Encouraging a Gender Perspective in Science Education: A Learning Experience for Pre-Service Early Childhood Education Teachers

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Abstract

Gender bias in science should be made visible to the pre-service teachers and those pre-service teachers should be given tools to implicitly counter that gender bias. One way to do this may be by simply including more female scientists together with male scientists in the teaching approaches, rather than the norm of predominantly including males. This work describes and evaluates a learning experience in which the aim was to encourage pre-service early childhood education teachers to consider aspects of gender in science education and to begin acquiring the skills needed to design teaching strategies that promote these aspects. Participants were 56 pre-service teachers whose task was to design workshops on science topics in which women scientists have made key contributions. At the outset, some of the participants showed little inclination to consider aspects of gender in the science classroom, and others did not contemplate that science and gender could be addressed in an integrated way. It was also apparent that the pre-service teachers lacked the skills needed to design activities that encompassed both scientific content and aspects of gender. Overall, the subsequent learning experience appears to have had a positive impact, although we suggest certain refinements that could lead to more satisfactory outcomes.

Introduction

Education today must, at all levels and across all subjects, be able to respond to the challenge of incorporating holistic perspectives that take into account a wide variety of different aspects (Delors, 1996). In other words, education in whatever field must seek to promote the different dimensions of a person’s development. In terms of science and technology education, this implies a greater emphasis on the human dimension and on personal, ethical, cultural and social interests.

Achieving this requires a highly skilled workforce of science teachers who must develop not only scientific knowledge in itself, but also an understanding of its epistemological aspects. That is to say, an awareness of how scientific knowledge is constructed and of the relationships between science, technology, society and the environment, among other aspects (Martín-Gámez et al., 2017). Future teachers across the educational spectrum must therefore acquire the skills and competences that enable them to incorporate this human dimension of science into their classroom teaching, taking into account the social and historical context in which scientific knowledge is created, especially in regards to bringing greater visibility to the role and contributions of women in science (Novo, 2007; Schiebinger, 1991).

There are several reasons why science education needs to raise the profile of women scientists. A recent UNESCO report (2017) highlighted the striking gender gap in science, technology, engineering and mathematics (STEM) education, noting that only 35% of students enrolled in STEM-related fields are female, and currently only 28% of all of the world's researchers are women. As to why women are under-represented in these fields (Esteve, 2017), proposed explanations include the different interests of men and women (Sjøberg & Schreirer, 2010) and the gender stereotypes that are transmitted through the media, families and the education system (Archer, DeWitt, & Willis, 2014; Kerkhoven et al., 2016; Reuben, Sapienza, & Zingales, 2014).

Authors such as García, Troiano and Zaldivar (1993) argued many years ago that women have been excluded not only as objects of science but also as its subjects. According to Kleinman (1998), the lack of studies that adequately acknowledge and appraise the contributions of women to the overall progress of humanity has been detrimental to women and it has meant that their role is undervalued. In the educational context, López-Navajas (2014) concludes that women are invisible within science textbooks, and hence there are no role models that associate the female gender with scientific and technological research.

On the other hand, in the specific case of early childhood education, most of the teachers are women, and they show gender stereotyped beliefs about their own profession (Sullivan et al., 2020). This may be a drawback for teachers to include more diversity in their teaching about science, to avoid sexism in science.

In this case, they present their male colleagues as a symbol of masculinity, a model to follow, a role challenger, an energizer, an emotional balancer, and a handyman, all roles presented as female deficits and aligned with the essentialist understanding of occupational sexual segregation

This situation means that teachers are likely to internalise these gender stereotypes and to transmit them in their classroom practice (Manassero & Vázquez, 2003). Studies also show that teachers' beliefs about science and gender tend to be androcentric (Camacho, 2010; Chetcuti, 2009; Lynch & Nowosenetz, 2009), that is to say, they are based on a more traditional, masculine conception of science (objective, rational, inductive, individual, neutral, experimental, absolute). This serves to reinforce a stereotyped (male) image of science, in which aspects related to the social and cultural context and associated with the feminine are given less attention (Camacho, 2014). This compromises the quality of women's learning experiences and limits their educational opportunities (UNESCO, 2017).

In summary, a failure to acknowledge women's role and contributions in the history of science not only undermines the rigor of academic teaching but also means that we lose part of our cultural legacy and have fewer resources for understanding the present and imagining the future (Martín-Gámez et al., 2017). Furthermore, by failing to bring visibility to these women, we reinforce existing structural barriers, both in society and within scientific institutions, which have hampered and continue to hamper women's progress as professionals in these fields (Schiebinger, 1991). According to Camacho (2010), processes of socialisation in the classroom play a key role in reproducing stereotypes about gender and science.

Therefore, if one of the aims of science education is to offer students a relevant education that helps them understand science, and without stereotypes, a teaching model appropriate to these objectives is necessary. One way to do this is by developing a teaching-learning process based on a constructivist approach, based on observation and experimentation, focused on the student's own interests (Mérida, Torres-Porras, & Alcántara, 2017; Vega, 2012), and where women of science, their contributions and their contexts can be integrated. That is why the types of activities designed by teachers are of key interest. As Lee, Capraro and Viruru (2018) state:

> *Teaching methods that positively impact students' perspectives toward STEM education and careers need to be considered. Because accessibility and practicality lead students to gain a positive perspective toward science and aspirations of STEM careers, teacher need to employ engaging STEM activities. These activities may encourage students to develop positive personal perspectives related to the present study's personal context themes of positive emotion, personal development, and tools for the job as well as societal perspectives such as helping people, interacting with others, and impacting the world (p.46).*

This decrease in girls' STEM participation is related to girls' identity formation from a young age. This results in the ongoing trend of underrepresentation of women in STEM fields due to underlying gender equity issues. To improve this gender gap, it is important to consider the beginning of the STEM pipeline, the early stages of education (Stephenson, Fleer, & Fragkiadaki, 2021). Thus, it is vital that the training offered to future science teachers provides them with the skills and knowledge required to incorporate a science education model with a gender perspective into their classroom practice. The literature points out that to build this perspective, teachers should pay attention to the image of science that is transmitted (Wang & Degol, 2017), the creation of female references in science and technology (Bleeker & Jacobs, 2004), and the emotions associated with teaching-learning in science and technology (Beauchamp & Parkinson, 2008).

In conclusion, gender bias in science should be made visible to the pre-service teachers and those pre-service teachers should be given tools to implicitly counter that gender bias. One way to do this may be by simply including more female scientists together with male scientists in the teaching approaches, rather than the norm of predominantly including males. This study is focussed on the creation of female referent to show the importance of making visible female scientists and technologists of today, their contributions and the work contexts where these were created. The aim is to counter the invisibility of women in educational proposals, which may be giving rise to referential models that do not associate the female gender with scientific and technological fields (Davies, 2003).

With this goal in mind, the present study describes and evaluates a learning experience that was carried out with pre-service early childhood education teachers. We were specifically interested in:

1. Eliciting the educational predispositions and beliefs of pre-service early childhood teachers to incorporate the gender perspective in their teaching-learning proposals (objective 1).
2. Examining the extent to which the learning experience helped them to consider aspects of gender in the teaching of science, especially in regards to bringing visibility to women scientists and their social and cultural context, and analysing the progress they made after being set the task of designing and implementing teaching strategies that incorporate a gender perspective into science education (objective 2).
3. Studying the type of activities proposed by pre-service teachers to incorporate the gender perspective (objective 3).

Methodology

Participants

The study was carried out during the 2018-2019 academic year in the context of a University program, as part of a Degree in Early Childhood Education, specifically as part of a compulsory course entitled *Teaching the Natural Sciences*. This Degree programme comprises a total of 10 modules addressing psychology, educational contexts, the teaching of science, social science and mathematics, sociology, the teaching of music, language and physical education, and a practicum. The 'science education' module consists solely of the aforementioned course, in which the learning experience was offered. It is taught in the second semester of year 3. This module has a total of 60 class hours for students, 28% of which are practical, and 72% are theoretical. The aim of the module is teaching pedagogical content knowledge of science education. Participants in the study were 56 pre-service early childhood education teachers (PT), split into 11 groups of 4-6 students each. All but one of the participants was female.

Learning experience

The learning experience comprised five, two-hour sessions (Figure 1).

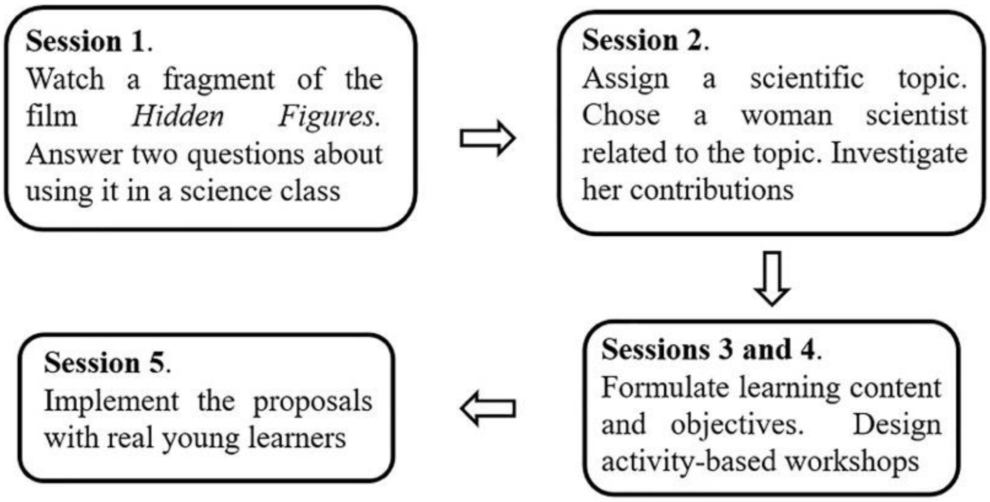

Figure 1. Learning experience sessions and tasks aimed to encourage pre-service early childhood education teachers to consider aspects of gender in science education

The aim of the first session was to find out whether or not the pre-service teachers currently considered that aspects of gender should be addressed as part of science education, and if so, what strategies or methods they would use in order to do so. To this end, they were asked to respond individually to two open questions, in the context of watching a segment of the film *Hidden Figures*:

- Q1. Would you use this segment as a classroom resource for teaching aspects of science and mathematics? Why?
- Q2. If you answered yes to the first question, please explain in detail how you would do this.

The segment lasted 5.15 minutes and involved a scene in which the professional skills of one of the female protagonists are shown to be superior to those of all her male colleagues. The scene also highlights the enormous obstacles that this woman had to overcome before her skills were recognised, merely because she was a woman. Certain scientific content is also addressed in the scene.

In the second session, each of the 11 groups was assigned a scientific topic to work on, based on those set out in the early education science curriculum in Spain (natural phenomena; animals; plants; the properties of matter; states of matter and their transformations; and the senses). The first task for each group was to conduct a search and identify at least two women scientists whose work was related to the topic they had been given. After presenting their findings, they agreed on which scientists each of the groups would work on. They then began to investigate in more detail the contributions that these women had made to science, the difficulties they had faced and the historical significance of their work. Over the next two sessions the task for each group was as follows: once they had identified and formulated the learning content and objectives associated with their assigned topic, they had to design activity-based workshops in which young children could explore together both the topic-related content and certain aspects of the chosen scientist (Table 1). Finally, in the fifth session, they implemented their proposals with real young learners (age 3, 4 and 5 years). These sessions were recorded and subsequently edited to produce a video lasting no more than 12 minutes. Consequently, a total of 11 videos were produced (one per group). Along with their respective video, each group produced a short report describing their teaching proposal and the associated learning content and objectives.

Table 1. Curriculum topics and the scientists chosen for each learning activity

Topic	Scientist
Human reproduction	Agnodice
Animals	Jane Goodall, Dian Fossey
Plants	Shirley Jeffrey, Tu Youyou
Properties of matter	Hedy Lamarr, Rosalind Franklin
States of matter	Anna Mani, Mary the Jewess
The spectrum of sunlight	Celeste Saulo
The universe	Hypatia of Alexandria

Instruments and data analysis

The instruments used for data collection were the two questions (Q1 and Q2) asked in session 1 of the learning experience and the edited videos produced by each of the 11 groups. The resulting data were analysed using qualitative content analysis (Schreirer, 2012). To this end, we first reviewed all this material in order to identify emergent themes, which were then compared and agreed by the research team in order to define and describe a set of broad categories. The authors then drew up a provisional coding of responses, once again comparing the results. This yielded 90% inter-rater agreement. The remaining responses were reviewed and recoded until full consensus (100%) was reached.

Objective 1

In the qualitative analysis of responses to Q1, we first considered whether participants had answered yes (Y) or no (N), and then examined the explanations they gave for their answer (the *Why?* part of Q1). Based on the latter we categorised ‘yes’ and ‘no’ responses as listed in Table 2.

Table 2. Categories of yes and no answers to Q1

Yes (Y)	Y1	It deals with scientific content
	Y2	It deals with aspects of gender
	Y3	It deals with scientific content and with aspects of gender, independently
	Y4	It deals with scientific content from a gender perspective
	O	Other
No (N)	N1	It requires a high cognitive level in children
	N2	Aspects of gender are not relevant to science
	N3	The scientific content is not properly dealt with
	O	Other

Objective 2

The qualitative analysis of responses to Q2 and of the workshops recorded on video focused on two aspects: 1) whether the activities proposed and used by participants included consideration of aspects of gender, taking into account the categories defined for Q1 (Table 2); and 2) the degree to which these proposals brought visibility to the women scientists of relevance to the topic. For this latter variable we considered four levels as shown in Table 3.

Table 3. Levels for the degree of visibility to the women scientists in the answers of Q2 and the workshops

L0	No mention of any woman scientist
L1	Mention is made of the woman scientist's name and/or her most important contribution
L2	In addition to the woman scientist's name and her contribution, some additional aspect of her life is mentioned (social context, difficulties faced, etc.)
L3	As for L2, but aspects of her life (social context, difficulties faced, etc.) are explored in greater detail and specifically linked to her gender

Objective 3

The types of activities described in participants' responses to Q2 and included in the workshops were also analysed using an adaptation of the category system developed by Cruz-Guzmán, Puig, and García-Carmona (2020). These authors derived their category system from the literature and used it to study the activities designed by pre-service early childhood education teachers for science learning corners. They distinguish between free and guided activities, depending on the role played by teachers and students (Epstein, 2014). In the present study, the activities designed by participants were implemented with real young learners outside the school setting in the form of workshops. Because these workshops had a fixed duration it was not appropriate to use open-ended activities, since there was insufficient time for the children to interact freely with one another. The types of activities used in the workshops were adapted to this reality, and hence we only used the part of the aforementioned category system corresponding to guided activities (Table 4).

These activities are classified into two groups, inquiry-based and not inquiry-based (Cruz-Guzmán et al., 2020). At the same time, the inquiry-based activities are divided according to the level of inquiry they promote, considering confirmatory activities, in which students confirm a phenomenon or explanation that they know previously; and structured activities, in which the teacher proposes a question and the procedure to be followed in the inquiry.

Additionally, in order to cover all ‘not inquiry-based’ activities used in the various workshops, we added a new category related to the manipulation of materials, and also expanded the play category so as to include symbolic play.

Table 4. Types of activities described in responses to Q2 and incorporated into the workshops (adapted from Cruz-Guzmán et al., 2020)

Type of activity (code)	Description: Activity aimed at...
Inquiry-based (I)	
Confirmatory (I.I)	
- Observation (OCI)	Confirming a principle through observation
- Cause-effect relationship (CCI)	Confirming a phenomenon based on the cause-effect relationship
- Design/construction (DCI)	Confirming a principle by designing and/or constructing models or artefacts
Structured (I.II)	
- Observation (OSI)	Answering a question through observation of a procedure
- Cause-effect relationship (CSI)	Answering a question by following a procedure in order to establish cause-effect relationships
- Design/construction (DSI)	Answering a question by designing and/or constructing models or artefacts
Not inquiry-based (II)	
- Observation (O)	Observing and describing a concept or procedure
- Manipulation (M)	Manipulating materials and describing properties or phenomena
- Design/construction (D)	The design and/or construction of a model or artefact
- Artistic expression (AE)	Expression/communication through the use of various artistic techniques
- Bodily expression (BE)	Expression/communication using one’s body and through movement
- Oral expression (OE)	Expression/communication by means of dialogue and spoken language (after a story, video or explanation)
- Relationships of order and/or equivalence (R)	Establishing relationships of order and/or equivalence (i.e. classification and identification) between elements according to different criteria
- Structured and/or symbolic play (P)	Structured play governed by pre-established rules (card games, puzzles, domino, competitions, etc.) or imaginative play (pretend, simulating situations, imitating adult life, etc.)
- Explanation by the teacher (E)	Listening to the teacher’s explanation

Results

Objective 1

Analysis of the pre-service teachers' responses to Q1 suggest a reasonable willingness to use a resource that explicitly addresses aspects of gender, in the science classroom. Specifically, 60.7% of participants said they would use the proposed segment of video (Table 5). However, the reason given by the large majority of them was either that the segment dealt with scientific knowledge (Y1): *"Concepts that are explained in the classroom appear in the film and therefore the students may be more interested."* (PT19); or that it addressed aspects of gender (Y2): *"I would use it to make children see more of the role of women in science."* (PT3).

Very few participants considered that the resource could be used to address aspects of both science and gender, albeit independently (Y3): "*I believe that in addition to dealing with scientific and mathematical aspects, it shows the great struggle of women to self-betterment and play a role in society*" (PT7); and none of them acknowledged that the segment might be useful for dealing with scientific content from a gender perspective (Y4). Those participants who answered no to Q1 (39.3%; Table 5) justified their response primarily through one of two arguments: using this resource would require a higher cognitive level in children (N1): *"I think these are very scientific things that young children would find it difficult to understand."* (PT24), and aspects of gender are not relevant to science (N2): *"I would not really use it because I see that this fragment shows women can be equal to or much more superior to men in all aspects, in this case related to mathematics, but I do not see that it teaches anything scientific or mathematical."* (PT28).

Table 5. Frequency of yes and no answers to Q1 (N=56)

Yes (Y)	Y1	17 (30.4%)
	Y2	12 (21.4%)
	Y3	4 (7.1%)
	Y4	0 (0%)
	O	1 (1.8%)
	Total	**34 (60.7%)**
No (N)	N1	10 (17.9%)
	N2	7 (12.5%)
	N3	2 (3.6%)
	O	3 (5.4%)
	Total	**22 (39.3%)**

Objective 2

Regarding the learning activities that were initially proposed by participants who answered yes to Q1 (34 pre-service teachers responding to Q2), it can be seen in Table 6 that the majority of these did not bring visibility to the women scientists of relevance to the topic (29 pre-service teachers at L0): *"It would make them think about the aspects that must be taken into account to carry out the mission that is proposed in the film"* (PT30); the others mention the woman scientist's name and/or her most important contribution (5 pre-service teachers at L1): "*After watching the video, I would ask them to name female scientists and talk about their models, theories, and learn about them."* (PT3), and they addressed either scientific aspects alone (Y1: 20 pre-service teachers) or solely aspects of gender (Y2: 13 pre-service teachers).

Table 6. Frequencies for the 34 individual responses to Q2 and analysis of the 11 workshops (56 participants split into 11 groups of 4-6 students) with respect to the incorporation of aspects of gender and the degree of visibility brought to women scientists

Incorporation of aspects of gender			Degree of visibility brought to women scientists		
	Q2	**Workshops**		**Q2**	**Workshops**
Y1	20 (35.7%)	0 (0%)	L0	29 (51.8%)	0 (0%)
Y2	13 (23.2%)	0 (0%)	L1	5 (8.9%)	9 (81.8%)
Y3	0 (0%)	11 (100%)	L2	0 (0%)	2 (18.2%)
Y4	0 (0%)	0 (0%)	L3	0 (0%)	0 (0%)
O	1 (1.8%)	0 (0%)			

It can be seen how the participants altered their thoughts around including gender in their science teaching before and after the learning experience by comparing the codifications of the two open questions (Q1 and Q2) answers and those of the workshop. As shown in Table 5, 22 pre-service teachers answered "No" to Q1, and 34 answered "Yes". However, on the third column of Table 6, all the workshops (11) were coded as Y3. This means, after the learning experience, each pre-service teacher (56 participants split into 11 groups of 4-6 students) dealt with scientific content and with aspects of gender in the workshop she/he designed and implemented. Furthermore, as shown in the last column of Table 6, in their workshops most of the participants mentioned the woman scientist and her main contribution (L1), some even went further and included additional aspects of her life (L2). This positive evolution constitutes an important result.

Objective 3

Many of the activities proposed were aimed merely at getting the children to talk about the video after watching it (oral expression, OE; see Table 7): "*I consider it a video that invites reflection, therefore I would watch it with the students so that, later, as a debate, we ask ourselves what has happened, why [...]*" (PT44). It should also be noted that only six proposals combined at least two types of activities, and 10 of the responses to Q2 did not specify the kind of activities that would be used, and hence they could not be coded (Table 7).

Table 7. Types of activities proposed by pre-service teachers prior to the learning experience (responses to Q2) and afterwards (activities implemented in the workshops)

			Workshops (11 group workshops)	
	Type of Activity	**Q2 (34 individual responses)**	**Focus on bringing visibility to women scientists**	**Focus on the scientific content**
Inquiry-based	OCI			1
	CCI			
	DCI			1
	OSI	1		
	CSI			1
	DSI			2
Not Inquiry-based	O	4		3
	M			5
	D	1		1
	AE			3
	BE	1		1
	OE	11		11
	R			5
	P	3	1	2
	E	9	11	11
	Total	**30**	**12**	**47**

Following the learning experience, improvements were observed in relation to some aspects. The analysis of videos (showing implementation of the workshops) indicated that participants were capable of designing activities that brought greater visibility to the women scientists of relevance to the topic (category L1 in Table 6). In addition, all 11 workshops addressed both scientific content and aspects of gender (category Y3 in Table 6), although the latter was almost always limited to naming the woman scientist and her contribution (category L1). For example, in workshop 1, the woman scientist was introduced, stating her name and her main contribution through a poem. Then, one of the children was assigned the role of the scientist to carry out the actions proposed. In other words, even in those workshops in which reference was made, for example, to the professional obstacles that these scientists had faced due to being women (category L2 in Table 6), this was not taken further and used to explore the impact of gender in science. This is shown in workshop 10, where the woman scientist is introduced by stating her name and alluding to a non-scientific fact that constituted an obstacle in her career: a fire that occurred in her laboratory, but in the subsequent actions proposed to the students, the scientist is no longer included.

The analysis also reveals a degree of disconnection between the scientific content and aspects of gender (category Y3 in Table 6), insofar as the visibility that was brought to the women scientists in question was not generally retained throughout the workshops. In the majority of cases, these women were mentioned at the beginning of the workshop, before moving on to deal with scientific content related to the assigned topic; in the process, the women scientists and their contribution to the topic became side-lined. Consequently, when studying the types of activities that pre-service teachers incorporated into their workshops, we decided to distinguish between those in which the focus was on bringing visibility to a woman scientist and those that were used to address scientific content. Under this approach, the data show that explanation (category E in Table 7) was the type of activity used in all 11 workshops to bring visibility to women scientists, whereas the activities used to address scientific content were more numerous and more varied (between 3 and 5 types used in each workshop), encompassing all but two of the types of activity (both inquiry-based, CCI and OSI; Table 7) that were coded in the analysis of videos. For example, in workshop 2, the only one in which two types of activities are combined to bring visibility to women scientists (E and P), where children simulate being a research group that must collaborate to solve an enigma (DEI), finding clues, extracting the information they contain and drawing conclusions (OE).

Conclusions

Gender bias in science should be made visible to the pre-service teachers and those pre-service teachers should be given tools to implicitly counter that gender bias. One way to do this may be by simply including more female scientists together with male scientists in the teaching approaches, rather than the norm of predominantly including males. This paper describes and evaluates a learning experience aimed at encouraging pre-service early childhood education teachers to consider aspects of gender in the teaching of science, at least to the extent of bringing visibility to women scientists who might serve as role models. When presented with a resource that could be used in the classroom to bring a gender perspective to science education, some of the participants did not regard it as suitable, while others who said they would use it did not recognise its potential for addressing both scientific content and aspects of gender in an integrated way. With regards to the latter group, the results also revealed a gap between their intentions and the characteristics of the activities they proposed as a way of approaching a science topic and/or aspects of gender. In addition, it was apparent that these pre-service teachers lacked the skills needed to design activities capable of addressing both science and gender, and most of the activities they initially proposed were limited to discussion by children (oral expression) and explanation by the teacher.

Following the learning experience the pre-service teachers were able to link certain women scientists to specific topics from the early childhood education curriculum and to address these in workshops that made use of various types of activities. However, the analysis showed that they did not make this link and its significance sufficiently explicit for young learners, and they generally relied on explanation as a way of bringing visibility to the women scientists. In other words, the pre-service teachers struggled to grasp the idea that a gender perspective could be embedded within the teaching of scientific content, and hence they did no more than acknowledge the contribution of a given woman scientist alongside the workshop activities.

One possible explanation for this is that the starting point for each group of pre-service teachers was a science topic from the early childhood education curriculum, to which they then had to link the work of a woman scientist. However, it may be better to do things the other way around, that is to say, to start by asking pre-service teachers to identify and choose important examples of women in science and then get them to link these women to aspects of scientific knowledge that are addressed in early childhood education. In this way, the focus of the workshops may have been on the woman scientist rather than the assigned topic. This approach may have helped to make the woman a continued presence throughout the workshops, rather than solely at the start, which is what occurred in the majority of cases, and it might also have encouraged the pre-service teachers to address in greater detail certain aspects of her life and, consequently, of her gender. We would also argue that greater emphasis should be placed within teacher training on the meaning of different types of learning activities, especially those which are inquiry-based, and this should include analysis of the specific skills and attitudes they each promote. This could help pre-service teachers to embed a gender perspective more firmly with their science teaching, as opposed to making only passing reference to gender while focusing on scientific knowledge.

Overall, our results suggest that learning experiences of the kind described here can, in the context of teacher training, help to identify female role models within the fields of science and technology and to bring greater visibility to women in the history of science. However, other studies asserted that it is important to provide planned and ongoing support for professional development on how to facilitate and implement various developmentally appropriate activities in classrooms, so teachers can develop, negotiate, and demonstrate their ‘practical knowledge’ (Ekawati & Kohar, 2016; Kim & Han, 2015). Therefore, further refinements are clearly needed in order to help pre-service teachers integrate the gender perspective within their classroom teaching of science. Given that this integration is, despite its importance, still regarded as an innovative approach, one way of promoting it would be to ensure that pre-service teachers are familiar with current research of relevance to their field (Tassella et al., 2019; Vereijken et al., 2018), especially regarding gender in early childhood science education. As examples, it is worth mentioning Jayne Osgood's mapping of the connection between Lego, gender, environmental problems and serious play, and what they produce in early childhood education and care (Fairchild, 2019), and her experiment with storytelling and children's media as a means of broadening what we know about how children deal with complex knowledge through their own world-making practices (Osgood & Andersen, 2019).

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