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ARTICLE

Enhancing Argumentation and Decision-Making of Preservice Early Childhood Education Teachers Through Role-Playing on Animal Experimentation

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Abstract
This study explores the socio-scientific issue of the relevance of animal experimentation using a role-playing game to develop argumentation and decision-making skills as key components of critical thinking. The activity was conducted with two cohorts, each consisting of 30 pre-service early childhood education teachers at the University of Málaga (Málaga, Spain). The study analyzes the arguments provided by the participants to justify their decisions and perceptions on the issue before and after engaging in the role-playing. The findings reveal a progression of participants from the initial rejection of animal experimentation to recognizing its imperative role in shaping scientific knowledge. Additionally, an enhancement in the understanding of rational aspects of the issue is detected, as observed through the evolution of the types of arguments employed in justifications before and after the intervention. Furthermore, emotionally charged arguments related to ethical and moral aspects of the issue are also observed.

1 Introduction

Scientific argumentation plays a fundamental role in science education (Erduran, 2020; Erduran & Jiménez-Aleixandre, 2007), serving as a cornerstone for deep understanding of scientific concepts and empowering students to actively engage in scientific discourse and broader societal conversations. Firstly, argumentation involves the ability to formulate and support claims with solid evidence and logical reasoning, fostering the skill to evaluate and analyze information objectively (Chai et al., 2015; Fang et al., 2019). Additionally, argumentation stimulates critical thinking (Franco-Mariscal, 2024) by questioning

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preconceived ideas and seeking evidence-based explanations. Moreover, argumentation nurtures the development of effective communication skills, as students learn to express their ideas clearly and coherently, as well as to persuasively defend their viewpoints.

The relationship between argumentation and Socio-scientific Issues (hereinafter, SSI) is close and significant (Simonneaux, 2008). SSIs address issues that involve both scientific and social, ethical, political, and cultural aspects (Sadler, 2009) requiring the application of argumentation for understanding and resolution. Argumentation becomes essential in SSIs because it encompasses the ability to analyze information, evaluate evidence, consider multiple perspectives, and defend viewpoints in a reasoned manner. SSIs are often complex and controversial, necessitating individuals to effectively argue and justify their positions. Additionally, argumentation in the context of SSIs promotes informed and responsible citizen engagement.

Moreover, education plays an essential role in fostering the development of argumentation and decision-making. These skills not only empower students to cultivate critical thinking in response to real societal issues (Erduran, 2020; García-Carmona, 2023) but also contribute to advancing reflection, debate, and activism (Zeidler, 2014). Therefore, nurturing a critical, responsible, and reflective citizenship capable of making informed decisions about the diverse challenges that emerge in society becomes imperative.

As a result, it is pivotal to instruct preservice teachers in argumentation and decision-making, as they will transfer the acquired knowledge to their students, contributing to the building of a critical and reflective society in a few years. The efficacy of such training is heightened when preservice teachers themselves have firsthand experiences related to these skills in the classroom (Avraamidou, 2019). In this regard, teacher training emerges as one of the challenges in science education (Caena, 2011; Darling-Hammond, 2006). Therefore, it becomes essential to provide preservice teachers with the necessary tools for crafting solid arguments, enabling them to make informed decisions grounded in evidence and encompassing all dimensions of the issue. Empirical studies focusing on elementary school students' socioscientific reasoning have suggested the importance of instructional support from teachers in facilitating the construction of informed and reasoned decisions (Evagorou, 2011; Ozden, 2020).

Additionally, the use of role-playing, as a simulation engaging diverse students representing different characters related to a SSI, stands out as a strategy to promote the development of argumentative skills and decision-making in the classroom (España-Ramos, 2023). The literature highlights the potential of role-playing in addressing various SSIs, spanning areas such as chemistry (Cruz-Lorite et al., 2023) and the environment (López-Fernández et al., 2021).

In the context of science education, animal experimentation (hereinafter, AE) is a SSI of particular interest, demanding societal solutions intertwined with environmental considerations, given its implications for animal welfare, and the broader respect for living beings and their habitats (Mazas et al., 2013). SSIs like the one presented not only call for a scientific stance but also entail ethical considerations, underscoring the pivotal role of ethical and emotional emphasis in science arguments (Archila, 2017). Striking a balance between these scientific and ethical perspectives is desirable as it significantly enhances citizens' critical thinking. However, achieving this equilibrium remains a notably complex challenge. In many SSIs, the final decision, although influenced by sound scientific argumentation, often places significant emphasis on emotions and moral sensitivity. These factors are indeed recognized as crucial for sparking student interest and facilitating the transition of science to society (Leung & Cheng, 2023; Sadler, 2004a; Tomas & Ritchie, 2012).

In this theoretical framework, the aim of this study is to examine how a role-playing game on AE influences the positions and arguments expressed by pre-service Spanish early childhood education teachers at various stages of the intervention.

2 Background

This section outlines the conceptual bases of the study, focusing on four key construct elements: critical thinking, argumentation as a dimension of the critical thinking, the influence of SSIs on science learning and the utilization of AE as a backdrop for an SSI, and the application of role-playing as a framework for this activity.

2.1 Key Construct One—Critical Thinking

The cultivation of critical thinking, facilitated through the integration of issues in science education, holds indispensable significance in our society. Its educational value extends beyond the confines of academic learning, encompassing cross-cutting and functional competences applicable to personal, social, and professional spheres. Within the framework of science education, critical thinking is necessary to develop a mutual comprehension of divergent viewpoints, a prerequisite for integrating conflict resolution within the landscape of social controversies (Kötter, 2018; Noddings & Brooks, 2017).

Ennis (2011, p.1) defined critical thinking as "a reasonable and reflective thinking focused on deciding what to believe." This definition is very broad, and as a result, different authors have proposed definitions of critical thinking as a combination of different components. According to Vieira and Tenreiro (2016), critical thinking includes cognitive, attitudinal, and affective components. In contrast, Puig and Jiménez-Aleixandre (2022) delineate critical thinking components as cognitive and epistemic skills, critical character (disposition), independent opinion, and critical action. There is no doubt that the promotion of critical thinking is a complex and time-consuming process (Andrews, 2015; Hyytinen et al., 2019). In practical terms, higher education courses provide students with limited opportunities to develop their critical thinking skills (Archila et al., 2022).

2.2 Key Construct Two—Argumentation

Several authors concur that the development of critical thinking relies crucially on skills in argumentation and decision-making (Fang et al., 2019; Jiménez-Aleixandre & Puig, 2012; López-Fernández et al., 2022). Specifically, argumentation is aimed at the rational resolution of questions, issues, and disputes (Siegel, 1995), and it constitutes a fundamental tool in the construction of explanations, models, and theories (Toulmin, 2003). Furthermore, Erduran and Jiménez-Aleixandre (2007) posit that effective arguing involves the ability to assess statements based on evidence, which is, recognizing that scientific conclusions and statements must be justified—in other words, grounded in evidence. In essence, the complex and potentially controversial nature of an SSI, especially those lacking clear-cut solutions, necessitates scientific reasoning anchored in robust argumentation—a process heavily reliant on evidence for the formulation of well-informed opinions (Erduran & Jiménez-Aleixandre, 2007; Sadler, 2009; Zeidler, 2014).

Toulmin's Argument Pattern (TAP) (2003) stands out as one of the most widely employed models for analyzing arguments. This model explains, from a logical perspective,

the structure of an argumentative text. As per Toulmin (2003), an argument explicitly introduces a thesis or opinion and unfolds a series of logical reasons that should culminate in a conclusion affirming the proposed thesis. Toulmin (2003) defines argumentative competence as the ability to integrate evidence into a structure to justify a conclusion, assessing its foundation in broader principles and considering potential counterarguments.

Jiménez-Aleixandre (2010) simplifies the components of an argument into three main elements: evidence, justification, and conclusion. However, she also recognizes the potential presence of other supporting elements, such as basic knowledge, modal qualifiers, and refutation. According to this author, the conclusion represents a statement of knowledge subjected to evaluation.

A datum refers to the information, magnitudes, or relationships that are invoked to verify or refute a statement. While evidence and data share similar meanings, their distinction lies in the context of use and the role evidence plays in assessing the statement. Regarding justification, its purpose is to establish a connection between the conclusion and the evidence, elucidating the process from data to conclusion or explanation (Jiménez-Aleixandre, 2010). According to Toulmin (2003, p.91), the role of justification is to demonstrate that, beginning with the data, the transition to the statement or conclusion is both appropriate and legitimate.

In relation to the auxiliary components of an argument, basic knowledge involves invoking theoretical or empirical understanding to support the justification, thereby enhancing the argument's robustness. Modal qualifiers articulate conditions that introduce nuances to the statement, such as its degree of certainty. Jiménez-Aleixandre (2010) distinguishes between refutation conditions, outlining circumstances in which the statement is invalid, and refutations, which challenge the evidence supporting the opposing statement. Although essential and auxiliary elements are distinguished, the presence of the latter is indicative of a higher quality of argumentation.

As responsible citizens, individuals are expected to make important decisions as stakeholders in various issues in their lives. SSIs provide the opportunity for such scenarios by presenting situations that necessitate a reasoned choice between typically incompatible options (Herreid, 1996) (such as nuclear energy yes or no).

Making informed decisions about climate change (Rehg, 2011), nuclear energy (Cruz-Lorite et al., 2023), plastic waste reduction (López-Fernández et al., 2021), COVID-19 (Ha et al., 2022), or genetics, ancestry, and race (Beckwith et al., 2017), among other SSIs requires educated citizens who critically identify and evaluate arguments, serving as a key element in the construction of democratic societies (Archila, 2018; Archila et al., 2022). Toleration of diverse viewpoints is a fundamental value that underpins democracy (Bohman, 2006). Moreover, these controversies offer students an educational advantage by fostering an understanding of the SSI and facilitating the formulation of potential solutions (Herreid, 1996).

2.3 Key Construct Three—Socio-scientific Issues

SSIs are defined as real, close, and relevant problems for citizens that conceptually address social issues linked to science and technology. These issues are potentially controversial and do not have a simple or direct solution. Instead, their resolutions encompass scientific-technological, social, economic, political, and ethical dimensions (Jiménez-Aleixandre, 2010; Sadler, 2004a, 2004b, 2009). Currently, the presentation of debates on SSIs is becoming increasingly common (Simonneaux, 2008), and their use

holds substantial significance in science education (Hancock et al., 2019), fostering the development of scientific competencies and critical thinking skills (OECD, 2019). This not only promotes a deeper understanding of the nature of science (Sadler, 2009) but also enhances the education of future citizens in moral and ethical aspects (Jiménez-Aleixandre, 2010).

As discussed earlier, SSIs are characterized by their multifaceted nature, which encompasses the ethical perspective (Sadler, 2004a, 2004b). Taking a closer look at this aspect, SSIs play a crucial role in integrating ethical considerations into education. The aim is to provide relevant tools and insights for decision-making within a scientific process that engages society holistically (Cambra & Lorenzo, 2018). Recognizing the ethical dimension of science and technology as a significant societal concern, it occupies a crucial place in science education (Millar & Osborne, 1998; Rhee & Choi, 2014).

A reference author in the realm of ethical normative criteria that guide decision-making is Haidt (2001, 2012a). According to this author, morality is innate and is driven more by intuitive responses than by rationality. In addition, our moral decisions often tend to rely on emotional, non-rational intuitions, although reason may step in to provide justifications and arguments that support these intuitions, shaping moral judgments. While a considerable number of authors may agree that many moral judgments share these characteristics, others assert the need for an effort to counteract these non-rational influences. LaFollette and Woodruff (2015), for instance, argue that rationality can play a more central role even when a person's intuitions are active. Haidt (2012b) also considers such a role, albeit with the condition that those intuitions contrary to rational criteria are deactivated.

Helm (2001) and Taylor (1992) are among the authors who draw a connection between morality and emotions, introducing the concept of moral emotions. These specific emotions are closely associated with the moral and ethical aspects of our lives and play a crucial role in shaping ethical judgments, decisions, and behavior. They represent emotional responses that we experience when confronted with moral situations, ethical dilemmas, or actions entailing considerations of right and wrong, justice, duty, virtue, and other ethical dimensions.

Taylor (1992) explored the relationship among morality, identity, and ethics in daily life. The study delved into how our emotions and values shape our ethical perspective of the world and how we construct and comprehend our own moral identity in the context of the society we inhabit. This author emphasizes the importance of understanding emotions in the context of our moral identities and how they impact our ability to discern and act ethically in various situations. Furthermore, Helm (2001), in turn, specifically examines the concept of moral emotion and its role in ethical deliberation and decision-making. Within his work, Helm (2001) explores how these emotions impact our motivation, assessment of moral values, and ethical decision-making.

In this context, science education would play a significant role by providing scientific foundations to cultivate a balanced perspective. Decision-making in SSIs should be grounded in scientific criteria. SSIs are intentionally incorporated into the science curriculum to educate citizens with discernment and heightened responsibility in our ever-changing and complex world (Sadler, 2004a). It is worth noting that we emphasize the concept of "balance" (Ross, 1988) rather than seeking the hegemony of scientific reason, recognizing that moral emotions are integral to learning about SSIs (Leung & Cheng, 2023).

Consequently, addressing decision-making within the classroom becomes essential, as the choices made by citizens in their daily lives are fundamentally grounded in intuitive beliefs and values. In this regard, science has the potential and responsibility to assist in these choices and in revisiting the origins of such values and beliefs (von Winterfeldt,

2013). From this perspective, SSIs can play a fundamental role, as they often present conflicts of interest between the aspects of scientific rationality and moral considerations.

An interesting study from this point of view is Sadler's (2004a), which explored, through interviews, university students' perceptions of the moral aspects of SSIs related to genetic engineering. This author employed a categorization system that combines the type of argument used with the coherence of the resolution given to the SSI. Regarding the type of argument, three options were considered: (a) the use of moral considerations, (b) the integration of moral and non-moral considerations throughout their decision-making process, and (c) the use of non-moral considerations. Participants expressed sensitivity to moral considerations, encompassing concerns and empathy for the well-being of others, an aversion to disrupting the natural order, and awareness of the implications of a slippery slope. In their final decisions, many participants successfully blended moral concerns with non-moral factors, illustrating the potential for aligning reasons from both types.

Continuing the exploration of reasoning in SSIs, Sadler and Zeidler (2005) identify different types of reasoning. Rationalistic informal reasoning is based on rational, logical, and evidence-based considerations. Emotive informal reasoning involves the incorporation of emotions such as empathy, compassion, and concern for the well-being of others. Lastly, these authors identify intuitive informal reasoning as an immediate personal positive or negative reaction. According to these authors, participants frequently relied on combinations of these reasoning patterns as they worked to resolve individual SSIs.

However, the goal is not to replace emotionally-driven criteria with purely cognition-based ones, as the former is also necessary given the complexity of many SSIs and the impact they can have on society (Martínez et al., 2019). In this sense, decisions regarding SSIs made solely based on criteria of scientific rationality would lead to a scientistic and technocratic society (Horkheimer & Adorno, 2002), far from the advisable outcomes of a complex worldview. It would, therefore, be more about finding a balance between reasons of both types and, above all, developing a critical spirit that allows for reasoned articulation of both criteria when taking a stance and providing a solution to the SSIs (Kolstø, 2001; Sadler, 2004b).

2.3.1 Animal Experimentation as Socio-scientific Issue

This work focuses on the SSI of AE, framed within the social aspects of the nature of science, specifically those related to the social control of science due to ethical and moral values (Osborne et al., 2003). The use of animals in biomedical research is a SSI in which decision-making is complicated (Abbott, 2010; Agell et al., 2015; Editorials Nature, 2011) as it poses the dilemma of whether AE is justified to achieve scientific advancements that benefit humanity. This SSI has implications of various kinds, scientific, social, legal, and economic, but above all, a significant ethical implication.

The scientific implications of AE include debates within the scientific community regarding the relevance and validity of results obtained from studies in animals to predict human responses (Akhtar, 2015; Greek, Menache, & Rice, 2012a). Additionally, there is a discussion on the necessity for more effective and ethical alternative methods, such as in silico methods (Lang et al., 2018). Some authors argue against these positions, asserting that the complexity of biological interactions cannot be fully replicated in alternative systems, such as cell cultures or computational models. They emphasize that animal models offer a more comprehensive representation of biological systems (French, 2012; Mogil

et al., 2010), highlighting that many fundamental discoveries and medical treatments have been developed through research involving animals.

The social dimension of this SSI is evident in its media presence and the controversy it generates due to the diverse opinions in society (Agell et al., 2015). The attitudes of individuals towards animal welfare in society are significantly influenced by the education they receive in early age. Additionally, these attitudes are shaped by traditional practices, received training, personal experiences, general beliefs, and philosophical ideas (Broom, 2005). The literature on the subject identifies two categories of predictors influencing the approval of AE. Firstly, approval is associated with intrinsic factors inherent to the experiment itself, such as the type of the research (more widely accepted in medical research), specific species (more accepted for mice), consideration of animal suffering (greater acceptance when minimizing suffering), and the availability of alternatives (greater acceptance when viable alternatives exist) (Agell et al., 2015; Hagelin et al., 2003; Serpell, 2004). Secondly, approval is linked to extrinsic factors or socio-demographic characteristics of the respondents, including gender, education, urban or rural background, personality, pet ownership, and attitudes towards the environment, animals, and values (Agell et al., 2015; Hagelin et al., Crettaz von Roten, 2013). Furthermore, research has demonstrated a correlation between attitudes towards AE and public perceptions of science and the environment. The social acceptance of AE is linked to an increased recognition of the contributions of science and technology, accompanied by a reduced interest in or awareness of environmental issues (Crettaz von Roten, 2013).

The legal dimension is regulated through the laws governing AE. In the Spanish context, its legal framework is influenced by its accession to the European Union, with the incorporation of European Directive 2010/63/EU (European Parliament and of the Council, 2010) into its legal system through the promulgation of Law 6/2013 (Spanish Government, 2013), which modified Law 32/2007 (Spanish Government, 2007) to align it with the European directive. This regulation governs aspects such as the purposes of procedures permitting animal use in research, eligible species, permitted procedures, and requirements for breeders, suppliers, and users. Moreover, this SSI motivates citizen participation in animal rights advocacy groups, which often engage in debates and activities to influence policies related to AE. An example is the citizen initiative that led to a debate in the European Parliament in 2015 on whether to cease AE. The outcome was a European declaration expressing a strong intent to gradually phase out AE in Europe in the future, despite its current necessity (Peter, 2015).

The economic dimension is linked to the costs and investments required, encompassing facilities, personnel, and animal care, which can impact the viability of research. This research is frequently an integral part of the drug and treatment development process, carrying substantial economic implications for the pharmaceutical industry. Furthermore, public opinions regarding the ethics of AE can influence the demand and consumption of products associated with such practices. In this context, alternative methods are emerging as a valuable opportunity, particularly in areas such as the production of cosmetics without animal testing, contributing to an enhanced image of these products for end consumers, among other reasons (Meigs et al., 2018).

The ethical aspects of research on animals have long been associated with implications related to experiments involving humans. The origins of this debate emerged in the field of biomedical research after World War II, resulting in successive protocols such as the Nuremberg Code of 1947, the Helsinki Declaration of 1964, or the ethical guidelines for human research in 1979, known as the Belmont Report (The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). These

principles involve the prohibition of experimenting on humans in any scientific research that could cause harm. In light of this constraint, AE serves as an alternative. Consequently, both the Nuremberg Code and the Declaration of Helsinki underscore that human experimentation should be based on the results obtained from AE (Greek, Pippus, & Hansen, 2012b).

The foundational principles guiding the ethical utilization of animals in science are commonly referred to as the 3Rs (replacement, reduction, and refinement). Initially introduced in "The Principles of Humane Experimental Technique" authored by Russell and Burch (1959), these principles, accompanied by the guideline of animal welfare, have manifested within society via the implementation of legislative measures regulating scientific work involving animals (Kirk, 2018). Moreover, in recent years, various authors have advocated for expanding the ethical requirements of animal research to standards applied to human studies, based on the recognition that animals possess fundamental moral rights similar to those of humans (DeGrazia & Beauchamp, 2019; Ferdowsian et al., 2020; Martin, 2022).

Different studies (Agell et al., 2015; Cassaday et al., 2023) indicate that providing participants with information about AE significantly influences their attitudes towards the use of animals in medical research. Similarly, societal changes seem to have impacted the acceptance of AE. This is evident in the decreased level of support when comparing studies from different decades, as indicated by Navarro et al. (2001) with a support rate of 65.7%, contrasted with the more recent findings of Sandgren et al. (2020) where the rate dropped to 43.4%.

Considering the characteristics mentioned in this section, the AE has sufficient interest and educational potential to be regarded as a SSI for discussion and debate in teacher training (Herreid, 1996).

2.4 Key Construct Four—Role-Playing

Introducing students to SSIs can be achieved through the utilization of role-play and debates (Howes & Crus, 2009). The educational strategy of role-playing entails a simulation wherein diverse characters assume opposing roles from different perspectives, with some in favor and others against, centered on a specific SSI (Cruz-Lorite et al., 2023). On one hand, the role-playing game combines the advantages of gamification, while on the other, it fosters a deeper understanding of societal issues that affect us. It sheds light on their multifaceted aspects and the social groups involved (Smith, 2015).

España-Ramos (2023) outlines the advantages of incorporating role-playing into educational settings. These include the facilitation of SSI identification, the search and selection of information, and the formulation of solutions and actions. The method also introduces oral communication into the classroom, fostering dialogue among participants. Moreover, it brings forth attitudes, values, and emotions, while simultaneously facilitating the acquisition of scientific and technical knowledge relevant to the addressed SSI. This integration gives meaning to the knowledge by making it essential for addressing real-life SSIs. Additionally, role-playing promotes collaborative teamwork by necessitating interaction and cooperation, both during preparation and enactment.

Among all these benefits, several studies agree that argumentation and decision-making stand out as two notable skills in the use of role-playing in science education (Agell et al., 2015; Cakici & Bayir, 2012; España-Ramos, 2023; Ferreira & Faustino, 2013; López-Fernández et al., 2021; Maharaj-Sharma, 2008; Rashid & Qaisar, 2017; Simonneaux, 2008). Role-playing games precisely focus on promoting spaces for debate, fostering

critical analysis and discussion, rigorously evaluating claims (Zohar & Nemet,2002), and employing justifications and refutations (Erduran & Jiménez-Aleixandre, 2007). Through this approach, role-playing facilitates the connection of evidence, justifications, and conclusions (Toulmin, 2003); juxtaposing one's own arguments with different perspectives, which can contribute to clarifying personal ideas; and persuading others with well-constructed arguments. Finally, role-playing allows for making responsible and well-founded decisions regarding the posed SSIs (Bhattacharjee & Ghosh, 2013). Concurrently, it facilitates the expression of different viewpoints on an SSI and the underlying criteria, providing the opportunity to experience changes in opinion (Simonneaux, 2001).

A literature review revealed the limited number of studies addressing AE through role-playing. Among them, the study by Agell et al. (2015) developed a role-playing involving students aged 15 to 20. In this scenario, students obtained information by visiting animal research laboratories, allowing them to engage in dialogues with researchers. Additionally, they interacted with various types of cards (such as story, information, issue, and challenge cards) as part of the character preparation process. The role-playing followed this structure: character preparation, a presentation round, debate and character's liberation, and voting. Table 1 presents the positions and justifications of students, as documented by Agell et al. (2015), both before and after the role-play. Notably, certain arguments expressing sentiments towards animals were identified in the undecided and against positions.

Before the role-playing, 43.5% of the participants supported the use of animals in biomedical research, while 5% were opposed, and 47% expressed a conditional stance depending on the circumstances. The remaining 4.5% did not provide an opinion. Agell et al. (2015) observed that 28% of the participants changed their opinions after engaging in the role-playing. Specifically, the affirmative position increased to 57.5% because some participants who initially believed it depended on the circumstances changed their opinion in favor. The conditional position decreased to 38%, while the objection position remained almost the same as before (4%). According to Agell et al. (2015), students actively participated in debates and effectively incorporated the new information provided by the game, particularly in terms of legal aspects. Furthermore, the role-playing assisted participants in forming more informed arguments, fostering critical thinking, and honing argumentation skills.

Simonneaux (2001) studied the impact of role-playing compared to a conventional debate on students' argumentation regarding a SSI related to animal transgenesis. Specifically, participants were required to make an informed decision about whether to install a

Table 1 Students' positions and justifications on the use of animals in biomedical research before and after role-play (Agell et al., 2015)

Positions	Justifications
In favor	Permit humans to progress
In favor	Before trying on humans, better on animals
In favor	There is no matter in animal suffering, it represents a benefit for humans
Depends	It depends on the animal and the experiment
Depends	Animals do not deserve this treatment but allow progress
Depends	There must be limits; animals must be kept in adequate conditions
Against	Animals do not deserve to suffer
Do not know	I am not well enough informed

giant transgenic salmon fish farm in a coastal town. This study revealed that, although there were no significant differences in the arguments presented between a traditional debate and the role-playing, only the latter was capable of inducing changes in opinion.

According to Simonneaux (2001), two obstacles that can influence the construction of arguments are the understanding of the scientific knowledge involved in the SSI and the associated emotions. This does not imply that emotions should be eliminated; instead, it suggests that students should be guided in identifying their emotional stance, as well as recognizing the arguments presented by scientists, their peers, and themselves. This process includes evaluating the validity of these arguments and understanding the stages leading to a decision.

Previous research on the subject underscores the necessity to delve deeper into this SSI, specifically focusing on the positions and arguments expressed by preservice teachers, as this particular group remains relatively unexplored.

3 Objective and Research Questions

The objective of this research is to present the design, implementation, and evaluation of a role-playing game about the SSI of AE, with preservice science teachers to assist them in arguing and making decisions on this subject, thus promoting critical thinking skills.

The novelty of this study lies in utilizing role-playing to enhance argumentation and decision-making, an under-researched possibility in science education for delving into issues related to ethical aspects (Archila, 2017; Braund, 2015; Toonders et al., 2016). Further innovations, in comparison to other role-playing in the literature that address the same SSI, include targeting a different audience—preservice early childhood education teachers (hereinafter, PECT)—instead of non-university students. The study examines the positions and arguments of PECTs, offering an opportunity for independent information search to develop varied perspectives, whether in favor of or against the SSI. This approach facilitates the promotion of critical arguments. In this article, promoting students' argumentation is understood as the opportunity for learners to construct arguments related to a decision (in this case, about ethics in science) made by themselves.

Specifically, the purpose of this study is to provide answers to the following research questions:

- RQ1: What types of positioning and arguments do PECTs employ concerning AE before participating in a role-playing?
- RQ2: What type of arguments do PECTs develop during the role-playing?
- RQ3: What changes occur in the positioning and arguments among PECTs regarding AE after engaging in the role-playing?

4 Method

4.1 Research Approach

The research corresponds to a case study conducted with PECTs who participated in a role-playing activity addressing the relevance of AE. The ideas and knowledge of these PECTs regarding this SSI were evaluated before, during, and after the intervention, along with the arguments they presented. This assessment employs a mixed-method approach,

incorporating both qualitative and quantitative data collection and analysis techniques. Another distinctive aspect of this study is its implementation within the authentic setting of the training classroom.

4.2 Participants

The role-playing game was implemented within a cohort of third-year PECTs enrolled in the Natural Sciences Didactics course as part of the Early Childhood Education Degree at the University of Málaga (Málaga, Spain) during the academic year 2021–2022. This group comprised 60 students, aged between 20 and 22, including 58 females and 2 males, all without an advanced scientific background. These participants attended both large-group theoretical sessions and small-group practical activities, each involving 30 students.

4.3 Scenario

The activity was carried out twice within small groups. These PECTs had received prior training in argumentation before the role-playing, which included the Toulmin model of argumentation (2003); the identification of its essential components (evidence, warrants, and claims); and the development of arguments and counterarguments. The training introduces a range of tasks, each increasing in complexity, to develop argumentation skills. These tasks include arguing about who walked in the snow based on animal tracks (Cebrián-Robles et al., 2021), whether a red-haired, freckled boy can get sunburned, or if the visiting team will win the football match with a 3–1 scoreline in the 73rd min, among others. The PECTs did not receive training on role-playing.

The design and implementation of the role-playing were overseen by two instructors (the first two authors of this paper), both of whom are experienced educators and researchers in science education.

The role-playing scenario takes place within a simulated parliamentary debate, premised on multiple animal welfare organizations joining forces to promote a citizens' legislative initiative in Spain. This initiative seeks to introduce amendments to Law 6/2013 (Spanish Government, 2013), which encompasses various aspects, including regulations for the use of animals in scientific experimentation and other purposes. The goal of these organizations is to secure a ban on AE for scientific purposes.

The PECTs are informed that the initiative's promoters have successfully gathered the requisite half-million signatures of support for its presentation. Furthermore, the Congress Committee has accepted the initiative for consideration, paving the way for deliberation and voting within the Spanish Congress of Deputies. In preparation for the debate, both the Congress and the proponents have requested the participation of professionals working with animals and citizens with a legitimate interest in the initiative. The PECTs assume these roles, divided into two groups: those advocating for AE, thus opposing the modification of the Law; and those against it, supporting the initiative. A series of roles representing different sectors of society (Table 2) were selected in the activity design, taking into account the multifaceted nature of the SSI. All aspects described in the theoretical framework, namely the scientific, social, economic, and ethical dimensions, are represented by these roles. The researchers crafted the role descriptions, taking these considerations into careful account. Additionally, two PECTs, chosen freely by participants, undertake the role of Congress President, representing the legal dimension. Their responsibilities encompass

Table 2 Role description

Roles in favor of AE in science		Roles against AE in science	
Environmental researcher	S/he works at a university conducting experiments with fish to use them as pollution indicators and to study the effects of these substances on organisms.	S/he fights against animal cruelty and believes that scientific progress cannot be built upon AE.	NGO activist
Researcher in human health	S/he investigates the detection and treatment of pathologies such as chronic pain and degenerative diseases.	Her/his commitment is the well-being and protection of animals. Among his/her proposals is the end of AE.	Animal rights politician
Pharmaceutical shareholder	Her/his company is dedicated to the development of medicines, new treatments, and vaccines.	S/he is in disagreement with the conditions of care and housing for the animals.	Biologist at an animal shelter
Veterinary student	As part of their training, s/he carries out surgical practices and AE for educational purposes.	S/he designs educational activities to promote awareness and sensitivity towards the respect and protection of the environment.	Environmental educator
Mother of a child with cancer (leukemia)	She is placing all her hope in scientific advancements that may lead to curing the disease.	She engages in dog-assisted therapy to provide stimulation and aid in their rehabilitation.	Mother of a child with neurocognitive disorders
Ethics committee member for AE	S/he collectively issues mandatory ethical reports requested by institutions and researchers for projects or research involving AE.	S/he uses alternative methods in scientific studies, such as *in silico trials* (computational models) or *in vitro* experiments (involving single-celled organisms or tissues, cell cultures, etc.).	Scientist advocate for alternative methods
Laboratory specialist technician	S/he works at the AE center of a university, where animals are bred to support research and teaching staff in conducting animal experiments for educational and scientific purposes.	Her/his mission is to ensure the conservation of nature and the environment, animal health, and the preservation of flora and fauna.	SEPRONA (Nature Protection Service) Civil Guard

introducing and moderating the debate, as well as overseeing the voting process to ratify or reject the modification of the Law.

4.4 Role-Playing Development

The activity was conducted over a 3-week period, following the design proposed by Juárez et al. (2019) (Fig. 1). In session 1, the news article "Barcelona University Announces Controversial Beagle Dog Experiment to Take Place in Madrid," sourced from a digital newspaper (Moncloa Allison, 2022), was employed to underscore the current and societal relevance of the AE SSI. This article highlighted the social concern stemming from the alleged sacrifice of 32 Beagle puppies as part of scientific research related to the development of novel pharmaceuticals. During this session, the activity was introduced to the PECTs, the different roles were described (as shown in Table 2), and the PECTs voluntarily selected both a speaker and an advisor for each role.

Over the next week, the PECTs prepared for the debate by filling out their respective character profiles. These profiles included a brief description of their roles, and they had to compile different arguments to defend their positions based on scientific articles, newspapers, scientifically rigorous websites, videos, or images, always indicating the sources used in all cases. The PECTs acting as congress moderators were responsible for gathering arguments both in favor and against, ensuring a comprehensive and balanced debate.

Session 2 consisted of the staging of the role-playing. The activity began with the Congress President introducing the SSI under debate. Next, each role had 1 min to present arguments either in favor of or against AE. During these expositions, the PECTs acting as advisors recorded the strengths and weaknesses of the arguments provided by the other roles. After the initial expositions, a 5-min break provided an opportunity for speakers and advisors to exchange ideas and strategize for the debate. Subsequently, a 30-min debate took place, where different roles had the chance to defend their positions. Finally, the PECTs voted on whether to accept or reject the modification to the Law.

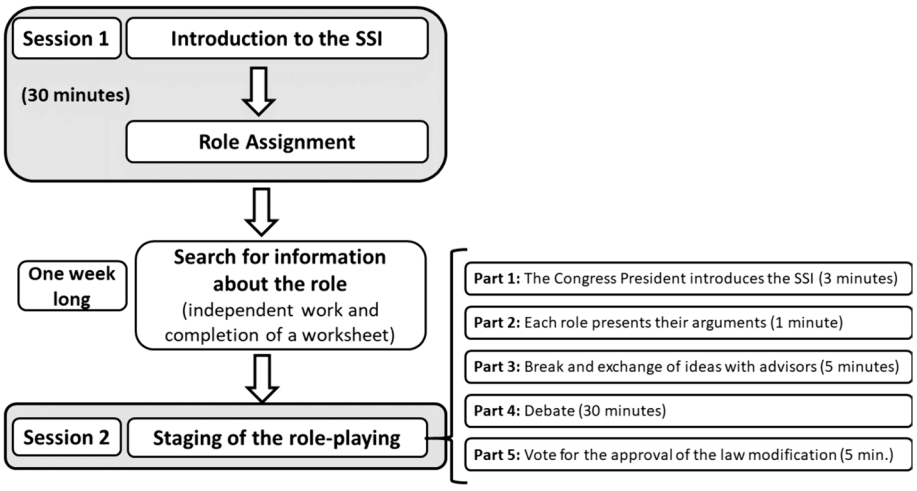

Fig. 1 Role-playing development

4.5 Techniques and Instruments for Data Collection

The employed instruments were as follows:

- A questionnaire (Table 3) consisting of three questions was designed to understand the standpoint of the PECTs regarding AE. This questionnaire was validated through expert judgment by three judges, who selected these questions as the most relevant from a larger list of AE for the study. The first question, closed-ended in nature, aimed to determine their position in favor of, against, or undecided on AE. It was supplemented with an open-ended question requesting justification for the response. The subsequent questions were also open-ended and intended to identify different aspects of the SSI (cognitive, ethical, emotional). The PECTs completed the questionnaire twice, once during the initial session and again after the debate. This instrument experienced a non-response rate of 10 PECTs for question 1 due to some participants not answering it in certain sessions. Furthermore, responses from 5 PECTs to questions 2 and 3 were excluded due to the absence of justifications.

- Audio recording and transcription of the debates were carried out in accordance with data protection laws through explicit consent requested from the PECTs

4.6 Data Analysis

Before describing the data analysis procedure of the questionnaire, it is essential to differentiate between "position" and "argument" held by the participants regarding AE. Specifically, "position" refers to the decision-making process provided in relation to the SSI, considering their responses in favor, against, or as undecided in question 1. On the other hand, "argument" corresponds to the supporting reasons for the possible viewpoints. In terms of the arguments, we incorporate all the information gathered from the justification of question 1 or the set of statements made in questions 2 and 3.

A qualitative analysis was carried out to assess the arguments presented by the PECTs as they adopted positions on AE in the different questions, both before and after the role-playing. This analysis involved an emerging categories system based on the types of arguments expressed. This system of categories drew inspiration from the notions of emotional intuition and rationalistic informal reasoning proposed by Haidt (2001) and Sadler and Zeidler (2005), as discussed within the theoretical framework. In our case, morality is interpreted in terms of moral emotions (Helm, 2001; Taylor, 1992). Thus, the category system used was the following:

Table 3 Questionnaire

Question
(1) Is AE necessary? Justify your answer.
(2) In your opinion, what ethical principles should guide AE? Justify your answer.
(3) Do you think that scientists have limitations on what they can research and how to do it? Justify your answer.

- Rational arguments are based on reason, logic, or scientific evidence, rather than moral considerations.
- Emotional intuitive arguments are based on moral emotions such as compassion and empathy towards animals, which highlight fundamental ethical concerns.
- Mixed arguments, which involve a conflict between science and emotion, or cases that provide both rational and emotional intuitive arguments simultaneously.

The transcripts of the interventions were subjected to content analysis in order to analyze the arguments provided during the role-playing. For this purpose, intervention fragments that formed coherent, standalone arguments were designated as the units of analysis. In this analysis, a category system similar to the one mentioned earlier was employed, focusing solely on rational and emotional intuitive arguments. The categorization process was collaboratively conducted by the first two researchers, achieving consensus in nearly all instances. A third evaluator was consulted in cases where consensus proved elusive.

A descriptive analysis was performed, examining frequencies during both the initial exposition and the debate. Subsequently, percentages of PECTs in favor, against, or undecided were calculated before and after the role-playing. To illustrate changes in positions, a Sankey diagram was employed. Moreover, these diagrams were used to depict the arguments provided for different questions before and after the intervention.

Inferential analyses were conducted to assess the changes in positioning regarding AE and the types of arguments employed by the PECTs. The marginal homogeneity test for two related samples was applied to determine whether statistically significant differences existed in positions towards AE and to analyze the evolution of arguments provided for the posed questions. To evaluate the relationship between the PECTs' position regarding the SSI and the arguments used at the beginning of the experience, the non-parametric chi-squared test was employed, with a significance level of $\alpha = 0.05$. These statistical tests were chosen because they are well-suited for examining changes in nominal variables.

5 Results and Discussion

5.1 Position and Arguments Employed by the PECTs Before Participating in a Role-Playing (RQ1)

Three positions are observed at the initial moment. The majority option (80% of PECTs) opposes AE, with only 14% in favor and 6% remaining undecided. The initial rejection of AE displayed by the PECTs contrasts starkly with the findings of Agell et al. (2015) among Spanish students across different educational stages. In their study, 43.5% expressed strong support, and 47% showed conditional support for AE, while a mere 5% expressed rejection. These outcomes emerged following a visit to a biomedical research center, where students received information about preclinical research involving animals, the legislation regulating AE, and the guiding principles supporting its role in scientific research. These findings are consistent with the study by Cassaday et al. (2023), which indicates that providing information to students enhances the degree of acceptance towards AE.

Moreover, a shift in societal attitude towards reduced acceptance of AE in the absence of information appears to be observed, as demonstrated by a comparison with studies from two decades ago, such as Navarro et al. (2001), where 65.7% of respondents strongly agreed or agreed with AE.

A cross-tabulation between the initial positions and the arguments used to support them (Table 4) reveals the following insights, exemplified with arguments from the PECTs:

- PECTs in favor of AE exclusively employ rational arguments. An illustrative example is the following argument that justifies AE in scientific fields to produce advancements in society: *From my point of view, I consider AE necessary, especially in fields like medicine, where testing drugs on animals is vital to ensure their safety during application* (PECT10).
- Undecided PECTs use mixed arguments, indicating how AE produces benefits for science while also causing suffering to animals: *AE is essential for scientific progress, but I am cautious about subjecting sentient beings to experimentation. They should not suffer, confined in a cage, and subjected to treatments that cause injuries and detrimental impacts on their well-being* (PECT11).
- Among the PECTs opposing AE, a broader range of arguments is found: rational (32%) related to advancements in science (*Numerous advancements have been made in seeking alternatives that do not harm animals*, PECT39), emotional intuitive (38%) related, for instance, to the inability of animals to make decisions about their participation in experiments (*AE should involve willing individuals who choose to participate, whereas animals do not have the capacity to consent to experiments. Why is it considered acceptable for animals but not for humans? If these products are intended for human use, it would be more equitable to test them on humans*, PECT41), and mixed arguments (10%) that advocate for alternative experiments (*I believe AE is unnecessary because, just as we wouldn't want to be experimented upon, animals also dislike it. Hence, an alternative approach could be explored for conducting these experiments*, PECT23).

This relationship between the nature of the arguments employed and the adopted position was also identified by Agell et al. (2015), who found that arguments expressing sentiments solely towards animals were prevalent among those in the undecided and against positions.

These findings highlight that AE constitutes a complex SSI open to diverse perspectives. PECTs engage not only in logical reasoning but also in emotional considerations while seeking answers, as emphasized by Ozden (2020). Our PECTs, when adopting a position against AE, do not prioritize logical reasoning or scientific knowledge. Instead, the rejection of AE is notably driven by strong emotional components, as evidenced by 38% of opposing PECTs employing intuitive emotional arguments. Conversely, supporting

Table 4 Cross-tabulation in percentage between position and type of argument of the PECTs regarding the necessity of AE (question 1)

		Type of argument			Total
		Rational	Mixed	Emotional intuitive	
Position regarding AE	In favor	14%	0%	0%	14%
	Against	32%	10%	38%	80%
	Undecided	0%	6%	0	6%
Total		46%	16%	38%	100%

AE implies a decision-making process where logical reasoning prevails over emotional considerations. These outcomes are consistent with the ideas of Haidt (2001), asserting the pivotal role of emotions in shaping moral judgments. From this standpoint, emotions and moral intuitions serve as the groundwork for ethical judgments, with reason being activated to provide justifications.

The chi-square test ($\chi^2 = 25.537$; $p < 0.001$) revealed a statistically significant relationship between the PECTs' position on the SSI and the arguments used. This suggests that the justifications employed were not random, underscoring the influence of emotional intuition on the PECTs' positions. Other studies on SSIs, such as the one addressing genetic engineering (Sadler, 2004a), have concluded that individuals are sensitive to the moral aspects of the issue. However, this sensitivity does not appear to fundamentally alter decision-making, unlike the scenario in the AE SSI. In this context, PECTs may develop a deeper emotional connection influenced by empathy towards animals, the appreciation of animal life, or personal experiences such as having pets or being involved in animal care (Broom, 2005).

Concerning questions 2 and 3, which encompass various aspects of the SSI, including ethical principles and scientific limitations—topics on which PECTs have not received prior training—a prevalence of rational arguments is evident. It was noted that among the arguments provided by the PECTs in response to question 2, considerations for animal welfare and, intuitively, the principles of the 3Rs, including reducing the number of animals used and replacing them with alternative methods whenever possible to minimize suffering, were evident. Conversely, the rational arguments presented in question 3 refer to economic, technical, or regulatory constraints. Nonetheless, emotional intuitive arguments are also relevant, particularly concerning the obstacles confronting scientists (Table 5). In this case, responses were found expressing the idea that science has no limits, yet without providing supporting arguments. Alternatively, some responses suggested that research involving animals is primarily motivated by economic interests. Furthermore, other PECTs, while acknowledging the existence of ethical or legal boundaries, asserted that there is insufficient oversight and enforcement of these limits.

5.2 Arguments Used by PECTs During the Role-Playing (RQ2)

Table 6 quantifies the rational and emotional intuitive arguments employed by each role during the staging of role-playing. This encompasses the initial exposition of arguments as well as the subsequent debate and counterargument against points from other roles, within the two cohorts of PECTs. The data from Table 7 was used to examine the

Table 5 Type of argument employed by the PECTs for questions 2 and 3

Question	Type of argument	PECTs frequency	PECTs percentage
2	Rational	25	55.6
	Mixed	6	13.3
	Emotional intuitive	14	31.1
3	Rational	25	55.6
	Mixed	0	0.0
	Emotional intuitive	20	44.4

Table 6 Frequency of employed rational and emotional intuitive arguments in the role-playing

Role			Initial exposition		Debate	
			Rational	Emotional intuitive	Rational	Emotional intuitive
Group 1	In favor	Pharmaceutical shareholder	2	1	2	1
		Mother of a child with cancer (leukemia)	3	0	3	1
		Environmental researcher	2	0	3	0
		Ethics committee member for AE	1	1	5	2
		Laboratory specialist technician	3	1	2	0
		Veterinary student	3	1	2	1
		Researcher in human health	3	1	3	0
	Against	Animal rights politician	2	0	1	1
		Scientist advocate for alternative methods	2	0	5	1
		Biologist at an animal shelter	0	1	2	2
		NGO activist	2	1	4	1
		Mother of a child with neurocognitive disorders	0	1	3	0
		Environmental educator	3	0	1	0
		SEPRONA Civil Guard	3	0	0	0
	Total (Group 1)		29	8	36	10
Group 2	In favor	Pharmaceutical shareholder	0	1	0	0
		Mother of a child with cancer (leukemia)	3	1	6	5
		Environmental researcher	3	0	4	0
		Ethics committee member for AE	2	1	2	0
		Laboratory specialist technician	2	0	0	0
		Veterinary student	2	1	4	3
		Researcher in human health	2	0	0	0
	Against	Animal rights politician	0	3	3	10
		Scientist advocate for alternative methods	5	0	4	1
		Biologist at an animal shelter	1	1	2	2
		NGO activist	4	0	0	0
		Mother of a child with neurocognitive disorders	5	2	1	3
		Environmental educator	5	2	2	1
		SEPRONA Civil Guard	3	1	1	2
	Total (Group 2)		37	13	29	27
Total			66	21	65	37

prevalence of arguments throughout the experience. This analysis aimed to determine the dominant types of arguments in the exposition and the debate, as well as to identify the segment where different roles utilized a greater number of rational or emotional intuitive arguments.

Table 7 Dominant argument type in the initial exposition and debate, as well as the segment with the highest frequency of arguments

Role			Dominant argument type in each segment		Segment with the highest frequency of arguments	
			Initial exposition	Debate	Rational	Emotional intuitive
Group 1	In favor	Pharmaceutical shareholder	Rational	Rational		
		Mother of a child with cancer (leukemia)	Rational	Rational		Debate
		Environmental researcher	Rational	Rational	Debate	
		Ethics committee member for AE		Rational	Debate	Debate
		Laboratory specialist technician	Rational	Rational	Exposition	Exposition
		Veterinary student	Rational	Rational	Exposition	
		Research in human health	Rational	Rational		Exposition
	Against	Animal rights politician	Rational		Exposition	Debate
		Scientific advocate for alternative methods	Rational	Rational	Debate	Debate
		Biologist at an animal shelter	Emotional intuitive		Debate	Debate
		NGO activist	Rational	Rational	Debate	
		Mother of a child with neurocognitive disorders	Emotional intuitive	Rational	Debate	Exposition
		Environmental educator	Rational	Rational	Exposition	
		SEPRONA Civil Guard	Rational		Exposition	

Table 7 (continued)

Role			Dominant argument type in each segment		Segment with the highest frequency of arguments	
			Initial exposition	Debate	Rational	Emotional intuitive
Group 2	In favor	Pharmaceutical shareholder	Emotional intuitive			Exposition
		Mother of a child with cancer (leukemia)	Rational	Rational	Debate	Debate
		Environmental researcher	Rational	Rational	Debate	
		Ethics committee member for AE	Rational	Rational		Exposition
		Laboratory specialist technician	Rational		Exposition	
		Veterinary student	Rational	Rational	Debate	Debate
		Research in human health	Rational		Exposition	
	Against	Animal rights politician	Emotional intuitive	Emotional intuitive	Debate	Debate
		Scientific advocate for alternative methods	Rational	Rational	Exposition	Debate
		Biologist at an animal shelter			Debate	Debate
		NGO activist	Rational		Exposition	
		Mother of a child with neurocognitive disorders	Rational	Emotional intuitive	Exposition	Debate
		Environmental educator	Rational	Rational	Exposición	Exposition
		SEPRONA Civil Guard	Rational	Emotional intuitive	Exposition	Debate

Empty cells correspond to situations where an equal number of rational and emotional intuitive arguments exist or instances where no differences in argument types have been detected across debate segments

The findings indicate a prevalence of rational arguments (Akhtar, 2015; French, 2012; Greek, Menache, & Rice, 2012a; Lang et al., 2018; Mogil et al., 2010) over intuitive emotional arguments (DeGrazia & Beauchamp, 2019; Kirk, 2018) (Table 6), occurring three times more frequently during the exposition and twice as often in the debate. Additionally, all the roles from both groups used rational arguments in some parts of the role-playing interventions, as evidenced by the data in Table 6.

An analysis by cohorts reveals that in Group 1, both the quantity of rational and emotional intuitive arguments increased during the debate compared to the exposition, although the proportion between the two remained constant. Conversely, in Group 2, the number of rational arguments decreased, while emotional intuitive arguments saw an uptick, resulting in rational arguments being nearly three times as frequent as emotional ones in the exposition. However, a state of equilibrium was achieved in the debate. This increase in the frequency of emotional intuitive arguments in Group 2 can mainly be attributed to the contributions of two roles during the debate: the animal rights party politician (opposing AE) and the mother of a child with leukemia (in favor of AE).

It is notable that during the exposition, only four roles—three of which are against AE—predominantly rely on emotional intuitive arguments based on the equality of rights between humans and animals (DeGrazia & Beauchamp, 2019; Ferdowsian et al., 2020; Martin, 2022) and abstain from employing rational reasoning. Three of these roles shifted the emphasis of their arguments in the debate towards rational reasoning. Consequently, it was only the PECT representing the role of an animalist party politician in Group 2 that predominantly employed emotional intuitive arguments throughout the entire role-playing. In contrast, just two roles made a transition from predominantly rational arguments during exposition to a prevalence of emotional intuitive arguments in the debate. Both of these roles advocated positions opposing AE within Group 2.

The analysis concerning the segment of the role-playing (Table 7) in which PECTs utilized a greater number of rational arguments did not yield conclusive data, as it is role-dependent. Specifically, 12 roles employed more arguments of this nature during the exposition, while 11 did so during the debate. However, an increase in emotional intuitive arguments was detected during the debate. As a result, 12 roles incorporated these to a larger extent in the debate, in contrast to the six roles that employed them during the exposition.

These findings reveal that the PECTs exhibited a tendency to utilize rational arguments in their initial interventions, which were more formal and well-prepared due to the preceding week of groundwork. These findings are consistent with the studies by Agell et al. (2015) and Cassaday et al. (2023), highlighting the significance of possessing information about the SSI. However, during the debate, where they needed to counter arguments presented by roles advocating opposing viewpoints, emotional intuitive arguments gained greater prominence without entirely replacing rational arguments.

This suggests that, during the debate, once the majority of rational arguments have been presented, the PECTs consider emotional intuitive arguments as valuable tools for influencing their peers' opinions. These findings are in line with Sadler and Zeidler (2005), asserting that decision-making on SSI in the classroom enables students to recognize and incorporate the moral and societal dimensions associated with science and its real-world applications. This demonstrates that even after an inquiry process, the PECTs engage with these SSIs from a broader perspective, extending beyond a purely rationalistic approach.

5.3 Changes in Position and Arguments Regarding Animal Experimentation by PECTs After the Role-Playing (RQ3)

The Sankey diagram (Fig. 2) allows for comparing the initial and final positions expressed by PECTs concerning the requirement for AE (question 1, Table 3).

After the role-playing, PECTs adopted more defined positions, without recording undecided responses. The percentages of PECTs in favor (54%) and against (46%) AE were very similar, indicating a balanced distribution between both positions. The role-playing had an impact on the initial positions of 52% of the participants (Fig. 2), with the majority of changes leaning towards positions supportive of AE. Specifically, 40% of the PECTs shifted from their initial opposing positions to make pro-experimentation decisions, whereas only 6% did so in the opposite direction. These changes align with Simonneaux (2001), who suggests that role-playing is an effective strategy for inducing decision-making changes. The following arguments provide illustrative examples of the observed changes in position after the role-playing:

> Through these methods, we can advance scientifically and educationally, preventing diverse illnesses, eradicating or mitigating their effects, and reducing mortality rates. (PECT41, from 'against' to 'in favor').

> AE is unnecessary, as advancements in novel research techniques can alleviate animal suffering. Furthermore, treatments developed through experimentation on alternative subjects could lead to more personalized therapies closely attuned to the human organism. (PECT08, from 'in favor' to 'against').

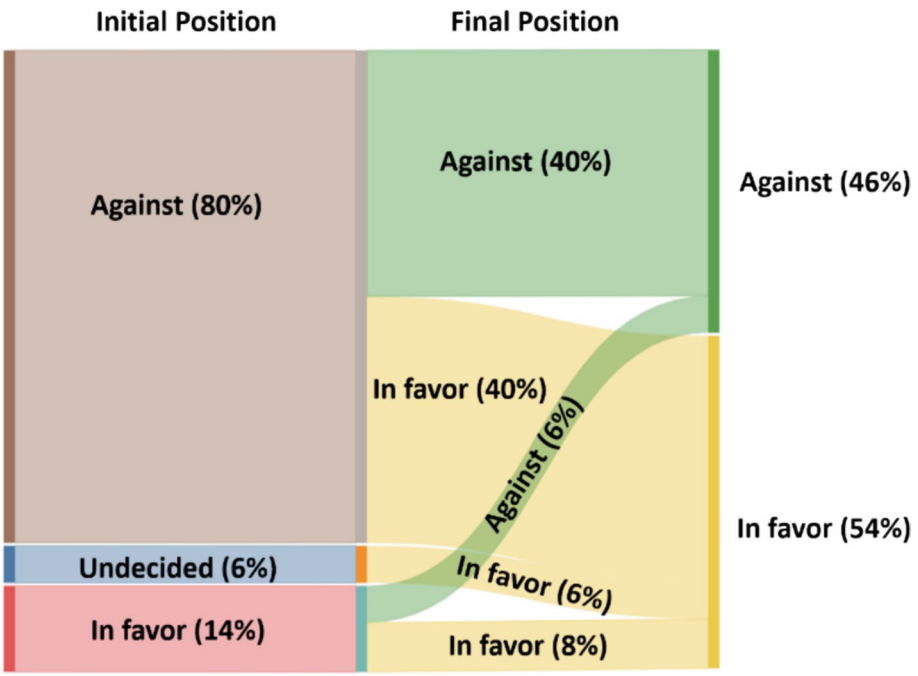

Fig. 2 Sankey diagram illustrating the maintenance or change of position before and after the role-playing

In addition, after the role-playing, all initially undecided PECTs shifted their position to support AE. In their arguments, they highlighted the significance of scientific advancements for society and the existence of ethical principles that oversee experimentation:

> AE is necessary, despite my sympathy for animals enduring treatments that may potentially be life-threatening. This research method has many positive aspects, benefiting both humans, animals, and the broader ecosystem. (PECT11, from 'undecided' to 'in favor').

> No alternative has been found yet for many diseases, leaving AE as the sole option to pursue cures or enhancements. Moreover, guided by the principles of the 3Rs, experimentation should be preceded by an exploration of possible alternatives. If none are viable, efforts are focused on minimizing the number of animals and reducing their distress. (PECT14, from 'undecided' to 'in favor').

Although the nature of the arguments used is already evident in the previous examples, Figure 3 displays a more detailed breakdown of the argument types employed by the PECTs to justify their position. It is noteworthy that, before the role-playing, the PECTs utilized rational (46%), emotional intuitive (38%), or mixed (16%) arguments to justify their initial position. However, after the role-playing, rational arguments predominated (94%), resulting in all participants who originally used a combination of rational and emotional intuitive arguments now exclusively opting for rational arguments to support their position. Similarly, a significant majority of PECTs who initially relied on emotional intuitive arguments shifted to using rational arguments after the experience.

These findings offer a broader perspective on the decision-making. In addition to the observed shift in PECTs' positions towards pro-animal experimentation stances, there is a noticeable correlation between an increase in rational arguments and a decrease in emotional intuitive ones. During both instances of intervention, it is observed that PECTs in favor of AE used rational arguments to justify their positions. They referred to arguments

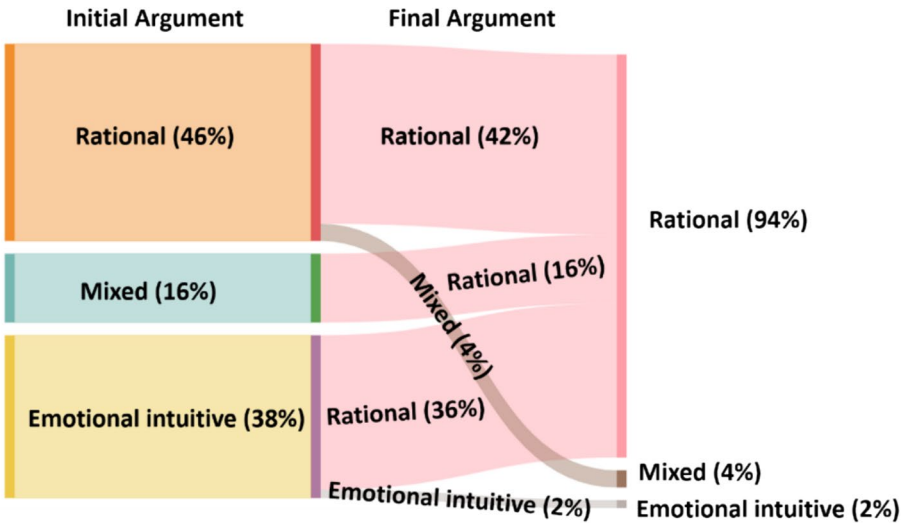

Fig. 3 Sankey diagram illustrating the maintenance or change of arguments employed before and after the role-playing for decision-making

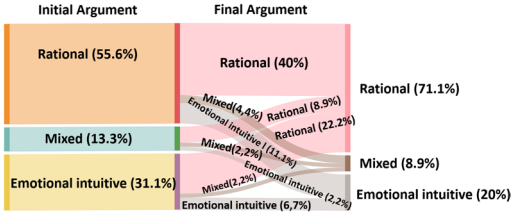

Fig. 4 Sankey diagram illustrating the maintenance or change of arguments employed before and after the role-playing for question 2

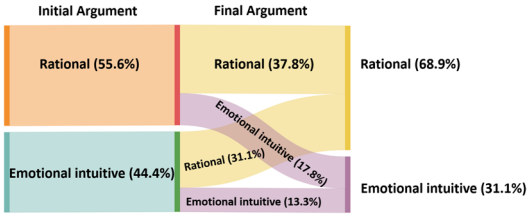

Fig. 5 Sankey diagram illustrating the maintenance or change of arguments employed before and after the role-playing for question 3

based on the importance of scientific progress and its social impact, as well as the limitation of usage to scenarios where feasible alternative methods are lacking, among other considerations.

On the other hand, PECTs who started undecided used mixed arguments, and after the experience, they expressed support for AE with rational arguments. Finally, over 90% of the PECTs who opposed AE after the role-playing were participants who initially expressed dissent, showing an evolution towards rational arguments. Specifically, a transition was observed from emotional intuitive arguments based on the equality of rights between humans and animals (DeGrazia & Beauchamp, 2019;Ferdowsian et al., 2020 ; Martin, 2022), as well as arguments questioning the discrimination of animals by considering them inferior species, to rational arguments grounded in the existence of alternative methods for AE, or the lack of applicability of results obtained in animals to humans, among other reasons.

Regarding question 2 (Table 3) concerning ethical principles in AE, rational arguments were predominant in both instances, exhibiting an increase after the role-playing (Fig. 4). These rational arguments were grounded in considerations of animal welfare or aligned with the principles of the 3Rs (Kirk, 2018). In relation to emotional intuitive arguments, a significant percentage of PECTs either invoked ethical principles advocating for the extension of human rights to animals (Ferdowsian et al., 2020; Martin, 2022), such as the reverence for life or the voluntary nature of participation in the experiment. Alternatively, they asserted that AE lacked proper regulation and ethical guidelines or argued against the utilization of animals altogether.

Regarding question 3 about potential limitations faced by scientists in their research, the initial findings showed a comparable distribution of rational and emotional intuitive arguments, without any instances of mixed arguments (Fig. 5). Among the initial emotional intuitive arguments, the idea emerged that there are no limits in research. Subsequent to the role-playing, a transference was noted between rational and emotional intuitive arguments, accompanied by a rise in the frequency of PECTs recognizing the existence of boundaries and regulations.

However, PECTs presenting initial emotional intuitive arguments also acknowledge the existence of controls. Nevertheless, their contention is that these controls remain unfulfilled

due to the dominance of economic interests and research objectives, as illustrated by the following example:

> Yes, there are limitations. Certain organizations overseeing scientists' work, driven by economic reasons, may have established regulations. Consequently, there might be scientists who act against their principles because they must obey those instructions (PECT08, after the role-playing).

After completing the descriptive analysis of the PECTs' positions regarding AE and their arguments to the various questions, we move on to the inferential statistical study to evaluate the impact of role-playing on the PECTs. Table 8 presents the outcomes of the marginal homogeneity test obtained when comparing the position and arguments given for each question during the two milestones of the activity.

The findings of our intervention reveal a significant impact on the PECTs' position towards the SSI. Over 50% of the PECTs changed their position, moving towards favoring AE. This change in perspective is also evident in the arguments used. A substantial increase was noted in the use of rational reasoning, suggesting that the intervention effectively promoted a greater understanding of the scientific foundations related to this SSI. Nonetheless, a decrease in the use of emotional intuitive arguments was observed. It is important to emphasize, however, that emotional intuitive arguments remain relevant in certain aspects, such as ethical principles and scientific control (Orlans et al., 1998).

Notably, certain PECTs who oppose AE started employing rational arguments to bolster their position. These findings underscore how the role-playing debate strategy applied to SSI serves as a reflective exercise that fosters critical thinking (Franco-Mariscal et al., 2023) and facilitates the realization of a key objective in scientific literacy, such as the formation of a democratic citizenship considering moral decision-making (Sadler & Zeidler, 2005).

In summary, the study's findings reveal two noteworthy shifts as a result of students engaging in the role-playing. Firstly, there is a substantial increase in the number of PECTs supporting AE, demonstrating that role-playing contributes to changes in decisions (Simonneaux, 2001). Additionally, there is a statistically significant rise in the number of scientifically informed rational arguments, contributing positively to the acknowledgment of science's role in decision-making (Von Winterfeldt, 2013).

However, the presented data contradicts our initial intentions, falling short of achieving a more balanced perspective that integrates scientific criteria with criteria based on moral emotions (Kolstø, 2001; Sadler, 2004b). Indeed, the proportion of PECTs combining both types of criteria not only failed to increase but also decreased after participating in the role-playing. These results stand in contrast to studies like Archila's (2017), where it was shown that an approach combining drama and argumentation could enhance students' awareness of the importance of ethics in science, recognized as one of its essential characteristics. In this instance, even though participants increased their use of scientific reasoning, they

Table 8 Marginal homogeneity test to analyze changes between before and after for the different questions

Question	Analysis	*n*	Statistical deviation (MH)	*p*
1	Position	50	3.888	< 0.001
	Arguments	50	4.638	< 0.001
2	Arguments	45	1.455	0.146
3	Arguments	45	−1.279	0.201

did not simultaneously support their arguments with moral factors. This lack of alignment could be attributed to the roles involved in the role-playing not being adequately balanced, with those with a rational profile prevailing over those that could have influenced moral factors, which were in the minority. Additionally, it appears essential not only to promote scientific reasoning in decision-making (Helm, 2001) but also to enhance a more intricate thinking that concurrently integrates both scientific and emotional criteria (Cambra & Lorenzo, 2018). This poses a challenge, as students commonly struggle to consider arguments involving multiple causes (Kuhn et al., 2000), especially when combining criteria of distinct natures. In this context, solving complex problems, as presumed in SSIs, demands intricate solutions (Mitchell, 2009). Within the educational domain and teacher training, it requires the practice of integrating various causal factors to attain a comprehensive understanding of a phenomenon (Pozo et al., 1994). Achieving this may require heightened student engagement in decision-making activities, where they are not only tasked with presenting arguments for or against the addressed issue but actively negotiating potential solutions to conflicts of interest within communities of practice in classrooms (Sadler, 2009).

6 Conclusions

This study presents the findings of a role-playing activity involving a debate aimed at enhancing argumentation and decision-making skills. The focus is on the AE SSI, a controversial topic that elicits contrasting viewpoints and strong opposition from various social groups and organizations. This SSI also introduces ethical and moral dilemmas that need to be taken into consideration in its discourse (Osborne et al., 2003).

The findings of this study reveal that the PECTs initially displayed a predominant rejection of AE (80%), primarily relying on emotional intuitive arguments (Agell et al., 2015). In contrast, those initially in favor employed rational reasoning (RQ1). During the role-playing, the PECTs placed a stronger emphasis on rational arguments in their initial expositions, which were marked by a more formal and prepared approach. Nevertheless, emotional intuitive arguments retained their significance in the debate, where the objective was to influence the opinions of peers (RQ2). Similarly, role-playing contributed to an enhanced understanding of the rational aspects of the SSI. This was demonstrated by a significant shift in position, transitioning from opposition to support for AE, accompanied by a modification in the arguments utilized. Notably, there was an increase in the use of rational arguments and a simultaneous decrease in emotional intuitive arguments (RQ3).

Debating through role-playing is an argumentative activity that offers participants the opportunity to investigate, inform themselves, reflect, and question their own ideas. Half of the PECTs were challenged to defend positions in favor of AE, which compelled them to seek out scientific evidence they had not initially considered. This experience's reflective approach, exposure to different viewpoints, and exploration of previously unexpressed ideas empower PECTs to critically evaluate their perception of science and make informed decisions. This transformation is evidenced through the activity's influence on PECTs' positions and arguments (Howes & Crus, 2009; Simonneaux, 2001).

Furthermore, educational interventions concerning SSIs involve not only scientific aspects but also moral, ethical, and belief-related factors, all of which hold significance (Cavagnetto, 2010; Osborne et al., 2003). This correlation holds true for the SSI implemented in this study. Moreover, it is important for PECTs not to rely solely on emotional

criteria for forming their opinions, but rather to consider scientific aspects as well. In this context, it is desirable for them to develop critical thinking skills and the capacity to integrate diverse criteria into their reasoning process (Kolstø, 2001; Sadler & Zeidler, 2005). This observation aligns with the findings of the present study, where rational arguments gained greater significance in subsequent positions following the role-play. This transition did not entail a disregard for the persistent relevance of emotional intuitive arguments, which continued to play a central role in influencing peers' viewpoints during the debate and in justifying responses to queries concerning the ethical aspects of AE and scientific oversight. However, the implemented intervention did not achieve one of its primary goals: increasing the use of mixed arguments, where students integrate both rational and moral reasoning in their decision-making. This prompts a reconsideration of our intervention to improve these outcomes. We propose two potential solutions to address this challenge. Firstly, a more balanced allocation of roles could be achieved by increasing the representation of those advocating for moral arguments. Secondly, we suggest adding a subsequent phase to the argumentation process, wherein representatives from different perspectives engage in negotiation to reach a common decision within communities of practice (Sadler, 2009). In the words of the aforementioned author:

> …the proposal suggests transforming classroom practices such that students are engaged in negotiation of real-world science. This real-world science does not correspond to professional science as practiced by academics and researchers but, rather, to science as it is experienced and used by engaged citizens willing to take up the challenges of living in a modern world. I am calling for the development of communities of practice in science classrooms that prioritise socio-scientific Discourses and development of identities reflective of engaged citizenship (p.12).

Among the study's limitations were sample attrition, resulting from PECTs' non-participation or incoherent responses to questions, and the challenge of generalizing these findings. Such outcomes could vary when replicating the experiment with a distinct cohort of PECTs or in alternative contexts, as different studies (Agell et al., 2015; Broom, 2005) have shown that attitudes towards AE depend on received training, personal experiences, general beliefs, and philosophical ideas. Additional role-playing experiences involving debates have garnered positive feedback from students and are considered effective strategies for enhancing science education (Agell et al., 2015; López-Fernández et al., 2021). In this regard, it is advantageous for PECTs to draw upon their own encounters with this approach, customizing and implementing it within early childhood education, utilizing either this particular or an alternative SSI pertinent to the stage.

As a potential future line of research, it is worth considering conducting a study that focuses on the emotions experienced by PECTs during the activity. Furthermore, an investigation into the impact of gender or previous exposure to science studies on the provided arguments could be undertaken. Additionally, exploring the insights that would emerge from the role-play within other degree programs, such as Primary Education or the Master's in Secondary and High School Teaching, would be of significant value.

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Declarations

Ethics Approval The study was conducted in accordance with the protocol approved by the Ethics Committee on Experimentation of the University of Malaga (Spain) (CEUMA) with reference 31-2022-H.

Competing Interests The authors declare that they have no conflict of interest.

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