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Stories about gender inequalities and influence factors: a science club case study

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ABSTRACT

This article explores the perception of gender inequality in science and the influencing factors. Data was collected through in-depth interviews with students belonging to a science club; we present it as a case study. This research sheds light on what high school and university students studying Science, Technology, Engineering, and Mathematics (STEM) perceive in Mexico, where the gender gap is the highest of all scientific disciplines, considering the relationship between science and gender through their study experiences and perspectives. The findings mainly revealed two positions: (1) denial of gender inequalities; and (2) recognition of gender inequalities associated with biological, psychological, and social factors. It is precisely this last factor that is based on a feminist position. How students define and label inequalities varies according to their participation in previous formative experiences linked to gender and contextual influences. Science education activities with a gender perspective are necessary in non-formal education spaces such as science clubs. In this sense, this work offers recommendations that can stimulate the design of training actions for a better-balanced integration of science and gender.

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Introduction

The progress of science is key to the advancement of society and cannot be done with half of the population (women and girls) not having the opportunity to participate. The persistent underrepresentation of women in science has driven policies and institutional interventions in scientific communities in various contexts. The 2030 Agenda gives a good account of the emphasis that must be given to these issues to achieve gender equality and empower women and girls to achieve the Sustainable Development Goals (United Nations, 2015). Along these same lines, the Ibero-American University Program 2030 establishes among its priorities strengthening the role of women in science (Organización de Estados Iberoamericanos [Organization of Ibero-American States], 2022). Despite

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these orientations and political guidelines, the study conducted by UNESCO-IESALC and Times Higher Education (2022) on gender equality in universities around the world concludes that only 30% of women in universities are Science, Technology, Engineering, and Mathematics (STEM) majors and less than a third of the authors of research papers are women. Likewise, a recent report by Bello (2020) indicates that the average global rate of female researchers was only 29.3%; in Latin America and the Caribbean, it was 45% in 2019.

More specifically, Mexico expresses its commitment to the Institutional Program 2020–2024 of the Consejo Nacional de Ciencia y Tecnología [National Council for Science and Technology] (2020), indicating as priority strategies the creation of public policies to include underrepresented groups in the scientific community and introduce the gender approach in programmes that generate and apply knowledge. Despite the positive evolution and the political will of these organisations, the data invite us to continue making efforts to achieve gender equality. In this country, 33% of researchers are women (UNESCO, 2019). Likewise, within the realm of education, it is worth noting that among individuals aged 15 years and above, six out of every 10 individuals lacking formal education are women; however, the distribution is almost equal between men (50.8%) and women (49.2%) in undergraduate studies (INEGI, 2020). Gender parity has not been achieved in STEM, since only 38% of the students are women, according to the Centro de Investigación de la Mujer en la Alta Dirección [Center for Research on Women in Senior Management] (2021).

Although gender imbalances persist, the feminist movement in science has become especially relevant in the last decade with the launch of numerous projects and campaigns aimed at raising awareness of gender equality, addressing inequalities and biases, introducing gender-sensitive educational policies, empowering women to pursue scientific careers, and improving their recognition and participation in science (UNESCO-IESALC, 2021). Support for the feminist movement in science is influenced by feminist consciousness (Guest, 2016). Feminist consciousness entails the recognition that the socially constructed disparities between women and men stem from acquired behaviours and disproportionately impact access to opportunities and resources (Cohen-Miller et al., 2020). Having a feminist awareness does not necessarily guarantee active engagement and involvement in feminism as a social and political movement. Nonetheless, it is widely acknowledged as a crucial factor that can drive substantial transformations in lived experiences and expectations, thereby fostering progress towards achieving gender equality (Dávila Dos Santos et al., 2022).

Extensive research has primarily concentrated on comprehending the gender disparity within STEM fields, as well as exploring gender-based variances in students' inclination, drive, and perspectives toward the realm of science (Kang et al., 2019; Khan et al., 2022; Oon et al., 2020). However, the examination of students' perceptions regarding the gender landscape in science, along with the influential factors that shape it, has received comparatively less attention in previous studies. Research has revealed that female physics students, both at the undergraduate and postdoctoral levels, possess a profound understanding of the gender imbalances prevalent in the scientific domain. They express genuine apprehension regarding the role of women within this discipline, emphasising the importance of achieving equal representation, combating unconscious biases and stereotypes, fostering supportive networks, promoting the

presence of influential female role models, and ensuring equitable opportunities for all (Eren, 2022). Nonetheless, the research conducted by Fernández Cézar and Sáez Gallego (2020) revealed that a significant proportion of secondary education students displayed agreement with an egalitarian view of the scientific profession, seemingly without critically questioning the persisting gender gap. An additional study focusing on students above 18 years of age unveiled a concerning perception. It found that participants believed women to be lacking the essential qualities required for success in the scientific realm, potentially contributing to discrimination and prejudice against women scientists (Carli et al., 2016). Furthermore, starting from primary education, students tend to make limited connections between scientific contributions and gender inequalities (Dapía et al., 2019). This relationship between gender and scientific education still has little research history in Latin America (Camacho-González, 2020).

This study conducts a comprehensive exploration of the viewpoints held by Mexican students with a strong interest in science, specifically examining their perceptions of gender equality within this field and the influential factors shaping these perspectives. These students hold the potential to become the future generation of scientists, rendering their views and attitudes towards gender equality pivotal in shaping the trajectory of their discipline. Furthermore, comprehending the perceptions of these students offers valuable insights into the formation and perpetuation of gender stereotypes in the realm of science. Such understanding enables the development of inclusive and equitable pedagogical approaches, fostering the participation and success of women in science across various educational contexts.

Gender inequalities in science

Gender imbalances in science persist despite the rise of the feminist movement. To try to overcome these inequalities, researchers have studied the probable causes. Studies show that the origin of gender inequalities in science is not the innate biological traits associated with sex but lies in social constructions (Nguyen et al., 2022; Thébaud & Charles, 2018). According to the Social Cognitive Career Theory (Brown & Lent, 1996), some social constructs achieve a deeper understanding of the mechanisms that regulate the development of vocational interests, career choices, and academic performance. Although the causes of the underrepresentation of women in the scientific field are complex, the literature highlights various environmental factors that may be interconnected.

The first refers to gender stereotypes and prejudices in science. STEM areas are characterised by a masculine culture in beliefs, norms, attitudes, and values, which interferes with women's sense of belonging and interest (León & Aizpurúa, 2019; Piatek-Jimenez et al., 2018; Soylu-Yalcinkaya & Adams, 2020), as well as the female scientific identity (Smyth & Nosek, 2015). Stereotypes and prejudices negatively influence the scientific self-concept gap and the equal chances of success between men and women (Ertl et al., 2017; Miles & Naumann, 2021). The idea that girls and women are more incapable of studying an engineering career than boys and men continuously undermines their scientific capacity (Cheryan et al., 2017; Sikora, 2019), and it has been shown that this is not the case (Cheng et al., 2021). It has also been proven that male

students believe more in their ability in chemistry and physics than their female peers (Jansen et al., 2014).

Social influences are another vital factor. The lack of women in science means that girls and adolescents do not choose a scientific career because they do not have role models to see themselves reflected (Olmedo-Torre et al., 2018). Female students exposed to a higher proportion of female STEM teachers during secondary education are more likely to enrol in tertiary STEM programmes (Dulce-Salcedo et al., 2022). Although the study by de las Cuevas et al. (2022) reported that girls feel comfortable even with the lack of role models in their environment and concludes that role models are not decisive. The support received from peers and family before starting the undergraduate career is a determining factor. Family influences are vital elements, specifically parental occupations, and affinity for gender equality. Parents who work in STEM occupations serve as role models for their sons and encourage daughters to study in these areas (Anaya et al., 2022), especially at younger ages (Ardies et al., 2021). Likewise, it has been proven that the degree of affinity with gender equality in society on the part of parents influences the motivation and academic performance of children in these studies (Rodríguez-Planas & Nollenberger, 2018; Stoet & Geary, 2018). As pointed out by García-Holgado et al. (2020), along with the family, the support received from peers is one of the most important in the choice of STEM studies. These causes of gender inequalities influence the interest and attitude toward science, although there is no consensus in the scientific literature. High school students have shown less interest in science than their peers (Kang et al., 2019) and less favourable attitudes toward it (Hanson et al., 2020). However, the studies by Lane et al. (2022) and Susilawati and & Paidi (2022) showed the opposite.

Feminist pedagogy in science education

Education has been singled out as the main engine enabling learning and transforming reality. Traditionally, scientific education has been considered a field that reproduces the patriarchal and androcentric system of knowledge, in which the scientific production of women has been made invisible, their participation in scientific activity has been limited, and gender stereotypes have been perpetuated in educational practices (García-Peñalvo et al., 2022). To achieve quality education, feminist pedagogy must enrich science education, understand and dismantle inequalities, and transform teaching-learning processes, betting on equity and social justice (Gough & Gough, 2018).

Feminist pedagogy is a pedagogical framework that aims to transform the current condition of gender relations through changing attitudes, values, and educational practices (Revelles-Benavente & González Ramos, 2017). More specifically, it is challenged to think more deeply about the implications of transforming the subject content and the teaching methodology (Palmieri & MacLean, 2022). The incorporation of the gender perspective requires more than making the contribution of women to science visible, although this represents progress. The situation poses significant challenges for science education and education in general, such as rethinking the nature of knowledge, sexism in pedagogical practices, the hidden curriculum, and social representations (Henderson, 2019). A dynamic and holistic understanding of science is needed to review the theoretical

frameworks in which women are made invisible or knowledge not subject to sexist distortion is ignored (Naskali & Keskitalo-Foley, 2019).

On the other hand, the scarce integration of feminist pedagogy in school curricula and university study plans has been evidenced (García-Holgado et al., 2020; Valenzuela-Valenzuela & Cartes-Velásquez, 2020). Despite this, university students consider that implementing the gender perspective in university education is practically non-existent. They positively qualify the need to incorporate a gender perspective in the curricula, recognising its importance in reducing sexism, developing gender competencies, and practicing a gender-sensitive pedagogy (Miralles-Cardona et al., 2020). Regarding the significant differences found in the gender variable, female students evaluated the need for this training more significantly than male students and were more aware of gender inequalities (Nash & Moore, 2019). Concerning the areas of knowledge, the students of social sciences and humanities are the most interested in gender studies being included in the study plans, unlike the students of science majors; however, awareness of gender inequalities is deficient in both cases (Kitta & Cardona-Moltó, 2022). On the other hand, the perception of the feminist movement and its contribution to developing the scientific identity of women have been studied. Female university students have considered how this movement encourages them to pursue a scientific career. Still, this perception differs according to their social circle, participation in the feminist movement, and gender experiences within a scientific community (Eren, 2022).

The positive effects and influence provided by the introduction of the gender perspective on university students have been studied. Cruz-Guzmán et al. (2017) and Cuesta and Witt (2014) showed that emancipation and self-criticism were stimulated, greater awareness achieved, a more profound intellectual and theoretical understanding of their problems gained, changes produced in the personal values and reflections on power structures, and activism evidenced of what they learned in their daily and work life.

Non-formal education spaces: an opportunity for science education with a gender perspective

The study of the sociocultural factors that affect gender inequalities in science has allowed the launch of initiatives to promote their interest. Continuous, voluntary, and self-motivated access to science education activities drives lifelong learning in science and leads to positive educational outcomes and choices among STEM careers (Magaji et al., 2022). The Social Cognitive Career Theory has a particular focus based on the construct of situational interest (Drymiotou et al., 2021). These spaces encompass a wide range of settings, such as museums, science centres, science clubs, science outreach programmes, science camps, and various other platforms (Chiang et al., 2022; Mori & da Silva Curvelo, 2016). Scientific education in non-formal spaces strives to offer engaging and accessible activities. These initiatives are particularly beneficial for students who may be more hesitant to engage with science and technology due to factors such as age, gender, or educational level (Affeldt et al., 2017). These initiatives primarily emphasise experiential learning through interactive activities, experiments, demonstrations, and hands-on projects. By engaging in such activities, students are encouraged to actively explore and discover scientific concepts firsthand (Leblebicioglu et al., 2019). Moreover,

the integration of diverse scientific and technological disciplines, as emphasised by Babaci-Wilhite (2017), nurtures a holistic understanding of scientific concepts, taking into account their broader context. These spaces not only serve as vehicles for transmitting scientific knowledge but also play a vital role in cultivating scientific skills and transversal skills. Rocha Fernandes et al. (2018) highlight the development of critical thinking, problem-solving abilities, scientific communication, and teamwork as essential outcomes facilitated by these spaces. Science clubs have been relevant non-formal learning spaces to engage students in science education. Behrendt (2017) explored the views of two rural high school science clubs and drew a connection between non-formal (science club) and formal (classroom) learning. This work demonstrated the benefits the science club brings to the student's overall science programme in high school. Additionally, science clubs have helped identify gender differences in support and motivation for entering STEM careers. Perceived attitudes and values, social support, appreciation of computer science, and commitment to science were the main characteristics that girl members of a science club considered for computer science careers (Vrieler et al., 2021). On the other hand, Smits et al. (2022) revealed that women in a science club reported being less interested in science and engineering than boys due to the scarcity of role models in STEM or the home. These authors consider science clubs to be important non-formal learning spaces to engage students in science education and understand the impact of their motivations from a gender perspective.

Method

Research questions and design

The research questions guiding this study are as follows:

1) How do students with a primary interest in science perceive gender equality within this domain?
2) What factors influence the perception of gender equality in science among students with a primary interest in this field?

To address these questions, the research employed a qualitative approach centred around a science club case study. This research design allows to examine in detail a particular phenomenon or case within its real context (Stake, 2010). Specifically, this study is based on studying the perception of students primarily interested in science about the situation of gender in this field.

Study context: Science Clubs

Science Clubs is a civil association that offers free extracurricular programmes to promote literacy and scientific vocation in STEM areas and allow the participation of high school and university students from various places to create talent networks. Teachers from Mexico and the United States work together. It began in Mexico in 2014 and has spread to nine cities in eight Latin American countries. Each year this association

changes the university where the science club is held. The programmes include Science Clubs, MiniMOOCs, Challenge CdeCMx, Science Café, Clubeando en Casa, and Academic Webinars. More specifically, the Science Clubs are intensive courses in science, engineering, technology, or mathematics where theoretical content is learned through didactic strategies such as experimentation, demonstration, or construction. Among its goals is a space for gender equality and promoting more women in science. The selection of students and professors who teach the programmes is carried out according to different criteria. For students, aspects such as the following are considered: 1. High school and university students in the STEM area; 2. Students from other places; 3. Students with a particular interest in science; 4. Gender parity. In the case of teachers, the relevant qualifications are that they are a) experts in science education in STEM areas and b) experts from Mexico and the United States.

Case study

A science club was selected as a case study, in which two different workshops were given: 'Electrochemical workshop: how do we transport energy?' (E.W.) and 'Microalgae in action workshop: their cultivation, biology, and biodiversity' (M.W.). Both were held simultaneously in summer 2022 at a Mexican university that is a benchmark in technological innovation; it was included in the 2022 Academic Ranking of World Universities and had 94,424 students in the same year. The workshops were implemented over five days and lasted 25 h. The 20 science club participants, who came from different parts of Mexico, were interviewed. Regarding their educational background, all participants of the science club expressed a strong inclination towards subjects that involve science education content within the formal educational context. Engaging in the science club offered them their initial experience of participating in a science education activity in a non-formal setting. Table 1 lists the main sociodemographic characteristics:

Instruments

To produce the information in the field of study, we applied a semi-structured interview protocol divided into three blocks:

1) Reasons, processes, and influences to participate in science education activities.
2) Lessons learned. Training experiences in gender equality in science.
3) Appraisal and perception of gender equality in science.

Table 1. Sociodemographic characteristics of the study participants.

	Sex (*N*)			Educational stage of the participants (*N*)	
Workshop	Man (M)	Woman (W)	Age (mean)	Upper secondary education	University
Electrochemistry: how do we transport energy?	6	4	18.5	3	7
Microalgae in action: their cultivation, biology, and biodiversity	5	5	19.4	4	6

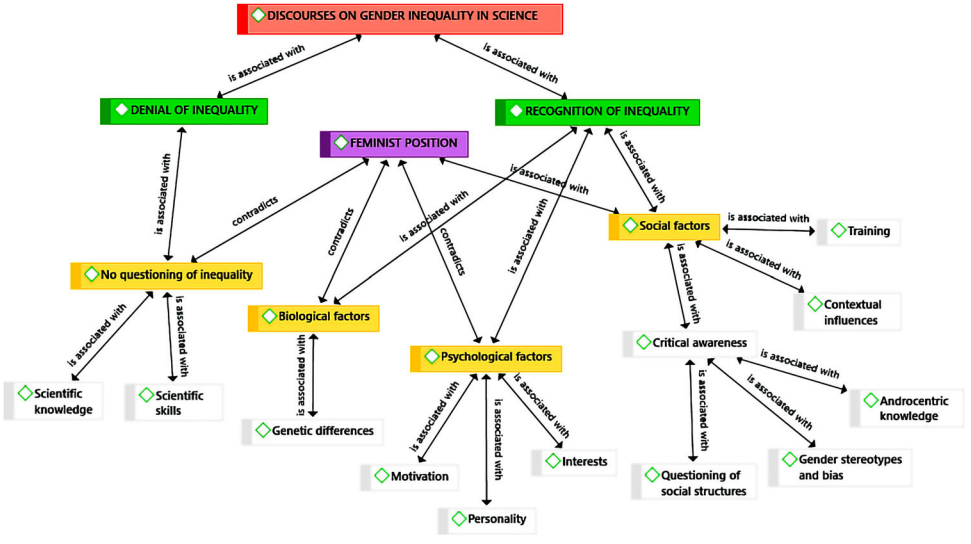

Figure 1. The semantic network of categories and subcategories of semi-structured interviews.

Procedure and analysis

The in-depth interviews with the participants were conducted when the science club ended. Participants were informed about the research approach before the interviews and subsequently gave their informed consent to participate. All interviews were digitally recorded and manually transcribed. Each participant was assigned a code for anonymity: gender (M/W), workshop (E.W./M.W.), and the interview date.

An eminently inductive procedure was followed to record the comments of the science club participants. The coding was open and emergent and later reorganised and grouped into categories and subcategories (Miles et al., 2014). Throughout the process, memoranda were created as an analytical reflection, facilitating the interpretation and final drafting. In addition, the creation of a semantic network (Figure 1) was constructed as a figurative representation of the discursive results (Braun & Clarke, 2013).

Results

The discourse analysed mainly distinguished two orientations on the relationships and meanings that gender inequality in science adopts for students primarily interested in it: denial and recognition. This latter orientation is associated with biological, psychological, and social factors. On the other hand, no relevant differences were found between the reports of the participants of both workshops and educational stages. Regarding the gender differences between the participants, the appreciation of the inequalities in science associated with biological factors was only shared by the men in the science club, and those related to social factors were more accentuated by the women. Each perspective is detailed below.

Denial of gender inequalities in science

This perspective is based on the implicit idea that men and women are equally important in science and that no inequalities negatively impact scientific knowledge production. From this position, what is important is that science is characterised by being objective, rational, and neutral, without the need to introduce the gender perspective or question androcentrism. It is an aseptic discourse, referring to having or not having sufficient knowledge and skills to carry out scientific activities, but not to the conditions that allow, facilitate, or prevent the presence and advancement of the research career. Some science club participants show a lack of recognition regarding the barriers and challenges women face in their participation and advancement in science. They do not perceive the limitations and obstacles that affect the presence and development of women in scientific careers. That is why it is sterile, avoiding the social, cultural, and structural axes of gender inequalities and their impact on power relations in the scientific community. Therefore, gender inequalities are not problematised in the discourse of these science club students and are reduced to denial without further consequences.

> 'It is not necessary to think if there are more women or men in a profession, but rather that everyone can do it. Everyone can do it, but not because of gender. It depends on the type of person, the interest, the affinity, and the effort. It doesn't matter if it's a man or a woman' (M_M.W._3-08-2022).

> 'I believe we all have abilities that make us know who we are. I believe that gender has nothing to do with it, whether it is a woman or a man … only those in science who have the skills and intelligence to do incredible things' (W_M.W._3-08-2022).

> 'I think it is the capacity that the person has. Not in itself that it must be a man or a woman, but it depends on the desire and the effort you put in to get there later. A woman can go much further than a man or, on the contrary' (M_E.W._4-08-2022).

> 'In general, it does not depend on whether you are a man or a woman in science, but on the knowledge, you have and the desire to learn and investigate' (W_M.W._4-08-2022).

Recognition of gender inequalities associated with biological factors

This second look is based on innate or genetic traits to explain gender differences in science. Science club participants perceive that women and men have distinctive characteristics influencing interest and scientific activity performance. This position is wrong. There are no gender inequalities caused by genetic factors. Gender inequalities are the result of social, cultural and structural constructs that assign different roles, expectations and opportunities to people according to their gender. The idea that biological differences between men and women are the direct cause of gender inequalities has been widely discredited. Biological differences between the sexes do not determine a person's abilities, aptitudes or intellectual capacities. Observed differences in roles and achievements between men and women in science are the result of complex social processes and cannot be attributed to biology.

> 'From my point of view, we are different. From the genetic part, we have a different DNA; we express genes differently. Yes, some biological aspects or characters are different in men and women, which influences science, interest, and work, although I cannot reach more conclusions about the differences in this, at least for now' (M_M.W._4-08-2022).

Recognition of gender inequalities associated with psychological factors

The third orientation is based on psychological factors to identify gender inequalities in science, such as personality, motivation, or interests to access and perform scientific tasks. In this sense, they consider that this is less in female scientists. From this orientation, they are unaware that gender stereotypes and prejudices are generators of inequality and discrimination. This position is also wrong. Gender inequalities originate in norms, values and stereotypes rooted in society, as well as in structures and systems that perpetuate discrimination and unequal access to opportunities in science.

> 'I believe anyone passionate and likes science can do an outstanding job. I attribute it a little more to the different personalities and the tastes and experiences that I have had. If someone is motivated by science, they will likely work on it somehow' (M_E.W._3-08-2022).

> 'It could also be because women don't get much attention. Some women say that they don't like chemistry because it has too many formulas. Of course, it is very complicated; it requires a lot of work and study' (W_E.W._5-08-2022).

Recognition of gender inequalities associated with social factors

This last assessment is based on a feminist position. The sexual differences between women and men are turned into social inequalities, and, in this regard, social structures and the existing political and cultural order are questioned. It also means overcoming the image of traditional science that is still being taught for one that shows androcentric knowledge and gender stereotypes and prejudices that cause discrimination against women in science. From this position, science club participants believe that to achieve gender equality it is necessary to address and challenge these socio-cultural factors, promoting equity, justice and the elimination of all forms of gender-based discrimination. They are aware of the repercussion of all this in the educational process. 'Because everything is a social construct, in what context you developed and above all the tools you had at your disposal. Especially here, the main limitation will always be economic resources because the education that you will receive depends on that – how much your family will encourage you to pursue a scientific career, etc. Then women's inequality is completely social; it will never be biological' (W_E.W._4-08-2022).

> 'Previously, it was seen that engineering and science were more for men, as women are not so socially accepted in the field of science. I have known doctors and researchers who do not value the work of women studying for doctorates for the simple fact of being women. That is why they do not consider the results of their research' (M_E.W._5-08-2022).

> 'The difference is that before, they were not taken into account. His name had not been recorded in history. I think they contributed important things, only they are not remembered yet' (W_E.W._3-08-2022)

It has been proven that this last perception is influenced by two factors: previous training experiences and contextual influences. Those science club participants who have more knowledge about the science-gender binomial and greater critical awareness of inequalities are those with prior training experiences where the gender perspective was considered. Also, they have contextual influences (family, colleagues, friends, teachers, among other people) who inspire them to participate in scientific activities. This

awareness was more accentuated among the women in the science club, who felt inspired by female researchers.

> 'At my university, I have learned a lot from women professors and researchers about science. I have taken part projects by women and read articles, and I think they are very good; they make you think of other realities. They make you think about the inequalities of women in research.' (M_E.W._2-08-2022).

> 'My lifelong doctor. She is a doctor at the hospital and is also a researcher. She is the best in her area, and she is internationally recognized' (W_M.W._5-08-2022).

> 'My mom worked at the nursing school. She saw the women doctors, I saw the projects they did, and I saw conferences where they brought international people. I loved hearing about the innovations they were making and their new scientific methods. That is … I said to myself: Wow, I want to be in the area of science' (W_M.W._2-08-2022).

Discussion

There are opposing positions in the perception of gender equality in science by students who are primarily interested in science. While some deny the existence of gender inequalities in science, alluding to equal opportunity for men and women and it only depends on the scientific skills and knowledge acquired, others perceive them. It is remarkable how students who possess a keen interest in the field of science continue to disregard the gender disparities that persist, despite the significant efforts made by the feminist movement and scientific communities to bring attention to this pressing issue (Khan et al., 2022). Furthermore, policy guidelines and directives in Latin America and Mexico have actively encouraged diverse organisations to incorporate a gender perspective into various scientific fields, including comprehensive training programmes (Consejo Nacional de Ciencia y Tecnología [National Council of Science and Technology], 2020; Organización de Estados Iberoamericanos [Organization of Ibero-American States], 2022). Nevertheless, the domain of scientific education has long been associated with reinforcing a patriarchal and androcentric structure of knowledge, effectively rendering the scientific contributions of women invisible. Their participation in scientific endeavours has been constrained, while gender stereotypes have persistently been perpetuated through educational practices (García-Peñalvo et al., 2022). As a result, it remains crucial to prioritise the development of strategies that effectively foster a critical awareness among young individuals regarding the prevailing gender disparities within the scientific field.

Other students hold the perspective that inequalities exist within the scientific field and are attributed to various biological and psychological factors. The notion that gender inequalities are directly caused by biological and psychological differences between men and women has been widely discredited (Nguyen et al., 2022; Thébaud & Charles, 2018). However, these findings align with previous studies that have yielded similar results. In a study conducted by Carli et al. (2016), it was revealed that high school students held the belief that women lacked the essential qualities required for success in the scientific field. This perception has the potential to contribute to discrimination and prejudice against women scientists. Furthermore, Dapía et al. (2019) conducted a study that presented evidence of the obstacles encountered by students in

linking gender inequalities with scientific work. Therefore, the integration of the gender perspective in science education is necessary. In this sense, there is a strong endorsement among young individuals regarding the necessity of integrating a gender perspective into educational curricula (Miralles-Cardona et al., 2020). The perception of gender inequalities in science related to social factors is the only one that is based on a feminist position. The lack of critical awareness of gender inequalities in science is more accentuated in male students. Women students are concerned about the imbalance of social structures, gender stereotypes and biases in science and androcentric knowledge. Recent research findings highlight the profound awareness among female students, both at the undergraduate and postdoctoral levels, regarding the prevalent gender imbalances in the scientific field (Eren, 2022). These students express genuine concerns about the role of women in this discipline, emphasising the significance of achieving parity, addressing unconscious biases and stereotypes, cultivating supportive networks, fostering the presence of influential female role models, and ensuring equal opportunities for everyone.

Gender equality training and contextual influences are two key factors influencing critical awareness of gender inequalities in the scientific field. This study verified how those students with a greater critical awareness of gender inequalities in science had participated in training activities with a gender perspective prior to the science club. In this, there is consensus in the literature. Cruz-Guzmán et al. (2017) and Cuesta and Witt (2014) verified how, thanks to this training, emancipation and self-criticism were stimulated, greater awareness and awareness were achieved, and deeper intellectual and theoretical understanding was achieved, given that changes are produced in personal values and activism. Smits et al. (2022) consider that science clubs are non-formal learning spaces that, in addition to involving students in science education, make visible the inequalities that prevail in science. Therefore, this implies the need to mainstream the gender perspective in science education training programmes of this type of non-formal education spaces.

Another factor that affected the critical awareness of gender inequalities and was evidenced in this study is the influence of family, friends, teachers, and people from the closest environment. This has also been shown in the investigations of Anaya et al. (2022) and García-Holgado et al. (2020). This perception is more prominent in female students inspired by female researchers to access science education activities. Regarding this finding, there is no consensus in the literature. According to Dulce-Salcedo et al. (2022) and Olmedo-Torre et al. (2018), the lack of scientific women occurs because girls and adolescents do not have references in which to see themselves reflected; however, for de las Cuevas et al. (2022), the absence of models is not decisive in this choice.

Conclusions and implications for practice

This study acquires a novel character by focusing on students with a particular interest in science. This study has answered the previously posed research questions:

1. It reveals the existence of erroneous beliefs concerning gender inequalities in science. The discourses of students primarily interested in science go from denying gender inequalities to recognising them, relying on innate traits that differentiate men and

women in their interests and scientific performance, and psychological characteristics such as personality, motivation, or cognitive ability.
2. However, the perception of gender inequalities in science has also been associated with social factors, such as questioning social structures and gender prejudices and stereotypes, and the revision of androcentric knowledge linked to a feminist position.
3. This last perception is conditioned by having or not having had other training experiences with gender perspectives before the science club and the influences of people from their closest environment.

Based on these findings, the following recommendations can stimulate the design of training actions with a better articulation of science and gender in different educational spaces, such as science clubs. We propose: (a) the inclusion of training content that encourages reflection on the social, political and cultural dimensions in the construction of scientific knowledge (the accessibility of women to the study of the discipline, scientific literacy, and the underlying causes in the choice of studies); (b) constructing scientific identity from an intersectional perspective (trait of gender diversity associated with others that have traditionally also suffered discrimination such as social class, ethnicity, language, etc.); (c) the visibility of women scientists, their knowledge and contributions to science (biography of women scientists, projects led by women, scientific articles, etc.); (d) evaluation of the practice of the scientific profession (stereotypes, remuneration, hierarchy, etc.), and sexist language in science; (e) the questioning of androcentric knowledge in disciplinary scientific production (problematising and knowledge identifying obstacles, errors, tensions, etc.); and (f) the mainstreaming of the gender perspective in scientific production in the discipline, among others.

This study is not without limitations. On the one hand, there are limitations to the research design (case study). Because it was limited to a single science club and its two biology-and-engineering-related workshops, the narratives presented may not apply to all science disciplines. It offers concrete, contextual, and in-depth knowledge, but it isn't easy to extrapolate it to the general panorama. Also, it was difficult to verify if there are significant differences in the perceptions and awareness of gender inequality where age is a criterion because the ages of the participants were close. Future studies can include more science clubs that integrate different scientific disciplines, not only STEM but also health sciences, social sciences, arts, and humanities. This would allow us to have a broader view of the perceptions and awareness of gender inequalities in science based on more diverse traits. It would also be meaningful to interview the people responsible for managing and organising the science club and the teaching team in charge to know their perceptions of how non-formal education spaces contribute (or not) to building critical awareness of gender inequalities in science. Finally, it would be interesting to analyse the integration of the gender perspective in scientific education training activities in non-formal spaces, as has been done in school curricula or university study plans.

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