Perception Disparity between Women and Men on the Gender Gap in STEM at a Spanish University

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***Abstract*— The gender gap in engineering is one of the problems in achieving gender equality in society. In this context, the "Engineering with a Gender Perspective" project, an equality initiative developed at the Higher Polytechnic School of Zamora (HPSZ), University of Salamanca, aims to understand the university community's perception of the gender gap and gender equality and to promote interest in STEAM (Science, Technology, Engineering, Arts, Mathematics) subjects, particularly among female students. To achieve these objectives, a questionnaire tailored to Engineering and Architecture, which had previously been validated for Computer Engineering, was administered and discussed to the entire educational community at the HPSZ. The first WE (Women in Engineering) Challenge Competition was also launched for pre-university students. The challenges, devised by women, were designed to demonstrate the relevance of engineering in everyday life, to inspire pre-university students to pursue STEAM disciplines. The study examines responses to the questionnaire from both students and faculty at the HPSZ, analysing differences in perceptions between men and women regarding gender equality, the gender gap, and gender stereotypes. The findings indicate significant differences in perceptions of the gender gap, particularly among the student population. However, there are no significant differences in views on gender equality and gender stereotypes. Overall, the university community at the HPSZ recognises the importance of achieving gender equality and eliminating stereotypes. Nevertheless, there seems to be some uncertainty regarding their stance on the gender gap issue. Active engagement across all educational levels, focusing on early education, is crucial for reducing inequality in the STEAM field, eradicating gender stereotypes, and fostering interest in STEAM disciplines.**

***Index Terms*— Gender gap, gender inequality, higher education, STEAM.**

I. Introduction

DESPITE progress in gender equality, women are still underrepresented in STEM fields. According to the Global Gender Gap Report of 2023 [1], they make up only 29.2% of the STEM workforce across 146 nations, a sharp contrast to their nearly 50% representation in non-STEM occupations.

When examining the profile of graduates from Spanish universities, women comprised 60.5% of undergraduate graduates, 57.2% of those graduating with a master's degree, and 49.9% of those earning a doctoral degree [2]. However, only 3.3% of undergraduate degrees were awarded in computer science, and 10.2% in engineering, industry, and construction. Similar trends were observed in master's degrees. These statistics position Spain with an average of 18.8% of graduates in STEM disciplines, below the European average of 25.1%. Regarding gender differentiation, there is a higher relative participation of women among STEM graduates in Spain, 36.3%, than in the EU, 34.9%, primarily in the fields of engineering, industry, and construction.

Regarding enrollment in Spanish universities at the same time [3], women constituted 56.4% of undergraduates, 54.9% of master's students, and 50.2% of doctoral candidates. However, in Engineering and Architecture, these figures dropped significantly to 26.5% at the undergraduate level, 29.8% at the master's level, and 30.8% at the doctoral level. Engineering studies represent a field where the gender gap has not shown good progress in recent years, in fields such as engineering, industry, and construction (29.8%), and particularly in information and communication technologies (15.4%), [2]. Fig. 1 summarises the data.

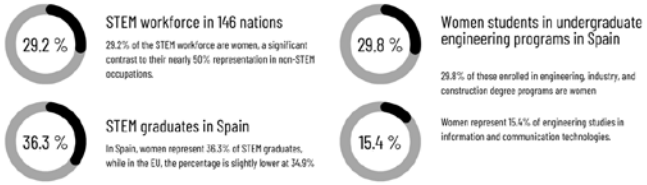

Fig. 1. Examples of the presence of women in the STEM field.

The percentages are similar at the University of Salamanca, where overall enrollment comprised 39.8% men and 60.2%

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women [4]. However, within the field of engineering and architecture, the representation of women was notably lower, with percentages of 24.1% at the undergraduate level, 21.9% at the master's level, and 32.1% at the doctoral level. Similar patterns were observed at the Higher Polytechnic School of Zamora (HPSZ), a specific centre affiliated with the University, where the current research was conducted. In engineering programs offered at HPSZ, women constituted an average of 26.3% of the student body, with variations ranging from 12.5% in Mechanical Engineering and 14,7% in Computer Engineering in Information Systems to 52,17% in Agri-Food Engineering and 58.3% in Technical Architecture [4], as shown in Fig. 2.

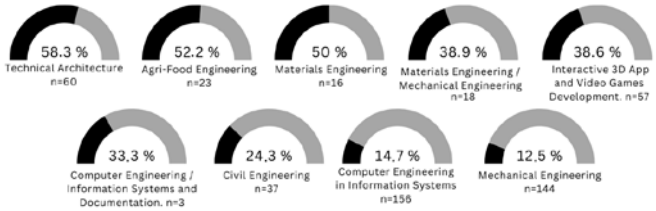

Fig. 2. Presence of women in Engineering Studies at the Higher Polytechnic School of Zamora.

II. Background

Gender segregation, with a lack of female representation, is referred to as the gender gap [5]. This phenomenon is observed globally and has adverse effects on the advancement and development of our societies [6], [7]. For instance, the absence of women in science and technology generates biases in AI algorithms that affect credit evaluations, image recognition, and urban design [8]. Hence, it is imperative to promote gender diversity and foster the formation of diverse teams in the STEM field to mitigate vulnerability and prevent the exclusion of minorities.

Addressing the gender gap requires efforts towards creating an egalitarian society [9], where individuals of various genders have equal opportunities to pursue these studies. International studies demonstrate that both men's and women's selection of fields of study is still influenced by gender biases and results from differing socialisation processes [6], [7]. As presented in the study [10], the gender gap in STEM fields arises from a complex interplay of factors involving abilities, preferences, beliefs about capabilities, and gender stereotypes. Among these, sociocultural factors such as gender stereotypes and expectations significantly influence career decisions [11], [12]. This suggests the potential for intervention to alter these outcomes. The optimal timing for intervention varies for each factor, spanning from early childhood to adulthood [13], impacting both career paths and lifestyle choices for women in STEM [14].

Consequently, initiatives aimed at reducing stereotypes in this field are necessary [15], for instance, making female role-models visible [16], [17], mentoring programs [8], [18-20], out of school time STEM programs [21], [22], practical experience with a real-world engineering challenge [23], and educational efforts in primary and secondary schools [24-28]. Their results in achieving gender parity are anticipated in the medium [15] and long term [2].

Coeducation plays a crucial role in attaining a just and egalitarian society. To promote genuine equality, a methodological approach has been proposed for the training and education of both women and men, ensuring equal conditions and opportunities [29]. This approach seeks to eradicate stereotypes that hinder progress toward equality.

The responsibility of fostering change lies not only with society as a whole but also with educational institutions, lectures, families, and students [12]. It is imperative for all stakeholders to actively participate in eliminating the expectations, biases, and social norms that influence women's choice of university degrees [30]. By addressing these barriers, we can create an inclusive environment that encourages women to pursue any field of study without limitations [6], [8].

In alignment with initiatives aiming to tackle gender equality in engineering and architecture, a teaching team from the University of Salamanca developed the Equality Project "Engineering with a Gender Perspective" [31] within the context of the HPSZ and the province of Zamora. The objectives of this project were to assess the perception of students and teaching staff regarding the gender gap and gender equality in Engineering and Architecture; to raise awareness in the educational community regarding the significance of cultivating competencies that facilitate the formation of gender-balanced work teams in the fields of engineering and architecture, respecting diverse identities and striving to eradicate entrenched stereotypes; to encourage scientific and technological vocations by exploring practical applications of Engineering and Architecture in daily life; and to highlight and promote the achievements of female talent in the field of Engineering and Architecture.

Part of the results obtained in the project [31] were presented at the TEEM 2022 conference[1]. The paper titled "Access and Dropout in Engineering and Architecture Studies: A Preliminary Study with a Gender Perspective" analyses the responses of HPSZ students to certain survey items, revealing that the primary motivation for students to study Engineering is personal interest [32]. Additionally, it indicates that women are more inclined to consider dropping out than men, which may be influenced by academic performance issues [32-34].

This work is an extension of the paper "Engineering with a Gender Perspective in Higher Education at a Spanish University" [35]. The activities outlined in the project [31] were initially presented at the XIII International Virtual Campus Conference, where it was recognised as one of the conference's best contributions and subsequently selected for extended publication in IEEE-RITA. This article summarises that paper and integrates a gender analysis focusing on perceptions of equality and the gender gap within the STEM field among HPSZ faculty and students. This analysis is based on survey results collected from the university community as part of the same project.

[1] https://2022.teemconference.eu/

III. "Engineering with a Gender Perspective" Project

The Equality Project "Engineering with a Gender Perspective" comprises a wide range of initiatives. On the one hand, the "Coffee for Everyone" action, centred within the HPSZ university community, aims to evaluate the perception of equality among the HPSZ educational community, to analyse the presence and influence of gender stereotypes in engineering studies, and to raise awareness about the importance of breaking down these stereotypes and fostering gender-balanced teamwork.

On the other hand, the "Proximity Engineering" initiative extends beyond the university sphere, reaching out to the wider community and specifically targeting pre-university students. Its goals include promoting STEM vocations, providing role models for pre-university students, engineering students, and graduates, and highlighting female talent in engineering and architecture. In Fig. 3, an outline of the project is presented.

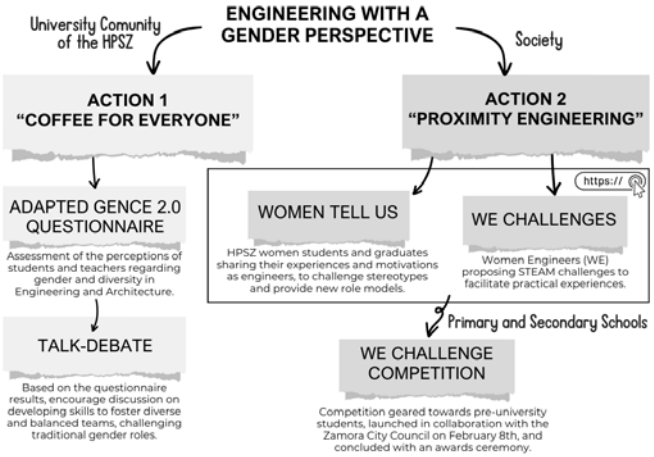

Fig. 3. Outline of the "Engineering with a Gender Perspective" Project.

Action 1 commenced with the administration of the GENCE 2.0 adapted questionnaire [36] to the HPSZ university community. Preliminary results were presented at the "Coffee for everyone" talk-debate. In a relaxed atmosphere, over coffee, and moderated by a journalist, students and lecturers discussed differences in the results obtained in GENCE 2.0 between men and women. This event witnessed the participation of a diverse group of 40 attendees in person. Most attendees consisted of HPSZ students and lectures, who actively engaged in the discussion. Notably, the event was graced by the presence of the HPSZ management and the Councillor for Equality from the Zamora City Council, highlighting the significance and support garnered by the debate. The debate was live-streamed on the dedicated YouTube channel for the activity, attracting a total of 122 views. Additionally, during the live broadcast, there were 6 individuals actively following and engaging with the discussion in real-time.

Action 2 allowed access to close female role models in engineering and architecture, crucial for making informed educational and career decisions [11], [16]. A series of videos featuring female students and alumni from HPSZ was developed. This initiative aimed to capture their experiences and motivations. Additionally, female engineers, architects, and scientists actively contributed by proposing challenges to be solved individually or in teams by pre-university students. All this content is hosted on a website[2] and promoted in primary and secondary schools across Zamora province. "Proximity Engineering" challenges were designed in a virtual meeting, where pedagogical guidelines were established to ensure quality. In total, 15 challenges were created by exploring practical applications of Engineering and Architecture in everyday life, covering various areas to provide meaningful learning experiences.

The interaction with society was realised through a collaborative agreement with the Zamora City Council, which made it possible to hold the 1st WE Challenges Competition. The council took charge of promoting the initiative to the society, assisted in drafting the participation rules, and provided funding for the prizes awarded to the winning educational institutions and participants.

Participants had the option to respond to the challenges individually or in groups. To solve the challenges, they were required to record a video of up to 7 minutes explaining their proposed solution and the corresponding challenge. The campaign was officially presented to the media at the Zamora City Hall, coinciding with the International Day of Women and Girls in Science (11th February). The deadline for proposal submissions was extended until May.

The call for challenges received significant media coverage in the district of the University of Salamanca, with features in both print and digital publications, as well as coverage on local television. The project actively reached out to all Primary Education centers in the province of Zamora, as well as all Secondary Education and Baccalaureate centers, both public and private, via phone and email.

A total of 10 proposals addressing the WE Challenges were received. Six proposals were submitted by groups from four schools and secondary schools in Zamora. At the same time, the remaining four were individual submissions from two boys and two girls from Zamora and Burgos. All proposals were published on the YouTube channel of the activity[3].

Separate evaluation committees were formed for group and individual submissions to select the winning challenges. The final decisions were communicated to all participants and shared with the local media. The prizes awarded were focused on promoting STEM and included Arduino kits, Micro Bit boards, and educational assembly kits.

The 1st WE Challenges Competition awards ceremony took place at the end of June. It was held in the auditorium of the HPSZ and streamed live on YouTube. The closing ceremony was attended by approximately 150 people, including HPSZ teaching staff, primary and secondary school teachers from the participating centres, the students who were the protagonists of their proposals, and their families.

Through a brief open-ended survey, the professors were asked about their participation in the WE Challenges

[2] https://ingenieraszamora.usal.es/propuesta/

[3] https://youtube.com/playlist?list=PL5IYpWd9MmrzBS_SsKp284jGcmYnYp1x5

competition. They reported that it was highly beneficial for students, enriching their education and boosting their motivation. They appreciated that the proposal came from the University of Salamanca, as it strengthened the connection between the university and the school, while also helping students overcome fears and prejudices. They also indicated that it contributes greatly to several subjects and fits perfectly with the current curriculum. As an additional suggestion for the future, they asked to include a visit to the university laboratories.

All participants, both students and centres, were awarded a diploma recognising their participation and the position they achieved. Two prizes and two runner-up prizes were awarded in each group and individual category.

IV. Objectives and Hypotheses

The study presented here aims to fulfil the first objective of the "Engineering with a Gender Perspective" project:

- Analyse the perception of the educational community at HPSZ regarding equality and the gender gap in Engineering and Architecture.

The specific objective is:

- Examine whether there are differences in perception between students and teaching staff based on one demographic data, gender.

Based on these objectives, the scientific or working hypotheses that we intend to evaluate are as follows:

$H_{Equality} \rightarrow$ There exists a positive correlation between gender and the perception of equality in Engineering and Architecture.

$H_{Gap} \rightarrow$ There exists a positive correlation between gender and the perception of the gender gap in Engineering and Architecture.

To operationalise them, we will work with the following specific statistical hypotheses:

$H_1 \rightarrow$ There are no statistically significant differences (n.s. .05) in the perception of gender equality between men and women in the field of Engineering and Architecture.

$H_2 \rightarrow$ There are no statistically significant differences (n.s. .05) in the perception of the gender gap between men and women in the field of Engineering and Architecture.

$H_3 \rightarrow$ There are no statistically significant differences (n.s. 0.05) in the perception of stereotypes between men and women in the field of Engineering and Architecture.

V. Methodology

A. Research design. Measuring instrument.

To address the study's hypotheses, a non-experimental, descriptive, and correlational methodology [37] was employed, utilising survey techniques. Specifically, a self-administered questionnaire instrument was implemented in an online format.

A validated and published instrument, the GENCE 2.0 questionnaire (Gender Perspective in Computer Engineering 2.0), was selected and modified to suit the field of Engineering and Architecture [36]. This adaptation involved replacing references to Computer Engineering with Engineering and Architecture where applicable. Both student and lecture versions of the questionnaire were adjusted accordingly. The modified instrument was named the Gender and Diversity in Engineering and Architecture Studies Questionnaire.

The GENCE 2.0 questionnaire comprises three sections: identification, context and perception. This study focuses on analysing the "perception" section, with particular attention to the independent gender variable, which is collected in the identification section. This section is common to both versions of the questionnaire (students and lectures) (Table I).

In the identification section, participants provide information regarding the bachelor's degree program they are enrolled in or where they teach, their current academic year, gender, age range, and sexual orientation. Respondents select from a predefined list of options for each category, totalling five questions.

TABLE I.
Questions in the Perception Sect. Adapted GENCE 2.0 Questionnaire

Gender equality (8)	Gender gap (7)	Gender stereotypes (5)
Q13 - Engineering and Architecture students are treated differently by their teachers according to their gender	Q26 - Nowadays, women have more problems than men in finding a job in the Engineering and Architecture sector	Q18 - The women who make studies in Engineering and Architecture are not feminine enough
Q14 - People who enrol in Engineering and Architecture studies receive the same institutional support regardless of gender	Q27 - Nowadays, men and women receive the same remuneration for similar positions	Q19 - People who study Engineering and Architecture are considered "freaks" (rare)
Q15 - All people must have the same rights regardless of gender	Q28 - There is a need for more women to work in the Engineering and Architecture sector	Q20 - Women have more problems than men when programming, calculations or design
Q16 - Gender equality is an important issue that must be addressed from all spheres (family, education, social, and work)	Q29 - The gender gap is a fad	Q21- Gender influences the fulfillment of Engineering and Architecture studies.
Q17 - Gender equality must be part of the University's curricula	Q30 - The gender gap is not a problem that must be addressed as part of Engineering and Architecture studies	Q25 - Gender influences the fulfilment of Engineering and Architecture studies
Q22 - Men and women have the same opportunities to study engineering careers	Q31 - People working in the Engineering and Architecture sector must help reduce the gender gap in their sector	
Q23 - People in Engineering and Architecture studies treat their peers of another gender in the same way	Q32 - The gender gap is a problem that only affects women	
Q24 - The professors in Engineering and Architecture studies treat all students equally regardless of gender		

The context section delves into participants' experiences and perspectives, including inquiries about feelings of discrimination, support received for pursuing STEM studies, challenges related to their gender, and whether they have contemplated leaving the field of Engineering and Architecture at any point. This section comprises 11 questions, five of which are open-ended.

The perception section, which we will analyse, comprises 20 questions. For this study, we will categorise these questions into three blocks: gender equality (8 questions), gender gap (7 questions), and gender stereotypes (5 questions) (Table I). Respondents were required to answer these questions using a Likert scale ranging from 1 (Totally disagree) to 5 (Totally agree).

In order to assess the reliability or internal consistency of the sets of items assessed we used Cronbach's Alpha.

The adapted GENCE questionnaire was sent in Spanish to both students and lecturers.

B. Population

The study involved the participation of the educational community of the HPSZ (University of Salamanca). Specifically, it included all undergraduate students enrolled in programs offered at the HPSZ (N=473, Bachelor's Degrees in Mechanical Engineering, Civil Engineering, Technical Architecture, Agri-Food Engineering, Computer Engineering in Information Systems, Materials Engineering and Development of Interactive 3D Applications and Video Games; Double Bachelor's Degrees in Materials Engineering and Mechanical Engineering and in Computer Engineering in Information Systems and Information and Documentation). Additionally, it encompassed the teaching staff assigned to the HPSZ during the same academic year (N=102). Among the 473 surveyed students, 24.9% were female and 75.1% were male. Regarding the 102 lectures surveyed, 29.4% were female and 70.4% were male (Table II).

TABLE II.
DISTRIBUTION OF THE POPULATION

Group	Gender	Population - N	% by gender in population
Student	Women	118	24.9%
	Men	355	75.1%
	Total	473	100.0%
Faculty	Women	30	29.4%
	Men	72	70.6%
	Total	102	100.0%

C. Data collection

The questionnaire provided participants with information about the individual responsible for collecting data and outlined the objectives of the project. It was administered to the entire educational community of HPSZ, including both students and teaching staff. The GRIAL Survey Tool application, utilising the LimeSurvey administration interface provided by the USAL GRIAL research group, was employed for data collection.

Invitations to participate and complete the questionnaire were sent out via the institutional email of the University of Salamanca and were accessible to the HPSZ university community for one month. Participation was voluntary, and anonymity was assured.

To test the hypotheses, we analysed the responses to the questionnaire, focusing on the independent variable under study: self-identified gender of the participants. This variable, collected during the study, consisted of three closed response options: female, male, and "Prefer not to answer."

Descriptive and inferential techniques ensured statistical methods addressed research questions with both substantive and statistical significance. Descriptive methods summarise the information contained in the observed data, employing techniques such as measures of central tendency (mean, median, and mode), measures of dispersion (standard deviation), and graphical methods to facilitate the interpretation of specific variables [38]. In contrast, inferential methods aim to draw conclusions that extend beyond the observed data. Specifically, T-tests for independent samples were used to test hypotheses about differences between two independent means [39], [40]. Additionally, Cohen's D was applied to assess the practical significance of statistically significant differences [41].

Responses were analysed using the GRIAL SURVEY tool and the statistical software package SPSS Statistics 28, which was licensed by the University of Salamanca.

To ensure consistency in the data analysis, the collected responses underwent pre-processing. This involved standardising the interpretation of all responses, as certain items were formulated negatively. Specifically, items were reversed for questions Q13, Q18, Q19, Q20, Q21, Q25, Q27, Q29, Q30, and Q32.

Cronbach's Alpha reliability coefficient [42] will be utilised to assess the internal consistency of each block. This analysis will be conducted separately for each sector of the educational community surveyed within HPSZ. Certain items were excluded throughout this process to achieve alpha scores nearing the recommended value of 0.7. Table III details the eliminated items and the reliability and internal consistency results for each block and sector of the HPSZ educational community.

TABLE III.
INTERNAL CONSISTENCY

Perception	Cronbach's Alpha		Removed Items
	Students	Faculty	
Gender equality	.65	.65	Q14, Q17
Gender gap	.74	.74	--
Gender stereotypes	.71	.68	Q21

VI. RESULTS

A. Sample characteristics

A total of 88 students and 41 HPSZ teaching staff responded to the questionnaire (Table IV). In the student sector, the sample, regarding gender (independent variable of the study), is composed of 41 women, 44 men and 3 participants who chose "Prefer not to answer" (Table IV). The sample in the teaching staff sector includes 14 women, 26 men and 1 participant who preferred not to answer this question (Table IV). Due to the limited number of responses, the option "Prefer not to answer" has been excluded from the analysis.

TABLE IV.
DISTRIBUTION OF THE SAMPLE

Group	Gender	Sample n	% by gender in sample	% Participation
Student	Women	41	46.6%	34.7%
	Men	44	50.0%	12.4%
	Prefer not to answer	3	3.4%	-
	Total	88	100%	18.6%
Faculty	Women	14	34.1%	46.7%
	Men	26	63.4%	36.1%
	Prefer not to answer	1	2.4%	-
	Total	41	100%	40.2%

The undergraduate degrees with the greatest presence in the sample are Mechanical Engineering, with 29.5% of students (n=88) and 45% of teaching staff (n=41) and Computer Engineering in Information Systems, with 22.7% of students (n=88) and 22.5% of teaching staff (n=41) (Fig. 4).

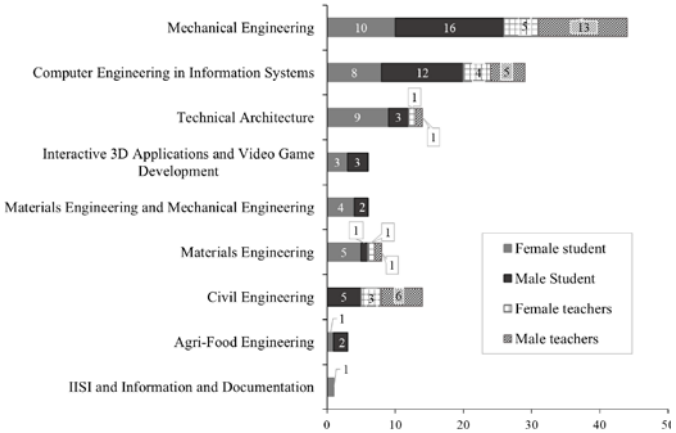

Fig. 4. Sample distribution by bachelor's degree programs and gender (students, n=88; faculty, n=41).

In terms of age distribution, in the case of students, the range between 21 and 25 is the most represented with 63.6% (students, n=88) and in the case of teaching staff, the ranges between 41 and 51 and between 55 and 60, both with 24.4% (teaching staff, n=41).

B. Descriptive analysis

In the gender equality perception block, it is observed that the assessment of all items approaches or exceeds a rating of 4. In the student sector, the overall mean for women is 4.25 (SD=0.91, n=41) and 4.30 (SD=1.05, n=44) for men. Among the teaching staff, the overall mean for women is 4.23 (SD=1.11, n=14) and for men is 4.59 (SD=0.76, n=26).

In the gender gap perception block, most of the items have ratings between 3 and 4. In this second block, the overall mean value in the student sector is 3.81 (SD=1.07, n=41) for women and 3.08 (SD=1.07, n=44) for men. The teaching staff's overall mean is 3.76 (SD=1.20, n=14) for women and 3.33 (SD=1.45, n=26) for men.

In the third block, concerning the perception of gender stereotypes, similar trends are observed as in the first block. The values of the items predominantly hover around 4 or higher. Specifically, in the student sector, the overall mean is 4.50 (SD=0.84, n=41) for women and 4.46 (SD=0.99, n=44) for men. Among the teaching staff, the overall mean is 4.79 (SD=0.48, n=14) for women and 4.79 (SD=0.44, n=26) for men, with a lower standard deviation noted (Fig. 5).

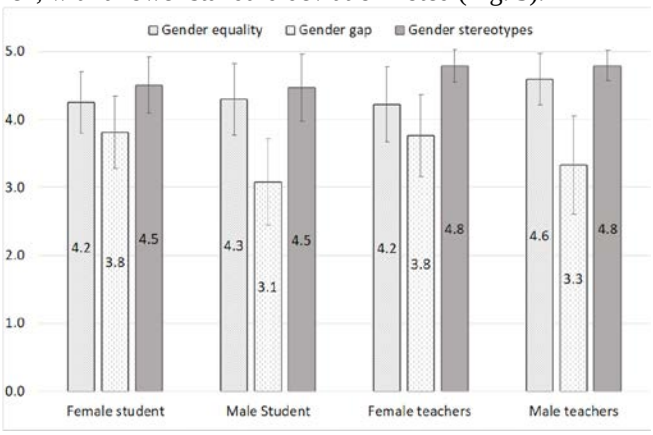

Fig. 5. Descriptive study. Mean values per block with standard deviation.

C. Analisys

Overall, statistically significant differences (n.s. .05 and n.s. .001) are noted in the perception of various statements related to gender equality, the gender gap, and gender stereotypes in engineering and architecture, which are the dependent variables of this study. In the student sector, these differences are observed in nine out of seventeen variables analysed: three at the significance level of $p < .05$ and six at $p < .001$. Furthermore, all these differences exhibit a high effect size (above .50) based on Cohen's d statistic [42] (Table V). Among lectures, only two variables display statistically significant differences (n.s. .01 and n.s. .05) when comparing responses between men and women, also with a high effect size (above .60) based on Cohen's d statistic [41] (Table V). In both sectors, the perception of an unequal situation is consistently more critical within the women's group.

Among the three blocks, the perception of the gender gap shows the largest discrepancies between genders.

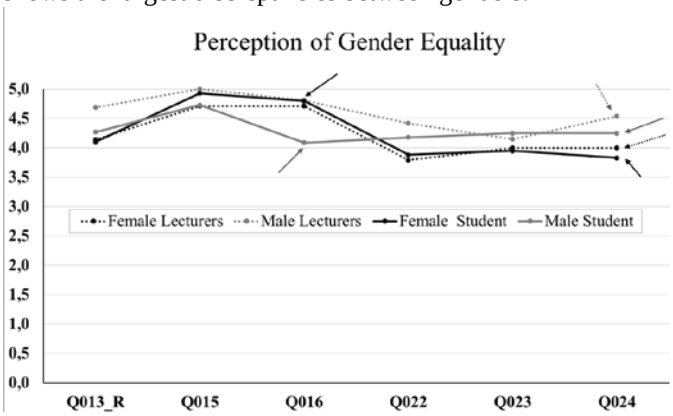

Fig. 6. Perception of gender equality among students and lectures, across both genders.

The study shows that the perception of gender equality is largely similar across both sectors and genders (Fig. 6). Statistically significant differences between men and women only appear in two of the variables analysed. In item Q16, "Gender equality is an important issue that must be addressed from all spheres (family, education, social, and work)", women in the student sector exhibit a more decisive response than men, with a lower standard deviation, and a n.s. of .001 (women:

n=41, mean=4.80, SD=.68; men: n=44, mean=4.09, SD=1.25), with a Cohen's d of .7.

TABLE V.
PERCEPTION OF GENDER EQUALITY. STUDENTS AND LECTURES, BOTH GENDERS

Group	Gender	N	Mean	SD	t	p	Cohen's d
			Q13_R				
Student	Woman	41	4.10	1.04	-0.80	.21	-.17
	Man	44	4.27	0.97			
Faculty	Woman	14	4.14	1.23	-1.43	.08	-.47
	Man	26	4.62	0.85			
			Q15				
Student	Woman	41	4.93	0.26	1.25	.12	.26
	Man	44	4.73	1.02			
Faculty	Woman	14	4.71	1.07	-1.38	.09	-.46
	Man	26	5.00	0.00			
			Q16				
Student	Woman	41	4.80	0.68	3.29	**<.001**[a]	.70
	Man	44	4.09	1.25			
Faculty	Woman	14	4.71	0.61	-0.42	.34	-.14
	Man	26	4.81	0.69			
			Q22				
Student	Woman	41	3.88	1.19	-1.20	.12	-.26
	Man	44	4.18	1.15			
Faculty	Woman	14	3.79	1.53	-1.4	.09	-.52
	Man	26	4.42	1.03			
			Q23				
Student	Woman	41	3.95	1.09	-1.29	.10	-.28
	Man	44	4.25	1.04			
Faculty	Woman	14	4.00	1.24	-0.39	.35	-.13
	Man	26	4,15	1.16			
			Q24				
Student	Woman	41	3.83	1.20	-1.82	**.04**[c]	-.40
	Man	44	4.25	0.89			
Faculty	Woman	14	4.00	0.96	-1.88	**.03**[c]	-.62
	Man	26	4.54	0.81			

[c] **n.s.: .05;** [a] **n.s.: .001**

In question Q24, "The professors in Engineering and Architecture studies treat all students equally regardless of gender", statistically significant differences also appear (Table V), but this time in both sectors, students and lectures, in both cases with n.s. 05 (female students: n=41, mean=3.83, SD=1.20; male students: n=44, mean=4.25, SD=.89, Cohen's d=-.4; female lectures: n=14, mean=4.00, SD=.96; male lectures: n=26, mean=4.54, SD=.81, Cohen's d=-.62). It is the female students and lectures who disagree the most with the statement.

It is worth noting that in response to a question such as "All people must have the same rights regardless of gender" (Q15), there is only one group, male lectures, whose response is unanimous and emphatic (n=26: mean=5; SD=0). In the remaining groups, although the mean score is close to 5, it is not as unequivocal (female lectures: n=14, mean=4.71; SD=1.07; female students: n=41, mean=4.93, SD=0.26; male students: n=44, mean=4.73, SD=1.02), regarding a fundamental issue outlined in the Universal Declaration of Human Rights [35].

The perception of the gender gap reveals its most pronounced distinctions, particularly within the student sector (Fig. 7). Among students, six out of the seven variables analysed exhibit statistically significant variances (five at n.s. .001 and one at n.s. .05, Table VI). The lone variable within this block that demonstrates similar perceptions across genders is "The gender gap is a problem that only affects women (R)" (Q32_R) (female students: n=41, mean=3.46, SD=1.12; male students: n=44, mean=3.64, SD=1.06; female lectures: n=14, mean=3.36, SD=1.55; male lectures: n=26, mean=3.88, SD=1.31). Neither sector appears definitively aligned on this matter (a survey value of 3 means "Neither agree nor disagree"). However, it is noteworthy that females in both sectors are more inclined to agree with the statement. It is possible that the wording of the item may be open to different interpretations.

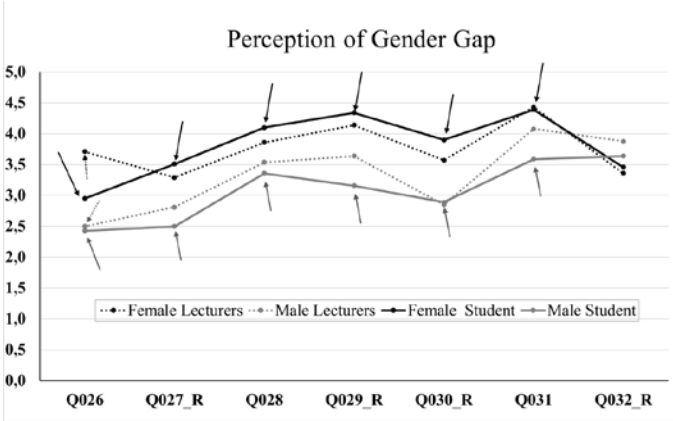

Fig. 7. Perception of the gender gap among students and lectures, across both genders.

TABLE VI.
PERCEPTION OF GENDER GAP. STUDENTS AND LECTURES, BOTH GENDERS

Group	Gender	N	Mean	SD	t	p	Cohen's d
			Q26				
Student	Woman	41	2.95	1.02	2.14	**.02**[c]	.46
	Man	44	2.43	1.21			
Faculty	Woman	14	3.71	1.20	2.68	**.006**[b]	.81
	Man	26	2.50	1.63			
			Q27_R				
Student	Woman	41	3.51	1.21	3.55	**<.001**[a]	.77
	Man	44	2.50	1.41			
Faculty	Woman	14	3.29	1.07	1.12	.14	.33
	Man	26	2.81	1.62			
			Q28				
Student	Woman	41	4.10	0.99	3.29	**<.001**[a]	.71
	Man	44	3.36	1.06			
Faculty	Woman	14	3.86	1.17	0.78	.22	.26
	Man	26	3.54	1.27			
			Q29_R				
Student	Woman	41	4.34	0.88	4.38	**<.001**[a]	.93
	Man	44	3.16	1.54			
Faculty	Woman	14	4.14	1.17	1.11	.14	.70
	Man	26	3.64	1.41			
			Q30_R				
Student	Woman	41	3.90	1.30	3.47	**<.001**[a]	.75
	Man	44	2.89	1.42			
Faculty	Woman	14	3.57	1.45	1.52	.07	.50
	Man	26	2.85	1.43			
			Q31				
Student	Woman	41	4.39	0.94	3.35	**<.001**[a]	.72
	Man	44	3.59	1.24			
Faculty	Woman	14	4.43	0.76	0.83	.20	.28
	Man	26	4.08	1.47			
			Q32_R				
Student	Woman	41	3.46	1.12	-0.73	.23	-.16
	Man	44	3.64	1.06			
Faculty	Woman	14	3.36	1.55	-1.14	.13	-.38
	Man	26	3.88	1.31			

[c] **n.s.:.05;** [b] **n.s.:.01;** [a] **n.s.: .001**

In both sectors of the educational community, significant differences emerge regarding item Q26, "Nowadays, women

have more problems than men in finding a job in the Engineering and Architecture sector" (n.s. < .01: female students: n=41, mean=2.95, SD=1.02; male students: n=44, mean=2.43, SD=1.21, Cohen's d=.46; n.s. < .05: female lectures: n=14, mean=3.71, SD=1.20; male lectures: n=26, mean=2.50, SD=1.63, Cohen's d=.81). Once again, responses tend to hover around the neutral value of 3 across both sectors and genders (as observed in most items within this category). However, it's noteworthy that female lectures exhibit stronger agreement with the statement, especially within this sector where Cohen's d is notably high (.81).

In the student sector, noticeable differences of more than one point between the means of women and men are observed in three of the remaining five variables within the block (n.s. .001) (Table VI). The responses to item Q29_R, "The gender gap is a fad" exhibit the greatest discrepancy, with a Cohen's d value of 0.93 (n.s. < .001: female students: n=41, mean=4.34, SD=0.88; male students: n=44, mean=3.16, SD=1.54). The other two items displaying substantial discrepancies are "The gender gap is not a problem that must be addressed as part of Engineering and Architecture studies (R)" (Q30_R) and "Nowadays, men and women receive the same remuneration for similar positions (R)" (Q27_R).

Of particular note regarding Q30_R is that, across both sectors, it is women who express stronger agreement that the gender gap should be addressed within Engineering and Architecture studies (n.s. < .001 - female students: n=41, mean=3.90, SD=1.30; male students: n=44, mean=2.89, SD=1.42, Cohen's d=.75; female lectures: n=14, mean=3.57, SD=1.45; male lectures: n=26, mean=2.85, SD=1.43, Cohen's d=.5). However, in the teaching staff sector, there are no statistically significant differences in this case. This pattern is also observed in Q27_R.

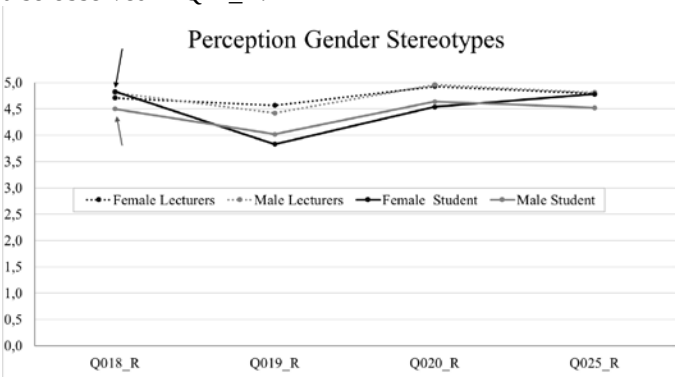

Fig. 8. Perceptions of gender stereotypes among students and lectures, across both genders.

In the final block, focusing on perceptions of gender stereotypes, responses from both students and lectures show remarkable homogeneity, with item ratings consistently exceeding 4.5 (all reversed items), except for one instance within the student demographic (Fig. 8). Notably, there are no statistically significant differences (n.s. .05) among teaching staff. Within the student sector, only one item (n.s. .05) shows statistically significant differences, namely item Q18_R: "The women who make studies in Engineering and Architecture are not feminine enough" (Table VII). Interestingly, female students strongly disagree with the statement, with high mean scores across both genders (female students: n=41, mean=4.83, SD=0.44; male students: n=44, mean=4.50, SD=1.04).

TABLE VII.
PERCEPTION OF GENDER STEREOTYPES. STUDENTS AND LECTURES, BOTH GENDERS

Group	Gender	N	Mean	SD	t	p	Cohen's d
			Q18_R				
Student	Woman	41	4.83	0.44	1.91	**.03**[c]	,40
	Man	44	4.50	1.04			
Faculty	Woman	14	4.71	0.61	-0.45	.33	-,15
	Man	26	4.81	0.63			
			Q19_R				
Student	Woman	41	3.83	1.22	-0.77	.22	-.17
	Man	44	4.02	1.09			
Faculty	Woman	14	4.57	0.65	0.65	.26	.22
	Man	26	4.42	0.70			
			Q20_R				
Student	Woman	41	4.54	0.98	-0.49	.31	-.11
	Man	44	4.64	0.89			
Faculty	Woman	14	4.93	0.27	0.45	.33	.15
	Man	26	4.96	0.20			
			Q25_R				
Student	Woman	41	4.78	0.57	-1.44	.08	-.31
	Man	44	4.52	1.02			
Faculty	Woman	14	4.79	0.58	-0.13	.45	-.04
	Man	26	4.81	0.49			

[c] **n.s.:.05**

VII. DISCUSSION OF RESULTS

The study presented herein aims to investigate the perceptions of equality and the gender gap in Engineering and Architecture among students and teaching staff. Additionally, we endeavour to discern whether these perceptions differ between genders. To achieve this, we have analysed variables pertaining to perception utilising the adapted GENCE 2.0 questionnaire [36].

It is noteworthy that, within the student sector, the sample was balanced in terms of gender representation, with 44 male participants and 41 female participants. However, it is important to highlight that, female students exhibited a higher participation level than their male counterparts. Specifically, 34.7% of female students from HPSZ (N=118) participated, while only 12.4% of male students (N=355) took part (Table III). As an initial observation, these findings suggest that male students display less interest in this subject matter than their female counterparts. This has been found in other similar studies [44], [45].

In the teaching staff sector, the sample is not evenly distributed in terms of gender representation (M: n=26; F: n=14). Nevertheless, there is a higher participation rate among female lectures (46.7%, N=30) compared to male lectures (36.1%, N=72), although the discrepancy is less pronounced than in the student sector (Table III). Despite the different age ranges, the appearance of the same pattern again suggests a lower level of interest or concern among men for equality issues and the gender gap. Gender equality is important because it unlocks the full potential of society by leveraging the talents of its entire population, driving progress towards global integration, innovation, and competitiveness.

The statistical hypothesis testing H_1, conducted through analysis of the "Gender equality" block (Table I), indicates no significant differences between the perceptions of women and

men regarding gender equality within the HPSZ's community (Table V, Fig. 6). Differences were observed only in two of the six analysed items. It should be noted that the responses of both students and teaching staff generally coincide, although with slight variations, with the teaching staff showing a greater conviction towards gender equality. Gender equality and diversity of thought enable society to harness the potential of its entire population, fostering inclusiveness, innovation, and global competitiveness [46]. Facilitating women's access to technology and engineering is crucial for closing diverse gender gaps and ensuring their complete participation in the technological revolution and leadership roles. Women's active involvement in developing advanced technologies, particularly in engineering, is pivotal for achieving the Sustainable Development Goals [47].

The significant difference (n.s. .05) observed among the teaching staff concerning item Q24, "The professors in Engineering and Architecture studies treat all students equally regardless of gender", may be associated with the fact that female lectures have taken on the role students, showing situations experienced in their university studies. As noted by [48], women encountering such barriers tend to perceive them as unjust. It is possible, especially in this sector but also among female students, to explore whether there is a correlation between the answers to this item and the question in the "context" section of the questionnaire: "Have you or anyone in your environment (family, friends, studies, etc.) ever experienced discrimination on the basis of gender or other factors such as sexual orientation, ethnicity, nationality, etc.? " In addition, examining the answers to the open-ended associated question, which asks about specific situations of discrimination, could provide valuable information. However, these correlations were not investigated in the present study. Understanding possible correlations could shed light on the observed response patterns.

The statistical hypothesis testing H_2, conducted through analysis of the "Gender gap" block (Table I), indicates statistically significant differences (primarily at n.s. .001) between women's and men's perceptions of the gender gap, especially among the youngest (Table VI, Fig. 7). This divergence was particularly evident in the student sector, where six out of the seven analysed variables exhibited significant disparities. Within the faculty sector for one variable. The gender disparity prevalent in STEM fields impacts team dynamics. To combat it is to promote scientific excellence and enhance the quality of STEM outputs by integrating perspectives that foster creativity, mitigate potential biases, and encourage more robust knowledge and solutions [6], [49]. Women are more collaborative and their greater presence in STEM teams improves results [50] and, therefore, company performance [51]. It is essential to perceive gender gap to combat it. The STEM field is a field of gender inequality, and in that situation, it is not easy to distinguish whether the difficulties encountered are personal or systemic [48], [52]. The study indicates a tepid conviction regarding the existence of the gender gap within the Higher Polytechnic School of Zamora's educational community, spanning both male and female participants (Fig. 7). Across both sectors, the ratings within this block ranged from a minimum of 2.43 to a maximum of 4.39, with the most common rating, or mode, being 2.50. Without awareness of the gender gap, efforts to mitigate it will falter [53], underscoring the necessity of raising awareness broadly, particularly among younger men.

The statistical hypothesis testing H_3, examining the perception of gender stereotypes, conducted by analysing the "Gender stereotypes" block (Table I), reveals no significant differences in perception between women and men in either sector (Table VII, Fig. 8). Only one variable in the student sector shows statistically significant differences (n.s. .05), albeit with notably high mean values (Q18_R). Gender stereotypes remain pervasive within today's society, particularly in the STEM field [54]. These stereotypes shape our emotions, thoughts, and behaviours [55], often carrying negative implications that can hinder women's leadership and success [56]. Thus, it is crucial to engage at all educational stages, particularly during early years, to diminish gender stereotypes and address inequality within STEM [54]. However, the study conducted at the university level within the HPSZ suggests a promising trend of recognising and rejecting these gender stereotypes.

The analysed results confirm the second scientific or working hypothesis (H_{Gap}). They provide evidence of a positive correlation between gender and the perception of the gender gap in Engineering and Architecture, particularly within the student sector. However, the former ($H_{Equality}$) has to be disregarded. There is little evidence showing correlation between gender and perception of gender equality, in any of the sectors of the educational community, students and faculty.

VIII. Conclusions

The initiatives under the equality project "Engineering with a Gender Perspective" have been warmly embraced, both within the university and in the wider social environment of Zamora. Female members of the university have actively showcased their teaching and research endeavours, while students have displayed enthusiasm in engaging with these activities and discussions.

Gender mainstreaming adds depth to the study by highlighting the divergent viewpoints and experiences between men and women pursuing studies in engineering.

It is widely recognised that the gender gap fosters inequality. This study indicates that in the HPSZ university community, consisting of people working or studying at the university, there is a belief in gender equality and recognition of stereotypes. However, there is a lack of clear recognition of the gender gap in engineering and architecture.

The research reveals that women are more critical of their position in Engineering and Architecture, and perceive the gender gap more acutely than men. Regarding gender equality and stereotypes, there is a similar perception between both sexes within the university community. Therefore, there is a need to increase social awareness, especially among younger people, as men tend to perceive the situation of women in Engineering and Architecture less comprehensively. Practical

steps, such as mentorship programs and stereotype-challenging initiatives, could help address these issues.

The collected data provide interesting findings; however, a key limitation of the study is the sample size, which necessitates caution in interpreting the results. These findings may not fully represent all students and faculty within the Engineering and Architecture domain, warranting further examination in future research. Additionally, these should consider cultural and socio-economic factors to gain a deeper understanding in gender perception analysis.

IX. Future Works

HPSZ students have cited their personal interest in the field as their primary motivation for studying engineering [32]. Additionally, there appears to be limited awareness of the gender gap among these students. These findings underscore the importance of introducing Primary and Secondary Education initiatives, such as those proposed in this project. Through these initiatives, both boys and girls have the chance to participate in hands-on activities like building structures, programming, and connecting science to their daily lives. Such efforts hold the potential to significantly boost their interest and enjoyment in these subjects. Given the success of this initiative, we believe it would be beneficial to host biannual challenges within the HPSZ framework. In 2024, the "All WE are STEAM" project [57] is underway in HPSZ, featuring the 2nd WE Challenge Competition for pre-university students[4].

The heightened concern among HPSZ students about the impact of academic failure [6], [15], [32] has reinforced our commitment to continuing the mentoring program for first-year HPSZ students [58]. We advocate for peer mentoring with a gender perspective. Initially launched exclusively for women in the 2020/21 academic year [59], the program expanded to include all first-year students of HPSZ (USAL) starting from the 2022/23 academic year [60]. Third and fourth-year students serve as mentors, providing support to first-year students. In the 2023/24 academic year, the program engaged 35 first-year students and 28 upper-year students [61], continuing in the 2024/25 academic year.

To further address the gender gap and drawing from our experience, we recommend establishing a dedicated forum within the HPSZ university community for discussions and debates. This initiative aims to enhance the visibility of women in the academic sphere [32-34]. Additionally, formal collaboration agreements between the university and local organisations should be considered to foster stronger ties between the university and the community. Such partnerships will promote community development and empowerment, emphasising principles of equality and respect for rights.

Acknowledgment

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[4] https://ingenieraszamora.usal.es/all-we-are-steam-retos-2024/

References

[1] World Economic Forum. *Global gender gap report 2023*. Geneva, Switzerland, 2022. Available: https://www.weforum.org/publications/global-gender-gap-report-2023/

[2] Fundación Conocimiento y Desarrollo. *Informe CYD 2023*. Barcelona, Spain, 2023. Available: https://www.fundacioncyd.org/publicaciones-cyd/informe-cyd-2023/

[3] Ministerio de Ciencia, Innovación y Universidades. *Estadística de estudiantes, curso 2022/2023*, June 2023. Available: https://www.universidades.gob.es/estadistica-de-estudiantes/

[4] Universidad de Salamanca. Unidad de evaluación de la calidad, observatorio de la calidad y el rendimiento académico. *Evolución de la matrícula de grado*. Available: https://indicadores.usal.es/portal/estudiantes/evolucion-de-matricula/

[5] S. Verdugo-Castro, S. "*The gender gap in university studies in the STEM sector in the Spanish education system*", PhD thesis, PhD Programme Education in the Knowledge Society, Universidad de Salamanca, Salamanca, Spain, 2022. Available: https://repositorio.grial.eu/handle/grial/2669

[6] UNESCO. *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM)*, 2017. Available: https://doi.org/10.54675/QYHK2407

[7] M. Grañeras Pastrana, M.E. Moreno Sánchez and N. Isidoro Calle. *Radiografía de la brecha de género en la formación STEAM*. Ministerio de Educación y Formación Profesional, Madrid, Spain, 2022. Available: https://www.educacionfpydeportes.gob.es/dam/jcr:95061d7e-da6f-46ad-a828-53f5d604697c/libro-steam-1-2-22-web-.pdf

[8] M. Guenaga and A. Eguíluz, P. Garaizar and A. Mimenza. "The impact of female role models leading a group mentoring program to promote STEM vocations among young girls" *Sustainability*, vol 14, no 3:1420, 2022. Available: https://doi.org/10.3390/su14031420

[9] Ş. M. Uludüz, and M. Çalik. "A Thematic Review of STEM Education for Disadvantaged Students". *Canadian Journal of Science, Mathematics and Technology Education*, vol 22, pp. 938–958, 2022. Available: https://doi.org/10.1007/s42330-022-00247-w

[10] M.T. Wang and J. L. Degol. "Gender gap in Science, Technology, Engineering, and Mathematics (STEM): current knowledge, implications for practice, policy, and future directions", *Educational Psychology Review*, vol. 29, pp. 119–140, 2017. Available: https://doi.org/10.1007/s10648-015-9355-x

[11] S. Verdugo-Castro, A. García-Holgado and M. C. Sánchez-Gómez. "The gender gap in higher STEM studies: A systematic literature review", *Heliyon*, vol. 8, no. 8:E10300, 2022. Available: https://doi.org/10.1016/j.heliyon.2022.e10300

[12] M. M. Msambwa, K. Daniel, C. Lianyu, and A. Fute. A systematic review of the factors affecting girls' participation in science, technology, engineering, and mathematics subjects. *Computer Applications in Engineering Education*, vol. 32, no 2:E22707, 2023. Available: https://doi.org/10.1002/cae.22707

[13] J. M. Delaney and P.J. Devereux, "Gender differences in STEM persistence after graduation", *Economica*, vol. 89, pp. 862-883, 2022. Available: https://doi.org/10.1111/ecca.12437

[14] F. Beroíza-Valenzuela Francisca and N. Salas-Guzmán Natalia. "STEM and gender gap: a systematic review in WoS, Scopus, and ERIC databases (2012–2022)", *Frontiers in Education*, vol. 9, 2024. Available: https://doi.org/10.3389/feduc.2024.1378640

[15] L. Cobreros, J. Galindo and T. Raigada. *Mujeres en STEM. Desde la educación básica hasta la carrera laboral*, EsadeEcPol – Center for Economic Policy, March 2024. Available: https://www.esade.edu/ecpol/wp-content/uploads/2024/03/Mujeres-en-STEM-2024-1.pdf

[16] S. González-Pérez, R. Mateos de Cabo, and M. Sainz, "Girls in STEM: Is it a female role-model thing?", *Frontiers in Psychology*, Vol. 11, 2204, 2020. Available: https://doi.org/10.3389/fpsyg.2020.02204

[17] T. Breda, J. Grenet, M. Monnet, and C. Van Effenterre, *Do female role models reduce the gender gap in science? Evidence from classroom interventions in French high schools*, Discussion Paper Series 13163, IZA Institute of Labor Economics., 2020. Available: https://docs.iza.org/dp13163.pdf

[18] M.C. Saffie-Robertson, "It's not you, it's me: An exploration of mentoring experiences for women in STEM", *Sex Roles* Vol. 83, pp. 566–579, 2020. Available: https://doi.org/10.1007/s11199-020-01129-x

[19] H. Stoeger, M. Heilemann, T. Debatin, M.D.S.Hopp, S. Schirner, and A. Ziegler, "Nine years of online mentoring for secondary school girls in STEM: an empirical comparison of three mentoring formats", *Ann. N.Y. Acad. Sci*., vol. 1483, pp. 153-173, 2021. Available: https://doi.org/10.1111/nyas.14476

[20] A. García-Holgado, S. Segarra-Morales, A.B. González-Rogado, and F.J. García-Peñalvo, F. J. "Definition and Implementation of W-STEM mentoring network". In M. Estrada & A. García-Holgado (Eds.), *Proceedings of the XIV Congress of Latin American Women in Computing 2022* (LAWCC 2022) co-located with XLVIII Latin American Computer Conference (CLEI 2022), Antioquia, Colombia, October 19-20, 2022, pp. 32-41. CEUR-WS.org. Available: https://ceur-ws.org/Vol-3321

[21] Z. Gecu-Parmaksiz, J. Hughes, and T. Butler-Ulrich. "An overview of current after school -OST STEM programs for girls", *Journal of Digital Life and Learning*, vol. 1, no. 1, 2021, pp. 68-92. Available: https://doi.org/10.51357/jdll.v1i1.150

[22] A. Cloutier, G. Yew, S. Gupta, K. Dissanayake, P. Monaco, S. Mengel, and A. Morse, "Modification and assessment of a residential summer program for high school women", *Journal of Pre-College, Engineering Education Research (J-PEER)*, vol. 8, no. 2, 2018, article 2. Available: https://doi.org/10.7771/2157-9288.1193

[23] J. Carballo, A. M. Gómez-Rodríguez and M. de las Nieves Lorenzo-González, "Providing female models and promoting vocations: A practical experience in STEM fields," in *IEEE Revista Iberoamericana de Tecnologias del Aprendizaje*, vol. 15, no. 4, Nov. 2020, pp. 317-325, Available: https://doi.org/10.1109/RITA.2020.3033217

[24] R. Rama-Ballesteros, S. Montalvo-Quirós, R. Perezzan, D. Herráez-Aguilar, and C. Fernández-Jiménez, "Django girls in secondary school: enhancing programming resources and skills through project-based learning", *INTED2024 Proceedings*, 2024, pp. 3949-3958. Available: https://doi.org/10.21125/inted.2024.1020

[25] K. Grosch, S. Haeckl, and M. G. Kocher, "Closing the gender STEM gap-A large-scale randomised controlled trial in elementary schools", *CESifo Working Paper*, no. 9907, 2022. Available: https://www.cesifo.org/node/71193

[26] R. Vilanova, C. Fernández-Córdoba, J. Lopez Vicario, and A. Espinosa Morales, "We want to be engin@@rs: Early stage stem motivating actions", *EDULEARN22 Proceedings*, 2022, pp. 6381-6388. Available: https://doi.org/10.21125/edulearn.2022.1507

[27] A. Peterson, M. Gaskill, and J. Cordova, "Connecting STEM with social emotional learning (SEL) curriculum in elementary education". In E. Langran and J. Borup (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference*, 2018, pp. 1212-1219, Washington, D.C., United States: Association for the Advancement of Computing in Education (AACE). Available: https://www.learntechlib.org/primary/p/182681/

[28] M. Levine, N. Serio, B. Radaram, S. Chaudhuri, and W. Talbert, "Addressing the STEM gender gap by designing and implementing an educational outreach chemistry camp for middle school girls", *Journal of Chemical Education*, vol. 92 (10), 2015, pp. 1639-1644. Available: https://doi.org/10.1021/ed500945g

[29] Red2Red Consultores S.L., *Guía de coeducación. síntesis sobre la educación para la igualdad de oportunidades entre mujeres y hombres*, Colección Observatorio, no. 9. Instituto de la Mujer (Ministerio de Igualdad, Gobierno de España), 2008. Available: https://www.inmujeres.gob.es/observatorios/observIgualdad/estudiosInformes/docs/009-guia.pdf

[30] A. Carrión, R. Cabrera and M. Huerta, "A Scoping Review and Bibliometric Analysis of Strategies to Increase Girls' Motivation in STEM," *2024 IEEE World Engineering Education Conference (EDUNINE)*, Guatemala City, Guatemala, 2024, pp. 1-6, Available: https://doi.org/10.1109/EDUNINE60625.2024.10500571

[31] "*Engineering with a gender perspective*" Instituto de las Mujeres, Ministerio de Igualdad. Gobierno de España, PAC 2021, INMUJERES, (reference number: 35/7ACT/21).

[32] A.B. González-Rogado, S. Nieto-Isidro and A. García-Holgado, "Access and dropout in engineering and architecture studies. A preliminary study with a gender perspective" in *Lecture Notes in Educational Technology*, Salamanca, Spain: Springer Science and Business Media Deutschland GmbH, 2023, pp. 431-439. Available: https://doi.org/10.1007/978-981-99-0942-1_44

[33] J.P. Salazar-Fernández, M. Sepúlveda, and J. Muñoz-Gama, "Influence of student diversity on educational trajectories in engineering high-failure rate courses that lead to late dropout", in *IEEE Global Engineering Education Conference (EDUCON)*, Dubai, United Arab Emirates: IEEE, 2019, pp. 607–616. Available: https://doi.org/10.1109/EDUCON.2019.8725143

[34] H.M. Matusovich, R.A. Streveler, and R.L. Miller, "Why do students choose engineering? A qualitative, longitudinal investigation of students' motivational values." *Journal of Engineering Education*, vol. 99, no. 4, October 2010, pp. 289–303. Available: https://doi.org/10.1002/j.2168-9830.2010.tb01064.x

[35] A. B. González-Rogado, A. B. Ramos-Gavilán, A. M. Vivar-Quintana, M. A. Rodríguez-Esteban, I. Revilla and A. García-Holgado, "Engineering with a gender perspective in higher education at a Spanish university" XIII International Conference on Virtual Campus, Porto (Portugal). 25-26 September, 2023. Available: https://www.uajournals.com/jornadascampusvirtuales

[36] A. García-Holgado, J. Mena., C.S. González S. and F. J. García-Peñalvo, "GENder perspective in Computer Engineering: GENCE questionnaire" (Technical Report GRIAL-TR-2019-001). Retrieved from https://repositorio.grial.eu/handle/grial/1487 Salamanca, Spain: GRIAL Research Group, 2019. Available: https://doi.org/10.5281/zenodo.2550690

[37] F. Kerlinger, and H. Lee, *Investigación del comportamiento. Métodos de investigación en ciencias sociales*. México DF: McGraw-Hill, 4ª ed, 2001

[38] J. Etxebarria. and F. J. Tejedor, *Análisis Descriptivo de Datos en Educación*. Madrid (Spain): La Muralla, 2005.

[39] F. J. Tejedor and J. Etxebarria, *Análisis Inferencial de Datos en Educación*. Madrid (Spain): La Muralla, 2006.

[40] L. Lizasoain and L. Joaristi, "Las nuevas tecnologías y la investigación educativa: El análisis de datos de variables categoriales". *Revista Española de Pedagogía*, vol. 70, no. 251, 2012, pp. 111-130.

[41] J. Cohen, *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Routledge, 1988. Available: https://doi.org/10.4324/9780203771587

[42] L. J. Cronbach, "Test "reliability": Its meaning and determination", *Psychometrika* vol. 12, 1947, pp. 1–16. Available: https://doi.org/10.1007/BF02289289

[43] UN General Assembly. *Universal Declaration of Human Rights* (217 [III] A). Paris, France, 1948.

[44] S. Verdugo-Castro, M. C. Sánchez-Gómez, and A. García-Holgado, "University students' views regarding gender in STEM studies: Design and validation of an instrument", *Educ. Inf. Technol*, vol. 27, 2022, pp. 12301–12336. Available: https://doi.org/10.1007/s10639-022-11110-8

[45] M-J. Wu, K. Zhao, and F. Fils-Aime, "Response rates of online surveys in published research: A meta-analysis", *Computers in Human Behavior Reports*, vol. 7, pp. 100206, 2022, Available: https://doi.org/10.1016/j.chbr.2022.100206

[46] E. D. Dos Santos, A. Albahari, S. Díaz, and E. C. De Freitas, "'Science and technology as feminine': raising awareness about and reducing the gender gap in STEM careers", *Journal of Gender Studies*, vol. 31, no. 4, 2022, pp. 505–518. Available: https://doi.org/10.1080/09589236.2021.1922272

[47] UNESCO, *Engineering for Sustainable Development: delivering on the Sustainable Development Goals*, 2021. Available: https://unesdoc.unesco.org/ark:/48223/pf0000375644

[48] S. R. Bird, and L. A. Rhoton, "Seeing isn't always believing: gender, academic STEM, and women scientists' Perceptions of Career Opportunities", Gender & Society, vol. 35, no. 3, 2021, pp. 422-448. Available: https://doi.org/10.1177/08912432211008814

[49] H. Lee, H. and E. Pollitzer, *Gender in science and innovation as component of inclusive socioeconomic growth*. a gender summit® report. London, Portia Ltd., 2016. Available: https://gender-summit.com/images/Gender_and_inclusive_innovation_Gender_Summit_report.pdf

[50] A. Woolley, and, T. Malone, "What makes a team smarter? More women", *Harvard Business Review*, vol. 89 no. 6, 2011 Jun, pp. 32-33. Available: https://hbr.org/2011/06/defend-your-research-what-makes-a-team-smarter-more-women

[51] A. A. Niler, R. Asencio, and, L. A. DeChurch, "Solidarity in STEM: How gender composition affects women's experience in work teams", *Sex Roles* vol. 82, 2020, pp. 142–154. Available: https://doi.org/10.1007/s11199-019-01046-8

[52] D. M. Britton, “Beyond the chilly climate: The salience of gender in women’s academic careers”, *Gender & Society*, vol. 31, no. 1, February 2017, pp. 5–27. Available: https://doi.org/10.1177/0891243216681494
[53] A. G. Holgado, C. S. González-González and F. J. García-Peñalvo, “Gender gap perceptions of computing students: a case study in two Spanish universities” *2020 X International Conference on Virtual Campus (JICV)*, Tetouan, Morocco, 2020, pp. 1-4, Available: https://doi.org/10.1109/JICV51605.2020.9375768
[54] A. A. Rogers, M. Boyack, R. E. Cook, and, E. Allen, “School connectedness and STEM orientation in adolescent girls: the role of perceived gender discrimination and implicit gender-science stereotypes”, *Sex Roles*, vol. 85, 2021, pp. 405–421. Available: https://doi.org/10.1007/s11199-021-01224-7
[55] A.A. Eaton, J. F. Saunders, R. K. Jacobson, and, K. West, “How gender and race stereotypes impact the advancement of scholars in STEM: Professors’ biased evaluations of physics and biology post-doctoral candidates”, *Sex Roles*, vol. 82, 2020, pp. 127-141. Available: https://doi.org/10.1007/s11199-019-01052-w
[56] M. A. Beasley, and M. J. Fischer, “Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors”, *Social Psychology of Education*, vol. 15, no. 4, 2012, pp. 427–448. Available: https://doi.org/10.1007/s11218-012-9185-3
[57] “*All WE are STEAM*” Instituto de las Mujeres, Ministerio de Igualdad. Gobierno de España, PAC 2023, INMUJERES, (reference number: 31-4ACT-23)
[58] “*Programa de mentorías con perspectiva de género para mujeres en carreras STEM*” Instituto de las Mujeres, Ministerio de Igualdad. Gobierno de España, PAC 2021, INMUJERES, (reference number: 35/3ACT/21)
[59] A. B. González-Rogado, A. García-Holgado, and F. J. García-Peñalvo, “Mentoring for future female engineers: pilot at the Higher Polytechnic School of Zamora” in *2021 XI International Conference on Virtual Campus (JICV)*, Salamanca, Spain, 30/9-1/11, 2021, pp. 1-4, IEEE. Available: https://doi.org/10.1109/JICV53222.2021.9600410
[60] “*Mentoras 4.0: creación de espacios coeducativos en carreras STEM*” Instituto de las Mujeres, Ministerio de Igualdad. Gobierno de España, PAC 2022, INMUJERES, (reference number: 18/4ACT/22)
[61] “*Fortalecimiento de espacios coeducativos en carreras STEM: mentorías con perspectiva de género*” Instituto de las Mujeres, Ministerio de Igualdad. Gobierno de España, PAC 2023, INMUJERES, (reference number: 31-3ACT-23)