





## Article

# Multimedia Analysis of Spanish Female Role Models in Science, Technology, Engineering and Mathematics

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**Abstract:** Horizontal segregation in the higher education framework is a problem that goes up in the work environment. Women are assuming traditional gender roles due to phenomena such as the threat of stereotyping, which prevents them from opting for higher studies in science, technology, engineering and mathematics (STEM). This research work arises within the project W-STEM, “Building the Future of Latin America: Involving Women in STEM”. The research aims to investigate women’s academic and professional development in science, technology, engineering and mathematics (STEM) through their personal experience in making career-related decisions. The research was developed by applying a qualitative method. During the year 2020, video semi-structured interviews were conducted with twenty-one women professionals in the STEM field. Of the twenty-one participants, six are linked to science, eight to technology, fifteen to engineering and one to mathematics. Due to their research lines, some of them are located in more than one STEM area, for example, in technology and engineering. These women were interviewed about their choice of studies and training, their jobs, professional achievements, family and social environment and their perspective on the gender gap in STEM. They all agree on horizontal segregation and consider it necessary to motivate girls and young women to study what they like. Furthermore, they all show passion for their work.

**Keywords:** vocations; women; STEM; Spain; gender gap



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## 1. Introduction

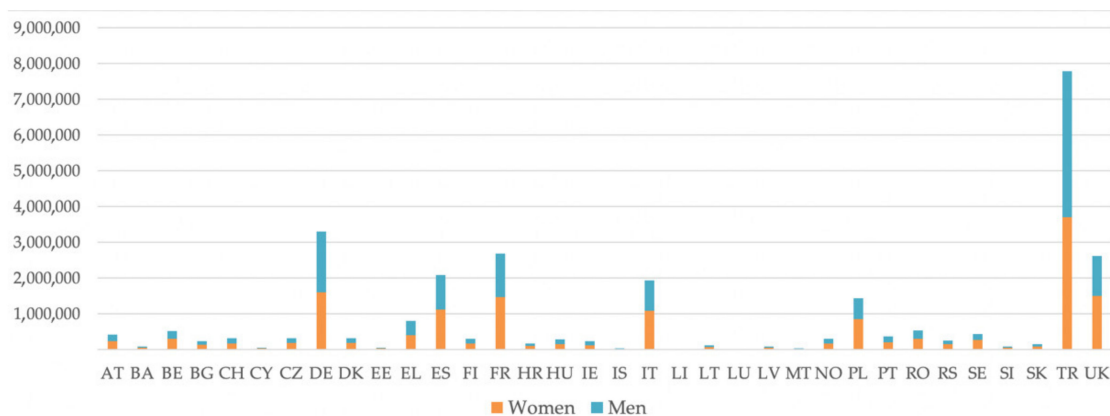
Human beings live in a society with constant technological progress [1]. We are heading towards a digital society where science, technology, engineering and mathematics are crucial for the progress of any community or dimension of life.

Therefore, the labour market currently requires more qualified professionals [2]. There is a need for professionals who, in addition to contributing to scientific and technological advances and achievements, provide new ideas and enable the construction of a society designed by and for people [3]. However, there is no equality between men and women regarding representation and recruitment of new professionals for STEM (Science, Technology, Engineering and Mathematics) areas [4,5]. Women are under-represented in STEM occupational sectors [6]. In Europe, despite women enrolling at university at equal or even higher rates than men, they enrol at lower rates than men in science, technology, engineering and mathematics [7–9]. One of the causes is the entrenched presence of traditional gender roles, which chronicles horizontal segregation [10,11], i.e., the perpetuation of clearly differential rates of enrolment in STEM studies. Myths and misconceptions exist about STEM studies. Combined with stereotypes [12] and internal and external factors, such as family and social environment, this leads to a gender gap [13]. In the face of this gap, women seem to lose interest in higher education studies as they move from adolescence to adulthood, confirming the problem of leaky pipelines [14,15], which represents

the loss of human capital once the university stage and its different academic levels are reached. Women complete higher education in STEM areas at a high rate. However, only a low rate of those who graduate eventually ends up in STEM fields [16–19].

The gender gap in STEM employment does not end there. Women must fight against other constraints, such as the lack of measures for family and work conciliation. The lack of solid protective mechanisms is an obstacle to women's employment status. They are sometimes forced to temporarily postpone their professional growth to respond satisfactorily to their family care responsibilities. Thus, the phenomenon of the sticky floor becomes evident. Career advancement and internal promotions are not balanced between men and women. Careers are slowed down. This is how social phenomena such as the glass ceiling [20–22] limit promotion.

The European Union database is used as a reference to highlight some statistics. In the field of education in the European Union, students enrolled in tertiary education are divided by academic level, programme orientation, sex and field of education. In 2019, for all academic areas of tertiary education (from level 5 to level 8 of the ISCED codes), more women than men enrolled in tertiary education, except Germany, Greece, Liechtenstein and Turkey. In Figure 1, men are represented by blue and women are represented by orange.



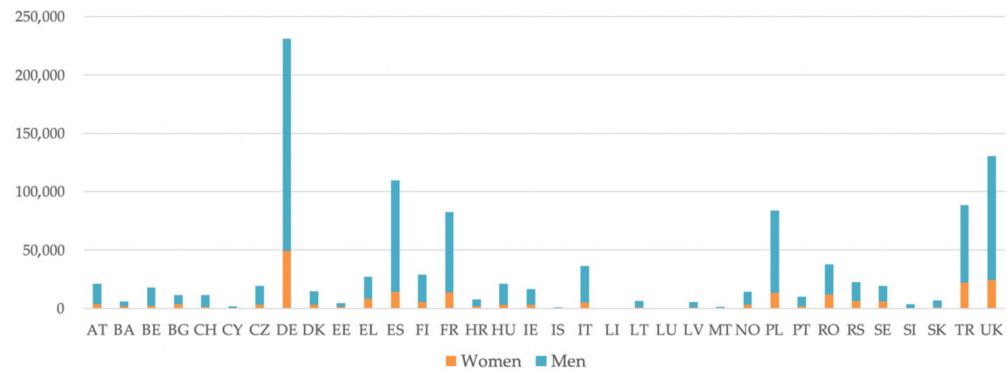
**Figure 1.** Students in tertiary education by programme orientation, education level, field of education and sex, in all educational areas at ISCED levels 5–8, in Europe in 2019. Source: Prepared by the authors using the data provided by the Gender Statistics Database—European Institute for Gender Equality [23].

However, if the analysis is done by ISCED fields of education and training, rather than all areas together, the representation of women changes, as is the case in the ISCED field of Information and Communication Technologies (ICT). Based on [23], in 2019, more men than women were enrolled in ICT. Some of the differences in enrolment were substantially significant (Figure 2), as is the case in Spain, where women represent 13.05% of the total number of students enrolled in ICT (95,320 men and 14,310 women). On the other hand, there are some areas in which the situation is reversed, i.e., where women lead the way. For example, in Spain, women represent 77.02% of the total of students in the ISCED field of Education, with 179,597 women and 53,583 men enrolled in 2019.

According to the last official records in Spain dated 2013 regarding the professional fields of science, mathematics and computing, engineering, manufacturing and construction, for the age group 25–64 years, women represent figures lower than men (Spain, 47.5% men and 12.5% women).

It is essential to work with children from an early age for these reasons. In this way, biased thinking can be modified, and studies according to personal preferences can be naturalised. It is essential to work on the Stereotype Threat [24] so that girls do not lose interest as they grow up because of the cultural patterns associated with segregation [25–27]. It is also essential to work with young people on professional motivations and socio-labour guidance so that each person decides according to their real interests, promoting different

vocations [28–32]. Moreover, it is also crucial to put in this work during their tertiary studies. In particular, higher education institutions have to take into account measures to reduce the drop out numbers, increase the comfort in the university environment [33], improve teachers support [34] and provide more support at the faculty level [35].



**Figure 2.** Students enrolled in tertiary education by programme orientation, education level, field of education and sex in the field of ICT in Europe in 2019. Source: Prepared by the authors using the data provided by the Gender Statistics Database—European Institute for Gender Equality [23].

In this context, the W-STEM project, a capacity building project funded by the European Commission through the Erasmus+ programme, aims to transform the processes of attraction, access and guidance implemented by the higher education institutions to increase the number of women in STEM programs. This study is framed within the W-STEM project to provide insights to define mechanisms and strategies that can have a real impact on the rates of women in STEM. In particular, the study is focused on those women that already study a STEM program.

This research aims to investigate women’s current and past experiences in science, technology, engineering and mathematics (STEM). The study consists of a research project based on semi-structured interviews to answer the following research questions: (1) What has professional women’s experience in their educational and professional fields? (2) What is the perception of women representation in the STEM sector in higher education? The study has been implemented through a multimedia analysis of interviews obtained in Spain using videos.

This work is an extension of the conference paper “Interviews of Spanish women in STEM: a multimedia analysis about their experiences”, presented at the 8th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2020) [36]. The paper presents the new results obtained from the research.

The paper is organised into five sections. The Section 2 provides relevant information on the context of the study, the project “Building the future of Latin America: engaging women into STEM”. The Sections 3 and 4 describe the methodology, analysis and results. The Section 5 describes the discussion of the results. Finally, the Section 6 summarises the main conclusions.

## 2. Semi-Structured Interviews of Women in STEM

### 2.1. The W-STEM Project

The research described in this paper is framed within the European project “Building the future of Latin America: engaging women into STEM (W-STEM)” with reference number 598923-EPP-1-2018-1-EN-EPPKA2-CBHE-JP under the funding programme ERASMUS+ Capacity-building in Higher Education Call for proposals EAC/A05/2017. The project involves fifteen higher education institutions, five from Europe (Finland, Ireland, Italy, Spain and the United Kingdom) and ten from Latin America (Chile, Colombia, Costa Rica, Ecuador and Mexico). The European Union funds the project through a programme focused on transferring knowledge between Europe and other regions.

In particular, the W-STEM project “aims to establish strategies and mechanisms to improve the processes of attraction, access, guidance and retention of women in STEM studies in higher education” [37]. The project consortium has developed the following actions to achieve this objective:

1. **Situation analysis:** This phase was focused on analysing the current situation of the STEM programs in each higher education institution involved in the project. In particular, we applied the survey to measure gender equality in STEM programs at undergraduate levels. Later, we identified the main processes related to attraction access and guidance in each institution. The last step focused on analysing good practices inside the W-STEM institutions and at the European and international levels.
2. **Gender equality action plans:** The next phase covers the definition of the actions plans to reduce the gender gap in the STEM programs identified during the previous phase. The gender equality action plan requires the decision-makers’ involvement to impact the universities’ policies, strategies and organisational mechanisms.
3. **Implementation of the actions:** This phase was focused on implementing attraction, access and guidance/retention actions. First, to promote STEM studies among girls and young women at secondary schools. Second, to reduce the gap during the access processes. Finally, to guide gender-sensitive mentoring activities during university studies.
4. **Training course:** Development of an online training package for higher education institutions to implement effective strategies to enhance attraction, access and guidance of Women in STEM programs.

The first year of the project was focused on the first action. Each institution involved in the project analysed its situation to have enough information to prepare the gender equality action plan to cover actions 2 and 3. The defined gender equality action plan covers three axes [38]: (1) the attraction processes to have an impact on the number of females who apply for STEM programs; (2) the access processes to ensure a higher conversion rate of applicants to enrolled students; and (3) the retention and guidance processes to reduce the dropout of students in STEM programs [39–41], with a particular focus on women.

During the project’s second year, the main activities have been focused on the attraction processes at the institutional and project level. Each Latin American university has developed a set of attraction campaigns. The activities were adapted to an online approach because of the COVID-19 crisis, and the target groups were mainly students and teachers from secondary education. Furthermore, all institutions have collaborated in the creation of materials to complement the attraction campaigns. In particular, a mobile app for iOS and Android (<https://wstemproject.eu/app/> (accessed on 13 November 2021)) was developed, and videos of women in STEM were recorded during the first semester of 2020. The recorded interviews are available through the mobile app as materials that teachers can use at secondary schools to show the heterogeneity of the STEM areas and, specifically, how women can achieve different milestones in those fields [42].

## 2.2. Video Collection Process

The process for recording and producing the videos was defined by the Tecnológico de Monterrey (Mexico). The mobile app development was coordinated by the Technological University Dublin (Ireland) with the University of Salamanca (Spain) as the project coordinator.

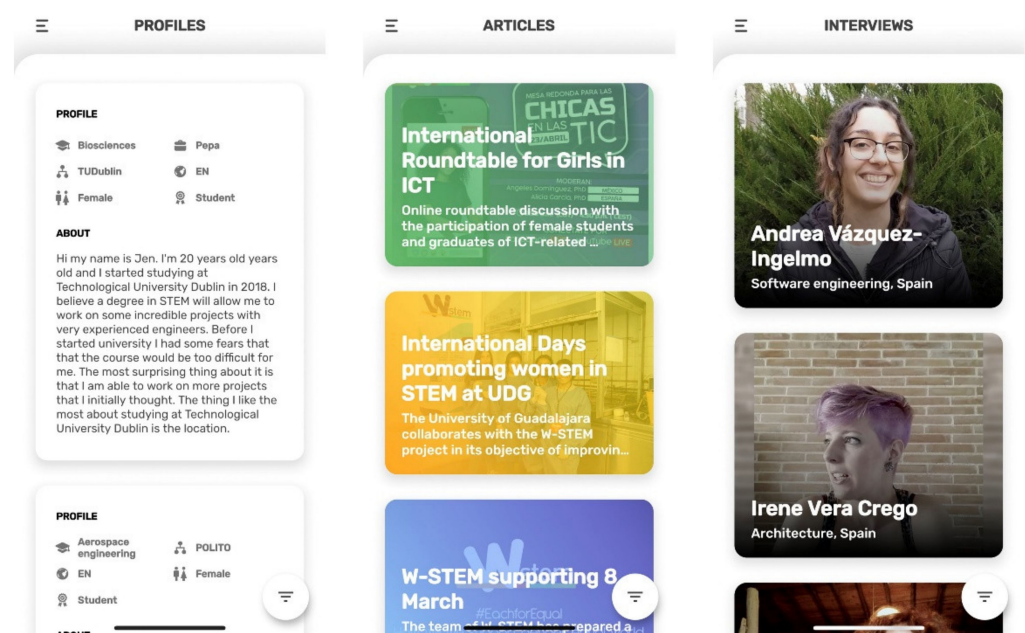
The protocol, which involves three phases, was applied by each university. The first phase was to record the videos. Each institution identified the women for the interviews following two strategies, a direct invitation by email or an online form, to spread the word through social networks. This phase was conducted during the lockdown period due to the SARS-CoV-2 pandemic from March to June 2020. Initially, the videos were meant to be recorded as face-to-face interviews; however, the lockdown in all the countries involved in the study forced the establishment of a recording protocol through video calls or self-recording. The aim was to get videos of women from different profiles, countries,



ages and sectors. Moreover, each institution was in charge of collecting the consent forms to get permission to share the videos and use them for research in the frame of the W-STEM project.

The second phase was focused on editing the videos. A set of guidelines was provided to the institutions through an online workshop to ensure that all videos had the same visual design and information. Finally, the last phase was focused on reviewing and uploading all the videos to YouTube (<https://youtube.com/c/wstemproject> (accessed on 13 November 2021)). The process to include them in the mobile app is slow to give new content each month.

All the videos are recorded in the mother language of the interviewee (Spanish, English, Italian or Finnish), and they have subtitles to be accessible in the original language and translations into Spanish. Figure 3 shows some screenshots of the videos, articles and profiles of students and graduates inside the app.



**Figure 3.** Screenshots of the W-STEM app (<https://wstemproject.eu/app> (accessed on 13 November 2021)). Source: W-STEM project under CC BY 4.0.

### 3. Methodology and Methods

Qualitative methodology was applied for the study, and we used the phenomenological method [43–46]. Phenomenology studies the reality of a phenomenon or a situation from the subjective opinion and the experiences of the person who participates in the study. Information was collected through the interview technique. The interviews were conducted in video format in this study, and informed consent forms were collected from the participants. Twenty-one women belonging to the STEM professional sector were voluntarily interviewed. The length of the videos ranged from three to seven minutes to ensure more engagement. Although the video length does not affect the cognitive value of the videos [47], nowadays, young people are consuming content using their smartphones, so content should be easy and quick to get their attention.

#### 3.1. Research Participants

Table 1 collects the information of the twenty-one women in Spain who belong to the STEM sector. This information is about their academic background and professional activity in STEM, to which specific STEM area they are linked and the organisation or company they belong.

**Table 1.** Information on the discipline, organisation and studies of the twenty-one women participating in the study. Source: Own production.

Participant	S	T	E	M	Organisation/Company	Studies
P1	No	Yes	Yes	No	University of Salamanca	Computer science
P2	No	Yes	Yes	No	University of Salamanca	Physics
P3	No	No	Yes	No	University of Salamanca	Civil Engineering
P4	No	Yes	Yes	No	Auth0	Computer science
P5	Yes	No	No	No	Institute of Geosciences, CSIC-UCM	Geological Sciences
P6	Yes	No	No	No	University of Salamanca	Food Technology
P7	No	Yes	Yes	No	University of Salamanca	Computer science
P8	No	Yes	Yes	No	La Laguna University	Computer science
P9	No	No	Yes	No	University of Cantabria	Chemical Engineering
P10	Yes	No	No	No	University of Salamanca, INCYL, IBSAL	Biology and PhD in Neurosciences
P11	No	No	Yes	No	University of Salamanca/EPSA	Mining and Energy Engineering
P12	Yes	No	No	No	National Centre for Research on Human Evolution (CENIEH)—Burgos	Degree in Geology—Master in Quaternary Archaeology and Human Evolution—PhD in Geochronology
P13	No	No	Yes	No	Allford Hall Monaghan Morris	Architecture
P14	Yes	No	No	No	University of Salamanca	Geology
P15	No	No	Yes	No	University of Salamanca	Architecture
P16	No	No	Yes	No	TIDOP Research Group (Ávila, University of Salamanca)	PhD in geotechnologies applied to construction, energy and industry
P17	No	No	Yes	No	TIDOP Research Group (Ávila, University of Salamanca)	Geomatics Engineering and Topography
P18	No	Yes	No	Yes	La Laguna University	Mathematics
P19	No	No	Yes	No	University of Castilla-La Mancha	PhD in Agricultural Science and Engineering
P20	No	Yes	Yes	No	University of Salamanca	Computer science
P21	Yes	Yes	Yes	No	University of Salamanca	Civil engineering

Out of the 21 participants, six are linked to science, eight to technology, fifteen to engineering and one to mathematics. According to their research lines, some of them are located in more than one STEM area, such as technology and engineering. The participants' primary fields of study and work are computer science, physics, civil engineering, geological sciences, geotechnologies, geomatics engineering and topography, food technology, chemical engineering, biology, mining and energy engineering, architecture and agricultural science.

The different STEM areas are possible fields of study and work for women, and they are also areas in which they can find their professional growth. Therefore, it is necessary to know what happens from a socio-cultural point of view, so some girls and young women do not feel a sense of belonging to these areas when they feel attracted to them.

### 3.2. Research Context

The research aims to investigate women's current and past experiences in science, technology, engineering and mathematics (STEM). From a phenomenological approach, the participants' subjective perception was fully respected throughout the process of recording, analysing and writing up the results. The research questions we worked on are:

- What has been the experience of professional women in their educational and professional fields?
- What is the perception of women representation in the STEM sector in higher education?

Regarding the first research question, we want to know the educational and professional background of the participants, how they have reached their STEM fields, if they felt a previous motivation for STEM studies or if the motivation and attraction for the studies were generated. We also want to know if they have had any references or support to guide them in the process. It is interesting to emphasise what attracts them to their job and how it translates into their research and professional achievements.

Regarding the second research question, it seeks to investigate their perception of the representation of women in the STEM sector and what they attribute as the causes of the under-representation. We also want to determine what motivational messages they would send to women and girls attracted to this sector.

The following interview questions were posed in order to be able to answer the research questions as well as the objective:

- Tell us about your career.
- Why did you choose your area of STEM?
- What topics are of interest in your studies or work at the moment?
- Did anyone inspire you to do so?
- What are you most passionate about in your work?
- How do you think you have made a difference in your area?
- What professional achievements do you hope to achieve, or have you completed?
- Why is it essential for more women to study STEM?
- What message would you give to young women and girls to be interested in STEM areas?

Both in the data collection and the analysis, the central theme addressed was what led them to enter the STEM sector, what are the main topics in which they work, who encouraged and motivated them to pursue their studies and what motivational message they would send to future women who wish to enter the STEM sector.

The content was transcribed, with the confidentiality of the personal data collected, to carry out the analysis of the speeches collected in the videos. The speeches have been anonymised through identification codes. The applied analysis is classical content analysis. The qualitative analysis software webQDA has been used to support the analysis process [48]. WebQDA is online software hosted in a web application. The software can work with internal and external sources, and the analysis is carried out following the qualitative procedure of category generation and discourse coding.

This study used a text search as a qualitative strategy to identify content linked to a specific term. This text search can be launched for different sources, interview questions and categories. Additionally, another search strategy was used to identify the most frequent terms, making it possible to detect most repeated concepts and in which categories, questions or sources they are repeated. The result could be presented employing word clouds. Finally, the categories can be represented in a code tree. Figure 4 shows the organisation of the category system and the interview questions that relate to the categories. This information is also offered from the code tree in Figure 5.



Figure 4. Categorical system. Source: Own production.

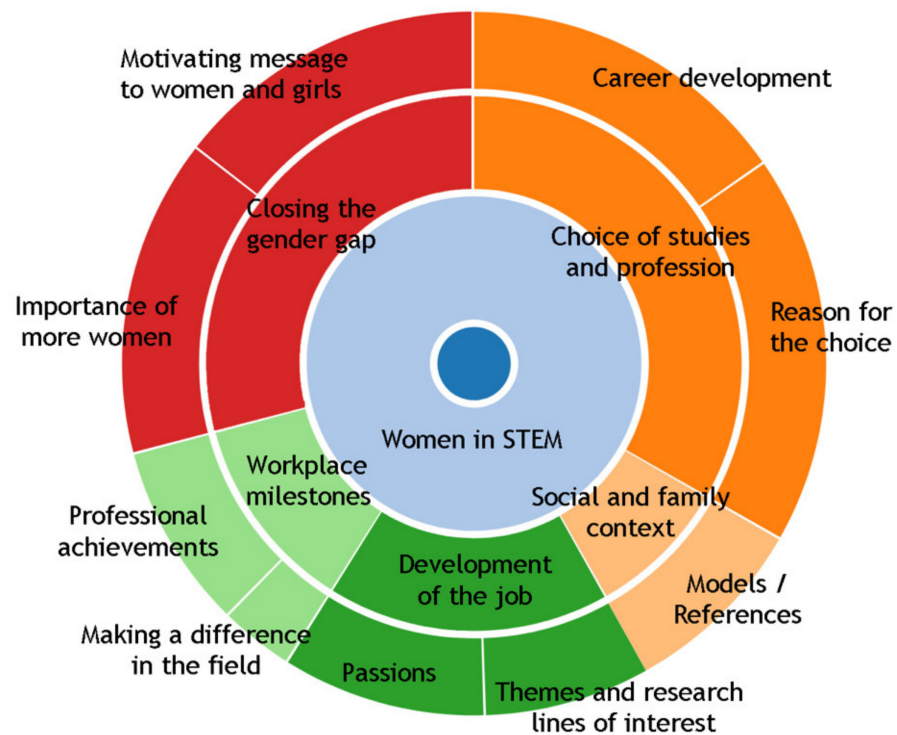


Figure 5. Density map of analysis categories. Source: Own production using webQDA.



#### 4. Analysis and Results

A process of codification of the discourses has been carried out. First, a categorical system was created. Subsequently, text search analysis was applied. The analysis based on the text search made it possible to detect concepts and expressions in those system categories and the sources defined by the researcher in the search. This procedure makes it possible to launch searches by codes and detect matches according to the desired sources.

The following sections present the results obtained for the search terms: girls, young people, encouragement, science, technology, engineering and mathematics. The search was launched in the different interview questions, according to their categories. In addition, to find out which terms were most frequently used in the discourse of the questions, a frequency analysis of the terms was applied.

##### 4.1. Choice of Studies and Profession

This category refers to the career path that each woman has decided to follow and the reason for this choice. In other words, what career path did she decide to follow, and what motivated her to do so. The category has two subcategories, "career development" and "reason for the choice", to respond to these aspects.

Within the subcategory "career development", these are some of the statements derived from the interview discourses:

- "I opted for civil engineering, for its contribution to society".
- "Engineering has made me a tenacious, hard-working person with a great capacity to overcome challenges and difficulties".
- "Studying engineering has allowed me to help environmental managers and farmers through the university where I work".
- "When I finished my high school studies, I was not clear about what I wanted to study, I think like most people. When it came to applying to the different university courses, my first option was, paradoxically, nursing, which is what I was going to do until a few days before I finally decided on my degree, and in the end, a stroke of courage and decision made me enrol in the Technical Mining Engineering".
- "I loved the course; it's true that at first everything sounded a little bit like Chinese to me, people also asked me a lot, they were surprised to hear I was studying that course since it was mainly related to the male sector [...], and I feel delighted to have been able to study this degree. After finishing these studies, I continued with the training. I took a Master's degree in Occupational Risk Prevention and continued with another Master's degree in Mining and Energy Engineering. Finally, all this gave me access to doctoral studies and last year, I got my PhD in Geotechnologies".
- "I have been a student, and I am currently a computer science student. In this case, I am doing my PhD in data visualisation, software engineering".

Within the subcategory "reason for the choice", these are some of the statements derived from the interview discourses:

- "Since childhood, I have always loved mathematics, numbers, physics and all that united by the love for the environment and agriculture and the desire to help farmers and breeders led me to choose the technical forestry and agricultural engineering career".
- "I have to say that ever since I was a child, I showed a particular interest in the world of technology, in the world of engineering".
- "I studied computer engineering because I was very interested in everything related to technology ever since I was a child. However, it is true that in a rural school of the eighties, technology is not as we know it today. Nevertheless, it always caught my attention, and I also think that my parents were a little bit the ones who led me to follow this path. Both of them studied science careers in somewhat tricky years, and I think they are also a little bit to blame. I remember the first IBM that my father bought me and that from time to time still reminds me of what it cost him".

- “When I studied at school, the subjects I was best at were the so-called letters, language, English and social studies and then in high school French, drawing. Until I discovered chemistry, it was a much more complicated subject than all I had faced. However, that same difficulty encouraged me to try to master it so that it was like something direct. When I passed my exams and started Chemical Engineering, I liked it and continued, and I still do”.
- “The truth is that if I had not studied engineering, I would never have found this path to follow, and the decision at the time was tough because I remember that I was not entirely sure. I had many doubts and fears that I was wrong and was not smart enough to tackle something like this. However, mathematics and technical drawing were the subjects I liked best, and I was clear about that. I tried to follow a university career that had these two subjects very much in mind”.
- “Now I am a Developer Advocate, I was also a developer, but the truth is that I don’t have a degree in technology. I have a degree in fine arts and a master’s degree in economics. It was after my studies that I started to become more interested in programming. The truth is that all my life, I have loved technology. From when I was six years old, I had a computer at home and, well, I liked to open the computer, remove all the components and put them back; and the truth is that I’ve always been in touch with technology; even when I was studying fine arts, I was doing contemporary art. It was very installation-oriented, with technological things. So I think it took me so long to get into this world because for me, a developer was a white man who sat in front of a computer, well, the typical computers you see the black screen with the Matrix-style code”.
- “As to why I chose to devote myself to architecture, well, I think it was a relatively early decision. I think I was very passionate about the art world in general, but I also liked the pure sciences. I believe that at some point, I realised that the beauty of architecture is that it brings these two things together. I combined the world of the arts and the world that was a little more subjective than the sciences, technology. I think that was a little bit what made me decide on this profession which gives you extensive possibilities to develop professionally and on a human level and intellectually in many fields”.
- “I chose to devote myself to science because even as a child, I was interested in everything around me, plants, animals, rocks, minerals. I have always wanted to discover what nature is like, how it works and why it is the way it is. Besides, I liked history, so I decided to study geology because it is a minimally known discipline. It is still very complete; it allows you to understand nature as it is today and as other worlds were thousands or millions of years ago. You can find out what plants and animals were like and how the landscape has evolved. It is like travelling through time, but without leaving home. That’s why I’ve always found geology fascinating”.
- “I was 16 years old when I entered university, so at that age, I had to make one of the most important decisions of my life, which is exactly the career I was going to study. After many doubts during high school, when I was seriously thinking about studying medicine or studying mathematics, I finally decided to learn mathematics, mostly because I had some excellent mathematics teachers in high school who inspired and convinced me”.
- “In principle, back in the nineties, the career of computer science was a great unknown, but we did know that it was the career of the future. I could not imagine the future without some computer science. I liked many things, not only I like maths or gadgets but I enjoyed dancing; I wanted to be a doctor, I wanted to do many things with my life, but I thought that there was going to be some computer science in all areas. Therefore, it did not matter what I liked, since I could always apply it to that area”.

#### 4.2. Social and Family Context

The “social and family context” category is raised to determine the environment’s influences on the woman. When deciding which educational and professional path to choose, it is essential to know what influences she has had from her family as well as the social context. In this sense, it is necessary to know what models and references she has had. This category has a subcategory called “models/references” to go deeper into the models and influences that the woman has had.

In the subcategory “models/references”, these are some of the statements derived from the discourses of the interviews:

- “And it was that curiosity, together with particular family influence, since both my brother and my father are engineers, and I loved to spend hours and hours watching them make plans, do calculations, and that was what motivated me to study engineering. Although there is indeed a great variety of engineering degrees, I have always had a particular weakness for nature, for the terrain that surrounds us, that is, for the engineering degrees that we know as ground engineering”.
- “And as an inspiring person, I can comment that I had two, mainly my mother and my cousin”.
- “The truth is that I had no female role model until I entered this world”.
- “And well, I could practically say that those who inspired me to study this science were my parents. They are both passionate about palaeontology, and when I was a child, they took me to the countryside to collect fossils, watch animals, bird watching, and identify plants. So, I suppose this passion for nature was passed on to me by my parents”.
- “Those who inspired me to choose this topic of study were the professors of the cellular biology area of the university and professors of the career who also, thanks to their passion for science, motivated me to continue on this path”.
- “I am well aware that it was just them, my maths teachers, who tipped my scales towards mathematics, and the truth is that I have never regretted it”.

#### 4.3. Development of the Job

Regarding the category “development of the job”, it is necessary to know the main research lines that the individual has and the central axes of his work. It is interesting to go deeper into the topics that a person deals with in their profession. It is also crucial to know their primary motivations, their passions. Knowing the main attraction of the profession for each woman helps to understand how other women and girls can be attracted to the STEM sectors. The category “development of the job” is composed of two subcategories, “themes and lines of research of interest” and “passions”, through which the lines of work and the main attraction of their profession for women are investigated.

For the subcategory “themes and lines of research of interest”, the most frequent words in the STEM highlight speech are Knowledge, Technology, Research, Engineering, Work, Science, Dissemination, Computer Science, Classes, Management, Students, Ecosystems, People, Value, Information, Food, Specialisation and Limestones.

Regarding the subcategory “passions”, these are some of the statements derived from the interview discourses:

- “For me, programming is fantastic, I feel like I’m doing magic, that I write a few lines of code and create something. It’s like power, like being a superhero”.
- “And all these characteristics are what I am passionate about in my area, the sense of mystery that surrounds technology, the difficulty that it entails because I have always liked difficult challenges, and how fundamental it is to our day-to-day technology”.
- “I like computers and technology, but as I have already told you, what I am passionate about is teaching, and that is why over the years, my research has been aimed at deepening, analysing and improving teaching in the field of engineering and computers and the use of technology”.

- “I love my work, and I enjoy it very much in the lab, but I enjoy it, even more, when I share the lab with my students when I help them learn and when I help them acquire the skills that will make them right professionals”.

#### 4.4. Workplace Milestones

It is not only essential to know which STEM area the person chose to pursue, but also why they chose that option and who encouraged them to do so. In addition to these aspects and lines of work, it is also essential to know what they have achieved professionally. The category “workplace milestones” involves finding out how each woman has made a difference in her sector. In other words, what successes she has achieved and where she has been a pioneer. It is also interesting to know what new achievements she is pursuing. The category has two subcategories: “making a difference in the field” and “professional achievements”, which answer these questions.

Regarding the subcategory “making a difference in the field”, this is one of the statements derived from the interview discourses:

- “I believe that the difference I am going to make is not exactly in the technological development part. Still, in all the work I have been doing to promote women and diversity within STEM. And in particular within engineering and technology. So all the work that I do, not alone but with colleagues [...] can be one more grain of sand in that whole community of people who are working to reduce that gender gap and to increase diversity in the context of STEM and the context of engineering and technology”.

In the subcategory “professional achievements”, this is one of the statements derived from the interview discourses:

- “During my professional career at the university, I have always worked a lot, because the truth is that I love my job and thanks to that illusion that I have put in all the challenges during my long professional career, I have managed to overcome or knock down a few obstacles. [...] About research, out of nowhere, I created a research group that has been quite successful, I must say, in competitive competitions for research projects, and I was also one of the first women and evaluators in the European Commission in my area. Fortunately, there are now many more. For the future, the challenge we have in the group is to try to lead a European project, one day [...]”.

#### 4.5. Closing the Gender Gap

Finally, the category “closing the gender gap” is a futuristic one. Once it has been demonstrated that women can also be part of STEM sectors and achieve, closing the gender gap is critical. Raising awareness among women and girls to study and pursue careers of their choice is fundamental to reducing segregation. For these reasons, participants are asked to share why they think it is vital for more women to study STEM. Finally, women are invited to share a motivational message to reach other women and girls interested in science, technology, engineering and mathematics. This category is divided into “importance of more women” and “motivating message to women and girls”, which respond to the above elements.

Within the subcategory “importance of more women”, these are some of the statements derived from the interview discourses:

- “I think that in all these years, many brilliant minds must have been lost because they did not choose as they wanted. I believe that nowadays it is essential to encourage this type of profession, in boys, in girls too, in both, and rural areas, that often this is lost a little and I also know it first-hand”.
- “I believe that the incorporation of women in civil engineering is standardised, but despite this, there are significant challenges, mainly in the field of construction. Many companies are still very masculine, with long working hours and high demand for

presence, preventing many women and many men from joining this industry as it is incompatible with family life”.

- “The STEM—Science, Technology, Engineering and Mathematics—I would say they are the gateway to the future, and women make up half of the population, so we cannot afford to be on the sidelines of the future”.
- “This is super important because we need more people in the technological world, and above all, we need more women. We have to standardise this because at the moment we are still the minority and we have to make a considerable effort for almost anything, and also to be able to have female partners and not always be surrounded by men”.
- “I believe that this is an area of knowledge in which a reformulation of education is needed”.
- “The professions of the future are undoubtedly linked to people and technology, and we women cannot let this opportunity to jump on the bandwagon and take over the future pass us by. We cannot allow half the population not to participate in this development. We all know that computers, artificial intelligence, the most fundamental science, everything is linked, everything is interconnected. So we women must be there and fight to be part of that future world in which we are closer every day”.
- “All these fields are inspiring, tremendously useful and fundamental in life. It is precisely in the circumstances in which we live, we see that investment in science is needed and how all fields of life have to be balanced out. There have to be men and women working on all these issues because all people bring their complementary perspectives, and without this complementarity, many projects fail”.
- “There is no reason why we should not be as brilliant as our male colleagues. So I think it’s worth working on why this difference exists. For all these reasons, I believe there must be more women in the STEM fields, in any branch of science, technology, mathematics”.

In the subcategory “motivating message to women and girls”, these are some of the statements derived from the interview discourses:

- “I encourage girls to confront all the stereotypes around us; stereotypes which unfortunately still exist and which continue to try to expel girls from STEM, stereotypes that continue to influence their level of self-confidence, especially at younger ages. And I encourage them to believe more in themselves and not let themselves be negatively affected by anyone, not to allow themselves, not to close doors, to choose STEM careers”.
- “I encourage all girls who are thinking about going into technology. I can tell you that it is an incredible world. At the working level, it is very satisfying. And I encourage all of you to consider it because it will bring you many benefits seriously”.
- “There are significant challenges ahead, so I encourage all those women who are considering studying civil engineering to do so and to transform the world with their work”.
- “I encourage you not to be discouraged no matter how much everyone tells you, “what are you doing in engineering?”, “why chemistry, mathematics?”, “how difficult”. If you like it, go ahead, because the important thing is not to see if we are going to be a Nobel Prize winner, which we might be, but we don’t know if it’s going to be fun on the road”.
- “I strongly encourage you to choose a scientific career, to develop it in the most ethical way possible and to have the best achievements in your professional life”.
- “We need other women, girls, like you, who still don’t know very well what you are going to do, getting started on the subject of technology. And of course, I encourage you to study architecture; you can study architecture [...]. So, come and get it; it is in your hands to continue with this work”.



- “Mathematics and physics are not a gender issue. It is not a matter of boys or girls, but anyone who likes it with a lot of work and effort can dedicate themselves to engineering. I encourage you all to study engineering”.
- “I encourage all women to study a STEM career. Above all, to study what you like, no matter what it will cost, the effort you have to put in. Do not care what others say about that career or the stereotypes that exist about them. If that’s what you like, you have to try it. We are waiting for you all”.
- “The message I would give to girls and young women is that you can go into STEM and you can go into any other career in the social sciences, education, law, many other careers, humanities, can also be combined with STEM. Technology and research are not separated from any of these careers. They can be mixed, and we can do multidisciplinary work, so in the end, engaging in STEM is a way of engaging in what will be the society of the future”.
- “I think the message is simple. It is to do what you like. If a girl likes computers, maths, physics, then goes ahead, and if a boy wants something traditionally also for girls, then the same thing. The message is precise, I believe that we are all equal, and we all have to be constant in what we want”.
- “I advise women and girls to do it because it is a job you can do every day and you will like it [...]”.
- “Those girls who have doubts about these careers, even if you are confused about whether to opt for engineering or one of the STEM branches, simply encourage you, if that is what you like, not to hesitate. Choose something that you know will make you happy, motivate you, and always find personal satisfaction. And I simply want to tell you about my experience that this has been my case, that I have felt delighted when it comes to studying engineering and that I hope it will help you. I encourage you to get into these careers if that is what you like”.
- “If I could give a piece of advice to my past self or to any other girl who is hesitant to do what she wants, I would tell her that it is normal to be afraid, but in the end, if you pursue something you like the way to it will be much easier than you imagine and the reward will be worth more. For all this, courage doesn’t matter if it’s engineering, maths, or any other STEM branch. The important thing is that you can handle it and much more”.
- “As a piece of advice, I would say that one should not be afraid to take responsibility in any area, neither at work nor personally. I believe that as a woman, I have different capabilities and perspectives than men, neither better nor worse, merely different. And that’s why our presence in STEM is necessary, it’s essential [...]”.
- “If I were to encourage you to study a STEM career, I think the main feature that links us to STEM studies is the ability to solve problems. [...] We are people who do not give up, and who grow with the difficulties”.
- “I want to encourage them not to focus only on those subjects that sell us hard, maths, technology, physics, etc., but to focus on the work they are going to do. And that they empower themselves and that they are going to be able to help many people from these areas of knowledge, even if they don’t realise it now a priori, OK? So nothing, let them be guided by their intuition and by what they are passionate about”.
- “And that’s why we need other women, girls, like you, who still don’t know very well what you are going to do, well then, get started on the subject of technology”.

Finally, some of the most frequently mentioned terms in the interview discourses were STEM (87 occurrences), women (74 occurrences), work (58 occurrences), engineering (52), believe (51) and career (50). This information provides insight into the trends of the participants’ messages. In this study, it is interesting that words linked to the different STEM areas appear, as well as optimistic terms such as “we can”, “achievements” and “future”. In addition, the coding frequencies of the main categories of the study were analysed. The category “Choice of studies and profession” received 39 codings, the category “Social and family context” received 10, the category “Development of the job” received 20, the

category “Workplace milestones” received 14 and, finally, the category “Closing the gender gap” received 34 codings.

## 5. Discussion

The objective and the research questions were answered after delving into the causes that led the participants to choose their profession. We went in-depth in the topics in which they work, their proposed achievements, their passions and the references that prompted them to pursue their studies. In addition, they were asked about their opinion on gender segregation in the STEM sector, and they were asked for a motivational message they could send to other women.

### 5.1. What Has Been the Experience of Professional Women in Their Educational and Professional Fields?

After conducting and analysing the interviews, it was found that some of the participants were attracted to STEM studies even before they had completed their degrees. Some of the fields of interest were computer science and technology, botany, life and geology. However, not all of the participants were determined to pursue STEM before their decision. Moreover, some women were attracted to other fields that are socially feminised, such as health sciences, education and fine arts.

The twenty-one women who participated in the study decided to study STEM degrees. This decision led some of them to fear their chosen studies, including feeling that what they were doing was a courageous act. Other women first wanted to try out how they felt about their chosen studies and then decide, and they decided to continue their studies because they liked it. The act of daring to try led them to take an interest in the degree and continue to pursue a career in academia and research.

According to [10], motivations on things such as choice of vocation are dynamic and can change. Some people do not start from a fixed idea, but their interests are dynamic. This highlights the importance of promoting STEM subjects from an early age. Children and young people need to approach the different sectors to pursue the studies that generate the most significant interest and attraction.

To the referents that motivated and inspired them, some women had no role models. Other women had male references. However, other women had female role models that inspired their decision, such as their mother or teacher. Thus, the influence exerted on the decision by the family and the immediate environment can be perceived.

Lent et al. [13] pointed out precisely that the conditioning induced by the family and the immediate context is natural. Thus, the influence of the immediate networks on the decision to study must be considered and on the rational mental processing before making the decision [13].

Concerning the research lines, the study shows that women, similar to men, have a place in the different STEM areas. The profiles of women who participated in the study are very diverse. The key to achieving such diversity is to be motivated and to have an interest in the profession without letting traditional gender roles stand in the way. For this reason, it is necessary to invest efforts in reducing the gender gap together with the professional segregation based on gender [7,9,11,26]. Some of the profiles are in computer science and programming, data visualisation, technologies, such as those applied to agriculture, and industries, such as food. Some women come from architecture; others are from the geology sector and what is linked to it. Other participants are from the energy sector, such as geothermal energy. There are also engineering profiles, such as chemistry and physics. Moreover, some participants worked in the scientific sector, such as those associated with blindness research.

Regarding their passions, all participants pointed to their enthusiasm for research in their field and teaching.

In addition to asking about their passions, we sought to know what achievements they pursue and how they think they have made a difference in their sector. The achievements they tended to point out are to obtain more monetary funds for projects and for women to

be more visible and represented in STEM areas. The participants consider STEM disciplines to be essential elements for the future. Thus, the women in the study stated that women should not be on the sidelines of progress but should strive for integration into it.

### 5.2. What Is the Perception of Women Representation in the STEM Sector in Higher Education?

There are different experiences regarding the differences participants feel they have introduced in their sector to fight segregation. For example, one of the women pointed out that she was a pioneer in her area, within her university. This example shows the importance of promoting a work–life balance [20], as some have presented their ambition to be promoted despite existing difficulties. Promoting progress could help to diminish effects such as the glass ceiling [21].

Finally, all the participants agree on the gender gap in STEM studies. They recount some experiences, such as that most of their students are male, despite women proving to be capable since they obtain good grades. The women point out that it is not a problem of performance or worth. The problem concerns the stereotypes, which affect self-esteem and self-perception. For this reason, the women issued messages of motivation and optimism, intending to encourage women to study their true vocation.

The goal is not for women to consider STEM studies exclusively, but rather to pursue their professional aspirations, whatever they may be, without being conditioned by gender stereotypes.

## 6. Conclusions

This study presents a qualitative approach to the experiences of twenty-one women in the STEM sector in their fields of study and work. Interviews were conducted to obtain information about their educational and professional trajectories, their achievements and aspirations and their perspective on the gender gap in the sector. From the interviews, findings of the different categories and subcategories defined for the research have been found.

Regarding how they came to their profession, some highlighted that they had a role model, mainly a family member or a teacher. Other interviewees highlighted that their interest in their profession had been a passion first. In addition, other participants highlighted that they were not sure what profession to pursue, and as they got into the STEM field, their attraction for the subject grew.

Participants commented on their passion for their field of work as a more integrated part of their life. Although they each belonged to different areas, they all expressed the importance of their profession in their daily lives. This passion translates into academic and professional achievements and ambition for further improvement.

According to the interviews, STEM fields are not inherently gender-specific, and all people have a place in them. What is needed to enter this sector, as for any other, is interest. This is the final message they wanted to send out: women and girls should pursue what they want.

Based on the study results, it is essential to promote socio-labour orientation from educational centres and reduce gender stereotypes from the early stages of education. However, caution must be applied with the small sample size, as the findings might not be transferable to all women in the STEM sector.

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