

# STEM Women in Ecuador: a Proposal to Reduce the Gender Gap

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**Abstract.** The participation of Ecuadorian female students in technical careers has increased; however, they still have a shallow representation in science, technology, engineering, and mathematics. In this sense, critical education is needed that breaks down the paradigms, factors, and barriers that students face, considering the unfriendly climate of the majors and the low women representation that are managers in companies linked to the STEM field. This article, we present actions carried out within the framework of the W-STEM project to create a new female role vision in technical careers. Besides, a proposal of an action plan to empower women in STEM areas focused on the High Schools in the north zone of the country, under the cross-cutting axes of access, attraction, and guidance. These axes will allow us to define the importance of the women role in STEM careers, opening horizons to ensure the conditions of a society with equal opportunities.

**Keywords:** Education, Ecuador, Women, Action Plan, STEM, University.

## 1 Introduction

Even though progress in developed countries increases women's representation in science, technology, engineering, and mathematics (STEM), Ecuador is left behind due to economic, environmental, sociocultural, and personal factors [1].

An issue in the low women representation in STEM careers, especially in engineering and science, is the lack of female models demonstrating that women can be successful. Added to this are the different stereotypes created. For example, the mathematics skill is for men. Women have different learning styles, high expectations of gender roles, strong competitive culture in the classroom, etc [2].

We have determined mechanisms or strategies to ensure the presence of future professionals in these disciplines. These strategies are related to the needs of an advanced production system and to greater capacities to promote innovation and improve productivity [3].

Universidad Técnica del Norte (UTN) is in Ibarra, Imbabura province, in Ecuador's Northern Andean Region. It is a public institution with 34 years of activity, has five

faculties: (1) Health Sciences, (2) Administrative and Economic Sciences, (3) Science and Technology Education, (4) Engineering in Agricultural and Environmental Sciences, and (5) Engineering in Applied Sciences. Same as in its affirmative status and policies enact gender equality and equity in its teaching, administrative, and student plant [4]. As a result, the University supports different academic clubs, for instance, IEEE – UTN student branches and especially their women’s affinity group WIE Engineering – UTN. To create spaces where students and teachers encourage activities for women in both the university community to strengthen their interest in technical careers and secondary-level communities and Educational Units to boost girls’ interest in technical careers.

Since 2019, this background helped the University to have a solid profile and proposal to be part of the project: “Building the future of Latin America: engaging women into STEM” (W-STEM) [5]. This project aims to improve strategies and mechanisms to attract, access, and guide women in Latin America in Stem’s higher education programs. It is the European project, funded through the Erasmus+ program and coordinated from the GRIAL the research group of the Salamanca University (Spain). Fifteen European and Latin American institutions participate in the project: Chile, Colombia, Costa Rica, Ecuador, Spain, Ireland, Italy, Finland, Mexico, and the United Kingdom. The Ecuadorian context is represented by the Universidad Tecnica Particular de Loja (Loja) and the Universidad Tecnica del Norte (Ibarra), with the present work focusing on the actions carried out in the latter.

UTN purpose concerning the project is to increase the interest and presence of women in the careers of the Faculty of Engineering in Applied Sciences (FICA), which has seven engineering majors (Electricity, Mechatronics, Textile, Telecommunications, Software, Industrial and Automotive). At first, it is intended to work with current students who pursue a major to receive an accompaniment, promoting STEM vocations, which allows the culmination of their career. In turn, we want to reach the students of secondary-level Educational Institutions who seek in the future a place in the University, so that they know and are interested in technical careers.

The main contribution of the research is to define strategies to boost the participation of female students in STEM areas, proposing action plans and specific activities to strengthen access, attraction, and retention based on previous results, which has been developed and implemented since February 2019 at the University in relation to W-STEM project.

The article is distributed by the following order, in section 2: STEM education, in section 3: the analysis of the current situation is carried out, section 4 describes the activities of involvement with its results and its proposal as an action plan. Finally, the conclusions in section 5.

## **2 STEM Education**

The education interdisciplinary requires creating a new path towards the new integration of STEM knowledge, forming teaching alternatives, creating an innovative environment for students, and generating the possibility of developing skills in specific areas [6]. In this regard, it is essential to turn education towards solving real problems,

not created to obtain a rating or based on classic texts [6]. In this way, students get involved and learn more by being participants [7].

In the global context, STEM work is expected to drive the development of the worldwide economy in the coming decades [2], as the economy requires a business environment with highly skilled employees [6]. Given this new technological age, research activities are considered core processes in STEM education.

University-level studies as in [8], propose the creation of a new STEM-oriented subject consisting of research and design of authentic projects in stem fields provided by local companies, within a professional learning community, aimed at connecting research and innovation. On the other hand, they define the prerequisites of the mathematics expected in new STEM students [9].

## **2.1 Women in STEM fields**

To identify the challenges women experience while following STEM careers provides information to understand the social context and psychological aspects associated with women's low representation [10].

It has been found that teachers to some extent linked to STEM, contribute to strengthening the self-esteem of female students by working collaboratively, helping them recognize obstacles, and learning to face them more effectively [2].

STEM professionals still face an inequitable world of work, where their projects require some level of prior review and supervision. Likewise, 6% of CEOs (Chief Executive Officer) in American companies are women, highlighting the need to promote changes that inspire university students to complete their careers, generate innovative lines of work, and high profitability [11].

According to [12], in Ecuador, 0.2% of women are executive directors of companies. This study uses a sample of 30.015 companies from 20 emerging markets from 2008 to 2016. Similarly, many women are involved in science and engineering; however, the number of physical women is not very remarkable. Thus, [13] identifies the specific steps that should be taken to increase female participation in physics. In general, Ecuador shows emerging female involvement in this field of science.

## **2.2 STEM initiatives and gender equality**

In the United States, an initiative was born in the presidency of Barack Obama, called "Educate to Innovate ETI". The purpose is to emphasize STEM education [14]. Another international initiative is the United Nations-led Sustainable Development Goals (SDGs) [15], mainly in its objective 5, that pursue gender equality and empower all women and girls to ensure a peaceful, prosperous and sustainable world. Similarly, the SAGA (STEM and Gender Advancement) project proposes a survey model to measure gender equality in science and engineering in support of gender equality in science, technology, and innovation [16].

In Ecuador, gender equality-focused initiatives have been implemented, which take into account the continuing social changes, such as HeForShe. This aims to provide cross-cutting strategies for the equitable and inclusive professional development of

future leaders [17]. This program has mostly been implemented in Ecuadorian public sector institutions with low-impact results.

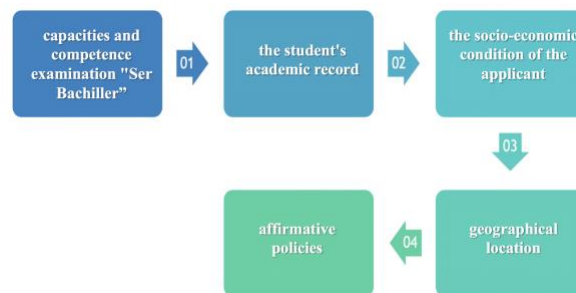
In addition, the following initiatives have been:

1. WISE (Women in Science and Engineering) Program, Latin America in Ecuador [18]
2. Ecuadorian Network of Scientific Women [19]
3. WIE (Women in Engineering) from the IEEE Section Ecuador [20]

The first initiative focuses on supporting women related to science and engineering for entrepreneurship, creation, and growth of companies. The second has been in place since April 2016, whose main objective is to contribute to the sustainable development of Ecuador through science, technology, and innovation, which is created and promoted by Ecuadorian scientific women. The third is the IEEE WIE affinity group, Ecuadorian women who broadcast and promote events, congresses, and academic fairs with the scientific, technological, and feminine approach.

### 3 Situation analysis

The process of entering Ecuadorian Public Universities is through the allocation of quotas through the National Leveling and Admission System (SNNA), as shown in Fig. 1, updated to 2019 referenced in [21]. According to the following process: (01) students take the “Ser Bachiller” capacities and competencies exam, (02) student’s academic record, (03) the socio-economic condition of the applicant and (04) its geographical location; they will also be taken into account (05) positive affirmation policies to provide greater opportunities for the most disadvantaged.



**Fig. 1.** Admission process to Ecuadorian Public Universities.

By obtaining the final grade to access public higher education, the student applies for up to 5 careers of interest and will be assigned a place according to the grade obtained. If a place is assigned and accepted by the student, they may enroll in the University’s SNNA, for example, SNNA– UTN, where he/she will perform his/her

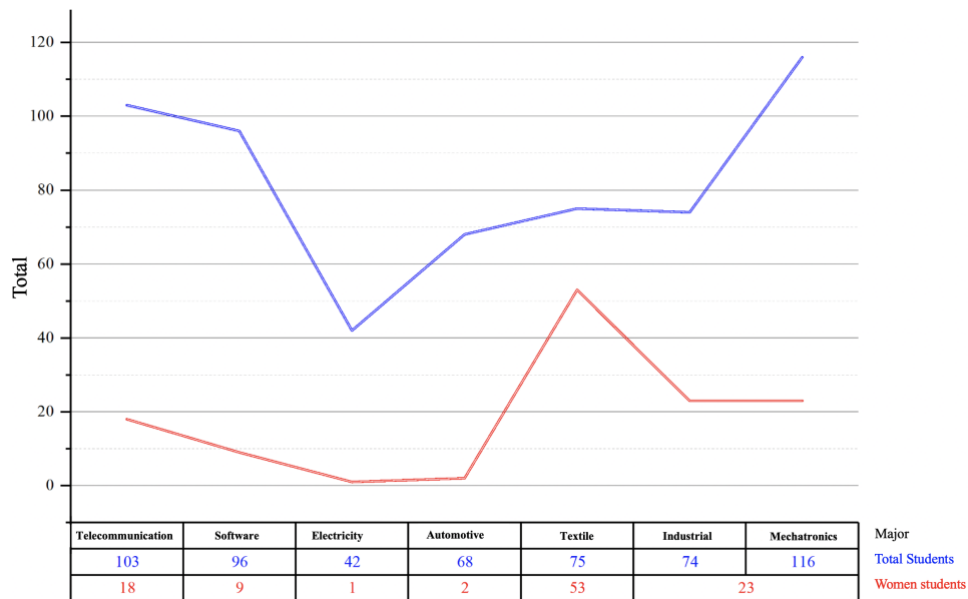
leveling period. In the end, you will be informed of the approval or not, depending on the result, the student may enroll in the first semester of the chosen career [21].

### 3.1 Participants

The study took into account the number of students who accepted a place in the SNNA National Leveling and Admission System, who approved The Leveling and enrolled in the first semester of STEM-related majors: Electricity, Mechatronics, Textiles, Telecommunications, Software, Industrial, and Automotive Engineering of the FICA, the research semesters were: September 2017- February 2018 and April – August 2018, for 2018 [22].

This information was obtained by completing a self-assessment matrix related to the first phase of the project. It was necessary to collect existing data in the University’s Integrated Computer System (SIU) and from archives of the institution’s National Leveling and Admission System (SNNA-UTN). Analysing this data, it is observed that 22.5% of women and 77.5% of men access a place, approve and enroll in the first half of these careers, showing a lower percentage of women’s participation, see Fig. 2.

Therefore, it is one of the reasons to seek the cooperation of Secondary Educational Units. This will help up to present the technical careers to future university students, with a gender approach, incentivized that they know real stories of engineers who have completed their higher education process.



**Fig. 2.** Total number representation of students who have passed leveling in STEM-related careers at the university versus the total number of women who have passed leveling, in the year 2018.

In Fig. 3 shows that 854 students earned a place to enter UTN technical majors in 2018. Also, the result of students approved Leveling in the SNNA- UTN that was 574. This data illustrates the level of demand and knowledge required to achieve a college entry quota.

National regulations for access and admission to higher education require closer work with the Secondary Educational Units so that from these instances, it is not only motivated if the necessary academic levels are not reached for students to obtain a quota to approve the leveling process.

Therefore, the project proposes to work together with university academic clubs to Secondary Educational Units on coordinated visits to increase necessary knowledge in engineering area



**Fig. 3.** Total number representation of students, men and women who obtain a place in careers related to STEM areas at the university versus the total number of students, men and women who pass the leveling process, in the year 2018.

As shown in Fig. 4, a significant difference in the number of women (187) who earn a quota, in UTN related to technical majors, and the number of women (129) who approve the Leveling process in the SNNA-UTN—representing 69% approval.

Numerical statistics show that of women who earn a place at the University, a percentage greater than half have the knowledge and dedication necessary to approve the leveling process. This is important to know to make an accompaniment together with University Welfare that seeks the retention of the students who have passed a level.

The purpose is to improve those statistics, so providing all the academic and motivational support through technical talks given by professionals and engineering clubs.



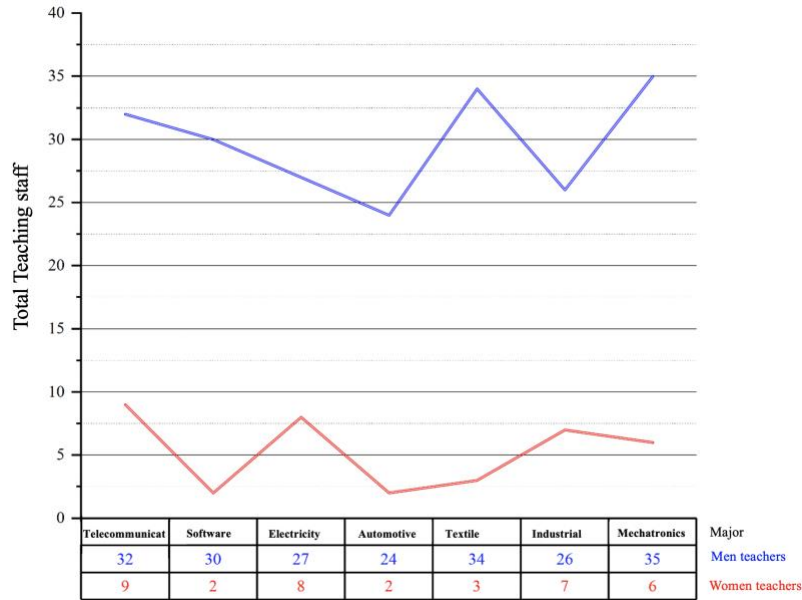
**Fig. 4.** Total number representation of female students who obtain a place in courses related to STEM areas at the university versus the total female number students who pass the leveling process, in the year 2018.

Having the above statistical analyses serve to examine the current situation, explore data related to female stem students, and gives a critical perspective to define the case study, which is presented in the next section.

### 3.2 Case Study

Under the process of implementing the W-STEM project [7] at Universidad Tecnica del Norte; we consider cross-cutting axes: access, attraction, and guidance. Focusing on attracting university students in STEM programs and generating mechanisms that achieve the retention and empowerment of this talent in the academic programs offered by the University

The percentage of female professionals performing in the FICA in 2018 was determined by comparative analysis, with only 17.8% of the population, according to Fig. 5. This data relates to the presence of female teachers in engineering careers as telecommunications, software, mechatronics, industrial, textile, electricity, and automotive.



**Fig. 5.** Teaching staff at FICA careers.

#### 4 Involving activities

As a first action, this set of female professionals is motivated to conform to the academic and research group “FICAS STEM” whose main objective is to support female students in developing activities, events, workshops, and projects; that motivate and strengthen their performance.

As a next goal, the group focuses on attracting women of different ages to STEM careers and ensuring the dissemination of information on projects being carried out within the University, where women who are part of the group are significant players in the planning and organization of events. Generating a space to motivate, promote skills of its members, and commitment to the needs of the environment in which the group performs.

The main activities in which the faculty’s engineers explain the careers they work and their experiences both as students and teachers are presented below, Fig. 6.





**Fig. 6.** FICA STEM group activities

These initiatives are based on gender equity, parity, and interculturality policies that the UTN has approved and in force since 2015, contributing to the sustainability and continuity of the project [4] and [23].

#### 4.1 Results

The results of the activities are presented in Table 1, with a description and the number of beneficiaries.

**Table 1.** Results of the activities carried out activities.

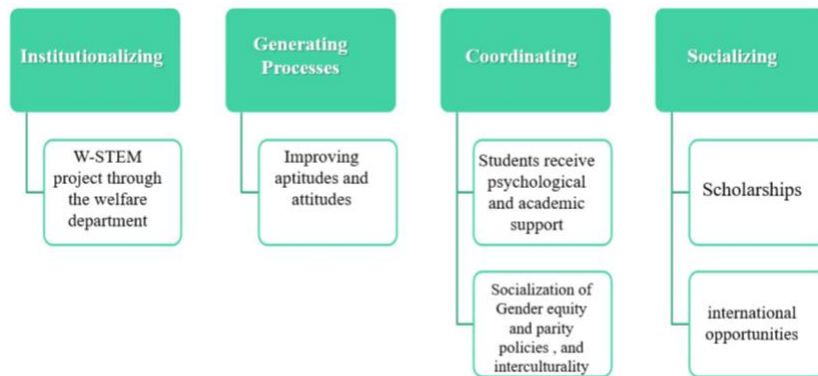
ACTIVITIES	DESCRIPTION	BENEFICIARIES	
		WOMEN	MEN
International Day of Girls in ICT- UTN	The event was held in April 2019 and included the socialization of FICA careers and a practical creative workshop.	40	7
International Day of Girls in ICT – Foster Care: Mercedes de Jesús Molina.	The event was in April 2019, it was held the socialization of FICA's careers and creative practical workshop.	25	-
International Girls' Day	In October 2019, the presentation of FICA careers and women's roles took place. Also, the visit to the FICA UTN laboratories.	51	52
W-STEM Project dissemination	On December 16 <sup>th</sup> and 18 <sup>th</sup> , 2019, professional workshops and presentation of academic women's roles to FICA female students	163	-
Socialization of the academic offer of engineering courses - FICA.	On February 28 <sup>th</sup> , 2020, the academic offer of FICA and the route of FICA-UTN laboratories was disseminated.	18	23

As a result, we found as factors affecting the following points:

- National educational regulations and that public universities do not have control over the process of admission of new students.
- Lack of a professional Network as part of the University.
- The need to create a team of professionals who support and encourage women of different ages to study STEM programs.
- Develop effective communication channels to promote success stories of women in engineering careers.
- Lack of appropriate academic and administrative training on inclusion and equity.
- The time of the volunteers participating in this program.

#### 4.2 Action Plan

Based on strengthening these factors, an action plan has been created to meet objectives that enhance the phases of attraction, access, and guidance of potential STEM majors' contenders. Activities such as institutionalizing the project through; linking (attraction), permanently monitoring the admission processes of applicants (access), supporting University Welfare to promote spaces where the guidelines of Gender Equity and Parity Policy and Interculturality (guidance) are socialized and fulfilled will enable compliance with the proposed plan development, which is shown in Fig. 7.



**Fig. 7.** Action plan - UTN

Hence, the plan goals are as follows:

- Institutionalize the W-STEM project through the Linking Department of FICA UTN for greater dissemination of projects in STEM areas to academic units at the secondary level.

- Generate processes of improving attitudes and skills through visits to academic clubs for development in the STEM area.
- Coordinate with the Department of University Welfare so that students receive psychological and academic support and socialize the Guidelines of Gender Equity and Parity Policy and Interculturality.
- Socialize international scholarships and opportunities through various presentations for the promotion of higher education.

Finally, as mentioned in section 3.1, the involvement of the Educational Units becomes a cross-cutting axis of the linking plan that is in charge of the operational part responsible for compliance and feasibility to carry out actions such as attraction campaigns and academic processes.

## **5 Conclusions**

This research identified the need for higher education institutions to have a better relationship with secondary-level Educational Units, allowing students to be attracted to STEM careers, as well as being accompanied when their interest in following these types of majors is born and oriented for better development of their vocational training activities. The most specific points that help conclude are the next:

- Understanding the importance of women's role in STEM careers allows to open horizons and ensure the conditions for a society with equal opportunities.
- By boosting women's participation, strengthening their training and development, it indirectly causes the elevation of their self-esteem, generating stability in their families and, therefore, in society.
- In middle education, vocational orientation needs to be strengthened, where STEM areas are given importance because they are the engine of the productive matrix in a technological age.
- Activities in basic education institutions, focused on gender equity, help eradicate stereotypes at an early age and foster a principle that women are able to play any role, whether it is their academic or professional performance.
- In addition, the study found that it is necessary to strengthen policies, spaces or platforms suitable for women, where new opportunities are created, and outstanding achievements can be got.
- A limitation is that the system of leveling and distributing places for university admission is run by the government system and not by public universities. Another challenge is the absence of clear policies focused on the process of access to universities, even if there is a vocational counsellor in each Educational Unit.

As future work, a new line of research is opened to link with the company, i.e., the processes and mechanisms will be designed to facilitate integration with the industry. Which involves defining and creating new functions.

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