The gender gap in STEM Education

La brecha de género en la Educación STEM

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Olga Martín Carrasquilla
Elsa Santaolalla Pascual
Isabel Muñoz San Roque
Universidad Pontificia Comillas

Abstract

Studies on declining attitudes toward science in STEM education, especially among girls, have become an increasingly important topic, given their implications for academic and professional decision-making. Although there is considerable research that indicates that these attitudes begin consolidating themselves in childhood, most of this research focuses on secondary education. The aim of this article is to explore whether the liking for science, perceived usefulness, self-efficacy and professional interest in science display significant gender-based variations at an early age. The study design is non-experimental transversal (ex-post-facto) and it employs a quantitative methodology, with the application of the ACESTEM scale (Martín, 2020) to a sample of 408 students aged 10-14 years. The tests conducted are Pearson correlations between variables, Student's *t*-test to compare boys and girls, and factorial ANOVA to analyse the interaction between gender, stage, and the father's and mother's profession. The results show that boys display more favourable attitudes towards science than girls, but interest in science decreases with increasing age in both groups. Depending on the father and the mother's professions (STEM or non-STEM), we observe that while the father's profession does not differentiate the means in either attitude or its dimensions, the mother's profession produces statistically significant differences. There is a greater negative relationship between self-efficacy and age in girls than in boys; but this is not the case for the other dimensions. These results open up new avenues of research in order to achieve quality education for all.

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Key words: STEM, gender, attitudes towards science, self-efficacy, stereotypes, identity, vocational interests.

Resumen

Los estudios sobre el declive de las actitudes hacia la ciencia en la Educación STEM, especialmente de género femenino, se han convertido en una temática de interés creciente por las repercusiones que estas tienen en la toma de decisiones académicas y profesionales. Aunque muchas investigaciones indican que estas actitudes comienzan a construirse en la infancia, la mayoría han focalizado su atención en la educación secundaria. El objetivo de este artículo es explorar si el gusto por la ciencia, la utilidad percibida, la autoeficacia y el interés profesional por la misma, presentan variaciones significativas respecto al género en edades tempranas. El diseño es transversal no experimental (ex post-facto) y la metodología de tipo cuantitativo con la aplicación de la escala ACESTEM (Martín, 2020) a una muestra de 408 estudiantes entre los 10 y los 14 años. Se han realizado correlaciones de Pearson entre las variables, *t* de Student para comparar chicos y chicas y ANOVA factorial para analizar la interacción entre género, etapa y profesión del padre y de la madre. Como resultados destaca que los chicos manifiestan actitudes más favorables hacia la ciencia que las chicas pero en ambos se constata una disminución del interés por la ciencia con la edad. En función de la profesión (STEM o no STEM) del padre y de la madre, observamos que la profesión del padre no diferencia las medias ni en la actitud ni en sus dimensiones, mientras que la profesión de la madre produce diferencias estadísticamente significativas. En las chicas destaca una mayor relación negativa entre la autoeficacia y la edad que la obtenida por los chicos, no ocurre lo mismo en otras dimensiones. Estos resultados abren nuevas vías de investigación con el fin de conseguir una Educación de calidad para todos y para todas.

Palabras clave: STEM, género, actitudes hacia la ciencia, autoeficacia, estereotipos, identidad, vocaciones.

Introduction

STEM Education (acronym for *Science, Technology, Engineering* and *Mathematics*), which is taught through real-world problem solving, is recognised as a learning requirement for all as it promotes the

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development of the inquiring, cooperative, creative, reflexive and critical dimensions in citizens (Greca et al., 2021; UNESCO, 2019).

The attraction of STEM Education, linked to concerns regarding a reality where students' interest (especially female students) in science, mathematics and technology is in decline, are the motivations behind this research. Data from different sources point to the existence of a persistent gap in future STEM aspirations between girls and boys, the latter having fewer possibilities of pursuing a career related to STEM Education (Sáinz, 2020). In this regard, during the academic year of 2018-2019 in Spain, of the 24.12% of university students who were in STEM education, the proportion of women (7.66%) was significantly lower than men (16.47%) (Ministry of Universities, 2020). With regard to Vocational Training, the proportion of women is far below that of men (Gamboa et al., 2020), with notable differences by professional families, the female presence being very low in industrial and STEM fields.

Researchers such as Vázquez and Manassero (2015) indicate that the origin of disinterest in STEM Education may be located in negative attitudes towards science and technology, which are acquired throughout one's school life. This has led to research which conducts a specific study of attitudes to science in STEM Education, given the role they play in generating interest and commitment to topics related to science and technology, and because promoting a motivation, liking and attraction for STEM Education may increase the number of students (especially female students) who are likely to consider a future STEM syllabus in both university education and Vocational Training.

Additionally, different studies indicate that aspirations regarding the possible choice of a specific syllabus related to STEM Education consolidate themselves in early childhood and attitudes towards science in STEM Education are formed at an early age (Tai et al., 2006), being hard to change during and after adolescence. For this reason, researchers such as Savinskaya (2017) consider that STEM education must begin even before Primary Education, thus ensuring a positive attitude towards these studies based on gender equality. However, most studies conducted in this area have focused on Secondary Education (above all, from the age of 14 onwards). The importance of our research lies precisely in the fact that this study is conducted on students between the ages of 10 and 14 years.

The research conducted on student gender reveals contradictory results. Some show that boys tend to display more favourable attitudes towards science than girls (Pérez & de Pro, 2018); others highlight more favourable attitudes in girls (Chetcuti & Kioko, 2012), and yet other studies appear to have deviated from these patterns and do not observe significant differences (Toma & Greca, 2018).

Denessen et al. (2015) conclude that girls enjoy science and technology lessons less than boys, the former being more susceptible to teachers' lack of enthusiasm than boys. Studies by López et al. (2021) demonstrate a connection, especially in girls, between the choice of syllabus or STEM studies and high performance in science.

Archer et al. (2020) conclude from the results of the ASPIRES 2 project that gender problems are evident from a young age, more specifically, from the age of 10, and that boys display more solid scientific aspirations than girls, the latter having less possibilities of aspiring to a STEM syllabus, regardless of the fact that a higher percentage of girls rather than boys, consider science to be their favourite subject. In this line, if we consider gender, age and the educational stage, different authors conclude that as the student advances in their education, favourable attitudes towards science reduce drastically (Said et al., 2016), affecting all scientific subjects, but especially physics (Sáinz, 2017).

Sáinz and Müller (2017) find that girls in Secondary Education give greater importance to achieving expressive-communal goals and boys to achieving agentic-instrumental goals. In this regard, the research conducted by Pérez et al. (2018) reveals that girls have more favourable attitudes towards most questions related to environmental aspects, reflecting a greater sense of responsibility, awareness and respect, although these were also positively reflected in boys.

Regarding research on family influence, their daily practices, resources and values, Peterson et al. (2018) show that it plays an important role in promoting the creation of attitudes towards science in STEM Education. More specifically, Avendaño et al. (2020) state that the mother is the most influential figure when it comes to choosing STEM careers, in comparison with fathers, while Holmes et al. (2017) point out that having a father in a STEM profession has a significant effect on the process of choosing STEM studies for both boys and girls.

The conclusions presented by the Ministry of Education and Vocational Training (2019) and the OECD (2018) on the Programme for International

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Student Assessment (PISA) with special reference to student attitudes demonstrate that when performance levels in science and mathematics are taken into account, significant variations are revealed. In the OECD, there is a lower proportion of girls than boys at upper levels of performance in science and mathematics, although it is true that in the case of mathematics, these differences have decreased over time, both in the OECD average and in Spain. In the case of sciences, the gender gap in average performance in 2018 is lower than that observed in mathematics and it may be stated that currently girls have a significantly higher average score than boys, whereas in 2015, the reverse was true.

Finally, several studies show that student behaviour and choice may be affected by implicit biases derived from exposure to generalised cultural stereotypes that consider science as a profession more suited to men than women (Kim et al., 2018; Oon et al., 2020), these stereotypes being sustained and displayed by both genders (Blazev et al., 2017). In relation to the above, Cheryan et al. (2017) argue that boys may feel pressurised to choose science as a topic that may be perceived as being stereotypically masculine, while the same may lead girls to abandon this topic as a means to establish their gender identity. In this regard, other factors that attempt to account for the apparent lack of interest in girls with reference to STEM studies are linked to the absence of role models for women, teaching methods that do not reach girls and low feeling of acceptance or decreased family support (UNESCO, 2019).

As we have seen, gender-related differences in attitudes to science are the result of an interconnected and complex reality influenced by socio-cultural, academic and psychological aspects (Cabero & Valencia, 2021; Luis et al., 2020).

The goal of the study is linked to the exploration of whether a liking for science, the perceived usefulness of science, self-efficacy and professional interest in science display significant gender-based differences. Based on this goal, we propose the following research hypotheses:

Hypothesis 1: There are statistically significant differences in attitudes towards science in STEM Education and its dimensions, according to gender.

Hypothesis 2: There is a statistically significant and negative relationship between age and attitude towards science in STEM Education and its dimensions and it differs based on whether it is analysed in the sample of boy or girl students.

Hypothesis 3: There are statistically significant differences in attitude and its dimensions according to gender (male/female), educational stage (primary/secondary), mother and father's profession (STEM/non-STEM) and the different interactions between these factors.

Method

The research was conducted by means of a non-experimental transversal (ex-post-facto) design and a quantitative methodology consistent with the objective and the declared hypotheses. The proposed approach is therefore a quantitative study that enables the analysis of students' attitudes towards science in STEM Education, considering beliefs and perceptions regarding scientific competence (self-efficacy), the perceived usefulness of science and future professional intentions, as well as the affective reactions displayed by male and female children between the ages of 10 and 14 years (5th and 6th year of Primary Education and 1st and 2nd year of Compulsory Secondary Education) onliking and enjoyment of science.

Sample

The sample was constituted by 408 students (210 girls and 198 boys) in the 5th and 6th year of Primary Education, and the 1st and 2nd year of Compulsory Secondary Education from three state-owned ($N = 147$), state-sponsored ($N = 113$) and private ($N = 148$) schools in the Region of Madrid. Their average age was 11.79 years (SD = 1.28, min. = 9 and max. = 16).

If we look at the gender-based distribution of the sample, the number of girls at 210 (51.4%) is somewhat higher than the number of boys at 198 (48.5%). The largest group of students belonged to the 1st year of Compulsory Secondary Education (12 and 13 years old) at 131, and the smallest group was that of the 6th year of Primary Education (11 and 12 years), with a total of 87. In all of them the number of girls exceeded the number of boys, with the exception of the 6th year of Primary Education, (49 boys and 38 girls).

With regard to sample distribution based on the profession of the father and the mother, it was observed that among students whose mothers were STEM professionals[1], 60% of the fathers were also in STEM

[1] According to the Recommendation of the Commission dated 29 October 2009 on the use of the International Standard Classification of Occupations (ISCO-08), STEM professionals belong to Sub-

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professions, while 40% were not. Among students whose mothers were not STEM professionals, 76.5% of the fathers were also not in STEM professions, and 23.5% were STEM professionals.

Instruments

In order to conduct this research, a scale that could measure attitudes towards science in STEM Education (ACESTEM, Martín, 2020) was developed for the ages in question (10 to 14 years). For this, an initial review of the scientific literature on scales to measure attitudes towards science (Fraser, 1981; Kennedy et al., 2016; Summers & Abd-El-Khalick, 2018; Wang & Berlin, 2010; Zhang & Campbell, 2011) was conducted, leading to an overarching view of the most common and relevant dimensions required for students to form positive attitudes towards science in STEM Education.

This analysis enabled the structuring of the model Attitudes towards Science in STEM Education (ACESTEM, Martín, 2020) with four fundamental dimensions as displayed in Table I.

TABLE I. Dimensional structure of the ACESTEM questionnaire

ACESTEM Dimensions	Definition	No. of items
Liking for science	Pleasure or enjoyment derived from learning or doing science-related activities or participating in science-related activities.	6 items
Professional interest in science	Willingness to undertake future studies in science or to work in a science-related profession.	6 items
Perceived usefulness of science	Social relevance given to science and male and female scientists.	5 items
Self-efficacy	Beliefs and perceptions regarding one's own ability to comprehend, learn, and work with science.	4 items

Source: Developed by author

Major Group 21 of Science and Engineering Professionals within Major Group 2 of Professionals; associate STEM professionals belong to Sub-Major Group 31 (Science and Engineering Associate Professionals) and to Sub-Group 35 (Information and Communications Technology Operations and User Support Technicians) within Major Group 3 of Technicians and Associate Professionals.

Building the scale required validating the content according to expert judgement followed by an exploratory factor analysis (EFA) of the scale on a sample of 408 students. This offered a four-factor structure with 24 items, a Cronbach's alpha of .906 and a McDonald's omega reliability of .909. The subsequent confirmatory factor analysis (CFA) conducted on a different sample of 295 students confirmed the four-factor structure, obtaining satisfactory adjustment indexes and a Cronbach's alpha of .914 and McDonald's omega with a reliability of .917, leading to a scale with 21 items.

Finally, once the dimensions and the items associated with each one of them were determined, the questionnaire was conceptually structured into two distinct parts: the first with socio-demographic data and the other with the dimension items. A five-response Likert scale was used to group the responses that accompany the questions in the items (Completely disagree, Disagree, Neutral, Agree, Completely agree).

Procedure

The students were selected by a non-probability convenience sampling, given that the schools chose to participate in a research and innovation project related to the attitudes and approaches to STEM Education. In this case, once the research was approved by the academic staff and the school's consent was obtained, the course tutors were contacted and the questionnaire items to be answered by the students were explained. Google Forms was used as an online tool, having previously applied the questionnaire to student participation in certain workshops related to STEM Education. The students were given 15 minutes to complete it in their school under the supervision of the tutor.

The descriptive analysis of each variable was conducted through frequency distributions, contingency tables, averages and standard deviations in quantitative variables. For the differential analysis of the variables, the averages were compared using Student's *t*-test, with gender as the independent variable, and Analysis of Variance (factorial ANOVA) to analyse the interaction of factors such as gender, the stage and profession of the father and the mother, in the attitude towards science in STEM education and its dimensions. Information regarding the Student's *t*-test value, the *F*-test in ANOVA, the probability associated

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with these values (*p*), the degrees of freedom (*gl*) and the effect size [2] (*d*) or h^2. To test the hypothesis on the relationship between the attitude towards science in STEM Education and its dimensions, and age, we have used Pearson's coefficient *r* (*r*) and its associated probability of error (*p*). An associated Type I error probability of 0.05 is used as the criterion to reject the null hypotheses. IBM SPSS 20.0 for Windows was the program used for the statistical processing of the data.

Results

After the data was compiled, they were analysed in order to test the hypotheses developed. The following sections present the results according to each hypothesis.

Hypothesis 1: There are statistically significant differences in attitudes towards science in STEM Education and its dimensions, according to gender.

The first hypothesis in this article is of key importance, therefore, it was decided to conduct a Student's *t*-test, analysing the attitude towards science in STEM education and its dimensions according to gender. The results obtained were subsequently confirmed by means of the factorial ANOVA. Thus, in the factorial ANOVA, the interest lies not so much in the effect of each factor, but in the effect of the interactions between the factors (gender, stage, profession of the father and the mother) in the attitude and its dimensions.

To conduct the Student's *t*-test, the assumption of homogeneity of variance was tested with Levene's *F*, and was found to be homoscedastic in all cases. Given that the assumption of normality was not met for any of the cases when analysed with the Kolmogorov–Smirnov test, Mann–Whitney U nonparametric test was also conducted, confirming the results of the Student's *t*-test.

The analysis of the data in Table II demonstrates that boys possess different and more statistically significant averages ($p<.01$) than girls with respect to attitudes towards science in STEM Education (average in boys

[2] Cohen's criteria was used to assess the magnitude of the differences. According to Cohen (1992), an effect size value of 0.20 represents a low difference, a value of 0.50 represents a moderate difference, and a value higher than 0.80 may be deemed a big difference.

being 3.47 and in girls, 3.20). This is repeated in all the dimensions except in usefulness (average in boys 3.90 and in girls, 3.79) where there are no statistically significant differences (p>.05) although the tendency is the same.

To assess the magnitude of the difference between the averages, its effect size was calculated. The attitude towards science in STEM Education (d = 0.37) and the dimensions of liking (d = 0.28), professional interest (d = 0.32) and self-efficacy (d = 0.42) were considered to range from low to moderate. The lowest effect size is associated with the dimension of usefulness (d = 0.15).

TABLE II. Differences in attitude towards science in STEM Education according to gender

	Gender	*N*	Mean	SD	*t*	*gl*	*p*	*d*
Attitude	Boy	198	3.47	0.70	3.76	406	.000	0.37
	Girl	210	3.20	0.71				
Liking	Boy	198	3.50	0.94	2.95	406	.003	0.28
	Girl	210	3.20	1.00				
Professional interest	Boy	198	3.09	0.98	3.20	406	.001	0.32
	Girl	210	2.77	1.02				
Usefulness	Boy	198	3.90	0.77	1.52	406	.128	0.15
	Girl	210	3.79	0.70				
Self-efficacy	Boy	198	3.45	0.82	4.20	406	.000	0.42
	Girl	210	3.11	0.84				

Source: Developed by author

Regarding the second hypothesis that posits that *there is a statistically significant and negative relationship between age and attitude towards science in STEM Education and its dimensions and it differs based on whether it is analysed in the sample of boy or girl students*, the analysis studied the existing correlations between age and attitude towards science in STEM Education and its four dimensions in the two samples separately.

It was thus observed that the relationships between attitude towards science in STEM Education and its dimensions of liking, usefulness and self-efficacy in the sample of girl students, and student age, are negative

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and statistically significant (p<.01). Professional interest is the only dimension without a statistically significant relation (p>.05) as shown by the values in Table III.

TABLE III. Correlations between attitude towards science in STEM Education and student age

Sample	*N*	Attitude	Liking	Professional interest	Usefulness	Self-efficacy
Total	408	-.17**	-.22**	.01	-.20**	-.17**
Girls	210	-.13	-.17*	.07	-.19**	-.20**
Boys	198	-.22**	-.27**	-.06	-.21**	-.14

*p<.05; ** p<.01; ***p<.001
Source: Developed by author

If the correlational analysis is conducted on the sample of boys, it is observed that the correlations are somewhat higher than in girls and in the same direction in attitude towards science in STEM Education, liking and usefulness, although there is no statistically significant relation with professional interest or self-efficacy (p>.05). It is worth pointing out that there is a correlation with self-efficacy in the sample of girls, but not in the case of boys.

It is noted throughout the entire sample that the relations between attitude and age are negative and statistically significant (p<.01) but low. The highest correlation is the one established with liking (r = -.22), which shows that as they grow older, their interest in science decreases. Nevertheless, there is no relation between age and the dimension of interest (p>.05).

The third hypothesis states that *there are statistically significant differences in attitude and its dimensions according to gender (male/female), educational stage (primary/secondary), mother and father's profession (STEM/non-STEM) and the different interactions between these factors*.

To test this hypothesis, we conducted a factorial ANOVA where the dependent variable is the attitude towards science in STEM Education and its dimensions, and the factors are gender, stage and profession of the father and the mother. Homoscedasticity was tested by means of

Levene's test for all cases. However, in some cases, the assumption of normality is not fulfilled and it is assumed, as stated by Blanca et al. (2017), that the non-fulfilment of the assumption of normality does not have a significant effect on the ANOVA and therefore, we proceed with the analysis, as displayed in Table IV.

TABLE IV. Factorial ANOVA Differences in attitude towards science in STEM Education and its dimensions based on gender, stage, profession of the father and the mother, and their interactions

	Attitude		Liking		Interest		Usefulness		Self-efficacy	
	F Prev.	η^2	F Prev.	η^2	F Prev.	η^2	F Prev.	η^2	F Prev.	η^2
Gender (M/F)	7.629* M	.019	6.411* M	.016	5.849* M	.015	0.617	.002	6.791* M	.017
Stage (Primary/Secondary)	1.417	.004	5,209* Primary	.013	0.488	.001	1.601	.004	1.581	.004
Father's profession (STEM/ non-STEM)	0.019	.000	.003	.000	0.388	.001	1.357	.003	0.387	.001
Mother's profession (STEM/non-STEM)	5.563* STEM	.014	4.062* STEM	.010	3.988* STEM	.010	0.907	.002	5.297* STEM	.013
Gender-Father's profession	0.073	.000	0.018	.000	0.000	.000	0.046	.000	0.532	.001
Gender-Mother's profession	0.187	.000	0.049	.000	0.129	.000	0.314	.001	1.082	.003
Gender-Stage	1,164	.003	1.578	.004	1.097	.003	2.179	.006	0.811	.002
Father's profession-Mother's profession	0.047	.000	0.003	.000	0.380	.001	0.038	.000	0,017	.000
Father's profession-Stage	0.149	.000	1.010	.003	0.010	.000	0.096	.000	0.030	.000
Mother's profession-Stage	0.448	.001	0.299	.001	1.831	.005	0,180	.000	0.960	.002
Gender- Father's profession-Mother's profession	3.315	.008	1.490	.004	1.814	.005	0.797	.002	6,483* M+Non-STEM Father+STEM Mother	.016
Gender- Father's profession-Stage	0.934	.002	2.225	.006	0.004	.000	0.723	.002	0.831	.002
Gender- Mother's profession-Stage	0.223	.001	0,381	.001	0.049	.000	1.584	.004	0.547	.001
Father's profession-Mother's profession- Stage	0.024	.000	0.644	.002	0.067	.000	0.010	.000	0.014	.000
Gender- Father's profession-Mother's profession-Stage	1.975	.005	2.761	.007	0.270	.001	0.383	.001	3.062	.008

*p<.05; ** p<.01; ***p<.001

Prev.: Prevalence The highest average is highlighted

Source: Developed by author

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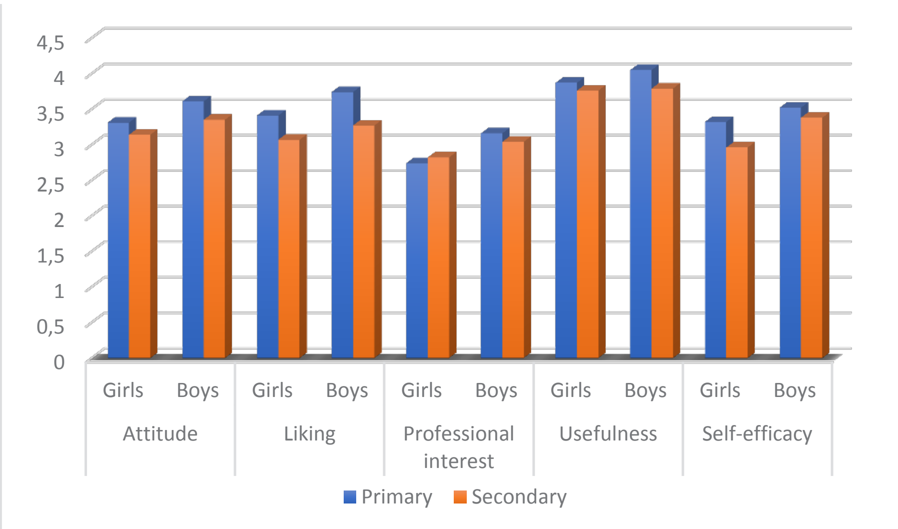
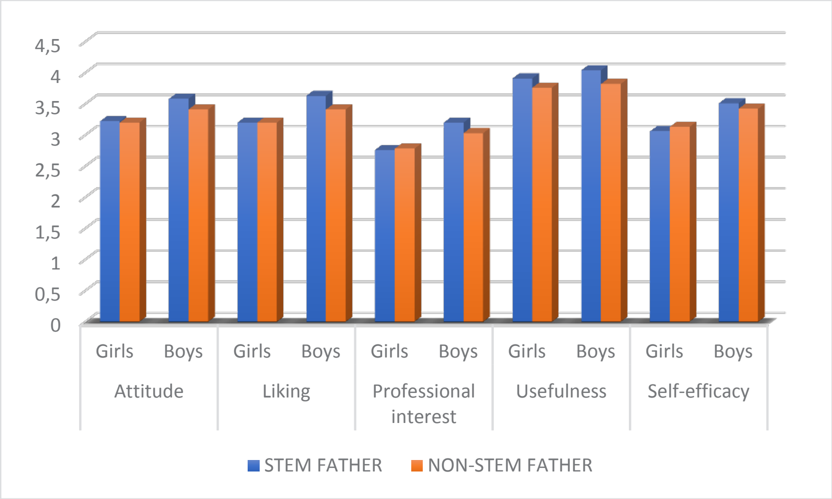
In Table IV, and in line with the results of testing the first hypothesis, there is a difference between girls and boys regarding attitude towards science in STEM Education and its dimensions (*p*<.05), as higher values are obtained, which is also displayed in Graphs I, II and III. This occurs in the different dimensions, except in perceived utility, where the differences are not statistically significant (*p*>.05), although the tendency is the same. With reference to the stage (primary or secondary), statistically significant differences were only noted in the dimension of liking (*p*<.05) for primary school students, compared to secondary school students who had lower values, as indicated in Graph I. This difference, however, is deemed low (h^2=.013) by Cohen's criteria (Cohen, 1992).

GRAPH I. Differences in attitude towards science in STEM Education and its dimensions according to gender and educational stage (primary/secondary)



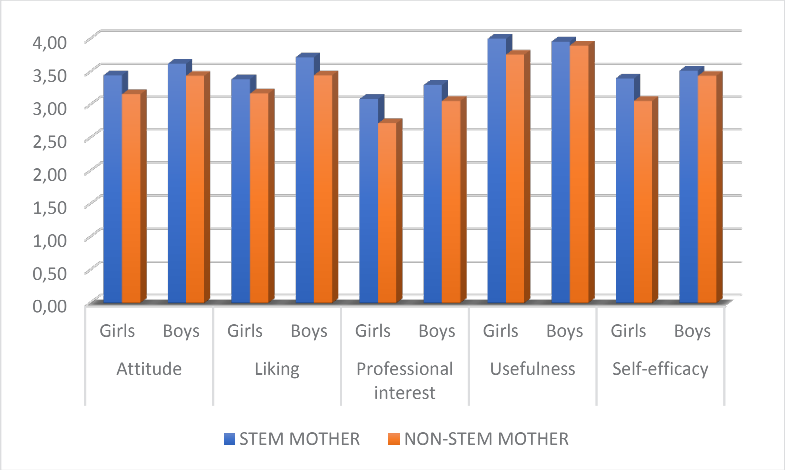
Source: Developed by author

GRAPH II. Differences in attitude towards science in STEM Education and its dimensions according to gender and the father's profession (STEM/non-STEM)



Source: Developed by author

GRAPH III. Differences in attitude towards science in STEM Education and its dimensions according to gender and the mother's profession (STEM/non-STEM)



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When we analyse the differences based on the father's profession, it is noted that they are not statistically significant, the mother's profession being the factor that differentiates students both in their attitude towards STEM Education, as well as its dimensions, with the exception of perceived usefulness. The group of girls and boys whose mothers are in a STEM profession display higher values than those with mothers in professions unrelated to STEM, and these differences are deemed (h^2<.15) low according to Cohen (1992). The dimension of perceived utility is the only one without statistically significant difference (p>.05) between both groups (student group whose mothers are in STEM professions, and group whose mothers are not in STEM professions). If we analyse Graph III, we see that girls tend to have higher scores than boys when mothers are in a STEM profession, although the interaction of both factors does not lead to statistically significant differences (p>.05). Additionally, and as may be seen in Graph III, when the mother is in a STEM profession, the differences in professional interest and self-efficacy are higher in the group of girls than in the group of boys where the differences are less notable. This trend may also be observed in Graph II where boys appear to have a tendency to score higher in attitude towards STEM Education and its dimensions when the father is the one in a STEM profession.

In the different 2 factor interactions, F does not have an error probability < 0.05, therefore, these combinations do not produce statistically significant differences in attitude towards science in STEM Education and its dimensions, as may be seen in Table IV, with effect sizes h^2 <.010 being very low.

F also does not have an error probability lower than 0.05 in the 3 factor interactions that have been studied, except in the interaction of gender, father's profession, mother's profession, with a p<.05 and h^2=.013, a magnitude deemed low according to Cohen's criteria (Cohen, 1992). Within the effect of this interaction, it is observed that boys whose mothers are in a STEM profession but not their fathers, have a significantly higher average than girls whose fathers are in a STEM profession but not their mothers.

Finally, we observe in Table IV that the interaction of the four factors (gender, stage, father's profession, mother's profession) does not lead to statistically significant differences in attitudes towards science in STEM Education, nor in any of its dimensions (p>.05).

Discussion and conclusions

This research was motivated by the goal of exploring whether attitudes towards science in STEM Education has significant gender-based variations at early ages. Although many studies indicate that attitudes towards science begin to be established in early childhood, most of them are focused on secondary education. Thus, the importance of this research lies precisely in the fact that it is conducted on students between the ages of 10 and 14 years. We now discuss the developed hypotheses, taking into account the results obtained.

Regarding the hypothesis that there are statistically significant differences in the attitude towards science in STEM Education and its dimensions, according to gender, the analyses conducted in this study reveal that boys have different and higher statistically significant averages than girls when it comes to attitudes towards science in STEM Education, liking, professional interest and self-efficacy. This data is in line with the considerable research that shows that boys display more favourable attitudes towards science than girls (Denessen et al., 2015).

A link may be drawn with the works of Kim et al. (2018) who attempt to provide an explanation for the differences between boys and girls by propounding the idea that STEM identity is a type of social identity. Social identity determines who belongs to a social group, at the same time that it describes what it means to be a member of the group through a set of norms, attitudes, behaviours, features and stereotypes. Thus, the prototypical STEM member tends to be white, male, socially awkward and uniquely obsessed with their field of work (Cheryan et al., 2015). Persons who do not fit this prototype of the group tend to be marginalised members and given that prototypes in many STEM areas are often to be male, it is probable that girl students in these areas experience low prototypicality in STEM during their schooling. In accordance with the theory of social identity, we may point to the difficulty faced by girl students in identifying with STEM since their social environment gives them a series of signs that they do belong nor do they fit into STEM stereotypes.

Other research such as Oon et al. (2020) support these ideas, demonstrating that students consider science to be a typically male subject, and it is more favourably viewed by boys than by girls, as a stereotypical threat. In connection with the above, Sáinz (2020) states

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that stereotypes that assign better skills in STEM areas to men may lead women to opt for education and professional careers that move away from STEM Education. Gender stereotypes in science are a source of concern as they generate a lack of identification with STEM Education in girls and women, thus creating not only negative attitudes towards science but also a decreased feeling of belonging to STEM Education, which lowers their intention to follow STEM careers (Ito & McPherson, 2018).

Additionally, and in relation to the second hypothesis, the analysis of the correlation between attitude towards science in STEM Education and its four dimensions in the sample of girls makes it clear that as their age increases, they derive less enjoyment from studying science, their liking decreases and they gradually lose interest in science-related subjects. Moreover, the social relevance given by girls to science and to male and female scientists (dimension of usefulness) also decreases with age, similar to self-efficacy. Nevertheless, a relation between age and professional interest or the intention of girls to pursue future studies in connection with science could not be drawn. In the case of boys, the correlations are somewhat higher than in girls, and in the same direction, although there is no relation either with professional interest or with self-efficacy.

The progressive lack of interest in science among boys and girls with age is a matter of concern, as if they develop and retain positive attitudes towards science at these ages, they are more likely to want to continue studying these subjects that they enjoy.

Regarding the second and third hypotheses, when we analyse what happens as boys and girls grow older, we found that in the case of boys, the negative correlation between the attitude towards science in STEM Education, liking and usefulness, is higher than in the group of girls. However, in the dimension of self-efficacy, girls obtain higher negative correlations than boys. When we look at the average values, what strikes us is that self-efficacy is the dimension that most differentiates girls and boys as they advance in their education, although we can only perceive it at the descriptive level. This is in line with some studies that demonstrate that within the same level of competence, girls tend to underestimate their results compared to how boys rate themselves (Bøe & Henriksen, 2013) or how self-efficacy has a greater influence on performance in women than in men (Fernández et al., 2019).

The results of different studies demonstrate that girls who internalise gender stereotypes have lower levels of self-efficacy and confidence in their skills than boys (Robnett, 2015) and that this appears to be influenced by their social context, including their parents' expectations (Garriott et al., 2017). It is not unreasonable to state, in line with Robnett (2015), that gender bias may be partially responsible for driving girls and women away from STEM Education and for the low self-esteem suffered by many of them.

If we continue to look at the results of this research and examine the differences based on the professions of the father and the mother (STEM or non-STEM profession), then we may infer that the father's profession does not make a difference in the averages with reference to the attitude or its dimensions. However, in the case of the mother's profession, there are statistically significant differences in attitude towards science in STEM Education, except in the dimension of usefulness. It is perceived that girls display greater differences than boys depending on whether the mother is in a STEM profession or not. This coincides with studies conducted by the OECD (2015) that confirm that the performance of girls in science appear to be more closely linked to backgrounds with mothers who have completed higher education (STEM profession), or with research such as the one conducted by Melhuish et al. (2008) that explains that the educational level of mothers is a relevant factor in the mathematical performance of girls and boys, or Avendaño et al. (2020) that shows the father's influence has a minimal effect in the process of career selection, while the mother's effect is significantly higher.

Finally, the role played by the mother's profession in developing self-efficacy in girls is highlighted. Of all the sources of the beliefs held by the subjects on self-efficacy, it is worth highlighting the role played by the vicarious experiences (Bandura, 1997) of children with mothers in STEM professions. Accordingly, girls may see other persons similar to themselves, in this case, of the same sex, being successful in their profession and thus develop positive beliefs regarding self-efficacy, thus creating a favourable judgement regarding their capacity to undertake similar activities, in this case, those linked to STEM areas. This vicarious observation may especially influence the self-efficacy of girls, encouraging them to continue their efforts when confronted with moments of failures.

It is also possible that the direct indication of mothers in STEM professions to their daughters that they possess the required capacity to

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successfully undertake a task in this area, strengthens the perception of self-efficacy. This may boost the subject's efforts which in turn leads to improved skills and thus translates into positive beliefs regarding one's own capacity and attitudes towards science in STEM Education.

The conclusions drawn from this research leads us to believe that it is necessary to promote, from a very early age, school interventions that transform gender-related STEM stereotypes, as well as guiding families to understand the concept, meaning and value of STEM Education (Martín et al., 2019).

Future lines of research include analysing the relationship between student intentions when choosing a syllabus related to STEM Education, the factors that influence these intentions and the consistency with which these intentions can predict student behaviour, especially female students, as well as the study of additional variables such as, for example, the family's socioeconomic status, the parents' attitudes to STEM, and STEM teaching practices.

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Contact address: Olga Martín Carrasquilla. Universidad Pontificia Comillas; Facultad de Ciencias Humanas y Sociales, Departamento de Educación, Métodos de Investigación y Evaluación. Calle Universidad Comillas, 3-5, C.P. 28049, Madrid. E-mail: olmartin@comillas.edu

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