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ORIGINAL ARTICLE

"Green Cities:" A Panel Discussion Activity for Promoting Pre-Service Teachers' Skills Oriented toward Environmental Education

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ABSTRACT

The purpose of this study was to analyze the potentialities of a learning module, created within an Erasmus+ project, which involved pre-service elementary teachers in a socio-scientific scenario related to green cities. The participants were involved in a panel discussion activity, with the main objective of discussing and reflecting on how to transform a particular city into a green city, taking into account the perspectives of the different stakeholders. A total of 60 pre-service teachers and one teacher educator were involved. In this case study, data were collected through a pre- and post-questionnaire, on the importance of a set of transversal skills at a professional and personal level, two focus-group interviews, and a panel discussion analysis. The results revealed that this activity has the potential to promote pre-service teachers' competence to assume a holistic view of an environmental issue, contributing to the development of their capacity to make "justified decision-making." It also allowed pre-service teachers to experience and reflect on new visions of science education from a learner's perspective. These outcomings are extremely important for helping pre-service teachers to create innovative learning contexts capable of promoting more critical, responsible, and pro-environmental active citizens.

KEYWORDS: Green cities; pre-service teachers' education; socio-scientific issues

INTRODUCTION

In the current context of the global climate crisis, any citizen is asked to judge the scientific information about global environmental and social issues, such as energy transition and blue economy, making crucial decisions for collective life. The acquisition of some understanding of science and scientific enterprise is imperative for democratic societies, which partly rest their decision-making on rational and scientific criteria, to guarantee the development of a socially just, egalitarian, healthy, and environmentally sustainable society (EU, 2015; OECD, 2019).

In this sense, the goal of education in general, and science education in particular, should be to improve the scientific literacy of citizens, providing them with the knowledge and skills necessary to get involved in the problems that affect society, intervening critically and responsibly in favor of a more sustainable and socially just society. Therefore, updating educational programs to promote and recognize new forms of community engagement is imperative. We need new tools and educational strategies, directed to all school levels, which could foster citizens' autonomy and responsibility for change, encouraging curiosity, criticism, self-learning, and self-expression, through lifelong learning (EU, 2015).

According to many international reports (e.g., UNESCO, 2016; OECD, 2019), we need an education focused on new educational approaches aimed at greater justice, social equity, and global solidarity, contributing to build together the social, economic, and environmental dimensions of sustainable development. This humanist approach for education (Siswadi, 2024) implies new pedagogical strategies, capable of educating students for the 21st century, creating situations in which they can develop critical thinking and problem solving skills, effective communication, collaboration, creativity, and innovation (OECD, 2019). However, several studies focused on curriculum innovation highlight the difficulty to change teachers' practices (Fullan, 2008; Osborne and Dillon, 2008). Actually, besides the importance for science teachers to have access to innovative curricular resources, it is also crucial for them, to have the confidence and competence to develop and implement, for themselves, more innovative approaches, capable of promoting students to become responsible and competent citizens (Holbrook et al., 2022). One effective approach for achieving this change will be to act in teacher education, in particular at the level of pre-service teacher education programs. These programs should implement new types of strategies and learning environments, allowing future teachers to develop skills to intervene responsibly and critically in solving society's problems, namely, through teaching

practices oriented toward environmental citizenship (Garrido Espeja and Couso, 2020).

The use of socio-scientific issues has been one of the strategies adopted and investigated in teacher education programs, but mainly among secondary teachers. This is particularly problematic because the few studies that have investigated socio-scientific reasoning and decision-making with elementary pre-service teachers highlight that more opportunities are needed to enhance their ability to provide quality evidence and reasoning to support claims (Ha et al., 2022; Ozturk and Yilmaz-Tuzun, 2017). Therefore, we may assume that without improving teachers' familiarity with socio-scientific issues, they will continue to be reluctant to address them in their teaching practice.

In this study, we analyze the potentialities of a learning module, which involves pre-service elementary teachers in a socio-scientific scenario related to green cities.

LITERATURE REVIEW

Nowadays, the vision of scientific literacy must be understood within the framework of humanized science education (Sjöström, 2024). Indeed, we need citizens prepared to act on STSE (science, technology, society, and environment) issues, and capable of having a critical and transformative impact on societies (Sanchez et al., 2022). For science education to contribute to these major goals, it must be practical, relevant, and responsive to recent trends, developments, and realities of context and time (Canlas and Karpudewan, 2020, and one of the most cited ways to attain it, is through a socio-scientific issue (SSI)-based approach (Canlas and Karpudewan, 2020).

Socio-scientific issues are controversial issues with conceptual and/or procedural links to science, generally consisting of open-ended problems with multiple possible solutions (Sadler, 2011). SSI also tends to be controversial in nature, not only because of their undetermined status but also because of their relations to society. Due to the social importance of SSI, scientific data are not sufficient for determining strategies for resolution. Indeed, these issues are not only informed by scientific data and theory, but they are also subject to economic, social, political, and/or ethical considerations (Sadler, 2009).

Through SSI, students must deal with social or moral dilemmas that appeal to them to apply critical thinking skills to analyze and synthesize scientific information to defend a particular position. In this approach, students are exposed to real-world scenarios to reinforce social development and simultaneously enhance scientific knowledge (Dolan et al., 2009).

According to the Global Education Monitoring Report (UNESCO, 2016), the transformation needed for a "greener planet" demands innovative, creative and integrative thinking, which, in turn, requires interactive, discursive, and experiential teaching and learning (Cotton and Winter, 2010; Cotton et al., 2009). Therefore, more than ever, environmental education should occupy a central position in the curriculum, seeking to improve citizens' abilities to use scientific knowledge to make informed decisions about personal and social issues (EU, 2015; Lederman, 2006). For this, students should improve their understanding of risk and probability and should learn to appreciate the values implicit in a range of scientific and environmental issues (Dillon, 2012; Grace and Ratcliffe, 2002) while using scientific evidence and data to support their reasoning.

The use of socio-scientific issues to address environmental problems (for a review see Sanchez et al., 2022) is one approach where students use reasoning to evaluate different arguments and negotiate positions and solutions to problems. In this respect, the didactic use of SSI offers interesting opportunities to discuss different perspectives and conflicting interests and to strengthen students' critical thinking and sense of responsibility for a more sustainable world (Sadler, 2011). Recent research developed about the impacts of the didactic use of an SSI-based approach (e.g., Anisa et al., 2020; Canlas and Karpudewan, 2020; Dishadewi et al., 2020; and Hariapsari et al., 2018) revealed its effectiveness in promoting conceptual understanding and scientific literacy. Indeed, it seems to have a positive impact on the overall learning process, namely, in improving reasoning and argumentative skills, increasing interest and attitude toward science and learning, promoting motivation and self-efficacy, as well as, promoting a sense of civic responsibility (Canlas and Karpudewan, 2020).

As science education seeks much more then to simply make students be able to talk about topics using scientific words, it is essential to create learning situations that not only facilitate the appropriation of correct scientific concepts but also promote their use in logical argumentation, in making sense of the socio-scientific situation. Indeed, as emphasized in the study by Grace and Ratcliff (2002), in the process of evaluating questions related to conservation issues, students have the tendency to base their thinking on their own values and attitudes, and not on scientific knowledge. Based on this, it is important to create learning situations that not only facilitate decision-making based on values and attitudes but also based on scientific data that students know and understand, highlighting the importance of involving them in argument-based activities for supporting the construction of arguments concerning socio-scientific issues (Grooms et al., 2014). Holbrook et al. (2022), proposed a new step to this education model, in which learning must be extended beyond the classroom-based socio-scientific consensus decision-making. Indeed, students must be engaged in creatively developing relevant and meaningful action plans to address the socio-scientific concern at the societal level and to undertake persuasive actions, responsibly and sustainably, to promote a collective way forward for the well-being of citizens within society.

Green cities (Brilhante and Klaas, 2018) is one of the major challenges facing society today. In 2021, European Union launched the Green City Accord that is a movement of European mayors committed to making cities cleaner

and healthier. It aims to improve the quality of life for all Europeans and accelerate the implementation of relevant EU environmental laws (EU Green City Accord, 2021), and thus, there is an urgent need of a more effective public education on this topic. According to the UN 2030 Agenda for Sustainable Development (UN, 2015), among other sustainable development goals (SDG), it is crucial to "make cities and human settlements inclusive, safe, resilient, and sustainable" (SDG 11). Therefore, developing classroom argument-based activities, focused on a socio-scientific issue, like green cities, might be a good strategy for facilitating students' use of scientific knowledge for reasoning, and simultaneously for stimulating their will and competence to get involved and to intervene in favor of a more sustainable society.

However, despite the promise of the classroom activities focused on SSI, elementary teachers still perceive these activities as challenging and are more reluctant to implement them in their lessons due to a lack of knowledge, skills, or confidence (Kinskey and Zeidler, 2021). Nonetheless, incorporating SSI in elementary school lessons is pivotal to cultivating scientifically literate citizens from an early age (Burek and Zeidler, 2015; Evagorou and Puig, 2017).

METHODOLOGY

This is a case study of the process of implementation of a science-learning module focused on a socio-scientific scenario related to green cities, and its impacts on pre-service teachers' skills oriented toward environmental citizenship.

Context of the Study

The module analyzed in this work was developed within the ERASMUS+ High-Fliers project, which seeks to contribute to the preparation of STEM-related professional careers, especially for educationalists within schools, higher education institutions, and science promotion organizations.

Description of the Module

The main task proposed by the module is to reflect on how to transform a particular city into a green city, taking into account the perspectives of the different stakeholders, and propose a set of possible solutions, developing sustained arguments based on Toulmin's argumentation model (e.g., Kneupper, 1978).

The module is organized in three different sessions:

Session 1: Scenario setting

Imagine that the City Council is implementing various measures to transform the city into a Green City. These measures include implementing traffic conditioning in the city to promote bicycle usage; promoting healthy habits, such as outdoor exercise, for the entire population; and creating a green ring that surrounds the city. However, the "Active Neighbourhood," an association of citizens focused on promoting well-being and cooperation between generations, is worried about how these measures could affect all the city inhabitants. The main tasks of this module are to reflect on how to transform the city into a Green City, taking into account the perspectives of the City Council and of the "Active Neighborhood" Association, and to make proposals to address these challenges – "The Mogreen Project."

The first step in this process is to understand the concept of a Green City. To accomplish this, participants are required to read and discuss the paper by Brilhante and Klaas (2018) which provides insight into the Green City Conceptual Framework. The goal of this discussion is to encourage participants to think critically about this concept, and to understand the steps necessary to make a city more sustainable, liveable, and less dispersed.

Session 2: Mogreen Project – Put the project into action

In the second task, participants are invited to fictionally take part of the MoGreen project team. Their challenge is to come up with solutions to make a city more environmentally friendly and sustainable, referred to as a Green city. At this step, participants work in groups of 3 to 5 – group of specialists – to brainstorm and discuss different solutions, according to various dimensions important for the city, such as energy, transportation, urbanism, urban biodiversity, and public health. For this, each group must research its area of expertise (according to the dimension selected) and gather information and arguments to support their ideas.

Session 3: Panel discussion and reflection

In the next step, participants participate in a role-playing panel discussion, in which all expertise groups share its proposals. The teacher educator guided this panel discussion. The finally objective for this panel discussion is to present a report, considering all dimensions discussed by the panel, which outlines the target areas for intervention and citizens' commitment to make the city more environmentally conscious. This task requires collaboration and effective communication skills, as participants must work in a multidisciplinary team and present their findings to the class as a whole.

Once participants discuss the solutions they have for the problem, they should be introduced to the main features of Toulmin's argumentation model (e.g., Kneupper, 1978), to help them to support their arguments. At the end of the activity, participants were engaged in a reflection about the skills developed during the panel discussion.

Participants

The study included 60 pre-service teachers of two different courses: The Degree in Basic Education (n = 34) and the Master's Degree in Teaching in the 1st Cycle of Basic Education and Mathematics and Natural Sciences in the 2nd Cycle of Basic Education (n = 26). Of these, 38 participants completed both a pre-test and a post-test questionnaire. The participants' ages ranged from 20 to 53 years old, with a mean age of 26.71 years (SD = 7.530). The vast majority of the participants were female (94.7%).

Data Collection and Analysis

This research followed an interpretative nature using a case study research (Krusenvik, 2016). Data were collected using two complementary approaches. First, a pre- and

post-questionnaire on the importance of a set of important skills (communication, research, thinking, social, and self-management), at a professional and personal level, was applied to most participants, and second, two focus-group interviews were performed, with two groups of volunteers (one with five participants and one with six participants). These interviews aimed at collecting participants' opinions about the module and its potential for their own professional development. In addition, the final session of the module, the panel discussion and reflection, were audio-recorded, fully transcribed, and analyzed.

The questionnaire, developed within the High-Fliers project, was composed by two different sections. One is dedicated to the importance that participants attribute, at professional and personal levels, to the following competences domain: communication, research, thinking, social, and self-management; and a second section, which assesses the participants' perception of whether or not, they have these same competences. Each competences domain was discriminated into different skills, in a total of 55 items, divided as follows: Communication skills (9 items), research skills (7 items), thinking skills (16 items), social skills (13 items), and self-management skills (11 items). This structure was based on the framework for transdisciplinary and development of 2030 skills (OECD, 2019). The answers were measured using a five-point Likert scale. For analyzing the questionnaire, the frequencies for each answer were calculated and compared, between pre- and post-questionnaire, by a Wilcoxon Test. Statistical analysis was performed using the computer program SPSS for Windows (Ver.23.0, SPSS Inc.).

For analyzing qualitative data, arising from focus-group interviews and the panel discussion, a method of content analysis was used (Sherman and Webb, 2004). After reading all the interviews and transcription of the panel discussion session, the authors identify the main key dimensions present (overall learnings and potentialities). Then, through an iterative process of reading and re-reading data (Milles and Huberman, 1994), meaningful pieces of text were assigned to each of these previously defined dimensions. Two of the researchers were involved in this process. First, one of the researchers performed the content analysis, and second, this analysis was discussed and reviewed by another researcher, of this team, to ensure greater reliability. During cross-check analysis, all differences in the classification between the authors were resolved through discussion until reaching a consensus.

All participants gave their oral prior approval to participate in the study, after being informed concerning the main objectives and research procedures of the research. Although the activity took place as part of a curricular unit, the participation was voluntary and they were informed that the module would not be used for their assessment. They were also informed that they may withdraw at any time. Participants' anonymity and privacy was guaranteed in accordance with the Ethics Committee of the institution involved.

FINDINGS

Perception of Skills Developed

The results of the questionnaire indicate that, at the beginning of the implementation process, both communication and self-management skills were considered as the most important competences, both at professional and personal levels. Besides, one of the least important groups of skills in participants' opinion was the research skills, both at the professional and the personal level. At the end of the implementation process, the importance of the research skills has increased (Wilcoxon Test, $p < 0.001$), showing the highest rate of change (11.23% at the professional level, and 5.93% at the personal level) (Table 1). At professional level, this increase is statistically significant, with an acceptable effect size (medium).

Concerning the skills that participants considered themselves to possess, both the research skills and the communication skills were the least mentioned at the beginning, but showed a greater increase at the end of the implementation process (9.74% and 7.57%, respectively) (Wilcoxon Test, $p < 0.01$ for both group of competences). Once more, thinking skills had also a high improvement after the module implementation (6.32%) (Wilcoxon Test < 0.001) (Table 2). In these three comparisons, the effect size is acceptable (medium). Hence, it seems that the module was important not only on helping participants to better understand the importance of the research skills but also on promoting their own perceived research, communication, and thinking skills.

In the focus group interviews, participants mentioned that they felt they had developed not only their communication skills but also deepened their knowledge about how to discuss with others, using useful and valid arguments, and their debating and argumentation skills, as illustrated by these excerpts,

> "We managed to improve our debate skills; more than only presenting our ideas, we began to ask questions that improved the proposals of each different specialist group."
> "I learn to build an argument, we learn to think critically, and to think by ourselves…"
> "We learned a lot about argumentation, it made me look at arguments and how to argue differently."

Panel Discussion and Focus Group Interviews

Considering the proposals made by each group of "specialists" during the panel discussion, participants presented a very rich and diversified set of suggestions, all sustained in the research they made. During the panel session, it was possible to reach a consensus and modify many of the initial suggestions according to the exchange of arguments and ideas, giving rise to final proposals that integrated the diverse solutions and alternatives of the different expertise considered.

As an example, within the scope of public health, the proposed measures covered aspects mainly related to the need to increase public health literacy through public lectures on quality of life and the need to promote public awareness about recycling. In the field of energy, participants discussed strategies mainly

Table 1: Importance of each group of competencies, at professional and personal levels, before and after the implementation of the activity

Competences	At the professional level					At the personal level				
	Pre-mean	Post-mean	% Change	Sig.	Effect size	Pre-mean	Post-mean	% Change	Sig.	Effect size
Communication skills	4.74	4.84	2.11	NS	0.24	4.66	4.68	0.43	NS	0.02
Research skills	4.18	4.65	11.23	***	0.45	4.05	4.29	5.93	NS	0.18
Thinking skills	4.61	4.78	3.69	NS	0,12	4.66	4.76	2.14	NS	0.05
Social skills	4.61	4.69	1.73	NS	0.17	4.61	4.68	1.52	NS	0,11
Self-management skills	4.66	4.75	1.93	NS	0.08	4.76	4.71	−1.05	NS	0.12

Wilcoxon Test: (***) $p < 0.001$; (NS) $p > 0.05$

Table 2: Participants' perception of their possession of each type of skill considered

Competences	Pre-mean	Post-mean	% Change	Sig.	Effect size
Communication skills (9 items)	3.80	4.09	7.57	**	0.54
Research skills (7 items)	3.68	4.04	9.74	**	0.47
Thinking skills (16 items)	3.89	4.14	6.32	***	0.63
Social skills (13 items)	4.24	4.32	1.91	NS	0.31
Self-management skills (11 items)	4.11	4.20	2.13	NS	0.30

Wilcoxon Test: (***) $p < 0.001$; (**) $p < 0.01$; (NS) $p > 0.05$

based on non-carbon energy sources, such as installing solar panels on abandoned sites, constructing houses and buildings with integrated solar panels, and using electric bicycles, with the possibility of being charged at solar energy stations. They also refer to the possibility of sharing this means of transport between different generations, with the younger ones being able to transport the older ones. Within the scope of urbanism, the strategies suggested were mainly centered on increasing green places all around the city, such as through the creation of vertical gardens on the facades of buildings, planting local species of trees, creation of 'garden islands' within the city, so assuring that all people have equal asses to these green places. Also mentioned was the possibility of public support for the maintenance of private gardens, allowing public access to these spaces. Finally, it was also proposed the establishment of local markets with biological and local products, promoting urban agriculture, sustainable trade, and the availability of healthy food.

During the panel discussion, several topics related to urban sustainability and public policies were addressed. Participants expressed their concerns about restricting access to the central part of the city for vehicles, to reduce traffic and pollution. Questions were also raised about the implementation of autonomous public transport, considering its efficiency and impact on employment. Another point discussed was the importance of establishing goals and plans related to urban sustainability, involving the active participation of citizens in defining these goals and the need to consider different perspectives and ideas. The importance of promoting lectures and activities on sustainability in schools and outside them was also discussed, as a way of sharing knowledge and making the population aware of environmental issues.

In general, the panel discussion highlighted the importance of urban sustainability and the search for solutions that improve the quality of life, reduce the environmental impact, and promote the active participation of the population, to ensure the involvement of all inhabitants, in a socially just way. The exchange of ideas and the participants' involvement showed their interest in seeking sustainable solutions, to build a greener and more harmonious future.

One important aspect mentioned during the focus-group interview was the fact that participants understood that these problems, related to green cities and the need to adopt new strategies and behaviors, are a complex issue that involves different perspectives and actors. They realized that real problems have more than one solution and imply the need to reach a consensus, as illustrated by the following excerpt,

> "I learned that things take time to do. We need to consider many other aspects, to make things work. I realized that there are other aspects that condition the effectiveness of our proposals. You can't get there and do it [to the city]."

Moreover, the panel discussion served as an excellent means to discuss issues related to argumentation. The engagement of the pre-service teachers in this panel discussion has provided a very fruitful discussion about what constitutes a reasoned and sustained discussion, what makes a good argument, and even the didactic application of this type of activity, as illustrated in the following excerpts:

> "…There are several interpretations of what it is to argue… I have here a first idea that to argue is to provide reasons for or against a certain thesis… others defend that arguing is more related to the importance of analyzing opposing perspectives, to convince the other regarding another solution… that is something that we tried to do in

this discussion panel. Clearly, the panel discussion started to get much richer when people asked someone to justify it when someone did not agree. Because, then you began to understand what the rationale was, what was the logic on which you based your solution."

"Deep down, we must think about the structure of argumentation itself, which is something that we do almost spontaneously, without thinking, and so we very rarely make it explicit when working with children. Think of all the hands-on activities you do with children. In all of them, this reasoning is valid – this is your conclusion, but "why is this your conclusion? What are the data and what is the reasoning that makes you take these data to support this conclusion, this thesis?"

"Now, thinking from a didactic point of view, whenever we teach science are we really working these ideas with children? How many times do we make available for the child to communicate the results, communicate their conclusions, argue and substantiate their points of view, making them be conscious about what are they doing and why?"

These didactic potentialities of the module were also emphasized by participants in the focus-group interviews, in terms of their competences as teachers and in promoting participants' motivation to learn, as revealed by these excerpts,

"…this part of the argumentation, of the panel discussion, the need to listen to what the others are saying to argue in favor or against something… it's an interesting way to work on this competence that is important for teaching."

"Then, if we apply it to the kids, they are much more motivated to learn these topics."

Finally, as an overall evaluation of the module, participants emphasized the innovative character of the module,

"I never had this experience in school. It was difficult to start. Critical thinking was never explored in school. But it went well."
"The dynamics used were very innovative. We are not used to having this type of dynamic."

Therefore, in synthesis, the involvement of future teachers in this activity seems to have allowed them, by one side, to realize the difficulties of analyzing real-life problems, promoting their capacity to identify and discuss measures to turn a city greener, supported by scientific knowledge. On the other side, they seemed to have developed some important skills, such as critical thinking, necessary to assessment of the advantages and disadvantages of different solutions, and the recognition of the importance of teamwork to answer to complex scientific problems. In addition, some communication skills, like the ability to communicate to convey the respective messages and to demonstrate an assertive and affable attitude using an articulated and sustained argumentation, were developed. Finally, they also had the opportunity to discuss and reflect on the importance of exploring all these aspects with their own future students.

DISCUSSION

These results revealed that the involvement of the participants in this activity seems to have contributed to deepening their competence to assume a holistic view of an environmental issue (green cities), being capable of thinking for the well-being of all, that is reflected in the proposals made. They also deepen their capacity to make "justified decision-making" (according to Fox and Mogdil, 2006), becoming capable of analyzing different arguments and making decisions based on their credibility. These results are aligned with the previous studies that highlight the impact of the use of SSI to enhance reasoning and argumentation skills (Dolan et al., 2009; Sadler et al., 2007; Walker and Zeidler, 2007).

These results also emphasize the importance of promoting students' engagement in discussion tasks, where they can question and argue with peers, based on evidences obtained and researched by them. Although these results are based on a small local sample, they are consistent with other studies (e.g., Lyons, 2006, Osborne and Collins, 2001). This consistency strengthens the idea that curriculum proposals that are based on methodologies that promote student engagement by stimulating their scientific thinking skills, are seen by them as worthwhile.

In resume, by experiencing a learning situation in which there was decision-making, discussion, experiencing different roles, argumentation, explanation and interpretation, pre-service teachers were required to think more critically, to look more deeply into events and, consequently, to develop more complex views on social issues in which science appears, most of the time, as central. These outcomes are extremely important for generating more critical, responsible, and pro-environmental active citizens, in general, and in future teachers, in particular, as they could apply these learnings to create and implement new learning situations, similar to this one, with their own students.

These positive results could be explained by the characteristics of the activity implemented. Indeed, and according to other studies (e.g. Holbrook et al., 2022; Hungerford and Volk, 1990), it is not sufficient to equip people with greater scientific skills and knowledge, to promote the capacity and motivation to reflect critically about the world, and to make both responsible and informed decisions concerning socio-scientific issues related to their lives. It is very important to give them the chance to be part of the process, searching and discussing possible solutions (Holbrook et al., 2022). In that sense, the activity implemented is, in some way:

- Participatory, emphasizing the need of collaboration and engagement to reach a solution;
- Constructive, challenging participants to participate in the creation of meaningful solutions;
- Critical, asking them to think critically about how things are and what should they be, and;
- Reflective, making them think about causes and consequences and how to improve the situation, based on a real problem.

Besides, the theme of the green cities, which was used both as a "real-life" scenario and as an appealing learning context, seems to have contributed to participants' engagement, with all groups proposing viable solutions, during the panel discussion task. Moreover, it allowed participants to have a sense of ownership (as the scenario could apply to their own city) and empowerment, giving them the notion that they could contribute to thinking about the best alternatives.

UNESCO (2015), recognizing the profound social changes currently underway in most countries, calls for new forms of education that are conducive to developing the skills that societies and economies may need in the future. The aim of this new education goes beyond literacy, focusing on learning environments and new approaches to greater justice, social equity and global solidarity, and clarifies that "Education must be about learning to live on a planet under pressure. It must be about cultural literacy, based on respect and equal dignity, helping to weave together the social, economic, and environmental dimensions of sustainable development" (p. 3).

Perspectives on education for responsible citizenship are inherent to the various curricula in several European countries, and in science education in the Portuguese curricula for primary and secondary education, environmental and sustainability perspectives have a central position, which must be understood in their multiple causes and consequences. Attention to the development of this range of teacher skills is a challenge for training at all levels.

Nowadays, there is a strong agreement about the need for high coherence between the teacher education assumptions and the experiences that it provides to future teachers. It is not enough to present and discuss relevant and innovative practices; it is essential to implement them in teachers' education programs. This activity seemed to respond to this need since it has allowed elementary pre-service teachers not only to experience new visions of science education from a learner's perspective but also to reflect on them from a teacher's perspective.

As a final note, we would like to point out that more studies are needed, as we should not generalize these conclusions, which are limited to a particular context and a small sample. Moreover, the participants who participated in the focus-group were volunteers, which could bias the results to some type of participants (for example, those that felt more comfortable with this activity).

Even so, this study emphasizes the need for and the importance of creating learning contexts, with these types of characteristics, described above, to involve pre-service teachers in real and complex learning contexts, helping them to be prepared to actively contribute to an education for a sustainable future.

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