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Teachers' self-perception of scientific competences: a gender approach

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ABSTRACT

This study analyses the self-perception of 274 teachers from public, urban, and rural schools in Manizales, Colombia, using a Likert scale instrument developed considering the scientific competencies determined by UNESCO. In the analysis of the results, it was found that, even though in the sample analyzed, women have greater training in research and scientific competencies, their perception of their abilities in this aspect is lower than that of men. With the Mann-Whitney U test and rank-biserial correlation, it was possible to test the alternative hypothesis that the female self-perception of capabilities is lower than the male for each question. The instrument was validated with the internal consistency index with an α=0.98. Additionally, the instrument has been validated with a confirmatory factor analysis, obtaining values of comparative fit index (CFI) of 0.869 and Tucker-Lewis's index (TLI) of 0.858 with RMSEA and SRMR of 0.103 and 0.063, respectively. The paper provides insights into the self-perception of scientific competencies among teachers, which can inform teacher training and professional development programs. The study highlighted the gender gap in self-perception of scientific competencies, which can inform policies and interventions to promote gender equity in science education.

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1. INTRODUCTION

The impact of social representations and common beliefs has undeniably taken root in the culture when it comes to revising the surrounding perceptions about the role of women in science [1], [2]. Although, in recent years, it has been possible to open educational spaces that promote gender equity, the traces and biases that permeate the minds of women and men are latent in speeches and actions, suggesting that despite the efforts of current feminists who have transformed women's participation in academia, some androcentric cultural and historical forms are still present [3] generating a deficit of girls and women pursuing science, technology, engineering, and mathematics (STEM) disciplines that can be attributed in part to subtle forms of bias linked to traditional gender role stereotyping [4]. The current research demonstrates another, more intangible gender gap in academia, called mismatch, whereby, compared to male academics, female academics perceive a greater mismatch between their professional self-concept and the stereotype of the successful academic [5].

Androcentric order narratives predominate in science and the beliefs of the common [6]. It is not easy to change the perceptions about women in science when the foundations of scientific thought have been presented by men, exalting their contributions, relegating, or ignoring the contributions of women, even when, as history shows us, some of these contributions that materialized under the name of a man have originated in the thoughts of women or in a collective work in which a woman actively participated. In this sense, a long legacy of contributions by women in science has been erased from memory. Cases in which recognition is only obtained by man, such as that of the physicist Lise Meitner, who is little known for having participated together with Otto Hahn in fundamental discoveries for the development of atomic energy -the fission of nuclei of heavy atoms-work that allowed Hahn to obtain the Nobel Prize in 1945, a prize that Meitner never received [7].

Recent historical research and narratives of science show that women have been vital for the development of science and the advancement of human knowledge [8]–[11], even though, historically, recognition is attributed to men either due to cultural traditions or because they have appropriated the original ideas of women, as is the case of Rosalind Franklin, whose contributions were essential for determining the helical structure of the DNA, but was appropriated without recognition by Wilkins, Watson, and Crick, who received the Nobel Prize after Rosalind’s death [7]. This has allowed different researchers to focus on the contributions of women to scientific development and the persistent gaps between men and women in the scientific field. Some researches [12]–[18] revealed this gender gap that has persisted in the history of science. In addition, some results indicate strong associations between information and communication technologies (ICT) self-efficacy and transfer learning measures. Both gender and ICT factors cause significant differences in the levels of ICT self-efficacy measures [19]. Furthermore, it could be shown that gender can still be considered a limitation in ICT use [20].

Despite the struggles initiated by different groups of feminist scientists and historians, the “persistence of traditional stereotypes concerning the roles and responsibilities of women and men in the family and society continues, which reinforce the traditional role of women as mothers and wife, which continues to affect their educational and career prospects” [21]. These stereotyped models of women have been established in social imaginaries, acquiring the meaning of what the culture accepts as the socially prescribed and experienced dimensions of “femininity” or “masculinity” in a society [22]. These models shape women's perceptions of themselves. In some cases, they turn out to be beliefs that hinder progress in the social construction of scientific knowledge. Some results in the food industry show differences in self-assessment categories concerning gender, with men having a better self-perception, especially in economic analysis and clarity of career goals. Women rate themselves better only in food development, traditionally associated with women from the domestic sphere to the food industry [23].

Thanks to various actions, the participation of women in different aspects of society has increased [24]. However, many sectors continue to have much lower female participation than men. In the field of research, for example, in Colombia, only 38% of all researchers are women. In STEM areas such as mechanics, electricity, electronics, computing, and civil and physical sciences, this proportion does not exceed 20% [25]. Ensuring gender equality in education is one of the Sustainable Development Goals specified by the United Nations. Ensuring gender equality in teaching/learning environments, however, requires sensitive and gender-aware teachers [26].

Current science education research pays attention to teachers' skills for teaching in secondary and basic education in a technological and social context. In this research, the perception of Natural Sciences and Mathematics teachers in the city of Manizales, Colombia, was explored, taking as data teachers' own conceptions about scientific competencies in science teaching, which we analyzed from a gender perspective to show that the gender gap goes beyond a social conception and that even the perception of gender is essential in this aspect, especially if one takes into account the attitude of the female and male teachers regarding scientific knowledge. We based our analysis on two key aspects in teaching school sciences: the first is associated with the production process of scientific knowledge; the second is related to the attitudes of students and teachers towards the learning and teaching of scientific knowledge [27]. This last aspect that is considered fundamental in the analysis is oriented towards the way in which scientific knowledge is assumed, that is, the attitudes and dispositions of both those who teach and those who learn, scientific knowledge: curiosity, imagination, problem-solving, the systematic use of scientific methods, values, ethics, and scientific processes in the classroom [28].

2. RESEARCH METHOD

In this descriptive research, we have used the self-perception angle because we do not have enough data available to measure and analyze the performance. We start from a database to analyze the self-perception that Natural Sciences and Mathematics teachers have about the skills to teach Science in the classroom, we choose this sample of the study, because there is evidence in the literature of the gender gap in these areas of knowledge in all levels of the educations system. An instrument on a Likert scale with five response possibilities in 37 questions was implemented in a sample within a population of 274 teachers from public schools in the City of Manizales, 175 women and 99 men, after cleaning the database to eliminate missing data or incorrect. As the study is a population-based study, the sample size is not calculated, since it analyzes all the individuals who have answered the instrument completely and globally. On the other hand, six categories of competences were classified to investigate the perceptions of teachers about the elements [29]. Each of these competences, in turn, were divided into three categories, namely: i) technological and communication skills; ii) deep learning; and iii) transfer and creation of new knowledge, as shown in Table 1 to Table 3, respectively [29].

Table 1. Scientific competences of category 1 (Technological and communication skills)

Competence 1 – The curriculum	Competence 2 – General teaching skills
– Develop and implement a coherent scientific curriculum. (C_1) – Develop, implement, and expand the framework of objectives, plans, materials, and resources for education. (C_2) – Plan an instruction that promotes problem analysis, critical thinking, creativity, leadership, and decision making, based on the organization and integration of curricular content in relation to science education. (C_3) – Orient teaching objectives to enhance student learning and motivation, with emphasis on individual differences, community, and current science education standards. (C_4)	– Use scientific teaching actions, strategies, and methodology. (HGE_1) – Establish interactions with students including questioning techniques that promote learning. (HGE_2) – Organize the classroom effectively, a laboratory or field experience in different groups of students. (HGE_3) – Use advanced technology to extend and enhance learning. (HGE_4) – Use students' prior concepts and interests to promote new knowledge. (HGE_5) – Design scientific investigations in the classroom. (HGE_6) – Operate complex laboratory equipment. (HGE_7) – Prepare materials used in the science laboratory. (HE_8) – Establish and enforce laboratory safety, including storage and hazardous waste deposits in the science laboratory. (HGE_9) – Monitor student learning through a variety of assessment strategies, providing feedback to students to improve their learning. (HGE_10) – Design, conduct, and evaluate laboratory activities that target the development of scientific concepts, using scientific techniques and methodologies. (HGE_11)

Table 2. Scientific competences of category 2 (In-depth learning)

Competence 3 – Knowledge and nature of the scientific context	Competence 4 – Evaluation
– Know the values, beliefs, and assumptions inherent in the creation of scientific knowledge, within the scientific community and compare the sciences with other forms of knowledge. (CNCC_1) – Analyze local, national, regional, or global problems or challenges in which scientific design can be or has been used to design a solution. (CNCC_2). – Evaluate the scientific design process used to develop and implement solutions to problems or challenges in everyday life. (CNCC_3). – Evaluate consequences, constraints, and applications of solutions to problems or challenges in everyday life. (CNCC_4) – Analyze how the advancement of scientific and technological knowledge, discovered, and developed by individuals and communities in all cultures of the world, contribute to changes in societies. (CNCC_5) – Analyze the effects of human activities on the earth and the ability to sustain biological diversity. (CNCC_6)	– Know the different dimensions and strategies for monitoring and evaluating student learning. (E_1) – Use assessment results to guide change in teaching and learning strategies in the classroom. (E_2) – Monitor and assess student learning through a variety of means, providing feedback to students to adjust teaching strategies in the classroom. (E_3)

Table 3. Scientific competences of category 3 (Transfer)

Competence 5 – Research	Competence 6 – Professional Practice
– Plan and conduct scientific research. (I_1) – Synthesize a scientific explanation using evidence, data and inferential logic. (I_2) – Apply knowledge of how to report complex scientific research and explanations of objects, events, systems, and processes and how to evaluate the results of scientific investigations. (I_3) – Analyze how important curiosity, honesty, cooperation, openness, and skepticism are to scientific explanations and research. (I_4) – Analyze the limitations of scientific theories using logic, history, current evidence, and the ability to be investigated and modified such a theory. (I_5) – Evaluate the inconsistency or unexpected results of scientific research using scientific explanations. (I_6) – Analyze scientific research, its validity, reliability, and results. (I_7) – Understand how scientific knowledge evolves. (I_8)	– Constantly update their disciplinary knowledge as a basis for the professional practice of teaching science and mathematics. (PP_1) – Know the standards of ethical conduct in science teaching, consistent with the interests of students and the educational community. (PP_2) – Participate in the activities of their professional community, which include other teachers and science organizations to enhance student learning. (PP_3) – Constantly reflect on their professional practice and make continuous efforts to ensure the highest quality of science and mathematics teaching. (PP_4) – Communicate effectively to parents, industry and commerce and other agencies, and the community at large how they can support science and mathematics learning for all students. (PP_5)

Furthermore, the instrument is evaluated with R-Project software on the RStudio platform version 2022.07.2 Build 576 and JASP version 0.16.4 for data analysis. There were two phases of analysis developed for the validation of the instrument. In the first phase, a confirmatory factor analysis (CFA) was performed. In the second phase, the reliability of the scale was tested with the entire sample (n=274) by calculating Cronbach's α and composite reliability (CR). The reliability or internal consistency of the data set was measured using Cronbach's alpha [30]. The internal consistency index for the database is verified with a result of $\alpha = 0.98$, so the internal consistency is excellent. The composite reliability was 0.99.

3. RESULTS AND DISCUSSION

We performed a confirmatory factor analysis CFA, which allows us to analyze how the six factors, called categories in Tables 1-3, the comparative fit index (CFI) and Tucker-Lewis's index (TLI) were 0.869 and 0.858 respectively with RMSEA=0.103 and SRMR=0.063. All the estimated loading coefficients are significant; however, this depends on the level determined according to scientific literature, Hair *et al.* [31] indicated that standardized loading estimates should be 0.5 or more, and ideally 0.7 or more. On the other hand, study by Fields [32] suggests considering a factor as reliable if it has four or more loadings of at least 0.6, regardless of sample size. Research by Stevens [33] suggests using a cutoff point of 0.4, regardless of sample size, for interpretive purposes. Comrey and Lee [34] also suggest using stricter cutoffs ranging from 0.32 (poor), 0.45 (fair), 0.55 (good), 0.63 (very good) or 0.71 (excellent). For the proposed model, all loading factors are greater than 0.7. The model is shown in Figure 1.

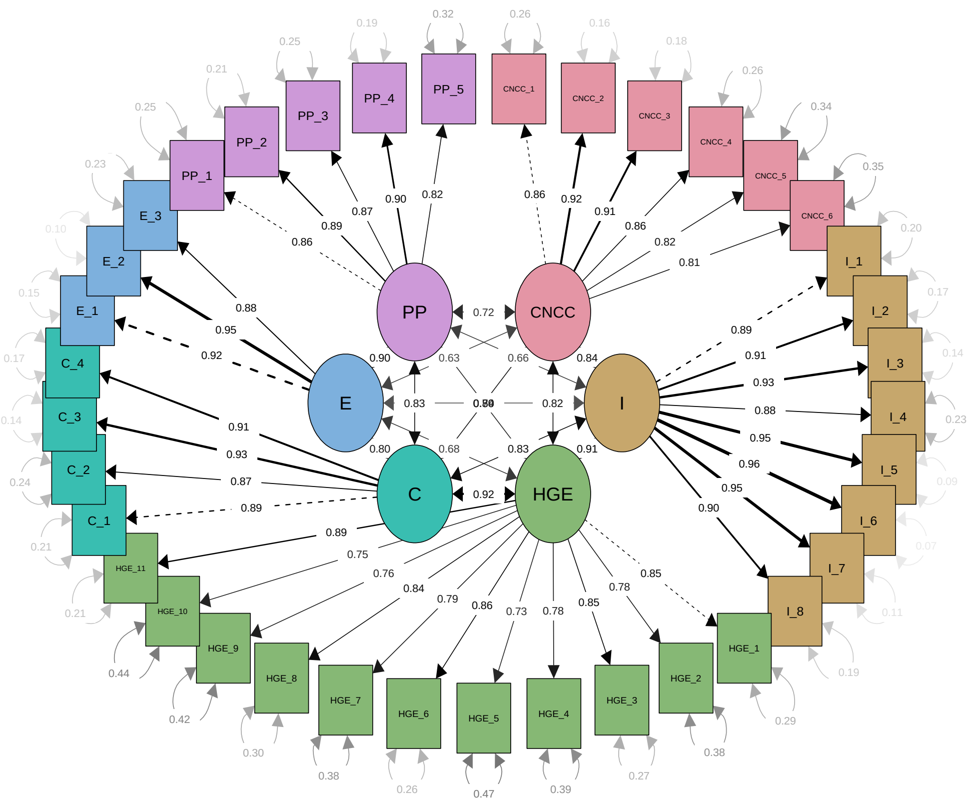

Figure 1. CFA model analyzed

The following results shows that the analysis of Likert scale, allow us to delve into the fact examined in the previous sections, subsequently, even though the highest level of training of the teachers who were part of the project was obtained by women, they conceived of themselves as little able to do science. They did not value their capacities for scientific thinking and their contribution to the construction of science. In other words, there was evidence of contempt for their abilities and participation in the construction of scientific knowledge. As previous study points out [35], "*New programs have been designed that, with fairness and equality, provide girls and boys with the capacity and autonomy to grow, develop and* *think of possible worlds, free of stereotypes and obsolete schemes* (…).” These still do not show the results in the change of thought against the conception that women have about themselves when talking about their role in science. Recent studies have shown that females' self-concept in mathematics is lower in classrooms where some of their female peers had a relatively higher level of mathematics achievement than boys, suggesting that counter-stereotypical performance patterns in the classroom do not increase students' self-concept in subjects with strong gender stereotypes. On the contrary, girls are more likely to compare themselves to their female peers, resulting in a negative association with self-evaluations [6], [36].

Perhaps the external discourse has been better structured, in order to achieve gender equality in the last three decades, but the actions and ways of thinking about themselves, in decision-making and within the scientific field, do not reflect an appropriation discursive for the empowerment required when identifying themselves as central actors when doing science, as evidenced by the answers presented by the participants of this study, which are aligned with the results on gender gaps in Colombia, presented in November [37], that account for the low incorporation of women into the paid labor market, since only 53.1% of those located in the main cities are employed, a lower range than the employability of men (73.9%). This being the case, reality shows that, “The work of women is valued less, because under the stereotyped notion their skills are not acquired, they are given to them by nature” [38]. Perhaps looking at themselves and returning to the social representations that show low self-esteem are alternatives, especially when, in reality, the surrounding imaginary reveals that perception of female teachers about the investigative skills they possess turns out to be extremely low, even though a high percentage of them have postgraduate training and have participated in research processes. The difference between females and males’ teachers, in the upper levels of education, is almost double. Female teachers at these levels double the number of male teachers as shown in Figure 2, this wide gap in educational levels is not evident in the self-perceptions of female teachers in relation to their abilities to do science, as shown in Figure 3.

On the other hand, although men are the ones with a lower educational level, at least at the highest levels, they have a much higher self-perception regarding their scientific competence, surpassing women in competences such as: the ability to plan and conduct scientific research where there is a high percentage of male teachers (72%) who strongly agree with such statement. Likewise, they state that they can synthesize a scientific explanation using evidence, data, and inferential logic (82%); In addition to this, they consider that they can evaluate the inconsistency or unexpected results of investigations using scientific explanations (73%). It should be noted that this study mentions some of the 6 sub-dimensions that UNESCO’s scientific competence includes.

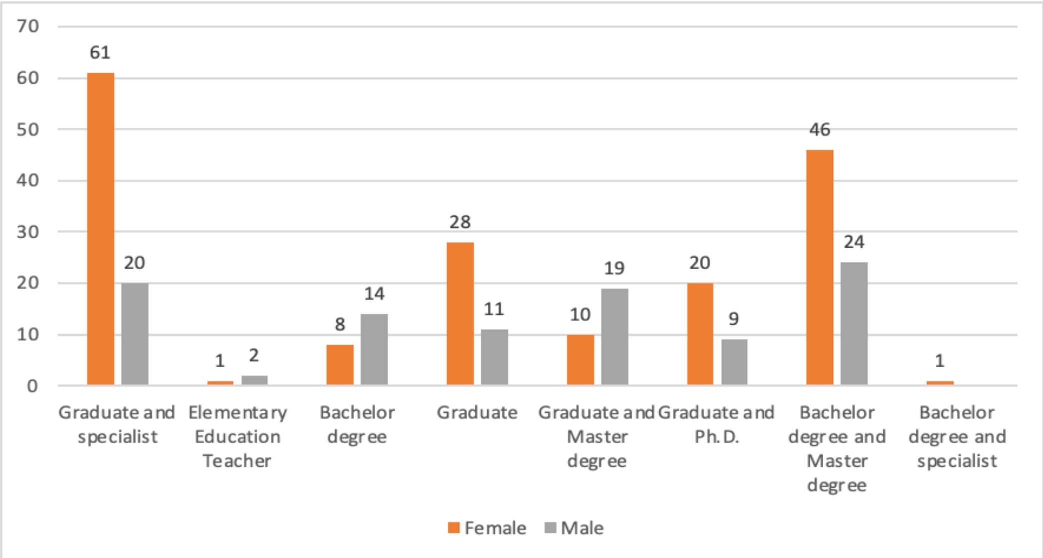

Figure 2. Educational levels differentiated by gender

According to previous study [39], although the self-perception of teachers has a high subjective burden, it should not be dismissed, since it affects the actions and the way they are thinking of science. For these authors, a high self-perception may reflect a lack of self-criticism, or it may reflect a refusal to “face the needs for change, stating that everything is fine like that, that nothing happens.” In addition, it should be noted that these self-perceptions were not contrasted in the classroom, with additional information data collection, which considered, for example, the recording and analysis of the classes of the teachers of both genres.

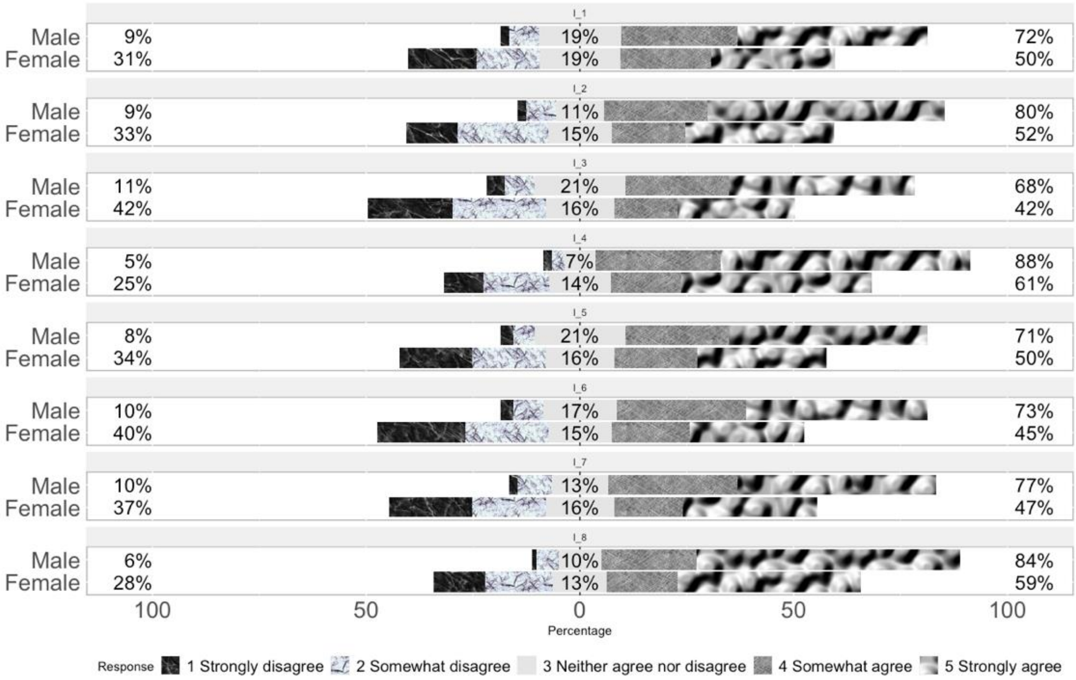

Figure 3. Investigative competences by gender

The sociocultural reality in which women have less economic autonomy, but a greater burden of unpaid work in the home, can be considered as a factor that strongly influences the representations and self-perceptions of women about themselves. Previous research [37] showed that a fixed and equal amount of 24 hours of unpaid work in the home represents 30% of their time for women, while for men only 14%. Even so, despite the fact that, as stated in previous research [37], they only have 6 hours for training and fun, while men have 10 hours; although female teachers have higher educational levels, which allows strengthening the development of investigative capacities, in their responses they make it clear that they fail to perceive these competencies in their professional development, as evidenced in Figure 3. Perhaps this perception is related to what was expressed by the study [40] on gender equality in science and technology, in which it is shown that exist gaps in the scientific productivity of women and men.

As we have mentioned before, there are gaps in scientific productivity between genders, particularly in terms of publications, or deflection towards less valued academic activities, such as teaching, administrative and extension work, but also less access to formal academic networks or informal ones - usually dominated by men- where the necessary support is obtained for the advancement of the research career, produce a decrease in the professional development opportunities of women, specifically, when they choose to deviate from the ideal scientific model of dedication and total availability to the activity. This situation is not unrelated to that found in previous studies, since as evidenced by several researchers, only 24% of women occupy higher level academic positions. The low positioning in the production of knowledge and in publications is the product of a culture in which machismo has predominated [41].

However, the findings of this research in relation to the general teaching skills competence present a similar pattern with the investigative competence. As seen in Figure 4, women have a lower perception than men in relation to general skills such as: Using scientific teaching actions, strategies and methodology, organizing the classroom effectively, designing laboratories or field experiments in different groups of students, planning scientific investigations in the classroom, monitoring student learning through a variety of assessment strategies, providing feedback to students to improve their learning among others; which confirms that the self-perception of their abilities affects the way of seeing and teaching science. It is evident, the low self-perception of women about their work in the classroom and their role in the teaching process.

Historically, women were restricted to domestic environment, their admission to universities involved transformations at the social and cultural level in the country [42]. Since the institutionalization of female education in 1942, in Colombia, educational institutions focused on the education of the female population were created. The creation of the nursing program in 1950 at the University of Antioquia reflects the inclusion and training of women in settings other than the home, even when the program focuses on care. Although the struggle of women in Colombia to access education has involved years, it was not until the 1970s that the first studies on Women and Education appeared [43]. Despite this, a deeper change of women's thoughts in relation to their contributions to scientific work have not been achieved yet. According to previous research [42], "*the educational work of women, in their relationship with the professional field, was a fundamental aspect to improve their self-esteem, which was very low, due in part to the discrimination they had suffered for so many years. These new spaces for the academic training of women allowed them to socialize, work as a team, develop personal itineraries, play cooperative games, monitor families, and create new social spaces for integration and understanding*." Although the development of women in the academic and professional sphere is related to an increase in her self-esteem, the data from this research seem to contradict.

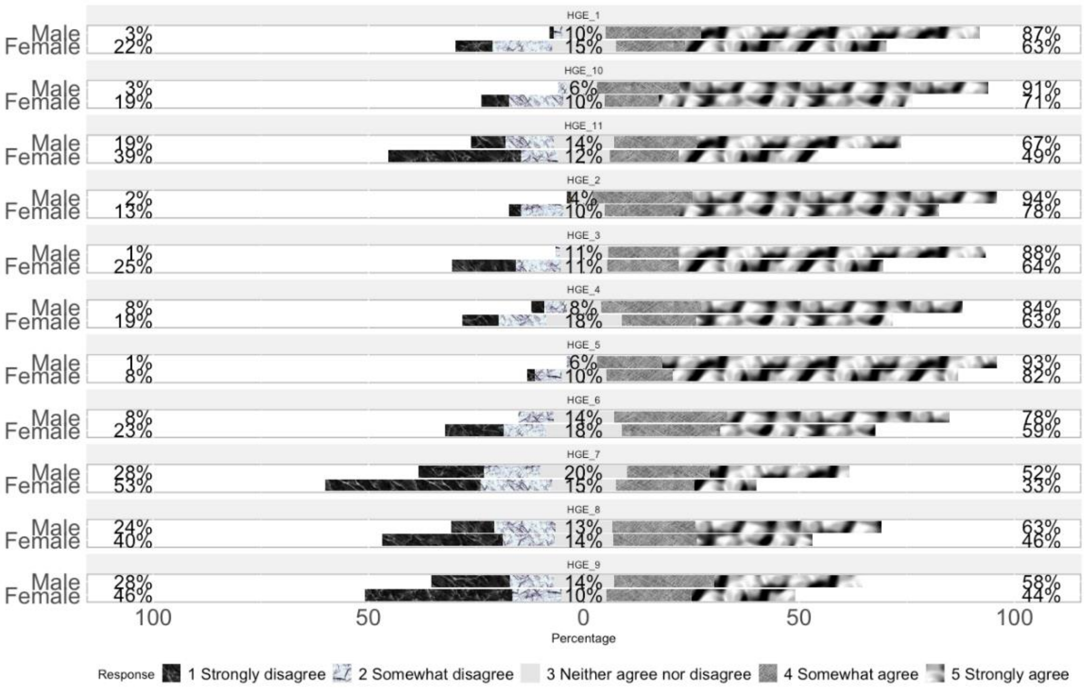

Figure 4. Competence general teaching skills vs. gender

Something similar can be observed in the previous studies [44], who maintains that in Colombia it was possible to improve the educational conditions of women and thereby close the gender gap. "(...) the increase in the level of education among women in relation to men, led to the fact that the gender differential in education practically disappeared in 1993". However, the differential remains, it has not disappeared, as the author suggests. In fact, this research shows us that it is necessary to make known in a new way the beliefs of the teachers themselves about their skills and abilities, especially around scientific development area, emphasizing that the idea of resignification stands for giving new meanings to the present, by assigning a different interpretation to the past. Identifying gender gaps allows, as Huang *et al*. explain, to rethink open debates on the sustainability of the professional practice carried out by women in the academic world, given that the presence of women in academia enables spaces for discussion and dialogue to train researchers by linking them from the classroom and strengthening their self-esteem in relation to the skills they can develop to carry out research processes [41]. There is no doubt that language plays a central role in giving importance to these beliefs that continue to accentuate the gender gap in science. The challenge is to begin to change these representations and imaginary that surround the minds of women and men who contribute to science and who fail to recognize themselves as active agents in the construction of knowledge, although achieving this change is not an easy task. For this reason, it is imperative to generate new beliefs that allow transforming androcentric knowledge and deactivating “the stereotyped and sexist messages that the female population receives, and that constitute an important factor of socio-environmental influence, which can be unconsciously persuasive” [16].

The gender stereotypes that have been established in the culture also show the beliefs of the students at each educational level, regardless that men and women have a doctoral educational level, they remain associated with the female image with the private sphere and homelike. Stereotypes that highlight the devotion of women and their service to others; structural and socially constructed stereotypes [16]. These beliefs and visions, as stated [45] invite to initiate permanent reflections, even more so, when students who aspire to become teachers and want to show a real change in the actions and perceptions that women have about themselves and their role in the world of science, technology, and innovation. In accordance with the explanation, it is urgent to deactivate “the stereotypes that continue to promote unequal conditions for women and affect their comprehensive development. Not only the school, but also the family and society, reproduce and strengthen these behaviors and stereotypes that produce a series of conditioning factors that increase inequalities between men and women” [46]; this necessarily implies a collective and conscious work in which we all must participate. The results of Figure 5 show that in the same way for the competencies analyzed in Figure 3 and Figure 4, the self-perception of abilities in all aspects for women is lower than that of men, reinforcing the hypothesis put forward in this study that the self-perception that women have has been influenced by the social aspects that have given rise to their development. Figures 5 (a) to 5 (d) show the analyzed competencies of knowledge and nature of the scientific context, professional practice, the curriculum, and evaluation, respectively.

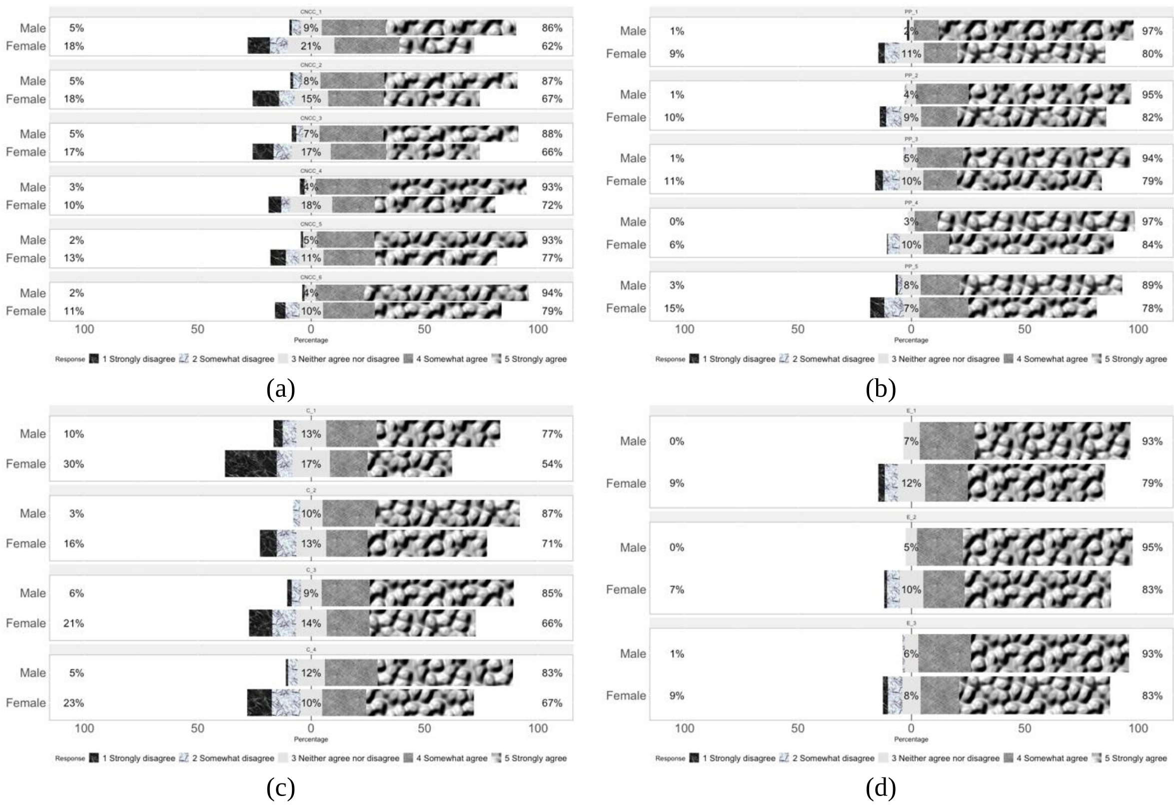

Figure 5. Results of analyzed competencies of (a) knowledge and nature of the scientific context, (b) professional practice, (c) the curriculum, (d) evaluation

In fact, as we see in Figure 5, each competency shows a slight difference in the response categories between female and male, of almost 10 percentage points. This occurs for all the competencies in the figure, although some variation in this difference is observed. In addition, we can explore these differences for the category responses in the lower range, and we observe that the female mean is higher than the male mean, but this difference changes for the higher ranges, where we observe that this difference is in favor of the categories of the responses for males. We can conclude that the self-perception of performance in each category is higher for males than for females, reinforcing our hypothesis. Table 4 presents the results of the Mann-Whitney U test that allows testing the alternative hypothesis that for each question the female self-perception of capabilities is lower than the male. The results show that the alternative hypothesis (group female is less than group male) is accepted for most of the variables except for questions E_3 (Know the different dimensions and strategies for monitoring and evaluating student learning) and PP_2 (Know the standards of ethical conduct in science teaching, consistent with the interests of students and the educational community) where the null hypothesis is accepted indicating that there is no difference between the self-perception of women and men. For most of the variables except for questions E_3 and PP_2 as shown in Table 4, there are small to medium negative effect sizes mean that the male group tends to be larger than female group measured with the rank-biserial correlation [47], [48].

Table 4. Mann-Whitney test

Variable	W	p-value	Rank-biserial correlation	95% CI for rank-biserial correlation	
				Lower	Upper
CNCC_1	5881.500	< .001***	-0.321	-∞	-0.210
CNCC_2	6621.000	< .001***	-0.236	-∞	-0.120
CNCC_3	6442.000	< .001***	-0.256	-∞	-0.142
CNCC_4	7363.500	0.011**	-0.150	-∞	-0.031
CNCC_5	7043.500	0.002**	-0.187	-∞	-0.069
CNCC_6	6926.500	< .001***	-0.200	-∞	-0.083
I_1	6244.000	< .001***	-0.279	-∞	-0.166
I_2	5923.000	< .001***	-0.316	-∞	-0.205
I_3	5821.000	< .001***	-0.328	-∞	-0.217
I_4	6551.500	< .001***	-0.244	-∞	-0.128
I_5	6150.000	< .001***	-0.290	-∞	-0.177
I_6	5766.000	< .001***	-0.334	-∞	-0.224
I_7	5920.000	< .001***	-0.317	-∞	-0.205
I_8	6271.000	< .001***	-0.276	-∞	-0.162
HGE_1	6429.500	< .001***	-0.258	-∞	-0.143
HGE_2	7405.000	0.010**	-0.145	-∞	-0.027
HGE_3	5983.000	< .001***	-0.309	-∞	-0.198
HGE_4	6844.000	< .001***	-0.210	-∞	-0.093
HGE_5	7487.000	0.010**	-0.136	-∞	-0.017
HGE_6	6563.500	< .001***	-0.242	-∞	-0.127
HGE_7	5999.000	< .001***	-0.307	-∞	-0.196
HGE_8	6557.500	< .001***	-0.243	-∞	-0.128
HGE_9	6946.500	0.003**	-0.198	-∞	-0.081
HGE_10	7082.500	0.002**	-0.182	-∞	-0.065
HGE_11	6458.000	< .001***	-0.254	-∞	-0.140
C_1	6308.500	< .001***	-0.272	-∞	-0.158
C_2	7200.500	0.005***	-0.169	-∞	-0.051
C_3	6718.500	< .001***	-0.224	-∞	-0.108
C_4	7000.000	0.002**	-0.192	-∞	-0.075
E_1	7590.500	0.024*	-0.124	-∞	-0.005
E_2	7531.000	0.014*	-0.131	-∞	-0.012
E_3	8098.500	0.140	-0.065	-∞	0.054
PP_1	6713.500	< .001***	-0.225	-∞	-0.109
PP_2	7815.500	0.052	-0.098	-∞	0.022
PP_3	7485.500	0.012***	-0.136	-∞	-0.017
PP_4	7299.000	0.001***	-0.157	-∞	-0.039
PP_5	7147.000	0.003***	-0.175	-∞	-0.057

Note: For the Mann-Whitney test, effect size is given by the rank biserial correlation.
For all tests, the alternative hypothesis specifies that group female is less than group male.

4. CONCLUSION

Although within this research, it is not possible to find the reasons for the existence of a perception oriented towards maintaining the gender gap, the quantitative results show that this gap persists in the teaching and learning imaginaries of teachers of both genders, who teach the scientific subjects. This study also shows that the gender stereotype may also be reinforced by the training process, considering that the teachers' self-perception persists in the same sense. It is important to design teaching strategies at all educational levels, oriented towards the promotion and recognition of the capacities of women, related to the scientific development of female teachers in postgraduate programs around science and mathematics teaching. It is essential to design teaching strategies at all educational levels, oriented toward the promotion and recognition of the capacities of women and their contributions to science.

A process that should begin from childhood and be done with greater emphasis on postgraduate training, given that it is precisely in this formative phase that spaces for research are openly possible, as well as for reflection and discussion on the role of women in the construction of scientific knowledge. Undoubtedly, it will be necessary to emphasize in those scenarios that have been traditionally masculinized, such as the teaching of mathematics and the construction of knowledge in what, for some men, is considered a "hard field". The gender stereotype may also be reinforced by the training process, pondering that the teachers' self-perception persists in the same sense. It is essential to design teaching strategies at all educational levels, oriented towards the promotion and recognition of the capacities of women, related to the scientific development of female teachers in postgraduate programs in science and mathematics teaching. Faced with this evidenced situation, it is necessary to generate collaborative work strategies in the classroom and avoid competition based on sexist prejudices.

Curriculum designs should allow girls to identify themselves as part of social change and recognize that the knowledge they build in the classroom can be used in everyday life from scientific constructions in which they actively participate. This implies that teachers have a conception of science based on gender equity and intend their teaching processes by opening reflective spaces to show the role that women have played in the construction of scientific knowledge; as well as design strategies and projects to link and motivate both girls and boys to participate in science and mathematics. It is essential to investigate the access of the proportion of female and male students to science teaching programs and what are the perceptions and motivations of both genders in the formation and widening of the gender gap in the selection of these programs. Also, we suggest formulating programs of non-formal science education, like math or science clubs, with a gender approach to enhance women interest in science programs and develop scientific competences at different levels of education.

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