

Exploring the Role of Women in STEM Education: The W-STEM Project in Latin America

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ABSTRACT

Significant progress has been made during the last decades to achieve gender equality, but there is still much work to do. In particular, the gender gap is pronounced in the science, technology, engineering, and mathematics (STEM) fields at all levels of education and labour market. In those areas, the women participation remains low, although there are differences from country to country. In the Latin American context, there is a need for carrying out studies to collect quality data about the actual situation of women in STEM. Although some available data show a high proportion of women in Latin American university education, they are a minority in STEM programs. Moreover, this problem is particularly severe in Latin America because of the biases or cultural norms that influence female behaviour. In this context, the W-STEM project seeks to improve strategies and mechanisms for attracting, accessing, and guiding women in Latin America in STEM higher education programs. This work aims to describe the main results to prepare a set of attraction campaigns in secondary schools in the Latin American countries involved in the project (Chile, Colombia, Costa Rica, Ecuador, Mexico). In particular, a self-assessment tool about gender equality in higher education institutions in Latin America, an interview protocol for female role models, and a mobile application to show those role models.

KEYWORDS

STEM, women, gender gap, Latin America, higher education, mobile app, self-assessment, gender equality.

1 Introduction

In today's society, women's equality in all areas is positioned as one of the main objectives of organizations and governments. Organizations such as the United Nations (UN) or UNESCO (United Nations Educational, Scientific and Cultural Organization) work on initiatives focused on promoting gender equality and the empowerment of women. The UN through its new campaign "Generation Equality: Realizing women's rights for an equal future" focuses on fundamental rights such as participation in decision-making, equal distribution of tasks or access to health services [1]. On the other hand, UNESCO through the SAGA project (STEM and Gender Advancement) developed from 2015 to 2018 has focused on offering governments and policymakers a variety of tools to help reduce the current global gender gap in science, technology and engineering fields existing at all levels of education and research [2].

Although significant progress has been made in recent years, the situation varies from country to country, and differences can

also be found between different sectors of society. In particular, in the professions associated with the areas of science, technology, engineering, and mathematics (STEM), the participation of women remains low [3, 4].

According to the report prepared by the World Economic Forum on the future of employment, around 26% of jobs in the technology sector are carried out by women [5]. In the scientific field, this figure increases to 28.8% worldwide according to the data provided by the UNESCO Institute for Statistics [6].

This gender gap is visible from an early age and is evident in the numbers of women attending STEM university studies. The Trends in International Mathematics and Science Study [7] clearly shows that men take advanced classes in STEM areas and demonstrate a gender pattern in higher education. The study in 110 countries shows that only 30% of women choose STEM careers.

In this context, Latin America has a great need for analytical and systematic studies capable of obtaining quality data that allows the generation of comparable statistics and indicators which show the actual situation of women, as well as their progress. Although some available data show a high proportion of women in university education, it is essential to notice that this distribution is uneven. Women are a vast majority in certain areas (social sciences, health sciences, economics, and administration), but are a minority in STEM areas. The participation rates of women in science and engineering studies are substantially and consistently lower than those of men. In Brazil, female representation at the level of tertiary education in biology, medicine, and life sciences was close to 70% in 2009, while in computer science, it was only 21% [8].

Even within STEM careers, the figures are not homogeneous. For example, in Industrial Engineering there is high participation of women, while in Computer Science it is low. Within the region there are also differences, some countries have a high proportion of women in science (Argentina, 52%, Bolivia, 62%); while in others such as Colombia, Ecuador or Chile, this proportion ranges around 30%. In Mexico, 47% of science graduates are women. However, by excluding some traditionally female areas, radical changes can be observed; as well as in lower socioeconomic populations. The situation is especially critical in Latin America in the technology industry. Women only represent between 10% and 20% of the total labor market and are mainly concentrated in occupations that are not linked to technology production and senior management [5].

Although the problem of the gender gap remains in force worldwide, especially in STEM professions, which have a high mathematical component, in Latin America this problem is particularly severe because of the biases or cultural norms that influence female behavior [9]. For example, the PISA tests conducted in 2012 in eight Latin American countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru and Uruguay) show a more significant gender gap in mathematics in favor of men, since in all participating countries men perform better than women [10, 11]. Attitude factors also show a grim picture worldwide: under similar conditions, men consistently outperform women in the PISA index of self-efficacy in mathematics. As for the science test, the difference was much milder in favor of men, with the exceptional case of Colombia with the most significant gap and with the cases of Argentina, Brazil, Peru, and Uruguay, where there are no statistically significant differences according to gender [12].

PISA shows that women generally have higher expectations for the profession they intend to follow, but on average, less than 5% of women in OECD countries intend to continue a career in engineering or computer science [4]. There is also evidence of cases in which women face a hostile environment in universities [13]. Therefore, it is not surprising that, in these countries, only a small proportion of women enter and graduate in careers such as engineering and computer science.

On the other hand, there is a lower representation of women in the academic field, especially those belonging to minorities are practically non-existent in the academic perspective of certain countries [14]. Not only are they underrepresented in STEM faculties, but also their job satisfaction is lower. Under this perspective, it is not surprising that the gender of teachers has a significant impact on the performance of science and math students.

Within this framework, the W-STEM project [15] funded by the European Union through the Erasmus+ program arises in order to develop concrete actions to modernize the government, management and operation of higher education institutions in Latin America to improve women's access to STEM programs. This paper aims to describe the main actions carried out within the framework of the W-STEM project, and the first results focused on making women visible in STEM areas, with special emphasis on Latin American profiles.

2 The project

The European W-STEM project (Table 1) is an initiative coordinated by the University of Salamanca through the GRIAL Research Group [16]. The call in which the project is funded aims to develop capacities in Higher Education through international cooperation projects managed by a consortium formed by European countries and associated countries belonging to different regions of the world. This type of project seeks to establish synergies between Europe and other regions of the world, as well as to support the participating countries in addressing the challenges in the management and governance of their institutions of higher education. In particular, W-STEM is a structural project that seeks a systemic impact in the Latin American region through the promotion of reforms in higher education systems, modernizing policies, governance, and strengthening relations between higher education systems and the economic and social environment. In addition, each of the regions that can participate in the call has associated a set of priorities eligible for funding. In the case of W-STEM, it focuses on the "Equity, access and democratization of Higher Education" priority, as it will contribute to increasing opportunities for women to enroll in STEM programs offered by Higher Education institutions.

Table 1. W-STEM project details

Title	Building the future of Latin America: engaging women into STEM
Acronym	W-STEM
Funding entity	European Union
Call	ERASMUS + Capacity-building in Higher Education Call for proposals EAC/A05/2017
Reference	598923-EPP-1-2018-1-EN-EPPKA2-CBHE-JP
Principal investigator	García Peñalvo, Francisco José
Coordinator	P1. University of Salamanca - USAL (Spain)
Partners	P2 Universidad del Norte - UNINORTE (Colombia) P3 Oulu University - OULU (Finland) P4 Politecnico di Torino - POLITO (Italy) P5 Technological University Dublin - TUD (Ireland) P6 Nothern Regional College - NRC (United Kingdom) P7 Tecnológico de Monterrey - ITESM (Mexico) P8 University of Guadalajara - UG (Mexico) P9. Federico Santa María Technical University - UTSM (Chile) P10 Pontifical Catholic University of Valparaíso - PUCV (Chile) P11 Technological University of Bolívar - UTB (Colombia) P12. Costa Rica Institute of Technology - ITCR (Costa Rica) P13 University of Costa Rica - UCR (Costa Rica) P14. Private Technical University of Loja UTPL (Ecuador) P15 Technical University of the North - UTN (Ecuador)
Budget	862.268 €
Dates	3 years. 01/15/2019 - 01/14/2022
Web	https://wstemproject.eu

2.1 Consortium

Due to the characteristics of the call, the consortium is composed of partners from European countries (Spain, Finland, Ireland, Italy, United Kingdom) and two partners for each of the Latin American countries involved in the project (Chile, Colombia, Costa Rica, Ecuador, Mexico) (Figure 1). Likewise, although for legal purposes the coordinator is the University of Salamanca, another coordinator has been established among Latin American partners in order to facilitate communication, with this task falling to the Universidad del Norte (Barranquilla, Colombia). Besides, the project has the collaboration of Columbus, an association whose mission is to be a space for European-Latin American university collaboration for economic growth, social innovation and human development. Within the framework of W-STEM, Columbus acts as an external evaluator of the project to ensure the quality and correct achievement of the project.

On the other hand, the consortium is completed with a set of associated partners that do not receive funding for participating in

the project but play a fundamental role in the network. First, UNESCO as vital support in the dissemination tasks at national and international level. Also, some of the Latin American countries have included the secondary and pre-university education centers where they will carry out the women's attraction and recruitment campaigns towards STEM studies, specifically, 11 centers in Colombia, 26 centers in Mexico, 49 centers in Chile and 18 in Ecuador.

Figure 1: Countries involved in the project

2.2 Objectives

The W-STEM project aims to improve strategies and mechanisms for attracting, accessing and guiding women in Latin America in STEM higher education programs. The following actions are proposed to achieve this objective:

1. Measure the gender equality in enrolment and retention rates in STEM programs - Natural sciences and mathematics; Information and communication technology and Engineering, manufacturing and construction- at undergraduate levels.
2. Implement Universities' policies, strategies and organizational mechanisms for improving attraction, access and guidance at undergraduate levels in STEM programs.
3. Promote STEM studies vocation and choice in girls and young women in secondary schools as well as guidance in the first year of the STEM programs.
4. Develop an online training package for Higher Education Institutions to implement effective strategies to enhance attraction, access and guidance of Women in STEM programs.

The work has been organized into five work packages that combine the top-down and bottom-up approaches to achieve these objectives. Each work package is the responsibility of two partners in order to ensure proper distribution of roles so that coordination will always fall on a European and a Latin American partner. This allows to promote collaboration between both regions and have a broader point of view when implementing tasks.

Figure 2 shows the distribution of work packages and the acronyms of the coordinating institutions. It should be noted that the work package focused on development has been divided into several work packages in order to facilitate its management and correct implementation because this package conglomerates the bulk of the project activities aimed at achieving the actions described previously.

3 Results

The main results obtained to date are focused on actions 1 and 3. First, a first version of the survey has been prepared to carry out the self-assessment of each of the institutions involved in the project concerning gender equality in STEM programs.

Secondly, the work has begun on the promotion of the STEM vocation in girls and young women in secondary schools. The tasks associated with this objective were scheduled for the beginning of the second year of the project, but the partners decided to take advantage of various opportunities for external collaboration to initiate some of the activities related to this action. Specifically, the development of multimedia material for attraction campaigns and the development of the mobile application to give visibility to female role models in the STEM field.

3.1 Self-assessment Survey

The activities associated with this self-assessment instrument are coordinated by the University of Oulu (Finland) and the Pontifical Catholic University of Valparaíso (Chile). The collaboration of both institutions together with the support of the other partners of the project, as well as the participation of UNESCO, has allowed defining a self-assessment matrix to analyse gender equality in STEM programs.

Initially, the instrument was intended to be applied only in Latin American institutions in order to obtain the necessary data to subsequently work on the processes of attraction, access and guidance at the undergraduate level in STEM programs. Finally, it has been decided to include European partners in the selfassessment process in order to have valuable data to implement possible initiatives beyond the W-STEM project.

The self-assessment survey or matrix is based on the SAGA toolkit [17], a set of tools to monitor and evaluate gender equality and integrate gender aspects into science, technology and innovation policies, which are often based mainly on anecdotal evidence since information disaggregated by sex is not always available.

Specifically, elements of the SAGA Indicator Matrix [17] (p.57-59) that were relevant to the objectives of the project and focused on higher education have been chosen. In particular, indicators 4 to 26 have been selected, introducing a small modification in indicator 9 "Total and share of women graduated from university programs by field of study and by educational level," leaving only the indicator according to the field study. Besides, two indicators have been added, indicator 46 concerning the guidance of women enrolled and graduated in STEM programs, based on SAGA indicator 9; and indicator 47 to measure female drop-out in STEM programs.

An Excel document was used to implement the matrix of indicators due to the complexity of the instrument. Moreover, the document should be edited by different profiles within the Among the activities associated with increasing the interest of current and future students to follow STEM careers, is the recording of stories of women who serve as role models. Although the initial expectation was to involve women of a very high level in science, the consortium decided to integrate young people with different profiles in STEM areas - last year students, PhD students, young researchers, developers, etc.

The initial planning placed the recording of the videos in the second quarter of 2020, but a pilot experience has been carried out on the occasion of the L'Oréal UNESCO 2019 awards ceremony that took place on March 14, 2019 in Paris (France). With the support of the Columbus Association and UNESCO, four interviews were recorded in which three key questions were used to guide the recording:

- What did you study and what do you do?
- What obstacles were presented to you and what facilities helped you realize your aspirations?
- What message would you give to young students who have to decide their future vocation?

Women interviews are world-renowned scientists. First, the Latin American winner of the 21st edition of the L'OréalUNESCO international awards for women in science, Karen Hallberg, a professor at the Balseiro Institute (Argentina), principal investigator of CNEA/CONICET, and Research Director at the Bariloche Atomic Centre.

On the other hand, three young scientists within the international program of young scientific promises (International Rising Talents 2019) [18]:

- Dr. María Molina (Chemistry, molecular biology), L'Oréal UNESCO regional fellowship Argentina, National

University of Río Cuarto.

- Dr. Maria Biola Javierre Martínez (Genomics), L'Oréal UNESCO regional fellowship Spain, Josep Carreras Leukemia Research Institute
- Dr. Ana Sofia Varela Gasque (Chemistry, electrocatalysis), L'Oréal UNESCO regional fellowship Mexico, Institute of Chemistry of the National Autonomous University of Mexico.

The interviews generated throughout the project will be shared through different channels in order to serve, on the one hand, outreach material and, on the other hand, make visible real profiles of STEM women as key elements in the attraction campaigns developed by each of the Latin American universities involved in the project.

3.3 Mobile app

The mobile application is among the elements that will be used in attraction campaigns. Specifically, it will focus on facilitating access to the role models of women in STEM worldwide. The different recorded interviews, both those described previously and those planned during the development of the project, will be available through the application. Likewise, the application will serve as an information point to share events, news, initiatives, etc. related to the STEM field and that can serve as attraction elements.

The prototype development was carried out in Flutter [19], a Google software development kit (SDK) that allows native development for iOS and Android based on a unique code. The goal is that the application available will be available for both iOS and Android in order to cover the bulk of the population with access to smart devices.

It is an application organized in four main screens that show two different types of content: articles and profiles. The articles consist of a title and a text, so that they can be used to publish events, news, or any other type of information related to women in STEM. On the other hand, the profiles of women in STEM. Each profile will show a video or photograph, the country, the field of work/study, a brief description and a set of links to social profiles.

The main screen shows profiles and featured articles under the title "Daily inspiration". From this screen you can navigate to a screen that shows only profiles or articles. Both screens will allow content filtering using predefined tags as can be seen in the third screenshot in Figure 4.

Regarding the publication of content, it is based on a plain text model through rich text files, so that a web service will be provided that allows authorized users to upload profiles and articles to the application without having to launch an update in the corresponding app stores.

The W-STEM project focuses on improving the processes of attraction, access and guidance in STEM programs in order to increase the number of women studying STEM careers, which in turn has an impact on society given that greater participation of women in these areas is related to economic growth, promotion of human development, strengthening the competitiveness of the region and increasing productivity [20]

The adaptation of the SAGA Indicator Matrix provides a solid basis for studying the current situation of the institutions involved in the project concerning the equality of women in STEM programs. Likewise, the pilot interviews and the prototype of the mobile application have allowed to test the protocol for preparing

the necessary material before the start of the attraction campaigns in secondary schools at the local level.

In addition, the results described will be used as a basis for the International Leadership Summer Camp that will take place in Barranquilla and Cartagena (Colombia), a meeting with leaders of the participating universities, to discuss the global and regional perspective of gender equality in education in STEM

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