experience to high-school and university students.

Colombian Women in STEM: This activity invites Colombian women who stand out internationally to share their STEM experiences with the viewers.

STEM and its magical world: the group organized activities exclusively for high-school students as the schools gradually resumed their presence in the classroom. In this case, senior students from STEM programs talked to school students about STEM careers.

Monitoring of activities

To keep track of the attendance at each event, participants had to register before starting each activity, and they answered one question about their interest in studying a STEM program. Then, at the end of some events, the group asked attendees the same question to determine if the activities changed the students' perception. Table 6.3, Figs. 6.1 and 6.2 show the participation achieved in the campaigns and the students' perception before the event.

Table 6.3 Registered and participated students in the attraction campaigns

Campaign	Students register	Students participant	STEM careers interest before Total responses
Cinema W-STEM	85	53	63
Programming workshops	557	303	530
Role models and empowerment	179	116	133
Total	821	472	726

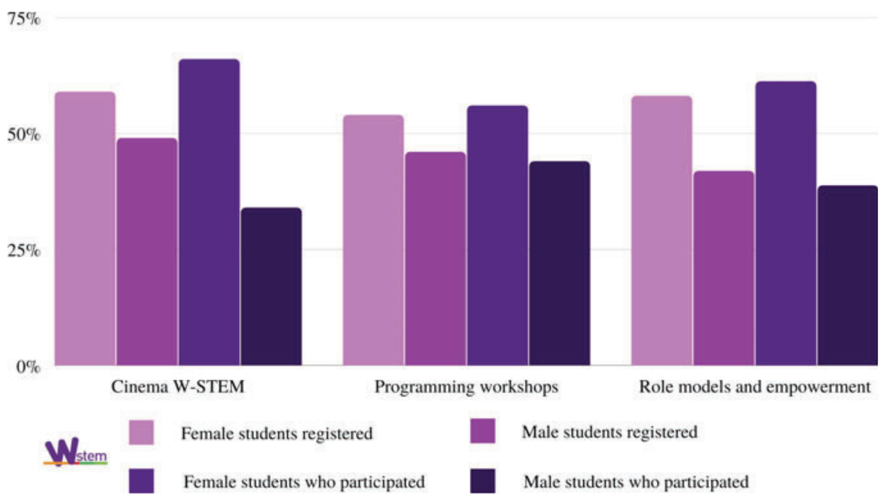

Fig. 6.2 Students registered and participated in the attraction campaigns

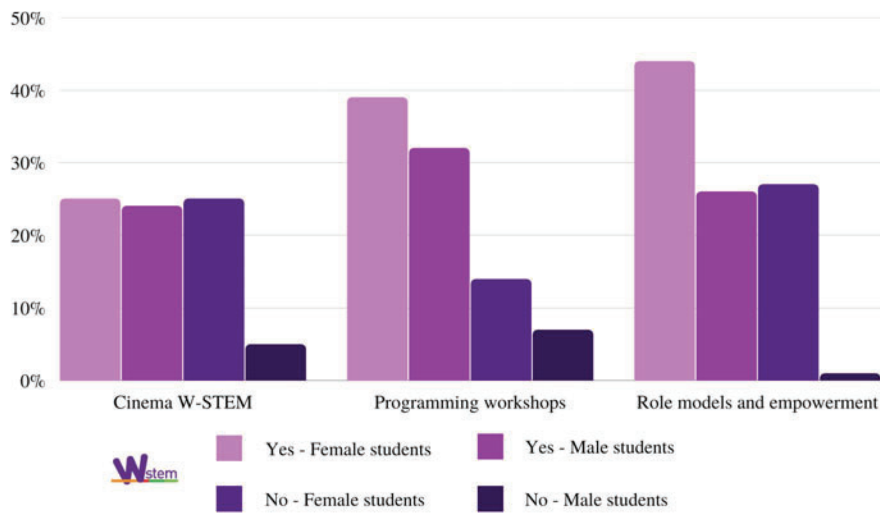

Fig. 6.3 STEM careers interest before the attraction campaigns

Table 6.4 Perception of the students post attraction campaigns

	STEM careers interest after						
	Total	Yes		Not sure		No	
Female	69	41	59,42%	16	23,19%	12	17,39%
Male	16	15	93,75%	1	6,25%	0	0%

Table 6.3 shows that 58% of the participants are women. Additionally, Figs. 6.2 and 6.3 show that 39% of women and 30% of men stated they had considered studying a STEM program. However, 5% of the male attendees said they were not interested in a STEM program, in contrast to women, whose responses reached 17%. This situation may reflect a perception influenced by gender stereotypes in STEM careers, where the possibility of choosing a profession of this type is perceived as more appropriate for men.

Finally, Table 6.4 presents the survey results at the end of some events. Unfortunately, due to logistical issues, the group could not apply it in all the events, nor did all the students respond. Nonetheless, Table 6.5 shows that the percentage of women who showed interest is 59%, while the ratio of men is 94%. The result is encouraging because it offers a surprisingly high rate for female students.

6.4.4.2 MentorADA

The Uninorte team created the MentorADA mentoring program to form a support network for guidance and advice for students of STEM careers. Additionally, the

Table 6.5 Comparison of program students and registered students for MentorADA

Program	Total First semester	Female First semester	MentorADA First-year
IEL	5	2	3
IEN	20	4	5
MAT and Data Science	13	5	3
IME	23	1	6
IST	43	10	5
Total	104	22	22

program aims to support students in their adaptation process to the university to feel represented and comfortable with their choice. The program's name maintains the principle of making visible female role models who have contributed to STEM, particularly as a tribute to the mathematician Ada Lovelace, a visionary of computer programming (Carlucci Aiello, 2016). The MentorADA program is directed to students from the STEM programs with lower participation of women and includes the following stages.

Team building

The first step was to define the target population of the MentorADA program, first-year female students from STEM programs with less female participation: IST, IME, IEL, and IEN. MentorADA also included a recently created STEM program: MAT and Data Science.

The second step was to identify outstanding students, professors, and graduates in the STEM disciplines and send invitations to participate in the mentoring group. Currently, the group has four mentors (professors and alumni) and 14 senior mentors (senior undergraduate students). The MentorADA team includes 21 people counting the W-STEM project staff.

Planification of MentorADA

The MentorADA team devised the structure of the network and the role that each member would play. For this purpose, one mentor per program should provide a global vision and create spaces for learning specific aspects of the program and the short- and medium-term skills required. The mentor should also identify possible misconceptions that may hinder the mentees' performance.

Additionally, the senior mentors will accompany the students to integrate into the university. These are senior students with good academic performance and working with various student groups. The senior mentors would also support the execution of specific activities of the mentors and provide personalized follow-up to the mentees assigned to them.

Fig. 6.4 First semester students from STEM programs

Training

After defining the team structure, functions, and program guidelines, the team set up training workshops for mentors and project staff. Professionals from Student Affairs at Uninorte conducted the workshops developing the most critical topics to allow mentors to perform their work in the best way. The training included four thematic axes: mentoring, emotions, empowerment, and leadership.

Preparation and execution of the action plan

Based on the established guidelines, the training, and their own experience, each mentor developed their work plan, reviewed and approved by the project staff. Next, the staff opened enrollment for first-year students of the identified programs. To disseminate the call for mentees, the team used mass mailings and posts on social media accounts. Furthermore, the team selected the first-semester course of each engineering program and visited the class to inform students about the MentorADA program and its benefits. Table 6.5 and Fig. 6.4 show the data of new students in addition to those who joined the MentorADA program. The table shows that the MentorADA program attracted most first-year female students.

6.4.4.3 Activities to Support Access to STEM Programs

The initiatives that best contribute to the access of young women to STEM careers at Uninorte are:

The creation of the Marvel Moreno scholarship to honor Barranquilla writer and outstanding woman in Colombian literature. The scholarship aims at high school women from the Colombian Caribbean region with exceptional academic performance during their secondary education. The applicants must be interested in studying MAT, ICI, IST, IME, IEL, and IEN, among other programs. The Marvel Moreno scholarship applies to young people of any socioeconomic level, preferably with economic difficulties to access university.

The structuring of a new scholarship, to be called W-STEM. The Uninorte team is currently studying this scholarship. The idea is to expand the opportunities for access exclusively to STEM careers for young people with economic difficulties but with outstanding academic performance in high school and motivation to study these programs.

6.4.4.4 Dissemination

The student group constantly carries out dissemination activities open to the university community and other interested parties. These activities deal with issues of gender equality to construct a more equitable society. Additionally, the activities create spaces for students to develop their soft skills and provide them with content informing them on gender issues.

This semester the group focused on using social networks (especially Instagram) to make more attraction and dissemination campaigns. The main reason was that the group could reach many more students in the region with graphic and audio-visual tools or content. Through the W-STEM Uninorte account, the group shared illustrative posts about pioneer women who have changed the world. The group also addressed related topics and highlighted the importance of diversity and female participation in STEM. This account also shares announcements of scholarships and national and international opportunities in STEM fields.

Additionally, the group recommends books and movies where the lead characters are women in STEM. Furthermore, the group provides tools that can be useful in their path as STEM students in college. Another type of dissemination activity is workshops, ranging from programming and software management to emotional intelligence and leadership.

The group has become a support network for students to share their experiences and learning. In case of needing professional help, the team makes the referral to the relevant entities of the university, such as the team of psychologists of Student Affairs and the academic program coordinator.

6.5 Discussion

6.5.1 Lessons Learned

The first big lesson is to value the importance of data and information as a measure of performance and analysis to detect the gap and identify the mechanisms to close it. This lesson helped establish appropriate indicators to measure the processes from a gender perspective. Thus, the research group took the first steps to start measuring and analyzing data to develop a gender equality policy, starting with STEM programs but reaching all institution levels.

The second lesson learned was that the research group is not alone. The best results are achieved by involving those responsible for the processes under study and showing the benefits of approaching their activities from a gender perspective. Thus, identifying internal strategic partners to support the project's development and to become future managers of the activities allows the sustainability of policies to close the gender gap in STEM programs over time.

Another lesson is the importance of networks or working communities to reflect and share experiences adapted to different contexts.

A further lesson learned is the importance of obtaining the support and commitment of institutional leaders to enable the implementation of more initiatives and obtain the necessary financial aid. One strategy to get this support is raising awareness in the institutional leadership about the problem. Additionally, the leadership must know about the benefits of increasing the population of women in STEM areas to the institution, the city, the region, and the country. Finally, it is also possible to seek strategic business allies for financial support.

A possible bias of the study is related to the profile of the participating students: did they attend the activities because they already had a prior interest? Did the project manager reach students who did not consider STEM careers among their options? Did it change their perception of these disciplines? All these questions should be answered with the evaluation instruments; however, the post-activity response rates were meager; therefore, no generalizations can be made about the results. To deal with this situation, strict planning of the activities should include a time margin to answer the evaluation instruments as part of the activity developed.

6.5.2 Sustainability

The project's sustainability relates to an institutional culture of support and encouragement for the access and permanence of young women in STEM programs. This culture employs policies, strategies, and procedures for attraction, recruitment, admission, advising, and permanence.

Uninorte has formulated strategies and developed initiatives and activities for these processes. The most important of them are:

The attraction, dissemination, and mentoring campaigns motivate young people from schools, Uninorte, and other universities in the region and the country. Every day more and more young people are involved in these campaigns.

Institutional scholarships, such as Marvel Moreno and the future W-STEM scholarship.

Creation and consolidation of the W-STEM student group, which serves as a model for the involvement and commitment of young women in these initiatives.

With similar initiatives and activities incorporated into the daily routine of academic life, the W-STEM project becomes an integral part of the institution's educational offerings, guaranteeing the project's sustainability.

6.5.3 Limitations

One of the main limitations in carrying out the activities in the schools was the reduced response of school principals to the calls. With the abrupt changes in teaching modalities during Covid confinement, some school principals claimed to be overwhelmed with the new demands and therefore declined to participate. Additionally, students also suffered consequences of these abrupt changes, aggravated by the limited connectivity, even within the urban area. This situation defined the activities' schedules; initially, they were planned in the mornings within the school schedule, but student participation was meager. The results could be very different if the project included activities with the teachers who directly contact the students. Undoubtedly, achieving teacher engagement will increase the impact of the project.

Due to the low response rate from school principals, the project staff used other communication channels such as contacts from the most used social networks such as Instagram and networks of friends through Whatsapp. Although these networks were very effective in some cases, there is a possible bias in the participants as they come from a direct or indirect relationship with the project staff. The challenge, in this case, is to make broader calls that include a variety of student profiles.

Another limitation in developing the attraction campaigns and implementing the MentorAda program was not having enough budget. Therefore, these activities were developed with the resources available locally by each university, which in some cases were very limited. To minimize this situation, Uninorte sought strategic partners within the institution to support the program's implementation. Also, the savings obtained by implementing online activities made it possible to reduce the effects of the reduced budget. However, despite having mitigated this limitation, the financial resources play a key role in sustainability.

6.6 Conclusion

One of the most significant achievements of the W-STEM project at the consortium level is the integration achieved between universities in two world regions. Specifically, Europe and LA are dissimilar in some aspects but share, in some countries, situations of inequality in terms of the gender gap in STEM careers. For Uninorte, the methodology developed has allowed the achievement of the goals established in each phase of the project; the main results are the following:

The project promoted reflection about policies, mechanisms, and strategies in attracting, accessing, and advising women in STEM programs. This way, the institution can improve and adapt them to the specific circumstances of the Caribbean region.

Forming the W-STEM student group contributes to disseminating strategies for attracting young people to STEM programs and offers a space for support and counseling to those interested in these fields; this good practice will be replicated in other consortium members.

The team developed activities, tools, and support materials to foster the interest and motivation of high-school girls in STEM careers.

To support the orientation process of women in the first year of higher education in STEM programs, the team formed a group of mentors with female teachers and students in their final year of STEM programs.

The project has obtained comprehensive visibility, interest, and importance within Uninorte and in the Colombian Caribbean Region due to the activities developed for the three processes.

The activities and programs developed (attraction and recruitment campaigns, dissemination, scholarships) and in development (mentoring) and the currently active student group contribute to the project's sustainability once the ERASMUS + program funding ends. Moreover, the Uninorte team expects that the W-STEM project will contribute to reducing the gender gap in STEM careers in the Colombian Caribbean region.

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