

Article

Equity or Stereotypes in Science Education? Perspectives from Pre-University Students

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Abstract: In this work, we explore the presence of stereotypes in pre-university students with respect to gender, science, and scientists. The possible differences between boys and girls, school stage, and rurality are analyzed. For this purpose, a sample of 404 participants between 13 and 18 years old were delivered a form with items from the Questionnaire on Opinions about Science, Technology, and Society. The responses were offered using a five-point Likert scale and agreement percentages were calculated. Descriptive and inferential statistics were used for the analysis, where the effect size was calculated for items associated with any of the three factors. Our findings show that the stereotyped ideas of gender in science were more intense in Compulsory Secondary Education (CSE) students in rural areas than in High School (HS) students from urban areas. In addition, perceptions of science and scientists showed greater agreement for CSE than for HS students. However, no differences were found between girls and boys. Regarding science items, there was a major agreement on the relationship between science and technology with problem solving, regardless of sex or school rurality. Finally, reflections on stereotypes and the presence of girls in STEM careers are provided.

Keywords: stereotype; gender; pre-university students; science education; rurality

1. Introduction

Hypothetical deductive reasoning resides in the frontal lobe of the brain, which has been called the “center of humanization”, due to its importance in the development of the human being [1]. Traditionally, such reasoning has led to many of the advances in the development of humanity in general, and in science specifically. This scientific development has contributed to increases in the level of well-being, thus creating healthier societies, as well as societies that are more supportive, egalitarian, and fair [2]. For this reason, it is important that young people show interest in the study of science, ensuring the potential development and progress of society. However, it seems that this interest, as measured by the enrolment in science subjects in pre-university stages or at university, diminishes with age in Spain [3,4], as well as in other geographical areas such as the United States [5,6], Asia [7], and Australia [8].

In the case of Spain, the decline in enrolment into science, technology, engineering, and mathematics subjects and university degrees (known as STEM) confronts the positive perception of science by citizens reflected in some official reports [9]. This positive social perception seems not to contribute to an increase in student enrolment in science majors, which also exhibits a male–female gap in developed

countries [10] and which is more acute in STEM than in health science careers [5]. Witherspoon et al. [11] found that Health and Medicine, as fields, cause retention in science degrees, while STEM are fields that cause attrition in science university degrees, without determining the specific contribution to the different sciences (e.g., physics, chemistry, engineering, mathematics, and so on). These authors also recommended exploring non-academic factors as possible causes of this gender gap.

Among the non-academic factors, although related to school environment, classroom experiences and self-concepts with respect to STEM, family and societal expectations show up. Classroom experiences in high school students have been analyzed by Patall et al. [5], in terms of teacher autonomy support, needs satisfaction, and engagement during science class. They found decreased perceived support and engagement during science classes for girls in all science subjects, excluding biology. On the other hand, self-concept and self-perception with respect to STEM have been explored by Sikora et al. [10] using data from 50 countries, in terms of the relationship between self-concept and occupational plans. They found that the male–female gap in science self-concept is larger in developed countries than in developing or transforming societies. Family and society expectations for adolescents also play a role, as reported by Lin et al. [7], who studied Taiwanese pre-university students. These authors have reported that female students regarded Social Persuasion as the most influential source in the Science Communication dimension, while male students considered Vicarious Experience as the main efficacy source, demonstrating that girls considered themselves to be under social pressure, while boys seemed to follow models which are strongly influenced by culture and context, and which are sometimes stereotyped. Among the developmental stages, adolescents are considered to be more stereotyped than other populations [12–14], adolescence being the stage in which vocations start to be forged. Therefore, these ages are of great interest regarding STEM vocations. In this vein, Makarova and Herzog [15] worked with a sample of 3045 pre-university students and 123 teachers, and found that Swiss pre-university students were trapped by stereotypes in such a way that a negative perception of mathematics was related to female gender, while chemistry and physics were positively related to male gender. Among teacher perceptions, they found a majority to consider that mathematics only matches with male gender. This suggests that women have long been the subjects of a stereotypical belief that they do not have the ability to succeed in STEM. Therefore, in the following section, the state-of-the-art of gender stereotypes in science focused on education at pre-university level is detailed.

Gender Stereotypes in Science Education

The STEM election at university has a deep cultural influence, in such a way that the male–female gap is not the same in developing than in developed countries, nor is the social perception of science and scientist. In this line, Lin et al. [7] reported that, in India, women are encouraged by male family members to choose computer science as the associated job positions are well-rewarded and, as a result, the family can gain social significance. On the contrary, these authors reported a different situation in Australia, where there exist negative stereotypes for women in computer science and, so, in STEM. Smeding [16] explored how strong the implicit stereotypes in engineering female students are, compared with female students of other majors, in Southern France. She found that the intrinsic stereotypes were much weaker in engineering than in humanities students, and that this strength was correlated with poor mathematics performance. Referring to Spain, Marbà-Tallada et al. [17] analyzed a similar situation, highlighting the lack of a profound explanation on the role of gender stereotypes associated with science and the scientific profession; while it has been widely studied in other professions [18–20].

In most cultures, women have traditionally been associated with roles characterized by delicacy, emotionality, and sensitivity, associations that can influence and foster the choice of career involving the care and attention of people, such as those in the health or education fields. On the other hand, the roles associated with men involve greater reasoning and a higher capacity to solve problems and make decisions; all of these aspects more traditionally relate to technical careers [2,21]. This division of roles has also contributed to a split of public (professional) and private (domestic and family) spheres

which, in turn, is associated with a renunciation of the professional sphere by women in favor of the family [22], in many cases, without even realizing it. Furthermore, it has been widely accepted that socio-cultural norms are transmitted and disseminated—implicitly or explicitly—through social agents [23]. From the viewpoint of the socio-cultural theory proposed by Vigotsky or the ecological perspective of Bronfenbrenner, socio-cultural factors are internalized through the instruments used in each socio-cultural and historical context [24,25]. Gender stereotypes are part of these sociocultural factors. Moreover, gender stereotypes are associated with the self-perception of intellectual ability in early aged girls [26], which could later influence their future career selection [27]. In alignment with this, Makarova et al. [28] found that secondary education female students perceived masculinity in mathematics, physics, and chemistry, while male students assigned more masculinity to mathematics and, even, to physics and chemistry. The masculine perception of STEM among girls can cause them to disregard STEM in their career selection, due to the disidentification effect reported by Deemer et al. [29].

At present, the main educational and socializing agents continue to be families, schools, and peers, in addition to television, books, the internet, and social networks, among others. Some of the latter—particularly social networks—have been recognized as having a strong incidence among adolescent populations [30]. Implicit in the socio-cultural norms that are disseminated by social agents are the gender stereotypes associated with science and scientists. These stereotypes conceive a scientist as a person who is dedicated mainly to his or her work, who has few social skills and, sometimes, poor family relations. These aspects of the profession, together with the gender stereotypes associated to science, could explain the decline in scientific vocations, especially among women [2], who do not find any fit between what is required for scientific professions and their own self-perception.

In this regard, Carli et al. [31] studied the degree of agreement that male and female college students displayed with the stereotype of a successful scientist. In addition, they looked at the degree to which scientists, either male or female, were perceived to have gender characteristics usually associated with women, common to both, and those associated with men. The results indicated an incompatibility between gender stereotypes for women and those corresponding to professions of high socio-economic status, as well as the perception that women did not possess the necessary skills to successfully develop scientific professions. On the contrary, McPherson et al. [32] detracted from the explanatory power of gender stereotypes in career choice, in favor of the mismatch between the perception of one's own skills and those perceived as necessary for the scientific profession. They also found that this mismatch of perceptions was manifested in the fact that the skills considered necessary to be a scientist did not match those which are actually required.

Furthermore, the presence of stereotypes is different in rural and urban societies and, so, in rural and urban schools. A school becomes an open mind center in rural areas, although this idea has not been widely explored in developed countries. Mass media and technologies have tried to alleviate this situation, supplying science education tools to rural areas through online proposals [33]. Regarding the attitude towards school science in rural schools, it has been studied among girls in Kenya [34] and United States [35], reporting that it is positive. On the contrary, Feniger [36] reported that the gender perspective is more deeply stereotyped among students from rural municipalities. In studies carried out in Spain with adolescents [37,38], the influences of sex and rurality were analyzed, among other factors. No significant differences were detected, with respect to sex, while students from rural environments showed a more positive attitude towards science; among them, girls were the most positive. However, as far as we know, no studies have been dedicated to analyzing the vision of gender in science among adolescents in rural environments in socio-cultural and geographical contexts close to ours.

Therefore, the study of gender stereotypes with respect to STEM is a key issue among pre-university students in Spain. It is worth asking: How do young students perceive science and the scientists? Are there gender stereotypes imbedded in this perception? Consequently, this study was carried out to explore the perceptions of gender, science, and scientists in pre-university students enrolled in

Compulsory Secondary Education and High School in Spain, as well as to know the possible differences between girls and boys, the educational stages, and the possible influence of the rural environment.

2. Materials and Methods

2.1. Participants

The sample was composed of pre-university students enrolled in Compulsory Secondary Education (CSE) and High School (HS), the first stage covering 13–16-year-old students, and the second 16–18-year-old students. These students were enrolled in schools from the center of Spain that requested to participate in an outreach project aimed at making women in science visible (To know the Science of Today open the Doors of Tomorrow: Gender perspective). Specifically, six schools from the Community of Madrid and three from Castilla-La Mancha participated, for a total of 464 students. Among the schools, five were urban and one rural from the Community of Madrid, and one was urban and two rural from Castilla-La Mancha, considering rural municipalities as those with less than 5000 inhabitants. Out of the 464 completed forms, 404 were considered valid and constituted the convenience sample. The sample composition was split by grade, as follows: 45 students were enrolled in the 2nd year of CSE, 157 in the 3rd year of CSE, 69 in the 4th year of CSE, 55 in the 1st year of HS, and 78 in the 2nd year of HS. All CSE students were compulsorily enrolled in a science subject, and those in HS had chosen the stem of Health Sciences and Technology. Among them, girls comprised 46.5% of the total sample, this percentage being unequally distributed between the two stages: 50.2% of the students in CSE (291), and 39% in HS (133).

2.2. Procedure

The forms were delivered by the researchers and filled out voluntarily and anonymously by the participants, in compliance with the Declaration of Helsinki. The informed consent of participants (and their families, when necessary) was collected. Personal data, such as sex and current grade, and demographics, such as the location and school name, were collected. The participants were informed that the data would be used for strictly educational and research purposes, and that they could voluntarily participate or withdraw from the project.

2.3. Instrument

In this study, we chose the survey instrument using the following criteria: Originally written in Spanish (to avoid translation and cultural mismatch) and not lengthy (to avoid the possible saturation of the young students) [39]. The form was composed of 21 items (see Table 1) extracted and modified from the Questionnaire of Opinions on Science, Technology, and Society [40]. The items were distributed in two blocks, the first referring to the perception of gender in science (G1–11) and the second to the perception of science (S1–4; S8–10) and scientists (S5–7). Specifically, analysis of the items related to the gender perception in science was carried out according to their semantic formulation, considering that G1 indicated equity, while items G2–G11 stated stereotyped ideas of gender in science; in many cases, related to stereotypes more generally linked to our culture [32]. In the section devoted to science and scientists, the perspective on scientists was set out in items 5 to 7. Given their semantic formulation, items 5 and 7 involved statements about the social involvement of scientific activity, while item 6 conveyed a stereotype of total dedication to their work. In the perception of science, no stereotype was included.

The agreement with the statements expressed by the items was presented using a five-point Likert scale, from totally disagree (1) to totally agree (5), crossing neutrality (3). These two scales showed good internal consistency (Cronbach's $\alpha = 0.80$ for perception of gender in science and Cronbach's $\alpha = 0.69$ for perception of science and scientists). For this study, we calculated the average of answers for each block (i.e., stereotyped ideas of gender in science, equity ideas of gender in science, perception of science, and perception of scientists). Thus, the scores for each block ranked from 1 to 5.

Table 1. Form used for the research.

Gender Perspective (G)
G1. Women and men are equal depending on what it takes to be a good scientist.
G2. Men and women work differently because, by nature or education, they have different values, opinions, perspectives, and characteristics.
G3. In a world traditionally considering men, women would work better because they have to show that they are competitive.
G4. Men would work better because they have no difficulty in combining their professional and family role.
G5. Scientific women endow their scientific work with greater value and feelings than men.
G6. Scientific men give greater human value and feeling to their scientific work than women.
G7. Scientists women endow more creativity and intuition to their scientific work than men.
G8. Scientific men have a greater capacity to solve problems and make decisions in their scientific work than women.
G9. The greater presence of scientific men is due to men are more rational than women and women are more emotional than men.
G10. Men find work before women because they focus on their studies, while women focus more on family life.
G11. Society has different expectations for men and women in relation to their professions.
Science and Scientists (S)
S1. The more students learn about science and technology, the more informed the citizens of the future will be (people can have better opinions about how science and technology are used).
S2. The policy of the country affects its scientists because, in addition to financing projects, they establish scientific policy taking into account new applications and directly affecting the type of scientific projects it would carry out.
S3. Science classes help students learn problem-solving skills and knowledge to solve practical problems.
S4. If private companies were controlled scientific research (high tech, communications, pharmaceutical companies, and so on), there would be more competitiveness, economic endowment, and greater discoveries.
S5. Most scientists are motivated to do their job. The main motivation is to solve problems to increase personal knowledge and benefit society (e.g., new treatments).
S6. Scientists need to be deeply involved in their work to succeed and such involvement prevents them from having social and family life.
S7. Scientists publish their findings for personal and social benefit, advancing science by sharing their ideas and results.
S8. The scientific vocation depends on education. Thus, families, educational centers, and institutions must convey to children the orientation, encouragement, and opportunity to be scientists.
S9. Scientific advances should be transmitted to society, such that citizens could learn about discoveries with the objective of becoming aware and being informed of all the responsible options that may affect their future.
S10. Science and technology offer possible alternatives to solve social problems such as poverty, crime, and unemployment.

2.4. Analysis

The statistical analysis was carried out with the Statistical Package for Social Sciences v. 24 software. Non-parametric hypothesis contrasting (Mann–Whitney U) was used for the inferential statistics, provided the result of the normality test (Kolmogorov–Smirnov, $p < 0.001$ for all items and factors). The tests used were made with two-tailed significance level of $p < 0.05$ for sex, stage, and rurality. To determine the relevance of the statistical difference, the effect size was calculated using the eta-squared coefficient [38].

3. Results

Responses were analyzed on agreement percentages. For descriptive purposes, the number (and percentage) of students who disagreed (i.e., totally disagree and disagree) and agreed (i.e., totally agree and agree) with each item and each sub-scale are shown in Table 2. The results showed a high percentage of agreement with the egalitarian perception of scientific professions (i.e., G1 = 95% of agreement). However, agreement with stereotyped ideas exceeded 10% in almost all items (exceptions: G6, G8, and G10). Regarding perceptions of science and scientists, most of the items were scored

with positive agreements, rather than negatives, showing a global positive perception of science and scientists.

Table 2. Absolute frequency and percentage of agreement and disagreement for each item.

	Agreement	Disagreement	Missing
Gender Perspective			
G1	386 (95.5%)	7 (1.7%)	1 (0.2%)
G2	104 (25.7%)	203 (50.2%)	8 (2.0%)
G3	93 (23.0%)	206 (51.0%)	7 (1.7%)
G4	42 (10.4%)	268 (66.3%)	8 (2.0%)
G5	51 (12.6%)	217 (53.7%)	11 (2.7%)
G6	33 (8.2%)	256 (63.4%)	11 (2.7%)
G7	70 (17.3%)	213 (52.7%)	6 (1.5%)
G8	37 (9.2%)	280 (69.3%)	8 (2.0%)
G9	46 (11.4%)	277 (68.6%)	8 (2.0%)
G10	32 (7.9%)	304 (75.2%)	11 (2.7%)
G11	268 (66.3%)	56 (13.9%)	3 (0.7%)
Stereotyped ideas	10 (2.2%)	296 (77.5%)	22 (5.4%)
Equity ideas	386 (95.5%)	7 (1.7%)	1 (0.2%)
Science and Scientists			
S1	353 (87.4%)	5 (1.2%)	4 (1.0%)
S2	248 (61.4%)	25 (6.2%)	5 (1.2%)
S3	328 (81.2%)	13 (3.2%)	6 (1.5%)
S4	170 (42.1%)	57 (14.1%)	10 (2.5%)
S5	295 (73.0%)	24 (5.9%)	6 (1.5%)
S6	97 (24.0%)	195 (48.3%)	7 (1.7%)
S7	283 (70.0%)	28 (6.9%)	8 (2.0%)
S8	246 (60.9%)	48 (11.9%)	7 (1.7%)
S9	317 (78.5%)	15 (3.7%)	6 (1.5%)
S10	235 (58.2%)	53 (13.1%)	11 (2.7%)
Perception of science	44 (11.3%)	9 (2.3%)	16 (4.0%)
Perception of scientists	64 (16.2%)	41 (10.4%)	9 (2.2%)

Tables 3–5 show the number (and percentage) of students who disagreed (i.e., totally disagree and disagree) and agreed (i.e., totally agree and agree) with each item and each sub-scale disaggregated by sex, educational stage, and rurality group, respectively. Regarding sex, similar response patterns were found. For instance, both groups showed a high percentage of agreement with an egalitarian perception of scientific professions (i.e., >95%) and a high percentage of disagreement with stereotyped ideas (i.e., >75%). In this connection, both groups indicated the global positive perception of science and scientists.

Conversely, responses disaggregated by educational stage showed a higher percentage of disagreement with stereotyped ideas in students at HS level (90% of agreement), rather than students at SCE level (71% of agreement). However, both groups showed a high percentage of agreement with egalitarian perception of scientific professions (94%). Indeed, similar positive response patterns were found in terms of the perception of science and scientists.

Finally, according to rurality, both groups showed a high percentage of agreement with an egalitarian perception of scientific professions (i.e., >94%). However, students from urban schools showed a higher percentage of disagreement with stereotyped ideas (81%), compared to the percentage of disagreement of students from rural schools (69%). Regarding the perception of science and scientists, students from rural schools showed a more negative perception of science and less positive perception of scientists, compared to students from urban schools.

The mean rank, statistics, and effect size for gender perspective, science, and scientists are listed in Table 6 (see Figures 1–3 for visual representations). It was found that some of the factors explored

were associated with responses to some sub-scales, but not to all. Specifically, Mann–Whitney U tests indicated that the stereotyped ideas of gender in science were more intense in CSE adolescents and rural students than in HS and urban students (both with $p < 0.01$). In the same vein, perceptions of science and scientists showed greater agreement for CSE than for HS ($p = 0.020$ and $p = 0.015$, respectively). However, no differences were found between girls and boys for any sub-scale.

Table 3. Absolute frequency and percentage of agreement and disagreement in girls vs. boys.

	Girls			Boys		
	Agreement	Disagreement	Missing	Agreement	Disagreement	Missing
Gender Perspective						
G1	178 (96.2%)	4 (2.2%)	0 (0%)	204 (95.8%)	3 (1.4%)	0 (0%)
G2	39 (21.7%)	93 (50.3%)	5 (2.7%)	61 (28.6%)	109 (51.2%)	2 (0.9%)
G3	51 (27.6%)	83 (44.9%)	3 (1.6%)	41 (19.2%)	121 (56.8%)	3 (1.4%)
G4	19 (10.3%)	123 (66.5%)	3 (1.6%)	22 (10.3%)	143 (67.1%)	4 (1.9%)
G5	26 (14.1%)	90 (48.6%)	5 (2.7%)	25 (11.7%)	126 (59.2%)	5 (2.3%)
G6	10 (5.4%)	119 (64.3%)	5 (2.7%)	22 (10.3%)	134 (62.9%)	5 (2.3%)
G7	35 (18.9%)	90 (48.6%)	1 (0.5%)	35 (16.4%)	120 (56.3%)	4 (1.9%)
G8	12 (6.5%)	138 (74.6%)	3 (1.6%)	24 (11.3%)	139 (65.3%)	4 (1.9%)
G9	10 (5.4%)	137 (74.1%)	3 (1.6%)	35 (16.4%)	36 (63.8%)	4 (1.9%)
G10	10 (5.4%)	151 (81.6%)	1 (0.5%)	22 (10.3%)	149 (70.0%)	9 (4.2%)
G11	140 (75.7%)	15 (8.1%)	0 (0%)	127 (59.6%)	39 (18.3%)	2 (0.9%)
Stereotyped ideas	4 (2.2%)	141 (80.1%)	9 (4.9%)	6 (3.0%)	162 (75.6%)	12 (5.6%)
Equity ideas	39 (21.7%)	93 (50.3%)	5 (2.7%)	61 (28.6%)	109 (51.2%)	2 (0.9%)
Science and Scientists						
S1	168 (90.8%)	1 (0.5%)	2 (1.1%)	180 (84.5%)	4 (1.9%)	2 (0.9%)
S2	183 (89.9%)	14 (7.6%)	2 (1.1%)	137 (64.3%)	11 (5.2%)	3 (1.4%)
S3	149 (80.5%)	6 (3.2%)	2 (1.1%)	174 (81.7%)	7 (3.3%)	4 (1.9%)
S4	69 (37.7%)	26 (14.1%)	4 (2.2%)	98 (46.0%)	31 (14.6%)	6 (2.8%)
S5	147 (79.5%)	5 (2.7%)	2 (1.1%)	143 (67.1%)	18 (8.5%)	4 (1.9%)
S6	33 (17.8%)	108 (58.4%)	3 (1.6%)	59 (27.7%)	87 (49.8%)	4 (1.9%)
S7	131 (70.8%)	11 (5.9%)	3 (1.6%)	146 (68.5%)	17 (8.0%)	5 (2.3%)
S8	114 (61.6%)	23 (12.4%)	2 (1.1%)	128 (60.1%)	35 (22.7%)	5 (2.3%)
S9	155 (83.8%)	2 (1.1%)	2 (1.1%)	157 (73.7%)	12 (5.6%)	4 (1.9%)
S10	108 (58.4%)	26 (24.2%)	4 (2.2%)	123 (57.7%)	26 (12.2%)	7 (3.3%)
Perception of science	86 (46.5%)	5 (2.8%)	6 (3.2%)	105 (51.9%)	15 (7.4%)	10 (4.7%)
Perception of scientists	51 (27.5%)	37 (15.5%)	4 (2.2%)	61 (29.3%)	35 (16.8%)	5 (2.3%)

Table 4. Absolute frequency and percentage of agreement of disagreement comparing adolescents in Compulsory Secondary Education (CSE) vs. High School (HS).

	CSE			HS		
	Agreement	Disagreement	Missing	Agreement	Disagreement	Missing
Gender Perspective						
G1	257 (94.8%)	5 (1.8%)	1 (0.4%)	129 (97.0%)	2 (1.5%)	0 (0%)
G2	81 (29.9%)	118 (43.5%)	3 (1.1%)	23 (17.3%)	85 (63.9%)	5 (3.8%)
G3	70 (25.8%)	134 (94.4%)	3 (1.1%)	23 (17.3%)	72 (54.1%)	4 (3.0%)
G4	29 (10.7%)	179 (66.1%)	2 (0.7%)	13 (9.8%)	89 (66.9%)	6 (4.5%)
G5	46 (17.0%)	125 (46.1%)	5 (1.8%)	5 (3.8%)	92 (69.2%)	6 (4.5%)
G6	29 (10.7%)	155 (57.2%)	4 (1.5%)	4 (3.0%)	101 (75.9%)	7 (5.3%)
G7	59 (21.8%)	123 (45.4%)	2 (0.7%)	11 (8.3%)	90 (67.7%)	4 (3.0%)
G8	32 (11.8%)	172 (63.5%)	2 (0.7%)	5 (3.8%)	108 (81.2%)	6 (4.5%)
G9	39 (14.4%)	170 (62.7%)	2 (0.7%)	7 (5.3%)	107 (80.5%)	6 (4.5%)
G10	28 (10.3%)	194 (71.6%)	3 (1.1%)	4 (3.0%)	110 (82.7%)	8 (6.0%)
G11	36 (13.3%)	179 (66.1%)	3 (1.1%)	89 (66.9%)	20 (15.0%)	0 (0%)
Stereotyped ideas	9 (3.6%)	185 (71.4%)	12 (4.4%)	1 (0.8%)	111 (90.2%)	10 (7.5%)
Equity ideas	257 (94.8%)	5 (1.8%)	1 (0.4%)	129 (97.0%)	2 (1.5%)	0 (0%)

Table 4. Cont.

	CSE			HS		
	Agreement	Disagreement	Missing	Agreement	Disagreement	Missing
Science and Scientists						
S1	231 (85.2%)	5 (1.8%)	3 (1.1%)	122 (91.7%)	0 (0%)	1 (0.8%)
S2	137 (50.6%)	23 (8.5%)	4 (1.5%)	111 (83.5%)	2 (1.5%)	1 (0.8%)
S3	217 (80.1%)	11 (4.1%)	5 (1.8%)	111 (83.5%)	2 (1.5%)	1 (0.8%)
S4	112 (41.3%)	40 (14.8%)	8 (3.0%)	58 (43.6%)	17 (12.8%)	2 (1.5%)
S5	193 (71.2%)	17 (6.3%)	5 (1.8%)	102 (76.7%)	7 (5.3%)	1 (0.8%)
S6	77 (28.4%)	114 (42.1%)	6 (2.2%)	20 (15.0%)	81 (60.9%)	1 (0.8%)
S7	194 (71.6%)	21 (7.7%)	7 (2.6%)	89 (66.9%)	7 (5.3%)	1 (0.8%)
S8	175 (64.6%)	19 (7.0%)	6 (2.2%)	71 (53.4%)	29 (21.8%)	1 (0.8%)
S9	207 (76.4%)	10 (3.7%)	5 (1.8%)	110 (82.7%)	5 (3.8%)	1 (0.8%)
S10	146 (53.9%)	41 (15.4%)	7 (2.6%)	89 (66.9%)	12 (9.0%)	4 (3.0%)
Perception of science	118 (45.4%)	11 (4.2%)	11 (4.1%)	54 (42.2%)	4 (3.1%)	5 (3.8%)
Perception of scientists	49 (18.1%)	42 (16.0%)	8 (3.0%)	25 (18.9%)	22 (16.7%)	1 (0.8%)

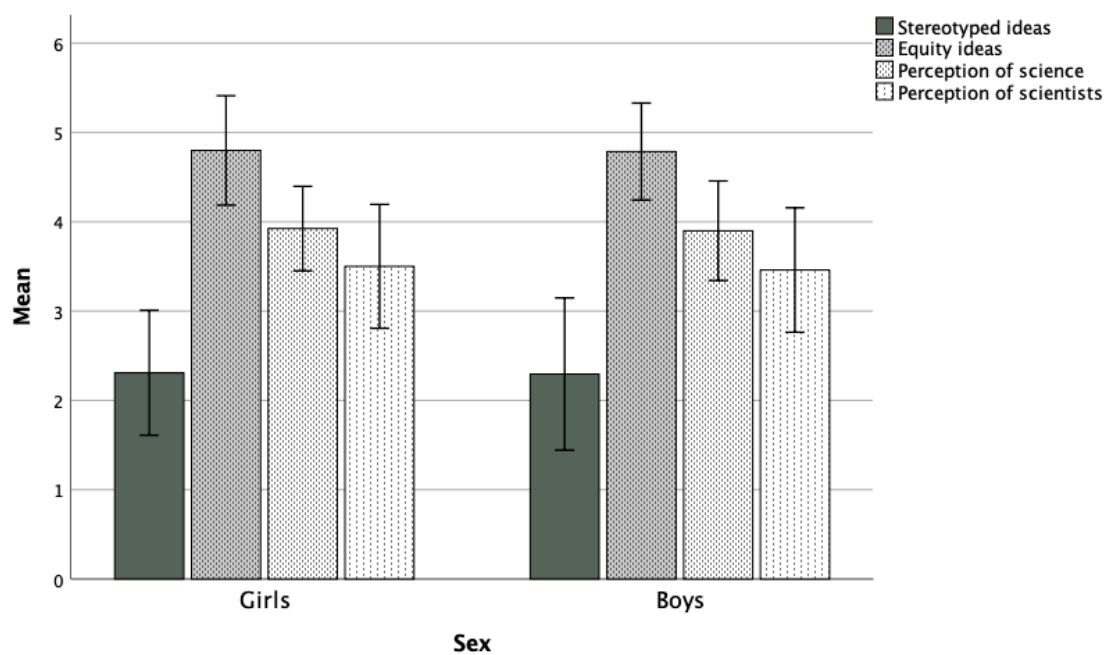
Table 5. Absolute frequency and percentage of agreement comparing rural vs. urban schools.

	Rural			Urban		
	Agreement	Disagreement	Missing	Agreement	Disagreement	Missing
Gender Perspective						
G1	104 (97.2%)	1 (0.9%)	1 (0.9%)	282 (94.9%)	6 (2.0%)	0 (0.0%)
G2	29 (27.1%)	50 (46.7%)	3 (2.8%)	75 (25.3%)	153 (51.5%)	5 (1.7%)
G3	32 (29.9%)	46 (43.0%)	1 (0.9%)	61 (20.5%)	160 (53.9%)	6 (2.0%)
G4	8 (7.5%)	69 (64.5%)	1 (0.9%)	34 (11.4%)	199 (67.0%)	7 (2.4%)
G5	18 (16.8%)	49 (45.8%)	1 (0.9%)	33 (11.1%)	168 (56.6%)	10 (3.4%)
G6	12 (11.2%)	56 (52.3%)	1 (0.9%)	21 (7.1%)	200 (67.3%)	10 (3.4%)
G7	28 (26.2%)	43 (40.2%)	1 (0.9%)	42 (14.1%)	170 (57.2%)	5 (1.7%)
G8	16 (15.0%)	65 (60.7%)	1 (0.9%)	21 (7.1%)	215 (72.4%)	7 (2.4%)
G9	13 (12.1%)	69 (64.5%)	1 (0.9%)	33 (11.1%)	208 (70.0%)	7 (2.4%)
G10	7 (6.5%)	81 (75.7%)	1 (0.9%)	25 (8.4%)	223 (75.1%)	10 (3.4%)
G11	71 (66.4%)	13 (12.1%)	1 (0.9%)	197 (66.3%)	43 (14.5%)	2 (0.7%)
Stereotyped ideas	3 (2.8%)	72 (69.2%)	3 (2.8%)	7 (2.4%)	224 (80.6%)	19(6.4%)
Equity ideas	104 (97.2%)	1 (0.9%)	1 (0.9%)	282 (94.9%)	6 (2.0%)	0 (0.0%)
Science and Scientists						
S1	92 (86.0%)	0 (0.0%)	0 (0.0%)	261 (87.9%)	5 (2.7%)	4 (1.3%)
S2	49 (45.8%)	7 (6.5%)	0 (0.0%)	199 (67.0%)	18 (6.1%)	5 (1.7%)
S3	91 (85.0%)	3 (2.8%)	0 (0.0%)	237 (79.8%)	10 (3.4%)	6 (2.0%)
S4	42 (39.9%)	12 (11.2%)	0 (0.0%)	128 (43.2%)	45 (15.2%)	10 (3.4%)
S5	74 (69.2%)	13 (12.1%)	0 (0.0%)	221 (74.4%)	11 (3.7%)	6 (2.0%)
S6	30 (28.0%)	43 (40.2%)	1 (0.9%)	67 (22.6%)	152 (51.2%)	6 (2.0%)
S7	77 (72.0%)	6 (5.6%)	1 (0.9%)	206 (69.4%)	22 (7.4%)	7 (2.4%)
S8	73 (68.2%)	3 (2.8%)	0 (0.0%)	173 (58.2%)	45 (15.2%)	7 (2.4%)
S9	83 (77.6%)	4 (3.7%)	0 (0.0%)	234 (78.8%)	11 (3.7%)	6 (2.0%)
S10	60 (56.1%)	14 (13.1%)	0 (0.0%)	175 (58.9%)	39 (13.1%)	11 (3.7%)
Perception of science	42 (39.4%)	8 (7.5%)	0 (0.0%)	78 (26.3%)	8 (2.8%)	7 (2.4%)
Perception of scientists	21 (19.6%)	2 (1.9%)	2 (1.9%)	84 (28.3%)	11 (3.9%)	16 (5.4%)

Table 6. Mann–Whitney U test results for significance of perception of gender in science and perception of science and scientists by sex, educational stage, and rurality.

	Group	N	Mean Rank	U	Z	p	η^2
Gender Perspective							
Stereotyped ideas	Girls	176	192.62	17,051.50	−0.604	0.546	0.00
	Boys	201	185.83				
	CSE	259	213.85	10,141.00	−5.746	<0.001	0.09
	HS	123	144.45				
	Rural	104	217.53	11,748.50	−2.822	0.005	0.02
Equity ideas	Urban	278	181.76				
	Girls	185	203.54	18,954.50	−1.052	0.293	0.00
	Boys	213	195.99				
	CSE	270	197.20	16,659.50	−1.880	0.060	0.01
	HS	133	211.74				
	Rural	106	206.90	15,221.50	−0.805	0.421	0.00
	Urban	297	200.25				
Science and Scientists							
Perception of science	Girls	181	195.91	17,984.00	−0.172	0.863	0.00
	Boys	208	194.21				
	CSE	260	185.26	14,238.50	−2.321	0.020	0.02
	HS	128	213.27				
	Rural	107	190.22	14,576.00	−0.465	0.642	0.00
	Urban	281	196.13				
Perception of scientists	Girls	179	190.47	18,659.50	−0.150	0.880	0.00
	Boys	203	192.41				
	CSE	263	207.79	14,782.50	−2.435	0.015	0.02
	HS	132	178.49				
	Rural	105	207.55	14,222.00	−1.012	0.311	0.00
	Urban	290	194.54				

Note: CSE, Compulsory Secondary Education; HS, High School.

**Figure 1.** Mean and standard deviation for each sub-scale disaggregated by sex.

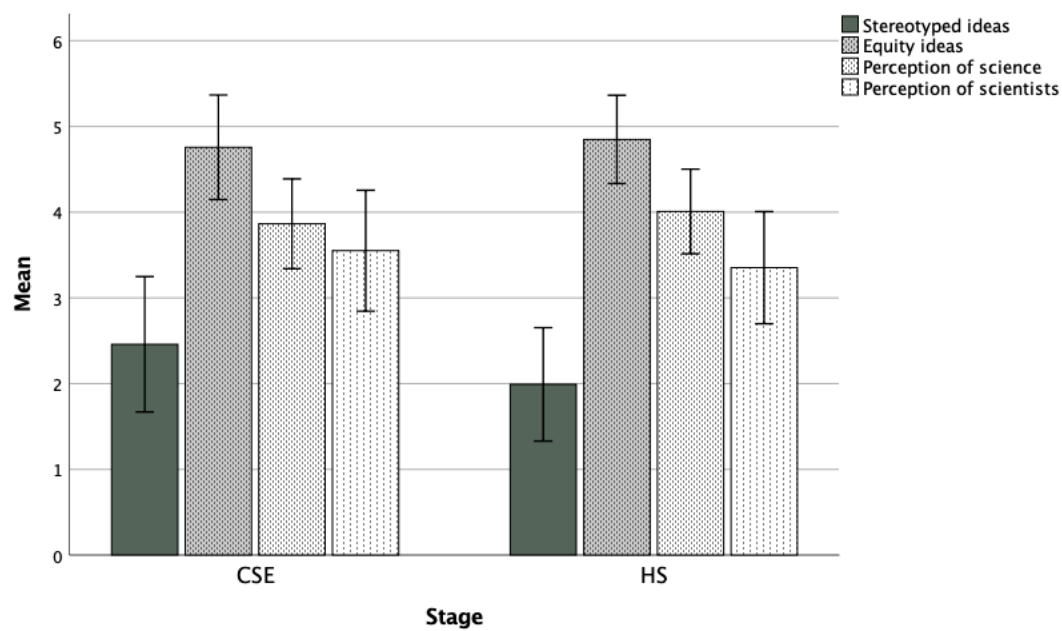


Figure 2. Mean and standard deviation for each sub-scale disaggregated by stage.

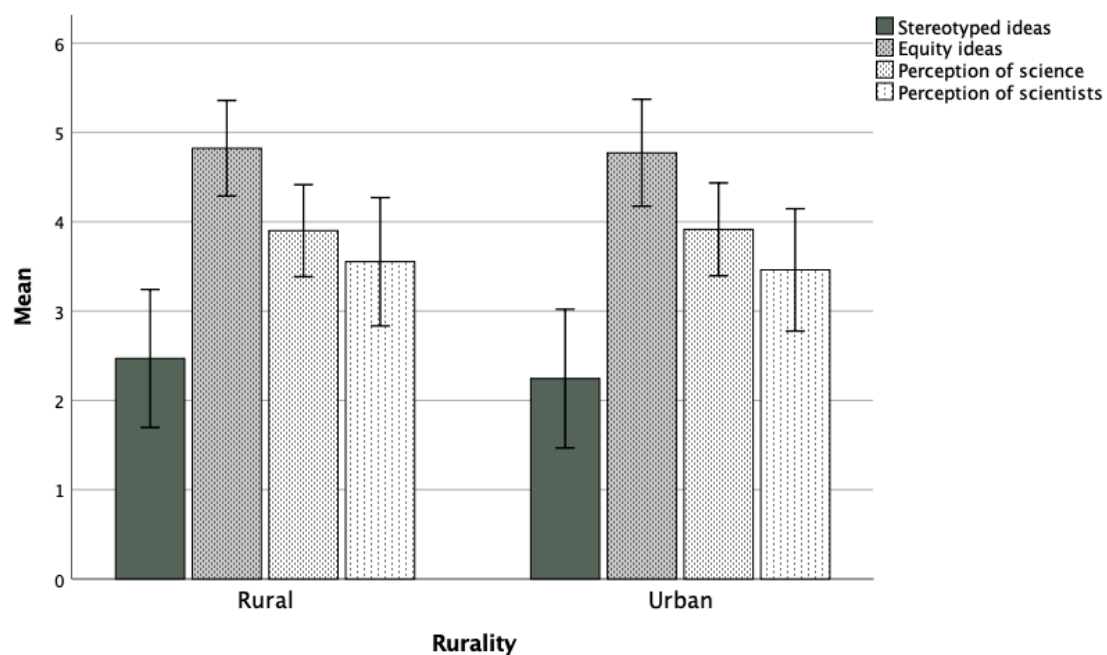


Figure 3. Mean and standard deviation for each sub-scale disaggregated by rurality.

4. Discussion

In this research, we sought to explore whether the perceptions of gender, science, and scientists in Spanish pre-university students are stereotyped, whether they evolve during adolescence, and whether they have differences with sex or the rurality of the school, using a sample of pre-university students. The issued questionnaire included stereotypes and assessed the level of agreement with them.

The results showed a high percentage of agreement with an egalitarian perception of the scientific profession, reflected by the 95% of the sample, who considered men and women to be equal. However, agreement with stereotyped ideas exceeded 10% in almost all the cases, with different percentages

when analyzed according to sex, stage, and rurality factors. Specifically, regarding sex, our results did not show differences between boys and girls in terms of gender perspective.

In a deeper descriptive analysis of the data, a higher percentage of agreement among girls in the perception of a demanding society towards women was reflected in the gender perspective items G3 (in a world traditionally considering men, women would work better because they have to show that they are competitive) and G11 (society has different expectations for men and women, in relation to their professions). These results partially confirm those obtained in other studies reporting gender differences with respect to stereotyped statements [18,20], as well as with respect to the analysis of the performance and/or attitude towards science of CSE students [5,12,17,37]. Furthermore, Sanchez et al. [19] found a strong presence of career-related stereotypes in students aged 16–32, although they reported a higher persistence of stereotypes in boys, contrary to what was found in our research. Moreover, if we observe the differences according to sex, we find a clear influence of “sense of belonging” [6]: Men agree more than women on those items that highlight the superiority of men over women in any aspect, and vice versa.

The results of this study regarding item G11 (society has different expectations for men and women, in relation to their professions) may reflect the perception that the young people participating have about modern society. In general, men and women have access to differentiated professions and, therefore, they perceive differences in the societal expectations on them. In many cases, it is even within the family context that the different expectations for boys and girls are exhibited and manifested, without necessarily implying that they (despite recognizing it) consider it fair or acceptable [7].

With respect to stage, the percentage of agreement with items that reflect the differentiated consideration of professions for men and women decreased in the high school stage; that is, in older students. This result indicates that stereotypes regarding men and women in the scientific profession are more accepted in early adolescence, noting that the acceptance of such stereotypes decreases with age [12–14]. This finding is in line with those reported by Heredia et al. [21] and Sánchez et al. [19] in Spanish students, in relation to stereotypes about professions in general and with respect to findings on the scientific profession performed in other geographical contexts [13,32]. The interpretation of this could be that older age could bring about a more formed identity and a more critical attitude corresponding to the evolutionary aspects of late adolescence (i.e., to high school students).

Regarding the rurality of the school, the findings related to the stereotyped ideas of gender in science seemed to be affected by this factor. Just a few works have researched this aspect in different geographical areas [34,37,38], without any specific focus on stereotypes. Their findings revealed that the degree of rurality was positive for the attitude that women show towards science. Other studies analyzed the case of co-educational or all-female school environments in Israel, such as that of Feniger [36], who concluded that an all-female environment does not influence the science or mathematics preferences of girls. However, regarding the gender perspective, the agreement with stereotyped statements is more intense among students from rural municipalities. It is widely accepted that stereotypes are influenced by culture [8], as well as gender stereotypes, which are more deeply embedded, and even masked by customs, in rural contexts. There are fewer job opportunities overall for women, who are forced to work inside the home and, thus, are much less common to find in a science-related position. This situation entails a lack of proximity models for girls outside science teachers, who act as role models for some science subjects, although not evenly for all [41]. Teachers may even serve to—implicitly or explicitly—transmit negative gender stereotypes towards STEM [15], possibly strongly in rural settings and educational institutions, through their pedagogical practices [41] (as recognized by Ruiz Medina et al. [23]), or through the perpetuation of gender roles in the educational and family environments in the rural setting [7]. Therefore, confluence in the maintenance and rooting of stereotypes of all social agents in the educational community makes adolescents from rural environments more prone to assume and accept stereotypes.

With respect to the perception of science in schools, there was a major agreement on the relationship between science and technology and problem solving, as reflected by item S3 (science classes help

students learn problem-solving skills and knowledge to solve practical problems), regardless of the socio-demographic characteristics of students. It should be noted, however, that more than 10% did not recognize the purpose of science classes, and about 3% did not find them to be useful. A majority of respondents also perceived the contributions of science and technology to have the ability to solve social problems, as reflected by item S10 (science and technology offer possible alternatives to solve social problems such as poverty, crime and unemployment); although, again, more than 10% of the sample did not share this perception. In contrast, the percentage of students who did not visualize the social contributions of scientists with their discoveries, as reflected by item S7 (scientists publish their findings for personal and social benefit, advancing science by sharing their ideas and results), was less than 10%, although the majority agreed that scientists should transmit these discoveries, as reflected by item S9 (scientific advances should be transmitted to society so that citizens could learn about the discoveries with the objective of becoming aware and being informed of all the responsible options that may affect their future). Despite the great perception of the contributions of science to our lifestyle, this does not mean that adolescents will lean towards studying science in the future, as previously evidenced [12,14,17,28]. The low percentage of pre-university students who did not perceive the influence of science and the contributions of scientists to our lifestyle contrasts with the ministerial reports of recent years, which collected much more positive data, in this regard, from the general population [9]. This result is somewhat surprising, provided that the students composing the sample had been exposed to science classes for a long time (from age 3 to present) and that their familiarity with technology is high (as they are digital natives). One could ask whether the focus of the science classes received by pre-university students in our sample should be more contextualized and more based on experiments where students could perceive the relationships between science, technology, and their implications in society. Overall, the results did not show any differences between boys and girls, or between students from rural and urban schools, in terms of perceptions of science and scientists. However, the findings related to perceptions of science and scientists seemed to be affected by the stage.

Regarding the relationship of scientific vocations with scientific education (S8), those students in CSE showed higher agreement than those in HS. This could be a consequence of the fact that HS students, being closer to the university and to the moment in which they should choose a scientific career (or not), would have previously decided whether to choose these science majors and, with the decision so made, have asked themselves what had influenced their choice, and do not see that their previous scientific education has been relevant in the decision. On the contrary, they are (or feel) more influenced by elements outside the education system, the importance of which has also been highlighted by other works, such as that authored by Michell et al. [8].

The perception of the influence of politics on science (S2; the policy of the country affects its scientists because, in addition to financing projects, they establish scientific policy taking into account new applications and directly affecting the type of scientific projects it would carry out) differed under all of the factors studied. It is worth noting that the percentage of agreement was high in boys and in girls (although higher in boys) and, comparing stages, it was higher in HS than in the CSE. The agreement on this item is connected with that of S4 (if private companies controlled scientific research there would be more competitiveness, economic endowment, and greater discoveries), which stated that research would generally be improved if it were carried out by private companies, which also presented higher agreement at the former stage. It could be that high school students perceive their university and working life more closely (as reported by Sánchez et al. [19]) and feel that a change in management could improve the current Spanish unemployment situation.

With respect to the scientific profession, the exclusive dedication of the scientist to their profession (S6; scientists need to be deeply involved in their work to succeed and such involvement prevents them from having social and family life) received a low agreement percentage, demonstrating certain differences in sex, stage, and rurality. Among girls, there was a slightly higher percentage of disagreement than among boys. In this regard, a lower agreement percentage was observed in

urban schools and HS stage, where contact with the scientific profession is, perhaps, more likely and standardized. These results also evidence the gap between the perception that many students have of the scientific profession and what it really is, as was the case among the participants in the study of McPherson et al. [32]. These authors argued that there is a mismatch between the perception of the scientific profession and reality. This mismatch is sometimes reinforced by the other socializing agents, such as the media and, specifically, successful TV series which show only a stereotyped character for scientists: A mostly male scientist, eccentric, with little social life, and who is dedicated exclusively to—even obsessed with—his work.

Although scientific vocations are low in the Western world, sex is not a determining factor in explaining the lower presence of women in STEM careers. Therefore, to afford it, a segregated programmed approach would not seem to be a solution, as reported by Feniger [36]. As there have been many studies on academic performance, attitude, and perceptions of science that have not found any cause inside the education system, perhaps it should be sought within other social aspects or agents. For example, as gender stereotypes about intellectual skills are created at early ages [15,26,28] and differentiated expectations from society and educational agents are perceived by children, including teachers or their families [7,29], early age actions are required that could avoid or counteract such low ability self-perception [42], which finally influences future career selections [26,27]. Furthermore, it seems appropriate to perceive the problem in a multidimensional way, as proposed by Michell et al. [8], addressing it from the environment closest to the student (microsystem) to the most global and far from it (macro-system), with respect to scientific, educational, and gender policies supported by the media, in order to counteract this situation. In this line, the support of projects where real scientists, with real lives, are involved should be framed, which highlights their life circumstances—both personal and professional—to adolescents [43], providing them with models to follow.

5. Conclusions and Limitations

To conclude, the students participating in this study had a generally egalitarian perception of gender in science, considering scientists equally, with a low (but not null) percentage of acceptance of gender stereotypes. Some interventions have been proven to have a positive effect on stereotype threat, such as RISE [44]. The wide actions and efforts of Spanish scientific community could be aligned with this effect, in order to make women in science visible, such as the present project, the project reported by López-Iñesta et al. [45], or even wider-impact actions carried out worldwide, such as the International day of women and girls in science, which has been run in Spain through the web site 11defebrero.org [46], as carried out in recent years. However, when stereotypical statements are made about the characteristics, tasks, or intensity of commitment involved in the scientific profession, some agreement with these stereotypes is declared. On the other hand, it can be concluded that sex does not have a determining influence on the persistence of gender stereotypes in science or in the scientific profession, while the rurality of the school has a bigger influence. This stereotyped perception varies over adolescence, being more persistent in Compulsory Secondary Education than in High School students (i.e., in younger students).

Nonetheless, on one hand, one of the limitations of this study was the difficulty of generalizing the conclusions, given that the authors used a convenience sample. Another limitation is that it is a transversal study and, therefore, it did not include the subsequent subjects chosen by the students, in order to see if they could be related to their acceptance of stereotypes. This emphasizes the need for more longitudinal studies on stereotypes and science education, which could deepen in the role of teachers in maintaining these stereotypes and in the later choice of scientific subjects at university. On the other hand, the rural versus urban difference cannot be clearly inferred from this study, provided that the ethnic or socioeconomic conditions of participants were not collected. Future research must be carried out to clarify the possible influence of these issues.

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