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# Socio-scientific issues for transforming conceptions of sexuality teaching in the training of natural science teachers

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**Introduction:** Sexuality education in teacher training is often reduced to biological aspects, ignoring its affective, social, and cultural dimensions, this represents a challenge for science education and the preparation of future teachers.

**Methods:** This paper presents a qualitative study conducted with 28 trainee teachers of the Science Didactics program of the bachelor's degree in Natural Sciences and Environmental Education. The objective of this research was to know the teachers' tendencies regarding their conceptions about the nature of sexuality, its relationship with natural sciences and the affective dimension of sex education. This, before and after a didactic intervention based on the design and application of socio-scientific questions on sexuality.

**Results and discussion:** The results show that, after the didactic intervention, the interest and willingness of teachers to be trained in sex education that includes affective, social, cultural and scientific aspects in their analysis and praxis, involving the context and favoring interdisciplinarity from the science classroom, increases.

## KEYWORDS

health education, teacher training, science education, socio-scientific approach, science and society

## 1 Introduction

Sex education in the formation of natural science teachers faces a critical challenge related to the integration of affectivity and cultural understanding of sexuality in the educational curriculum (Astudillo, 2017; Martini and Bornand, 2018). This problem, according to Zemaitis (2016), arises from the tension between a reductionist view that limits sexuality to biological and reproductive aspects (Ministerio de Educación Nacional [MEN], 2004, 2013), and a more an integral perspective that recognizes the influence of emotions, social interactions and culture in the construction of sexuality. In this context, the faculty-trainer plays a crucial role, since their conceptions and educational practices largely determine how sexuality education will be addressed in future generations.

From the point of view of biopower theoretical references such as Foucault, López (2008) it is argued that the discourse on sexuality is not neutral but is imbued with power relations that regulate and control bodies and behaviors. From this perspective, Marín (2019, 2021) states that sexuality in educational institutions can operate as a power device that reinforces hegemonic norms and values, particularly around heteronormativity.

In this sense, on lacking adequate training in affective and sexual education, the faculty may inadvertently perpetuate practices that discipline and regulate students' sexuality, instead of fostering a critical and liberating understanding (Mosquera and García García, 2021a; Mosquera et al., 2023). This theoretical framework suggests that it is necessary to rethink the way sexuality is taught, not only as a set of technical knowledge, but as an integral dimension of human experience that is deeply influenced by power and culture (Badilla et al., 2018).

According to Merleau-Ponty, affectivity is fundamental to understanding sexuality as an embodied and relational phenomenon (Guenther, 2011). The subjective experience of sexuality cannot be fully understood or taught without recognizing the central role of emotions and interpersonal relationships. In this sense, the teachers training should integrate these aspects to provide an integral and relevant sexuality education for students' lives.

Thus, the problem lies in the fact that the faculty lacks a sexuality education that considers the affective and cultural dimensions of sexuality (Mosquera et al., 2023). This lack translates into educational practices that are frequently limited to biological and clinical aspects, without addressing psychosocial and cultural complexities that are essential for an integral understanding of sexuality.

It is essential to recognize the influence of power and institutional discourses in shaping sexuality education while valuing subjective experience and affectivity as essential elements for an integral understanding of sexuality. Research and educational practice should be oriented toward the creation of a curriculum and pedagogical environment that fosters inclusive, critical and transformative sexuality education that prepares future teachers to address sexuality in a complete and relevant manner in their educational contexts.

In this context, the objective of this research is to know the tendencies of teachers regarding their conceptions about the nature of sexuality, their relationship with the natural sciences and the affective dimension of sexuality education. This, before and after a didactic intervention based on the design and application of socio-scientific questions about sexuality.

## 2 Nature of affective-sexual education and its relation to teacher training

Sexuality and its study must include psychological, social, biological, historical, and political aspects. This is because these aspects are crucial for the development of different interactions that contribute to the recognition of the self in each individual and the use of pleasures as part of the ecological survival of all organisms (Foucault, 1984). To achieve the above, it is relevant

to address issues of human sexuality such as school and family violence, typologies of violence, pregnancy and abortion, sexual and reproductive rights, life histories, self-schemas (such as self-esteem, self-image), social practices related to the affective dimension, and attitudes and emotions that promote actions at the individual and collective level (Traslaviña and Macías, 2021). That is, from a biopsychosocial perspective that contributes to the formation in collective health, promoting a critical vision of social phenomena, where natural science participates in a transversal way. This means that, Affective-Sexual Education encompasses the biological (sex, genitality) and social (gender, culture) considerations of the human being from a plane of dialogue and a biographical model around health education (Lameiras et al., 2013; Morgade et al., 2016). In this sense, training science teachers should be articulated to the development of alternative didactics that allow recognizing the scientific dimension of the phenomena in articulation with other components that affect the development of sexuality in this case and favor the construction of this dimension (Gómez-Fierro and Peralta-Velosa, 2021). As evidenced in Figure 1, the Affective-Sexual Education addresses problems such as affective education and ethical formation from a sensitive and humanizing reason that allows fostering respect and recognition of the other from an early age, good community relations and the optimal integral development of the human being (Mosquera and García García, 2021a).

When defining the Affective-Sexual Dimension, it is necessary to understand that human sexual behavior is determined by both biological and cultural factors (emotions and feelings), in other words, it is a biopsychosocial-cultural fact (Fallas, 2009; Gavidia, 2016). This bases on the four components of sexuality, which allow human beings to empower and fully live their sexuality (Lamerias and Carrera, 2009; Fallas, 2009; Agud et al., 2016). The first one is the body, understood as a means of expression of sexuality, which must be accepted, estimated, and valued, since it confers self-contact and allows a personal self-discovery or self-exploration process. The second is the affective relationship and communication, aspects that lead to the desire to share with the other, something beyond a coital relationship, adding physical attraction, affection, endearment, feeling and communication (language) of what is desired, felt (competent internal or external emotional stimuli) or thought (consciousness framed in processes of subjectivity and articulation of images). This component recognizes the existence of the emotional dimension (construction of valences and generation of feelings from emotions themselves) (Damasio, 2003, 2018). The third is pleasure and eroticism, which favor the enjoyment of one's own body and that of the other, without fears, without guilt and without implying harm to either party. Here, it is important to value the importance of eroticism as an input in both genital and non-genital sexual practices, all from an ideal of survival and search for that cultural homeostatic balance or Conatus according to Spinoza (Lenoir, 2019). The fourth component is made up by ethics and responsibility, issues involving self-care to any fact that causes injury as a person or couple, in addition to supporting gender equality and materialization of the rights of men and women as premises of dignity in human relations.

The recognition of these four components places sexuality in the theory of emotions, in that affective dimension from which no human being can detach. Therefore, to think of education about sexuality from an instrumentalizing practice, which privileges

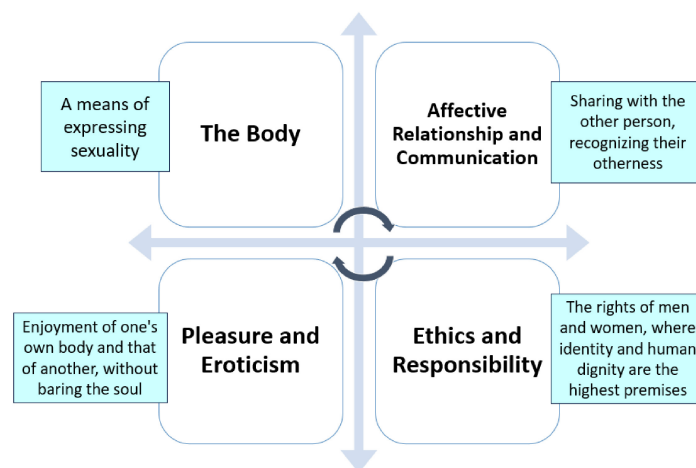


FIGURE 1  
Behavioral foundations underlying the dimensions of human sexuality.

reason over emotion and promotes disciplinary knowledge without any context, is to think of the process outside of humanity and its sensitivity. Therefore, teacher training is an essential element in Affective-Sexual Education, because as Plaza (2015) states, the teacher's beliefs and knowledge about its own and collective sexuality have a direct impact on the conceptions and learning that students build in the classroom. That is, the teacher, as it is well known in any educational process and its own conceptual and experiential reality, influence human formation beyond the structuring concepts of science. This relationship bases also on the affective dimension of the faculty itself and how it impacts its student's lives, generating negative or positive valence emotions during the teaching and learning process (Retana-Alvarado et al., 2019).

### 3 Use of socio-scientific issues in the teaching of cultural phenomena

When thinking about the implementation of the Socio-scientific Issues (SsI) approach to the teaching of health-related subjects, Torres (2014) recognizes that SsI and the STSE approach contribute to the development of meaningful learning in science students. In addition, these two strategies in science didactics contribute to the critical training of natural science teachers. On the other hand, it is recognized that SsI-based classroom interventions favor the development of scientific thinking competencies (Torres, 2014), positive emotions toward science (Domènech-Casal, 2017) and socio-political postures toward cultural phenomena (Conceição et al., 2019). That is, the implementation of SsI is a relevant strategy to address cultural phenomena such as human sexuality, specifically the Affective-Sexual Dimension and the training of science faculty.

In this sense, experiences such as that of Giraldo (2014), who developed a SsI to promote debate on organic crops and agrochemicals with 3rd grade students at a school in Copacabana (Colombia), stand out. In this work, the aim was to promote civic education, enabling critical argumentation and civil actions

on issues of science and society. Likewise, Villamizar et al. (2014) addressed the study of transgenic foods as SsI from their potential uses in the food industry, the possible consequences, and benefits for humanity, all it from the development of critical thinking in students. On the other hand, Rojas and Joglar (2017) implemented a Didactic Unit for teaching the structure and function of the plasma membrane in the framework of a SsI, favoring the formulation of questions with more complex cognitive levels.

In this way, Conceição et al. (2019) state that, to achieve an important contribution to the development of critical thinking in science education, it is necessary to recognize controversial elements that allow the development of argumentation skills within the framework of activities that make it possible to question and establish contrasts, in the face of opinions that are taken for granted. These requirements are met by the Socio-Scientific Issues (SsI) that involve controversial situations and relate critical thinking and science education (Reis, 2013, 2014). Then, the Science, Technology, Society and Environment - STSE approach and the SsI promote controversial activities with no immediate solutions that possess complexity because they involve social, environmental, and scientific aspects. In other words, SsI are strategies that allow teachers and students to articulate scientific concepts with real situations (Reis and Galvão, 2004; Aikenhead, 2011). Furthermore, Simonneaux (2008) points out that SsI deal with controversial and current topics, both in society and research, and even in the classroom, which can articulate thematic content from biology, sociology, ethics, politics, economics, and the environment. For this reason, social phenomena with biological and cultural connotations such as sexuality, can be possible objects of analysis to be proposed within the framework of socio-scientific issues (Mosquera and García García, 2021b).

### 4 Materials and methods

This research was developed using a qualitative approach focused on understanding and interpreting social and human phenomena from the perspective of the people involved (Denzin

and Lincoln, 2011). The methodological strategy selected was the case study, which, according to Yin (2018), enables an in-depth exploration of a specific phenomenon within its real-life context and allows for the triangulation of different sources of information and analytical techniques.

The case under study was a group of 28 trainee teachers enrolled in the Science Didactics course, part of the bachelor's degree in Natural Sciences and Environmental Education at Universidad Surcolombiana (USCO) in southern Colombia. The research setting was their regular academic semester in 2021, which was extended due to the Covid-19 health emergency. The case included the design and implementation of a didactic intervention focused on socio-scientific issues (SSI) addressing topics related to sexuality, science, and health. This intervention was developed to foster critical thinking around the affective-sexual dimension and was validated by experts in science education and sex education.

Data collection was carried out primarily through a validated open-ended questionnaire applied before and after the intervention. However, additional data sources included written reflections produced by the trainee teachers during the SSI-based activities and notes taken during class discussions and debriefings. These sources allowed for a more comprehensive understanding of the changes in conceptions and attitudes (Elo et al., 2014).

For the analysis, a content analysis approach was employed (Bardin, 1977), using thematic coding to identify recurring patterns, conceptual changes, and emotional attitudes reflected in the participants' responses. The open-ended questionnaire responses were coded inductively and organized into thematic categories aligned with the research objectives (e.g., conceptions of sexuality, links between science and emotion, pedagogical strategies, etc.). This triangulation of data sources and methods ensured the validity and reliability of the findings, as well as a deeper understanding of the educational and cultural dynamics involved in the teaching of sexuality in science education.

## 4.1 Information collecting instruments

To collect the information and identify the conceptions before and after the didactic intervention, a questionnaire was designed with 22 open questions about theoretical axes such as the nature of sexuality, the relationship of sexuality with feelings and emotions, the possible practices in sexual education, the teaching and learning purposes of affective-sexual education, and the incidence of issues such as pornography, promiscuity, sexual commerce and social networks in the construction of sexuality. This core questionnaire was validated by seven (7) researchers with extensive experience in the thematic field and in training science teachers in Ibero-america. The validation demonstrated the instrument objectivity, given that the questionnaire questions were reviewed under criteria such as efficacy to inquire into the conceptions, use of language, wording and clarity, and relevance to the proposed objectives. Some of the questions used in the instrument, which lead to this paper analysis, are presented below.

- What relationship do you think could be established between Sex Education and Science Education? Why?

- Do you think that the study of emotions and feelings could be part of Sex Education? Why?
- How do you define love in the context of a relationship?
- How do you think that love differs from friendship?
- From your personal and formative experience to what extent would issues related to sexual diversity have a place in natural science classrooms?
- From your experience and training as a future teacher, what purposes would you consider for Sex Education?
- From your personal and formative experience, what factors can influence decision-making in relation to sexuality?
- Which sexuality-related issues would you consider working with your students in the classroom?
- How do you think that preconceptions and value judgments that are immersed in some pedagogical practices influence human sexuality?
- Which aspects do you think are involved during the development of human sexuality?
- Which school experiences do you consider that contribute to the construction of our students' sexual identities?

On its turn, the didactic intervention was structured under the Socio-scientific Issues model (SsI), allowing the trainee teachers to appropriate a disciplinary content in the thematic field of interest and subsequently design Didactic Units (DU) (Martínez and Villamizar, 2014), aimed at students of basic secondary education. In each of the UDs designed by the trainee teachers, purposes of teaching were defined in articulation with the training in competencies such as inquiry and phenomena explanation. These competencies are established by the Ministry of National Education (Ministerio de Educación Nacional [MEN], 2004, 2014, 2016) through the curricular guidelines for natural sciences, and have been acknowledged in research on affective education with high school students and trainee teachers (Retana et al., 2017; Retana-Alvarado et al., 2018, 2019) as suitable for the development of critical thinking. The didactic intervention structure applied to the group of natural sciences trainee teachers (Table 1) is presented below. This structure responds to the four components that allow human beings empowering and fully living their sexuality (Lamerias and Carrera, 2009; Fallas, 2009; Lameiras et al., 2016; Agud et al., 2016).

Table 1 shows the approach to one of the thematic units, which includes the structuring of three SSIs.

The application of the questionnaire occurred in week 1 and week 16 of the first term 2021 in the Didactics of Science course of a trainee teacher program in the Colombia southern region. However, the time elapsed between those two moments was 7 months, given the extensions of the academic semester in response to the conditions of the Health Emergency in the framework of the Covid-19 pandemic, being week 1 in March and week 16 in September 2021.

For the implementation of the core instrument and the development of the teaching intervention, each participant in this study obtained prior written informed consent. Since all the preservice teachers were of legal age, the supervision of a legal guardian was not required. Furthermore, a confidentiality agreement was established with the coordinating faculty member



TABLE 1 Structure of the didactic intervention.

Unit	Ssl subjects	Development time
The body and the Alterity Principle	1 – Emotions and feelings, a construction from biophysics	Week 1 (4 h)
	2 – Love and beauty transgression: a matter of viewpoint	Week 2 (4 h)
	3 – Procreation beyond chromosomes and gametes	Week 3 (4 h)
	4 – “Cousin and cousin boil good soup”, incestuous relationships	Week 4 (4 h)
The affective relationship and the communication	5 – Love or friendship?	Week 5 (4 h)
	6 – A matter for everyone: Who is the other?	Week 6 (4 h)
	7 – Sexuality in colors, theories, and gender types	Week 7 (4 h)
Pleasure and erotism	8 – Erotic self-totalization: What happens with women in science?	Week 8 (4 h)
	9 – What is the real “beautiful”? A closer look (Botox, surgery, bulimia)	Week 9 (4 h)
Ethics and responsibility	10 – Human rights and Sexual and reproductive rights	Week 10 (4 h)
	11 – Affective-Sexual Dimension and digital consumption society	Week 11 (4 h)

Source: authors.

of the bachelor's program, and the project was shared with all participants to clarify any questions and voluntarily sign the informed consent form.

Regarding the pedagogical interventions in schools within the framework of the preservice teachers' pedagogical practices, a confidentiality agreement was signed in writing with the school leaders of each of the schools visited.

For each of the previously proposed subjects in the didactic intervention, a Socio-scientific Issue (SsI) was designed, some individually developed and others in groups up to 3 trainee teachers. The methodology of the didactic intervention was based each week on the work rhythm of the group of future teachers. In each SsI, an introductory context was proposed, using texts compiled from newspapers, public documents from the southern region of Colombia, infograms adapted from scientific sources, or texts proposed by the authors of the study on Affective-Sexual Education. Then, activities were proposed with problems that led to reflection and critical analysis of each situation from a scientific, social, and cultural perspectives. Then, statistics from DANE (National Administrative Department of Statistics) and the Ministry of Health and Social Protection on gender violence, violence against women, early pregnancy, sexually transmitted infections, consumption of psychoactive substances, and development of dependencies at school age, among others, were used. Likewise, videos extracted from short films, television series and documentaries were used, which contributed to the process of didactic transposition of concepts and theories, in relation to their possible implications in cultural phenomena such as the construction of sexuality from a biopsychosocial perspective.

## 5 Results

During the development of the didactic unit on the affective-sexual dimension, three SSI were implemented to address sexuality education from a critical perspective in the training of future natural science teachers.

### 5.1 Sexuality in color

The objective of this unit was to examine and promote a training proposal that employs the SSI approach to address the teaching of sexuality from a critical perspective in future natural science teachers. Through this proposal, it is intended that teachers in training not only recognize the stereotypes present in sex education practices, but also be trained to implement pedagogical actions that prevent gender violence from the science classroom. This approach aims at promoting an integral and sensible sexual education that challenges heteronormative norms and promotes a culture of respect and gender equity (Brossi, 2012).

The first activity was aimed at recognizing the stereotypes present in sexual and reproductive education practices in educational institutions. To this end, a space for sensible dialogue was introduced based on a short audiovisual clip from the U.S. series South Park, entitled Proper Condom Use. This video showed the sale of condoms and barrier condoms without age restrictions to children, who were unaware of the real purpose of these pharmaceutical products.

Based on this situation, the teachers were invited to analyze several aspects. Among them, the process of unconscious supply and demand of condoms to the child population, the possible perceptions of pharmacists, and the heteronormative and moralistic practices on the teaching of sexuality that the elementary school teacher presented in the face of his students' concerns.

In this activity, the trainee teachers expressed their disagreement with access to the purchase and sale of condoms without age control, as they thought that this would accelerate, to a certain degree, the process of sexual maturation in children (DF1:G5). In addition, they stressed that, not only as seen in the television series, but also in real life, it is increasingly common for children and adolescents not to enjoy their childhood and development at the ideal time of mental maturation (DF20:G10), and that, on the contrary, they assume work, commercial and consumerist identities that do not correspond to them (DF2:G5).

In this sense, the trainee teachers are concerned about how human development influences the formation of sexuality and identity without imposing moral judgments in the process. Teachers deem important to accompany the consumption of

information from childhood to adolescence, making sure that such consumption is aligned with the cognitive, physical and psychological development of students.

For the second activity, two photographs taken from an international media were used, corresponding to the 2017 and 2018 Gay Pride March in Mexico City, Mexico. On this occasion, the faculty was asked to reflect on their reactions to these images, their stance on the inclusion of sexual diversity in the natural sciences classroom, and their knowledge of similar demonstrations in their own city.

DF1:G5 [trainee teacher number 1 who participated in DU number 5 reflecting on the Gay Pride March and sexual diversity]: *“I have always thought that the pillar of anything, including this one, is to promote respect. Therefore, being an upcoming science educator, I think that a formative strategy is to promote respect for different beliefs, thoughts, decisions, attitudes, etc. Followed by this, the correct teaching of the human body with respect to the gender in which each one feels identified without imposing or reproaching anything to the student, with very clear and concise terms, without reservations and calling things by their true name. I believe that all this generates in children a degree of maturity that will help them to take these issues in a more responsible and respectful way”.*

The responses of some trainee teachers reveal a marked interest in promoting axiological values such as respect above any scientific content in their classroom practices. This perspective is particularly relevant, as it is complemented by the emotions and perceptions that teachers experienced when observing the photographs of the Gay Pride March. This approach underscores the importance of addressing sexual diversity not only from the realm of scientific knowledge, but also from the promotion of fundamental values in coexistence and mutual respect.

Johns et al. (2019a,b) point out that, given the considerable amount of time that students who identify themselves as lesbian, gay, bisexual or transgender (LGBT) spend at school, it is crucial to promote educational programs that allow overcoming social stereotypes that lead to hateful and repressive practices. In this context, school climate becomes a key factor in developing school projects that seek to support and contribute to the inclusion of LGBT-related issues from a critical perspective in educational institutions (Sondag et al., 2022).

In this sense, the critical stance of the trainee faculty regarding the inclusion of sexual diversity issues in the classroom is interesting. This faculty recognizes the importance of fostering attitudes and emotions that provide security to high school students, promoting a more inclusive and respectful environment.

## 5.2 Feminism vs. patriarchalism

This SSI sought to recognize the image of women in science and the way in which patriarchal systems have violated their rights in society. Therefore, it began with a reading constructed by the authors of a research based on Varela's postulates (2020) to make visible the feminist movement and its relationship with the construction of sexuality and affectivity.

In the first activity, the faculty was asked to think about the themes, characters and aspects they would consider if they had to

organize a Science Fair, celebrate Environment Day or develop the Sex Education Project. Below, the proposals are recognized in the faculty's answers.

Regarding the Science Fairs, teachers would link the design of technological and robotic prototypes to explain some complex machines that may be of interest to their students. This, in attention to the science, technology and society component defined in the basic competency standards. Likewise, the teachers expressed their preference to talk about the life and work of new scientists, or rather about those who have been little visible in history and about whom little is known (DF20:G7). Among these scientists, they mentioned several women at the international and national level. An interesting issue is the preference for Latin American women over European or North American women, as well as a not very positive view of the knowledge generated by black and indigenous women.

To commemorate the Environment Day, the trainee faculty prefers to socialize classroom experiences on recycling projects, home gardens, composting, reuse of solid waste and innovations that arise in programs such as Ondas Huila (science initiation program with elementary, high school and middle school students) (DF13:G5), which is present in most of the educational institutions in the department.

It is evident that, in this teacher training, there is a tendency toward the visibility of violence against women and all types of violence that alienate boys, girls, adolescents, women and men from their rights in different contexts. In accordance with this, according to Cale Lituma (2022), the educational field is favorable to analyzing the incidence of social positions and perceptions regarding people's self-definitions, subjectivities and identities (Valle Vázquez, 2021). From this same perspective, Solís-Sabanero (2016) states that the perceptions present in educational processes can generate stereotypes and foster inequality or inequity among future citizens in the short and long term. In this sense, the oral discourses and practices of teachers could contain elements that contribute to the construction of sexuality issues such as the image of women and end up influencing the deconstruction of categories such as identity and gender within school spaces (Paz Enríquez, 2018; Cale Lituma, 2021).



FIGURE 2  
Conference what is gender identity? Neither pink nor blue. Source: TEDx Talks (2013).

### 5.3 Are they born or are they made?

This was the last SSI applied with the group of trainee teachers in natural sciences. In this case, the educational objective was to recognize the various identities that are formed around gender and to understand their deconstruction within the context of sexuality as a cultural phenomenon. To this end, the teachers were initially presented with a text based on Gavilán (2021) contributions on the complex identities that influence the deconstruction of gender. Subsequently, a TEDx lecture entitled What is gender identity? Neither pink, nor blue, presented by activist Sam Killermann (Figure 2), also author of the handbook entitled A Guide to Gender was analyzed with the teachers. This activity generated great interest among the trainee teachers, as they believed that TEDx conferences addressed basic science topics or contemporary political issues, but, instead, they found a talk on the dilemmas of gender, its origin from science and its deconstruction in a cultural context.

When asked about the way in which they would approach gender issues and their stereotypes in primary, elementary and middle school education, the trainee teachers suggested clear and coherent dialogue as the most appropriate strategy to bring these issues to the classroom (DF15:G8). However, some teachers stated that, when faced with situations in which their students manifest a sexual orientation different from the heteronormative ones, and dilemmas arise in the construction of their identity, the most advisable would be to escalate the case directly to a professional in psychology (DF7:G3 - DF11:G10).

This perspective shows how, by the last week of the semester, the faculty was developing conceptions and sensible practices around issues of sexuality. At the same time, future teachers recognized that there are situations in which the support of other fields of knowledge is necessary, including the family as a formative space in the development of a person's character (Clarke, 2013). In addition, regarding the integration of natural sciences in the discourse on gender, the teachers pointed out that sexuality should not be seen only as a biological issue, limited to hormones and sexual gametes. On the contrary, they considered that science education should allow students to understand that, on the biological basis, various social and cultural interactions are generated that contribute to the formation of a person.

## 6 Final considerations

Based on the analysis of the integration of sexuality, affectivity and health in teacher training, the importance of a cultural understanding of sexuality in teacher training is highlighted. Through the focus on socio-scientific issues, future teachers not only acquire technical knowledge, but also develop a critical sensitivity toward gender stereotypes and heteronormativity. This approach fosters a more inclusive and sensible sexuality education that responds to the needs of students in a diverse educational context.

This formative process contributes to an education that not only informs, but also forms individuals capable of questioning and transforming current social and cultural norms. However, the need

to strengthen these competencies and ensure that teacher training in the natural sciences systematically and effectively includes these approaches in future pedagogical practices is identified as an ongoing challenge.

Then, the SSIs implemented with the trainee teachers on issues of the Affective-Sexual Dimension have strengthened their conceptions, allowing a change among their thought trends during the formative proposal and contributing to the emergence of positive emotions and attitudes about their role in Sexuality Education. In the SSIs that addressed issues of gender violence and sexual diversity, the faculty proposed the interdisciplinary nature of the natural sciences as a classroom strategy to analyze the variables about phenomena such as gender violence, transgression of affectivity and the construction of new gender and family identities. Thus, the intervention based on SSI has allowed trainee teachers to become aware about contemporary realities such as same-sex families, surrogate pregnancy, inclusive language, and intersexuality. In addition, the activities proposed in the SSI have enabled curricular transversality in the training of science teachers. As a result, some teachers proposed art and literature as fields that can favor the sensitization of their students in the classroom toward the analysis of practices of violence and transgression of the principle of otherness.

### Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: <https://bibliotecadigital.udea.edu.co/handle/10495/33221>.

### Ethics statement

The patients/participants legal guardian/next of kin provided written informed consent to participate in this study.

### Author contributions

JM: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing. EC: Writing – original draft, Writing – review and editing. JG: Conceptualization, Writing – original draft, Writing – review and editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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