Co-creation of BootCamps Focused on Promoting STEM

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Abstract. This work shows the results obtained in the execution of a group of workshops oriented to the attraction of women to the STEM branches in the context of the European project W-STEM, which has the objective of establishing mechanisms and strategies that influence in the policies of gender equality, focusing mainly in the attraction, access, and orientation of women in the STEM careers offered in Latin American universities. The strategy adopted for the definition of the action plan for gender equality in STEM careers by the Universidad Técnica Particular de Loja (UTPL), initially due to the project and a view of its long-term sustainability, is based on co-creation. In particular, a co-creation approach has been applied to diagnose the situation with the same students and, on the other hand, to design more inclusive and collaborative workshops and bootcamps that allow students to know the STEM areas through collaboration, experimentation, and application to the resolution of real problems of their environment posed in the format of challenges.

Keywords: Workshop, Co-creation, Self-perception, STEM, Gender gap.

1 Introduction

Women are one of the least represented groups in science, technology, engineering, and mathematics (STEM) [1]. For reasons unrelated to their talents or preferences, women's low presence in these areas represents significant economic losses for modern societies [2]. In general, women's increased participation is related to economic growth, human development promotion, strengthening the region's competitiveness, and increasing productivity [3]. According to the report "Women in the Digital Age," the incorporation of more women into digital jobs would benefit Europe's Gross Domestic Product (GDP) by up to 16 billion euros per year [4]. Specifically, increasing women's participation in the technology sector will boost the economy and allow their full participation in society [5].

In Latin America, there is a high proportion of women in higher education; however, the areas to which they have access mostly correspond to social sciences,

health sciences, economics, and administration; but they are a minority in the STEM areas. Besides, women's participation rates in science and engineering courses are substantially lower than those of men. There is a reduction in the gender gap in STEM [6] in Latin America, with Chile being one of the countries with the greatest progress; however, training in STEM disciplines is significantly low, at only 19% [7]. Even within STEM careers, this panorama is not homogeneous; for example, there is high participation of women in Industrial Engineering, while in Computer Science is low. There are also differences within the region; some countries have a high proportion of women in science (Argentina, 52%, Bolivia, 62%), while in others like Colombia, Ecuador or Chile, this ratio is 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 the lower socioeconomic populations. In the technology industry, the situation is especially critical. 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.

In this context, the W-STEM project [8] is being developed, in which various higher education institutions in Latin America and Europe [9] are participating. The project aims to reduce the gender gap in STEM studies, not only through specific initiatives but also through strategies and mechanisms that impact institutional policies, thus allowing their sustainability once the project's funding period ends. The Universidad Técnica Particular de Loja (UTPL) is one of the two Ecuadorian institutions participating in the project, coordinated by the GRIAL research group of the University of Salamanca (Spain) [10].

The main focus during the second year of the project is to work on the mechanisms and strategies of attraction in Latin American universities through three phases: (1) identification of schools; (2) identification of students with key aptitudes and skills, related to STEM disciplines, in the previously identified schools; and (3) implementation of the attraction campaigns. In particular, the UTPL has formed a local node with schools in the Loja city in which the project activities will be developed. A co-creation workshop of bootcamps has been carried out among the activities developed, with a double objective. Firstly, to make a diagnosis of young people's perception regarding STEM careers in the context of Loja, as a first step to identify women with interest in STEM areas to address the second phase of the attraction mechanisms. Secondly, to involve young people in the co-creation of action plans to develop bootcamps focused on encouraging and strengthening STEM vocations.

The present work describes the workshop of perception diagnosis developed at the UTPL, as well as the main results obtained so that the experience can be replicated in other institutions.

The work has been organized into five sections. The second section presents the W-STEM project in which this work is framed. The third section provides an overview of the activity developed in the context of International Women's Day with pre-university students. The fourth section describes the workshop and the main results of the participants' perception of STEM careers. The fifth section then

describes the process of co-creation of the bootcamps. Finally, the last section concludes the work with its most significant contributions.

2 The W-STEM Project

This initiative has been developed as part of the European project "Building the future of Latin America: engaging women into STEM (W-STEM)." This project arises from the need to build a joint strategy between Latin America and the European Union to attract young women to STEM programs through access and democratization of higher education. Despite the large number of initiatives focused on reducing the gender gap in the Latin American context, most of these initiatives are disjointed at the university level.

This project aims to establish mechanisms and strategies that affect gender equality policies, focusing mainly on attracting, accessing and orienting women to the STEM degrees offered in Latin American universities, emphasizing the countries involved in the project [11]. Although European countries are at different stages concerning the gender gap in STEM, the culture of gender equality is incorporated into the universities. Therefore, they have mature procedures, experiences, and regulations that can be transferred to Latin American institutions through this project.

A consortium has been created between universities in the European Union and Latin America that contribute different experiences to build a "joint strategy at the university level for STEM programs" composed of fifteen partners plus the significant presence of UNESCO and the participation of the Columbus Association as external evaluator; Table 1 summarizes the main aspects of the project.

Table 1. 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-ES-EPPKA2-CBHE-JP
Principal Investigator	Garcia Peñalvo, Francisco José
Coordinator	University of Salamanca - USAL (Spain)
Partners	• University of the North - UNINORTE (Colombia) • Oulu University - OULU (Finland) • Polytechnic of Turin - POLITO (Italy) • Technological University Dublin - TUD (Ireland)

	• Northern Regional College - NRC (United Kingdom) • Tecnológico de Monterrey - ITESM (Mexico) • University of Guadalajara - UG (Mexico) • Universidad Técnica Federico Santa María - UTSM (Chile) • Pontificia Universidad Católica de Valparaíso - PUCV (Chile) • Technological University of Bolivar - UTB (Colombia) • Technological Institute of Costa Rica - ITCR (Costa Rica) • University of Costa Rica - UCR (Costa Rica) • Universidad Técnica Particular de Loja - UTPL (Ecuador) • Technical University of the North - UTN (Ecuador)
Budget	862.268 €
Dates	3 years. 15/01/2019 - 14/01/2022
Web	https://wstemproject.eu

3 Implementation

The W-STEM project's attraction campaigns in the context of the UTPL have among their objectives the development of bootcamps focused on the promotion of STEM areas. To make the implementation of these bootcamps fit the needs and interests of young people, an activity has been carried out that focuses on involving young people in the design process, so that they are involved in the co-creation of the bootcamps.

Under the name of "Women in Engineering," the activity has been developed in the framework of the International Women's Day, which is celebrated on March 8 to claim the equality of women in all areas of society. Specifically, the activity took place on 3 and 5 March 2020. In this context, the activity was organized in two stages. The first focused on diagnosing the perception of young people about STEM careers, and a second stage focused on designing action plans for bootcamps.

A total of 78 second- and third-year high school students from three schools in Loja (Ecuador) participated. In particular, third-year high school students from the Antonio Peña Celi School, second-year high school students from the San Gerardo Educational Unit, and third-year high school students from the Cordillera Educational Unit. Of the participants, 53.85% were women and 46.15% men, distributed as shown in Table 2. The spatial distribution of the activity can be seen in Fig. 1.

Table 2. Distribution of participants in diagnostic workshops on the perception of STEM careers among young people in Loja.

Sex	School X	School Y	School Z	TOTAL	Percentage
Woman	9	13	20	42	53,85%
Man	14	11	11	36	46,15%
TOTAL	23	24	31	78	100,00%

Fig. 1. Development of the bootcamps co-creation workshop

4 Perception diagnosis workshop

Firstly, before the bootcamps were co-created, the perception diagnosis workshop was carried out.

4.1 Development of the workshop

For the organization of this diagnostic workshop of the perception of the young people in the Loja city, regarding the careers in STEM areas, two fundamental objectives were raised: the design of a strategy to obtain information from the vision of the young people and to use the technological resources habitual to the group; and, to include the young people in a process of co-creation of bootcamps plans to stimulate and to strengthen the STEM vocation.

To fulfill the first objective, it was decided to organize an informal meeting with the groups of young people, in a space intentionally designed at the UTPL, to

encourage conversation, creativity and innovation (Fig, 1). As a technological resource, an online survey was designed and implemented using Socrative, which the young people accessed using tablets acquired within the W-STEM project.

The workshop was organized in three moments to fulfill the second objective: (i) preliminary assessment of the level of knowledge of the youth about the STEM topic, (ii) brief presentation of the objectives and scope of the W-STEM initiative, and (iii) implementation of an online survey to discover the predisposition of the youth to choose or not a STEM career.

At first, the preliminary evaluation allowed to know the youth's level of knowledge about the STEM concept and the experiences in secondary education. Although it is a concept widely used in the academic field, it is a term that is not part of the usual vocabulary of young people, and is not always presented in secondary education. The approach used to develop this first moment was a round of open questions and answers, which also served as an icebreaker dynamic.

The second moment of the workshop focused on presenting the W-STEM project. Specifically, one of the members of the project at the UTPL, shared with the young people the objectives and scope of the W-STEM project and the initiatives developed in the Ecuadorian context, as well as the experiences and experiences in university training in STEM-related careers.

Finally, in the third moment, a data collection was carried out through a brief questionnaire developed in Socrative to know young people's opinion regarding STEM careers. In particular, the questionnaire consisted of the following questions:

- Name: you can use your real name.
- Sex (Female/Male).
- Do you have among your first three options, to study a STEM career (Science, Technology, Engineering or Mathematics)? (Yes/No).
- Why would you choose a STEM career? (Open question).
- Why would not you choose a STEM career? (Open question)

4.2 Workshop results: What do young people in Loja think and feel about STEM careers?

Although the sample is still not very significant, it allows us to get closer to the young people's perspective in the schools of the city, the country and the Latin American region, concerning the careers related to STEM. As previously described, the sample comprises 78 pre-university students with distribution by sex of 53.85% females and 46.15% males (Table 2).

Regarding the first question, “Do you have among your first three options, study a STEM career (Science, Technology, Engineering or Mathematics)?,” of the total students who participated in the workshop, 38 students (49%) have as an option a STEM career for their university education. On the other hand, 40 students (51%) indicated that they do not have a STEM option. Regarding the distribution by sex, of those who consider STEM as an option for their university education, 42% are women and 58% are men, as shown in Fig. 2.

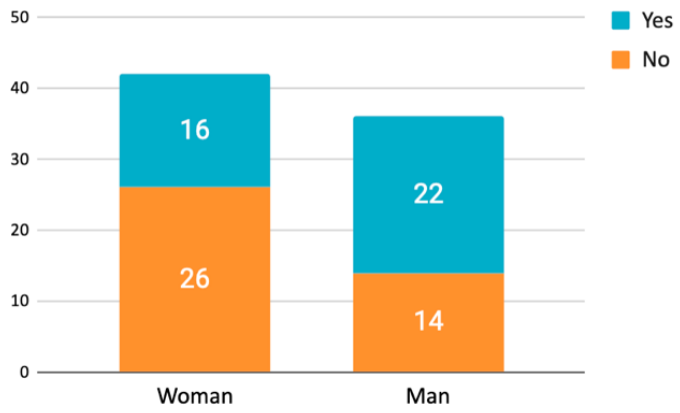

Fig. 2. Gender distribution of the participants' choice of a STEM area

Regarding the reasons for selecting a STEM career, these have been synthesized from students' comments in the open questions. Of the reasons identified in the analysis of the qualitative data, there are five main reasons why pre-university students would choose STEM careers:

1. They consider them to be innovative careers.
2. They are attracted to technology related topics.
3. They like STEM-related topics.
4. They are considered applicable and useful careers for the future.
5. They consider these to be interesting careers.

Fig. 3 shows a graphical representation of the total answers obtained in the question “Why would you choose a STEM career?” in descending order. On the other hand, the main reasons why women would choose a STEM career are:

1. Possibility to create or contribute new ideas.
2. They are considered applicable and useful careers for the future.
3. They consider these to be interesting careers.
4. Possibility of knowing how things work.
5. Good demand for labor.

Finally, the five main reasons why the young people who participated in the workshop (men and women) would not choose a STEM career are shown and synthesized below, which in this case coincide with the five main reasons identified by the women:

1. They are more interested in other sciences or careers.
2. They do not like, are not interested in, or are not aware of STEM.
3. They consider that they have a high level of difficulty.
4. They do not like math.

5. They consider the offer of STEM careers to be old.

Fig. 4 is a graphical representation of the total answers obtained in question 3: “Why wouldn't you choose a STEM career?”.

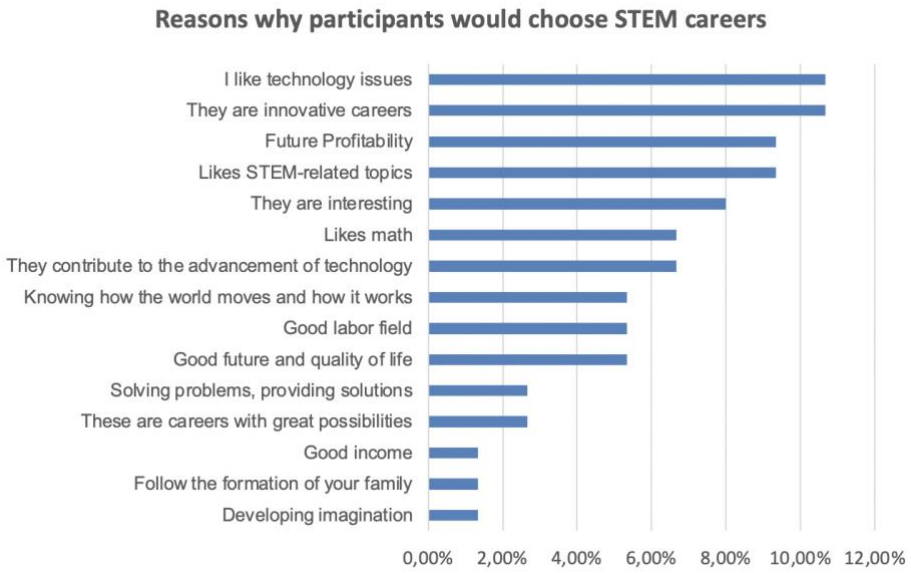

Fig. 3. Summary of reasons why participants would choose to study a STEM career

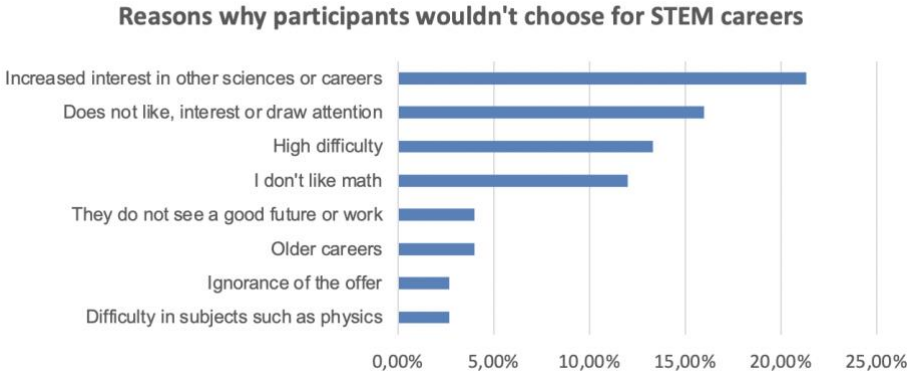

Fig. 4. Summary of reasons why participants would not choose to study a STEM career

5 Co-creation of BootCamps for the promotion of STEM

In this work, the concept of co-creation is closer to the Nordic meaning of a collaborative innovation [12]. The decision to adopt a co-creation methodology for the design of BootCamps, aimed at promoting and strengthening the inclinations and skills of young people around the STEM topic, was born in response to the challenge of meeting the needs of the target group, not from the experts perspective, university students or administrative teams in secondary education, but the understanding of the aspirations and dreams of young people.

Just as a reference, it is worth mentioning that by 2018, 39% of the world's population was young between 10 and 24 years old, while 14% of the population was between 25 and 64 years old [13]. Only in Latin American region, this corresponded to 235 million people [14]. This population generally remains on the sidelines of proposals and decisions made by those who exercise social and political power.

Then, the objective was set to involve young people in the design of the proposed BootCamps, with the support of the STEM subject teachers and directors of the proposed ones, with the support of the STEM subject teachers and directors of the secondary education establishments, and the support of the STEM working groups in the universities. Priority support comes from the parents of the young people, who are involved in the planning and implementation of activities.

In this context, the planning of a BootCamp is a space for discussion and identification of the expectations of young people concerning science and technology, prioritizing activities according to their scale of urgency, co-creating workshops or challenges that motivate them intrinsically and extrinsically, and the development of what is proposed and monitoring of results. A fundamental activity should be the dissemination and socialization of results in the formats of greatest acceptance among young people, such as audio, video and new forms of graphic expression such as comics, among others.

One of the main contributions collected and agreed upon as a strategy for the attraction workshops to be carried out is to adopt the format of challenge-based learning to solve real problems. Teams of students and parents will be formed, with the guidance of one or more professionals from the university environment who will transmit the foundation and application of STEM careers, to propose solutions to the problems raised.

Finally, it is proposed to include as a transversal variable the effort of the W-STEM Node partners, the consolidation of work teams, the insertion of rapid prototyping with the support of methodologies such as Design Thinking, and the accompaniment of potential enterprises related to STEM applications.

6 Conclusions

It can be observed from the beginning that one of the reasons why young people do not consider choosing a STEM career is because they are not aware of the academic offerings and the advantages they offer as professional training. This aspect can easily

be improved from universities and interest groups, creating and implementing spaces for socialization and experimentation.

In terms of STEM selection by gender, it was found that the percentage of female students who selected any STEM-related university career is 16% less than that of male students.

It is encouraging to note that the number of reasons students select a STEM career is 27% more than the reasons they would not take this option. The answers obtained in this sample of students allow us to approximate the students' reasons for selecting a STEM career in Ecuador and Latin America.

Using the co-creation methodology for the definition of bootcamps development, the W-STEM Node team has served to carry out a planning with methodologies and activities according to the requirements of the young people but oriented to know the advantages of STEM careers.

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