A Case Study in Brazil and Spain about the Students' Perception of the Gender Gap in Computing*

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Foster diversity and inclusion are part of the strategic actions of public and private organizations. Some of these actions are focused on increasing the representation of historically underrepresented groups and investing in creating a culture where all employees can reach their potential. Moreover, there are sectors in which the lack of inclusive environments is more critical. In particular, in the engineering and technology sectors, there is a lack of diversity related to gender and race. This problem is present in all worldwide regions, despite vary from one to another. Regarding the gender gap, governments and organizations put their efforts into reducing it in engineering and technology through actions mainly focused on engaging more women into these areas, avoiding dropping out during STEM studies, and joining the labor market. In this context, we have developed a project to mainstream gender within this framework and foster diversity in computer engineering studies. The project has two main objectives: prepare students to introduce diversity and inclusion as part of the software development processes; and build work environments that follow the principles of diversity and inclusion. In order to improve the actions related to both objectives, this study collects the perception of students regarding the gender gap in computer engineering studies to answer two questions: R1 – What kind of support do computer engineering students have before starting their university studies?; R2 – Are there differences between the perception of the students in Brazil and Spain related to the social, academic, and professional context? The results show that almost half of the participants had not received any support before studying Computer Engineering. On the other hand, mothers are the principal support in both countries. Finally, the results show that Spanish participants have more awareness of the lack of women in the engineering and technological sector and the need to work on this issue.

Keywords: gender gap; computer engineering; women; quantitative analysis

1. Introduction

Diversity is an inherent characteristic of the societies of the world. Diversity can be defined as observable and non-observable characteristics among group members [1]. Gender, race, ethnicity or age, are observable characteristics. Meanwhile, attitudes and values are non-observable or deep-level characteristics [2, 3]. According to [4], most of the studies related to diversity theory and research are focused on two dimensions, gender, and race.

When we talk about diversity, we should also take into account inclusion. Both concepts are interconnected. Diversity is used to describe the composition of groups or workforces [5]. Meanwhile, inclusion means "creating an environment that acknowledges, welcomes, and accepts different approaches, styles, perspectives, and experiences, to allow all to reach their potential and result in enhanced organizational success" [6].

Nowadays, organizations seek to foster diversity and inclusion through increasing representation of historically underrepresented groups and investing in creating a culture where all employees can reach their potential. Although these goals should be achieved in all the sectors, there are differences among them. In particular, there is a lack of inclusive environments in the engineering and technology sectors, with a particular focus on gender and race [7]. According to the Commission's 2020 Women in Digital (WiD) Scoreboard, only 18% of ICT specialists in the European Union are women [8]. This percentage ranged between 13% (Korea) and 32% (South Africa) in G20 economies for which data are available [9].

This gender gap has an impact on the economic growth of the countries. Meanwhile, the labor market is transforming as the Fourth Industrial Revolution unfolds [10, 11]; only around 26% of jobs in the technology sector are carried out by women [12]. Companies seek to harness new and emerging technologies to reach higher levels of efficiency of production and consumption, expand into new markets, and compete on new products for a global consumer base composed increasingly of digital natives [11].

Governments and organizations put their efforts into reducing the gender gap in engineering and technology and science and mathematics (STEM). Some actions cover all educational stages and the labor market [9, 13, 14]. However, these initiatives are usually focused on engaging more women in these areas, avoiding dropping out during STEM studies, and joining the labor market.

We have developed a project to mainstream gender within this framework and foster diversity in computer engineering studies [15, 16]. The project has two main objectives: prepare students to introduce diversity and inclusion as part of the software development processes; and build work environments that follow the principles of diversity and inclusion. In this work, we answer the following questions: R1: What kind of support do computer engineering students have before starting their university studies?; R2: Are there differences between the perception of the students in Brazil and Spain related to the social, academic, and professional context?

A validated instrument, called GENCE (GENder perspective in Computer Engineering questionnaire), has been developed as part of the project to identify the perception of computer engineering students about issues related to gender and diversity [17]. Version 2.0 of the instrument comprises 20 items organized in three dimensions (social perception, professional competence, and academic perception).

This work describes a case study conducted in Brazil and Spain to analyze the perception of computer engineering students using GENCE 2.0. The instrument was applied in three institutions, the University of Salamanca and the University of La Laguna in Spain, and the Mackenzie Presbyterian University in Brazil.

This paper has been divided into four sections. Second section details the methodology: the target population, the instrument, the study design, and the data collection process. The third section presents the comparative analysis regarding gender, country, and other socio-demographic variables. The fourth section describes the discussion of the results. Finally, the last section summarizes the main conclusions derived from this work.

2. Methodology

2.1 Participants

The Mackenzie Presbyterian University (MACKENZIE) is a Brazilian private university based in Sao Paulo created in 1870. It is one of the oldest institutions of higher education in Brazil. In particular, the population was composed of students and graduates from the B.S. in Computer Science and the B.S. in Information Systems at the Faculty of Computing and Informatics (FCI).

Regarding the Spanish institutions, the population is composed of students and graduates from the B.S. in Computer Engineering at the University of Salamanca (USAL) and University of La Laguna (ULL). These institutions are in two different regions of Spain, one located in the peninsula and another in the Canary Islands.

2.2 Instrument

GENCE 2.0 is a questionnaire developed and validated across the last three years by García-Holgado et al. [18]. The instrument is divided into three sections:

- Background (12 items): a set of questions related to the decisions made and the support received before enrolling in the computer studies. These questions were a combination of tailor-made items and an adaptation of previous works [19, 20].
- Demographic information (9 items): Highest course enrolled, gender avoiding binary bias, age, sexual orientation, family unit, the person who contributes the most income to the family unit – plus his/her highest level of education, his/her employment situation, and his/her occupation according to the ten main groups of ISCO-08).
- Opinion (20 items): Five-level Likert items (Table 1) about the students' perception about the gender differences in the computing sector covering three dimensions – social perception, professional competence, academic perception. The Likert scale expresses agreement (1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, 5 = strongly agree).

The GENCE 2.0 was initially developed and validated in Spanish. Also, it was available in Chinese and translated into English. Furthermore, it was translated into Brazilian Portuguese to conduct this study. Native speakers reviewed the translation in order to adapt the academic vocabulary.

2.3 Study Design and Data Collection

The questionnaire was applied in the 2019–20 academic year. It was implemented in a hosted version of LimeSurvey to share in an online format. The students voluntarily participated in this study and decided whether to complete the questionnaire. Anonymity was guaranteed.

The authors were in charge of sharing the questionnaire among the computing students in their institutions. In the Spanish institutions, mail and contact through the virtual campus were used to achieve the population. Regarding the Brazilian institution, the main channels were mail and the Facebook group of students of the Faculty of Computing and Informatics.

Regarding data analysis, the answers were downloaded in CSV format and imported into SPSS

Table 1. Likert items of GENCE 2.0 to measure the perception of the gender gap in computing

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

Statistics 25 (License of the University of Salamanca) to conduct the statistics test. We reverse the score of the items negatively phrased (Q13, Q18, Q19, Q20, Q21, Q25, Q27, Q29, Q30, and Q32), so all items have the same scale.

We used Cronbach's alpha coefficient to measure the internal consistency of each dimension for each sample (Table 2). Although both samples used the same instrument, the translation into Brazilian Portuguese could modify the instrument's consistency. We have removed several items from each dimension during this process to achieve alpha scores over the recommended value of 0.7 [21]. In particular, items Q17, Q19, Q26, Q27, and Q32 were deleted due to negative item-total correlations.

3. Results

We collected 207 valid responses, 95 from Spain (45.9%) with a similar distribution between institutions (42.1% from ULL and 57.9% from USAL) and 112 from Brazil (54.1%). Regarding gender, 35.3% are women, 61.8% are men, 0.5% are non-binary (not mentioned above) and 2.4% preferred not to answer. Table 3 summarizes the main characteristics of the sample.

Regarding the analysis of the results, Table 4 shows the descriptive statistics of the students' responses grouped by country. There are visible differences between countries, although it is necessary to perform hypothesis contrasting to confirm it. According to the Kolmogorov-Smirnov test, the items do not follow a normal distribution for $p < 0.05$. Therefore, non-parametric tests are used to perform hypothesis contrasting regarding a set of characteristics.

First, we analyze significant differences between both countries using the Mann-Whitney U test (Table 5). The results show statistical differences in all items except Q16, Q20, and Q25 for $p < 0.05$. Based on these results, we have further analyzed whether these differences are due to some of the characteristics collected by the instrument. In particular, we have considered gender and discrimination based on previous studies with the same

Table 2. Cronbach's alpha coefficient per dimension/sample

	Alpha – Spain	Alpha – Brazil	Alpha – Total	Deleted items
Social perception	0.799	0.818	0.818	Q19, Q32
Professional competence	0.851	0.335	0.673	Q26
Academic perception	0.693	0.808	0.813	Q17, Q27

Table 3. Distribution of the sample per gender, age, discrimination, support received to start the computer studies and consider drop-out computer studies

Variables	**Spain (N = 95)**	**Brazil (N = 112)**	**Total (N = 207)**
Gender			
Women	23 (24.2%)	50 (44.6%)	73 (35.3%)
Men	67 (70.5%)	61 (54.5%)	128 (61.8%)
Not mentioned above	1 (1.1%)	0	1 (0.5%)
Preferred not to answer	4 (4.2%)	1 (0.9%)	5 (2.4%)
Age			
Less than 20 years old	65 (68.4%)	16 (14.3%)	81 (39.1%)
Between 21 and 25	29 (30.5%)	19 (17.0%)	48 (23.2%)
Between 26 and 30	1 (1.1%)	15 (13.4%)	16 (7.7%)
Between 31 and 35	0	19 (17.0%)	19 (9.2%)
Between 36 and 40	0	17 (15.2%)	17 (8.2%)
More than 40 years old	0	26 (23.2%)	26 (12.6%)
Discrimination[a]			
Yes	28 (29.5%)	58 (51.8%)	86 (41.5%)
No	67 (70.5%)	54 (48.2%)	121 (58.5%)
Support received[b]			
Nobody	41 (43.2%)	41 (36.6%)	82 (39.6%)
Father	13 (13.7%)	22 (19.6%)	35 (16.9%)
Mother	22 (23.2%)	25 (22.3%)	47 (22.7%)
Other relatives	4 (4.2%)	9 (8.0%)	13 (6.3%)
A friend	4 (4.2%)	4 (3.6%)	8 (3.9%)
A teacher	2 (2.1%)	6 (5.4%)	8 (3.9%)
Other	9 (9.5%)	5 (4.5%)	14 (6.7%)
Drop-out computing studies[c]			
Yes	46 (48.4%)	43 (38.4%)	89 (43%)
No	49 (51.6%)	69 (61.6%)	118 (57%)

[a] Have you or someone in your environment (family, friends, school, etc.) ever been discriminated against because of belonging to a particular group (men, women, people of other sexual orientations, ethnicity, etc.)?
[b] Who supported you to start your computing studies?
[c] Have you ever considered dropping out of computer studies?

Table 4. Results of the descriptive analysis divided by country (N = 207)

	Spain			**Brazil**		
	md	**sx**	**N**	**md**	**sx**	**N**
Q13	4.04	1.081	95	3.03	1.436	112
Q14	4.06	1.278	95	3.51	1.294	112
Q15	4.72	0.895	95	4.89	0.575	112
Q16	4.39	1.055	95	4.46	1.106	112
Q18	4.27	1.086	95	4.60	0.864	112
Q20	4.52	1.030	95	4.38	1.033	112
Q21	4.31	1.158	95	3.98	1.308	112
Q22	4.17	1.173	95	2.94	1.544	112
Q23	3.85	1.220	95	2.90	1.237	112
Q24	3.96	1.166	95	3.05	1.451	112
Q25	4.39	1.123	95	4.63	0.737	112
Q28	3.57	1.191	95	4.31	1.031	112
Q29	3.54	1.375	95	3.94	1.180	112
Q30	2.97	1.447	95	3.86	1.314	112
Q31	3.60	1.371	95	4.21	1.158	112

Table 5. Mann Whitney U results for the variable country

Country (N = 207)			
	U	**Z**	**Sig**
Q13	3217.500	–5.046	**0.000**
Q14	3968.500	–3.304	**0.001**
Q15	4940.000	–1.911	**0.056**
Q16	4883.000	–1.287	0.198
Q18	4486.000	–2.392	**0.017**
Q20	4866.000	–1.323	0.186
Q21	4624.000	–1.841	**0.066**
Q22	2976.500	–5.689	**0.000**
Q23	3110.000	–5.274	**0.000**
Q24	3488.000	–4.400	**0.000**
Q25	4972.000	–1.039	0.299
Q28	3324.500	–4.946	**0.000**
Q29	4467.000	–2.078	**0.038**
Q30	3447.500	–4.492	**0.000**
Q31	3875.500	–3.581	**0.000**

Table 6. Mann Whitney U results for the variables gender and country

	Gender – ES (N = 80)			Gender – BR (N = 111)			Women – BR – ES (N = 73)			Men – BR – ES (N = 128)		
	U	Z	Sig	U	Z	Sig	U	Z	Sig	U	Z	Sig
Q13	756.5	–0.138	0.890	1189.0	–2.044	**0.041**	268.0	–3.733	**0.000**	1411.5	–3.132	**0.002**
Q14	711.0	–0.608	0.543	1447.0	–0.478	0.633	366.0	–2.586	**0.010**	1635.5	–2.064	**0.039**
Q15	655.5	–1.950	**0.051**	1457.0	–1.122	0.262	563.5	–0.678	0.498	1868.0	–1.546	0.122
Q16	630.5	–1.550	0.121	1431.0	–0.752	0.452	562.5	–0.216	0.829	1850.5	–1.107	0.269
Q18	589.5	–1.915	**0.055**	1364.0	–1.271	0.204	554.0	–0.363	0.716	1652.5	–2.158	**0.031**
Q20	729.5	–0.504	0.614	1350.5	–1.237	0.216	463.5	–1.589	0.112	1993.5	–0.305	0.761
Q21	682.5	–0.973	0.331	1502.5	–0.147	0.883	458.0	–1.609	0.108	1830.5	–1.147	0.251
Q22	724.0	–0.482	0.630	1231.0	–1.788	0.074	208.0	–4.477	**0.000**	1304.0	–3.726	**0.000**
Q23	591.0	–1.747	0.081	1504.5	–0.125	0.901	419.0	–1.896	**0.058**	1086.5	–4.700	**0.000**
Q24	715.5	–0.540	0.589	1232.5	–1.785	0.074	278.5	–3.607	**0.000**	1538.0	–2.507	**0.012**
Q25	728.5	–0.480	0.631	1358.5	–1.298	0.194	555.5	–0.287	0.774	1789.5	–1.579	0.114
Q28	470.5	–2.902	**0.004**	1084.0	–2.967	**0.003**	436.0	–2.011	**0.044**	1236.5	–4.015	**0.000**
Q29	630.5	–1.334	0.182	1225.5	–1.899	0.058	499.0	–0.994	0.320	1763.0	–1.382	0.167
Q30	593.5	–1.677	0.094	1335.5	–1.186	0.235	411.5	–2.043	**0.041**	1280.5	–3.730	**0.000**
Q31	589.5	–1.733	0.083	1324.0	–1.328	0.184	490.5	–1.142	0.254	1432.0	–3.053	**0.002**

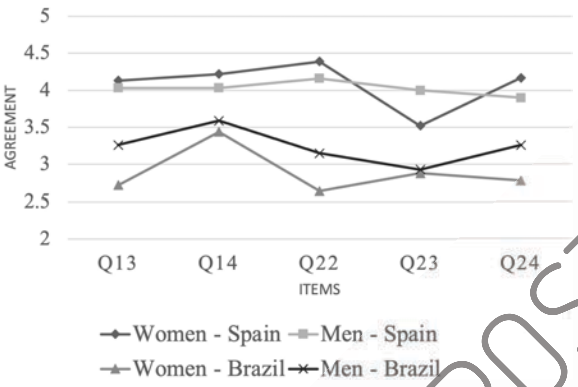

Fig. 1. Mean scores per country and gender in the Academic perception dimension.

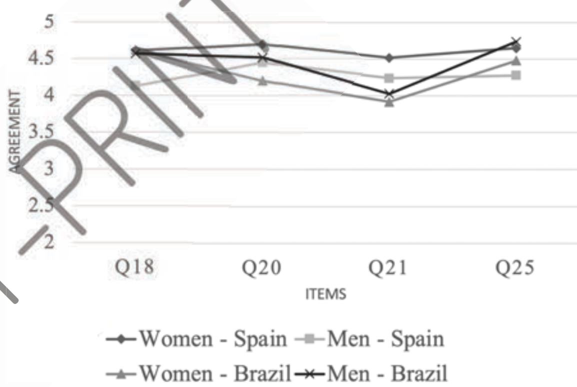

Fig. 2. Mean scores per country and gender in the Professional competence dimension.

instrument. We exclude "age" because the sample distribution in Spain does not cover all ranges, as is the case in Brazil (see Table 3).

Regarding gender, a second hypothesis contrast was conducted to analyze if there are significant differences inside each country and between countries. The analysis compared only women and men due to the low number of answers in the categories "not mentioned above" and "preferred not to answer" (Spain N = 80, Brazil N = 111).

First, we applied the Kruskal-Wallis H test for four groups of the independent variable "country-gender" with the following values: women in Spain, men in Spain, women in Brazil, men in Brazil. The results confirm statistical differences between gender and countries because the hypothesis is rejected in all items except Q16, Q20, Q21, and Q25. For this reason, we analyzed the perceptions inside each country and between gender using Mann Whitney U test (Table 6).

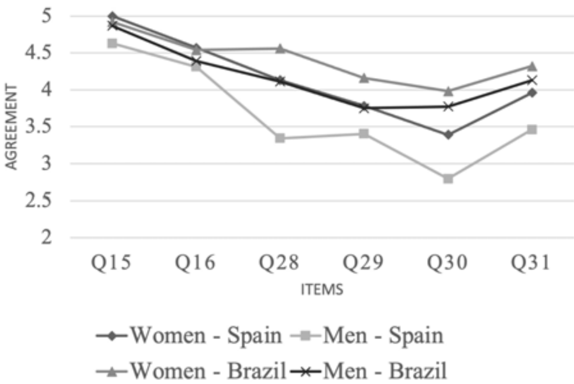

Fig. 3. Mean scores per country and gender in the Social perception dimension.

Hypotheses have also been contrasted for the variable "discriminations." It is a dichotomous variable (yes, no) that collect the answer to the question "Have you or someone in your environment (family, friends, school, etc.) ever been discriminated against because of belonging to a

Table 7. Mann Whitney U results for the variables discrimination and country

	Discrimination – ES (N = 95)			Discrimination – BR (N = 112)			Discrimination = Yes (N = 86)			Discrimination = No (N = 121)		
	U	**Z**	**Sig**	**U**	**Z**	**Sig**	**U**	**Z**	**Sig**	**U**	**Z**	**Sig**
Q13	525.5	–3.580	**0.000**	676.0	–5.315	**0.000**	353.0	–4.355	**0.000**	1447.0	–2.033	**0.042**
Q14	905.5	–0.291	0.771	1325.5	–1.448	0.148	502.0	–2.956	**0.003**	1529.5	–1.555	0.120
Q15	827.5	–1.624	0.104	1478.5	–1.424	0.154	797.5	–0.512	0.609	1667.0	–1.333	0.182
Q16	748.0	–1.851	0.064	1034.0	–4.193	**0.000**	700.5	–1.847	0.065	1708.0	–0.599	0.549
Q18	902.5	–0.334	0.738	1458.5	–0.837	0.403	663.5	–1.763	0.078	1574.0	–1.469	0.142
Q20	789.0	–1.621	0.105	1515.0	–0.356	0.722	662.0	–1.807	0.071	1713.0	–0.610	0.542
Q21	900.0	–0.370	0.712	1544.0	–0.141	0.888	669.5	–1.483	0.138	1614.0	–1.161	0.246
Q22	861.0	–0.700	0.484	1064.0	–3.001	**0.003**	335.5	–4.496	**0.000**	1284.5	–2.943	**0.003**
Q23	730.0	–1.781	0.075	1115.0	–2.697	**0.007**	471.0	–3.232	**0.001**	1204.0	–3.269	**0.001**
Q24	655.5	–2.440	**0.015**	850.0	–4.291	**0.000**	400.5	–3.902	**0.000**	1515.5	–1.628	0.104
Q25	806.0	–1.340	0.180	1451.5	–0.880	0.379	812.0	0.000	1.00	1668.5	–0.893	0.372
Q28	643.0	–2.521	**0.012**	910.0	–4.323	**0.000**	526.5	–3.177	**0.001**	1311.0	–2.699	**0.007**
Q29	483.5	–3.827	**0.000**	799.5	–4.768	**0.000**	746.0	–0.718	0.473	1678.0	–0.705	0.481
Q30	676.0	–2.190	**0.029**	867.5	–4.291	**0.000**	479.0	–3.315	**0.001**	1382.0	–2.275	**0.023**
Q31	488.0	–3.802	**0.000**	863.5	–4.549	**0.000**	691.0	–1.388	0.165	1448.0	–1.938	**0.053**

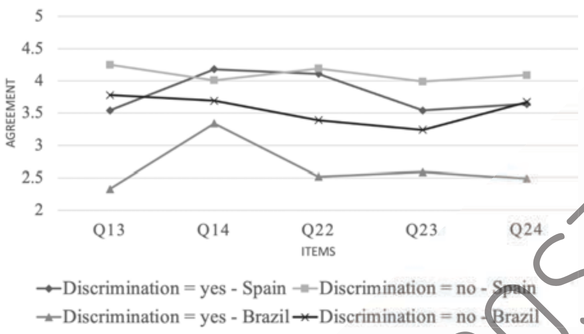

Fig. 4. Mean scores per country and discrimination variable in the Academic dimension perception.

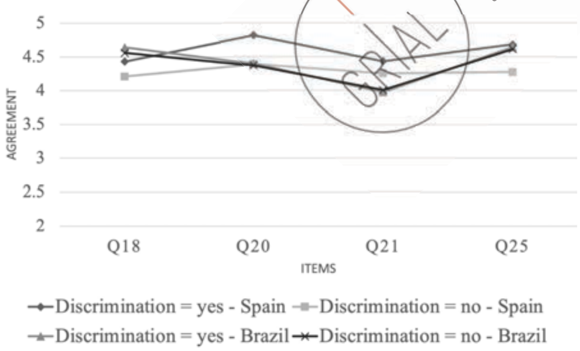

Fig. 5. Mean scores per country and discrimination variable in the dimension Professional competence.

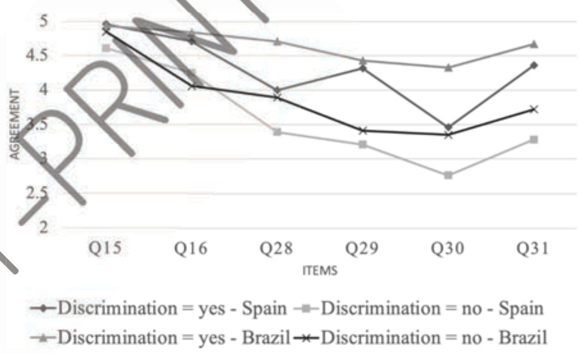

Fig. 6. Mean scores per country and discrimination variable in the dimension Social perception.

particular group (men, women, people of other sexual orientations, ethnicity, etc.)?''. The hypothesis contrast shows that 12 of 15 items have significant differences depending on this variable (all items except Q16, Q20, and Q25). Furthermore, the hypothesis contrast inside each country also shows differences (Table 7, columns 1 and 2).

We have also combined country and discrimination in a variable to compare the perception of people who experiment discrimination in Brazil and Spain (Table 7, column 3) and people who answer no in the question about discrimination (Table 7, column 4). The results show significant differences between Spanish and Brazilian participants that answer ''yes'' in the item about discrimination (Q13, Q14, Q22, Q23, Q24, Q28, and Q30). Concerning people who report not having encountered discrimination, there are also significant differences between countries for the following items (Q13, Q22, Q23, Q28, Q30, and Q31).

Regarding the support received before starting the computing studies, the variable was clustered into two categories, students who did not receive support (39.6%) and students who receive any kind of support (60.4%). According to Kruskal-Wallis H, only items Q16, Q21, Q25, and Q29 do not show differences in the students' perception about the gender gap in computing.

Table 8. Mann Whitney U results for the variables support and country

	Support received – ES (N = 95)			Support received – BR (N = 112)			Support received = nobody (N = 82)			Support received = someone (N = 125)		
	U	Z	Sig	U	Z	Sig	U	Z	Sig	U	Z	Sig
Q13	1067.0	–0.475	0.635	1092.5	–2.399	**0.016**	533.5	–2.933	**0.003**	1116.5	–4.116	**0.000**
Q14	1100.5	–0.216	0.829	1015.0	–2.898	**0.004**	684.0	–1.519	0.129	1357.0	–2.939	**0.003**
Q15	1113.5	–0.181	0.856	1479.0	–0.075	0.940	693.5	–2.513	**0.012**	1913.5	–0.044	0.965
Q16	1112.5	–0.129	0.897	1177.5	–2.478	**0.013**	694.0	–1.630	0.103	1884.0	–0.217	0.828
Q18	1099.5	–0.236	0.813	1475.5	–0.064	0.949	803.0	–0.398	0.691	1487.5	–2.830	**0.005**
Q20	975.0	–1.509	0.131	1343.5	–1.005	0.315	680.5	–1.709	0.088	1877.0	–0.270	0.787
Q21	1074.5	–0.466	0.641	1412.5	–0.468	0.640	790.0	–0.530	0.596	1575.5	–1.939	**0.053**
Q22	1088.0	–0.324	0.746	1426.5	–0.350	0.726	468.0	–3.626	0.000	1089.0	–4.294	**0.000**
Q23	943.5	–1.434	0.152	1179.5	–1.868	0.062	385.5	–4.332	0.000	1283.5	–3.233	**0.001**
Q24	1121.0	–0.047	0.962	1079.5	–2.488	**0.013**	662.0	–1.717	0.086	1086.0	–4.264	**0.000**
Q25	1057.0	–0.648	0.517	1274.5	–1.650	0.099	778.0	–0.714	0.476	1806.5	–0.728	0.467
Q28	1058.0	–0.538	0.591	1203.0	–1.899	**0.058**	447.5	–3.848	**0.000**	1314.5	–3.217	**0.001**
Q29	1066.5	–0.465	0.642	1310.0	–1.109	0.267	578.5	–2.523	**0.012**	1794.0	–0.646	0.518
Q30	1062.5	–0.492	0.623	1219.0	–1.669	0.095	577.5	–2.503	**0.012**	1193.0	–3.736	**0.000**
Q31	932.0	–1.503	0.133	1099.0	–2.558	0.011	504.5	–3.274	**0.001**	1556.5	–1.936	**0.053**

4. Discussion

This section organizes the discussion to answer the research questions posed about the type of support students receive before starting STEM careers and the main differences between countries.

R1: Which kind of support has received the Computer Engineering Students before starting their University Studies?

As we can observe in the results, the men are the most represented in the sample (61.8%) in both countries, maybe due to Engineering studies being more represented by men. According to the results, both countries show a similar percentage of lack of support before the career (39.6% of total). However, among the support note that the mother is fundamental in both countries, presenting similar results more than 20%, compared to the father with a media of 16.9%. Previous studies have found a lack of support from teachers and peers before entering university [22] in both Spain and Brazil. Our study reinforces these previous findings and also highlights the role of mothers in supporting STEM studies.

It should be noted that there are no significant differences between countries in terms of the support received during the pre-university stage, although as observed in Table 8 related to the support variables for STEM studies. Also, there are differences between having received some type of support or not having received it when deciding to study computer engineering. In particular, only items Q16, Q21, Q25, and Q29 do not show differences in the students' perception of the gender gap in computing. It stands out that the students think on a scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree) and independently of gender and whether they have received support or not the following: that gender equality is an important issue that needs to be addressed from all spheres (family, education, social, and work) (mean = 4.42), that gender does not influence the completion of Engineering studies (mean = 4.13), they disagree that men are better prepared than women to work in the IT sector (mean = 4. 5) and somewhat agree that the gender gap is not a trend (mean = 3.75).

Regarding question Q15 (All people must have the same rights regardless of gender), those who have received some support in their studies are more in agreement with this statement. In the same way, people who have received some support, both themselves and in their environment, agree more with the statements related to the fact that there is a need for more women in the technology sector, that the gender gap is not a problem that should be solved as part of Computer Science studies and that people working in the technology sector should help reduce the gender gap in the sector (Q28, Q30, and Q31). This may be due to the positive influence of the supporters on the awareness of the gender gap in the technology sector.

On the other hand, about the professional context, the people who have not received any kind of support to carry out their studies in Computer Engineering are somewhat more in agreement with the statement that the women who make studies in Computer Engineering are not feminine enough (Q18). It also stands out that they somewhat agree that Women do not have more problems than men when programming (Q20), while those who have received some kind of support strongly agree with this statement. These results may be associated with the lack of role models or references during the pre-university educational stages, which is related to the lack of support in the educational or family environment.

Although there are significant differences, there is no particular pattern in the academic perception dimension influenced by the support received for starting computer engineering studies. These results can be explained by the fact that this dimension focuses on the experiences lived within the academic institution once access to studies has ended.

R2: Are there differences between the Perception of the Students in Brazil and Spain related to the Social, Academic, and Professional Context?

First, it is essential to highlight that the distribution of age between the Spanish and Brazilian students is different. In Brazil, there are students over 31 years old until more than 40 years old. This can impact the support received before and during their studies. However, it is crucial to notice that in Spain, there is a law related to the time enrolled in the university to finish a degree, and this is not mandatory in Brazil. Despite this, the drop out in computing studies is similar in both countries; in Spain, 48.4% have considered living their studies and, in Brazil, 38.4%.

Regarding experiences of discrimination on the grounds of belonging to a specific group (men, women, people of other sexual orientations, ethnicity, etc.), of all the women who responded to the questionnaire in both countries, more than 60% responded that they had suffered discrimination on the grounds of gender, in contrast to the case of men, where only 30% indicated this, as can be seen in Table 3. Of those who said that they had suffered discrimination based on gender, there is a high difference between countries: in Spain, 29.5% responded affirmatively, while in Brazil, this percentage rises to 51.8%. This difference can be explained by gender-related discrimination and ethnicity, as there is a population difference between the countries because Brazil has a larger black population than Spain. This result reinforces findings by other authors who have identified barriers in STEM careers related to gender, race, and ethnicity [23].

Concerning the people who have indicated having suffered or perceived some type of discrimination in their environment in Brazil, as can be seen in Fig. 4, it can be seen that the perception of the gender gap in the university context is more pronounced in Brazil than in Spain. Similarly, it is observed that those in Brazil who have not experienced any type of discrimination perceive a more significant gender gap in academic studies than in Spain. No major differences are observed in terms of professional perception in the two countries (Fig. 5). Regarding the social dimension, those who have not experienced discrimination in Spain and Brazil do not have a clear opinion on the gender gap in the technology sector (Fig. 6). For example, we can observe that in the opinion on whether the gender gap is a fashion, they neither agree nor disagree.

Similar perceptions have been found between women and men in each country. However, some differences can be noted in the dimensions of social perception (Fig. 3), professional competence (Fig. 2), and academic perception (Fig. 1) (Table 6, columns 1 and 2). Thus, in Spain, women and men's perceptions are different in Q15 (All people must have the same rights regardless of gender), Q18 (The women who make studies in Computer Engineering are not feminine enough), and Q28 (There is a need for more women to work in the technology sector), but in Brazil, there are significant differences only in items Q13 (Computer Engineering students are treated differently by their teachers according to their gender) and Q28 (There is a need for more women to work in the technology sector).

However, comparing the same gender across countries shows significant differences in several items, both for men and women. On the one hand, Spanish and Brazilian women (Table 6, column 3) differ in items Q13 (Computer Engineering students are treated differently by their teachers according to their gender), Q14 (People who enrol in Computer Engineering studies receive the same institutional support regardless of gender), Q22 (Men and women have the same opportunities to study engineering careers, such as Computer Engineering), Q23 (People in Computer Engineering studies treat their peers of another gender in the same way), Q24 (The professors in Computer Engineering studies treat all students equally regardless of gender), Q28 (There is a need for more women to work in the technology sector) and Q30 (The gender gap is not a problem that must be addressed as part of Computer Engineering studies). On the other hand, the comparison of Spanish and Brazilian men (Table 6, column 4) shows statistical differences in the same items as women plus Q31 (People working in the technology sector must help reduce the gender gap in their sector). Only items Q16 (Gender equality is an important issue that must be addressed from all spheres (family, education, social, and work), Q21 (Gender influences the fulfilment of Computer Engineering studies), Q25 (Men are better prepared than women to work in the informatics sector) and Q29 (The gender gap is a fad) do not show differences in the students' perception of the gender gap in computing.

5. Conclusions

The study compares students' perceptions regarding the gender gap in computer engineering studies in Brazil and Spain. In particular, the sample is composed of students from three institutions, the Mackenzie Presbyterian University (MACKENZIE) from Brazil, and the University of Salamanca (USAL), and the University of La Laguna (ULL) from Spain.

As main findings of this study, we note the first research question about "*Which kind of support has received the computer engineering students before starting their university studies?*", we found that almost half of the participants had not received any support before studying Computer Engineering. Besides, mothers are the principal support in both countries. We also found that when participants did not receive any support, their perception regarding the gender gap is lower than participants that received any kind of support (teachers, school, family, and friends).

About the second research question, "*Are there differences between the perception of the students in Brazil and Spain related to the social, academic, and professional context?*", we found that there are differences between both countries on their gender gap perception in Computer Engineering. Moreover, there are also differences between men and women across both countries related to discrimination. The results show that women have experiment more discrimination than men. Also, there are differences between Brazil and Spain regarding the gender gap perception, independently of their sex. Spain shows more awareness of the lack of women in the engineering and technological sector and the need to work on this issue.

Finally, several important limitations need to be considered. First, the sample is N = 207, although the questionnaire was extensively shared with engineering students. Due to the small sample size, caution must be applied, as the findings might not be transferable to all computer engineering students in Brazil and Spain. On the other hand, although the GENCE 2.0 has a non-binary selection (female, male, not mentioned above, no answer), the data collected have a gender bias. Further work needs to be done to analyze the perception of non-binary students.

The data collected provides exciting results to go deeper in future studies. Other institutions across Brazil and Spain should be included to check whether the conclusions obtained extend to the entire Argentine and Peruvian context. Furthermore, parallel studies will be conducted in other countries, focusing on Latin America and Europe.

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