

# Environmental Education toward Sustainable Development: Training Early-Ages Pre-Service Teachers to Design Their Own Scientific Didactic Proposals

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## Abstract

This study was implemented with 540 early-ages pre-service teachers during three academic courses in Spain. Students designed their own didactic proposals with environmental education aim toward Sustainable Development Goals (SDGs). Countless initiatives are being implemented at all educational levels around the world to include these SDGs in didactic programs. However, traditional teaching methods are sometimes insufficient to achieve a “proactive attitude” toward environmental problems by pupils. Certain characteristics of teaching and learning in the early-ages are exploration, motivation, curiosity, questioning, dialogue, collaboration, and reasoning to establish connections between scientific concepts and their environment. Therefore, the study was induced by the interest of introducing scientific methodology to achieve environmental education aims. The design of scientific didactic proposals was helpful for early-years prospective teachers to acquire environmental education skills toward SDGs. They increased their knowledge regarding environmental issues and their feeling of moral obligation to protect the environment and self-reported pro-environmental behavior, being aware of their role as educators. However, future experiences will be specially intended to enhance the importance of met a cognitive and emotive learning in pupils, including observation, identification, argumentation, and discussion.

## Keywords

Environmental education, Sustainable development, Early-ages, Pre-service teachers, Science activities

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## 1. Introduction

A decade ago, the United Nations Educational, Scientific and Cultural Organization (UNESCO) suggested a rethinking of education and knowledge for common global benefit. A global report, *The Futures of Education* (UNESCO, 2022a) proposed an agenda for education policy dialogue and action at multiple levels. In relation to development and sustainability, the UN World Commission on Environment and Development was constituted more than 30 years ago. Promoting the SDGs ‘UNESCO moving forward the 2030 Agenda for Sustainable Development’ was adopted by the UN General Assembly in 2015 (UNESCO, 2022b). It has been working tirelessly on enforcing the four pillars of education—learning to know, learning to do, learning to be and learning to live together—as defined in the 90s report *Learning: the Treasure Within*. Some of its proposals have been implemented; however, much remains to be accomplished. It

is essential to understand environmental education as a permanent process, within an educational context, which begins at an early age within the family and schools, to be incorporated by children into their learning (Deci & Ryan, 2012; Freire, 2011). Moreover, it is important to consider the entire community, and to continue this education through primary, secondary, and even university education (Amaro et al., 2015). Multiple didactic resources and activities are available. Some of them were produced by more than 50 organizations working in the humanitarian sector (UNESCO, 2022c). Actions such as the reduction of waste, energy and water consumption and the recycling of materials are traditional activities implemented from an early age (Ruiz, 2008). Furthermore, through outdoors activities, children can gain an understanding and appreciation of the natural environment. Simultaneously, they can improve physical, social, and emotional well-being (Turtle, Convery, & Convery, 2015). To discover and respect the environment around us, it is of special importance from an early-age to promote a culture of thinking, to answer our own questions (Abd-El-Khalick, Lederman, & Schwartz, 2015; Salmon, 2008; Steele, Hives, & Scott, 2016), and to discuss the use and application of objects for working scientifically in everyday situations (Fusaro & Smith, 2018) through scientific thinking, stimulation and personal curiosities (Chichekian & Shore, 2016). Thus, the authors consider that the training of prospective teachers in the application of science activity through the design of their own environmental didactic proposals with sustainable development aims makes a scaffolding to promote proactive attitude in citizenship from an early-age. The approval in September 2015 of the new Sustainable Development Goals (SDGs) and the 2030 Global Action Plan represented a new attempt to improve the collective health of the planet. As problems are global, global approaches and solutions are required. Integration between possible economic, social, and environmental solutions is essential to face global challenges.

The United Nations International Children's Fund (UNICEF) promulgates that it is essential to transmit competence on this subject from an early-age (UNICEF, 2021). It will certainly contribute to the awakening of the values and attitudes characteristic of this approach that different studies have detected in the population and in specific groups (Cebrián & Junvent, 2014). Consequently, it is of vital importance to pay attention to the supporting role that early childhood education can perform in sustainable development and in the training of children (Davis, 2009; Gutiérrez-Pérez & Perales-Palacios, 2012). The kindergartens and preschools can provide foundations for lifelong learning about sustainability and the importance of human actions (Reunamo & Suomela, 2013). Teachers can promote children's understanding through enriching pedagogical activities (Bahtić & Jevtić, 2020). It encourages the acceptance and care of oneself, the others, and the environment in which they live (Castro & Renés, 2018) in a framework of listening, participation, and action that favors the transformation of a reality that requires measures to change.

## **2. Application of scientific activity into environmental education**

### **2.1. Education programs at an early-age**

There are many fields of action of education for sustainability. Few of the most widespread by education programs are probably recycling, the use of low-pollution transport, renewable resources, organic food consumption, and bioclimatic building construction. Nevertheless, the scope of this initiative is still limited (Pol & Castrechini, 2013). For an effective improvement in transversal skills and scientific literacy of citizens to express opinions and act, it is necessary to evaluate factors of teaching behavior linked to particular results. Prospective teachers highlighted the importance of actions to prevent climate change, to protect submarine life and terrestrial ecosystems life, and to foster clean water and sanitation. However, they did not give utmost importance to quality education where they will be key actors. From the scope of the didactic of sciences, several studies concluded that active role of children in their learning make them develop constructive, sustainable, ecological skills (Mileto et al., 2017). Discovery-based instruction (Alfieri et al., 2011) is helpful to achieve this aim. Environmental education pedagogies have the capacity to support certain characteristics of scientific learning such as self-determination, opportunities for choice, and a sense of belonging (Darner, 2009; Darner, 2014; Deci & Ryan, 2012). A bibliographic review related to environmental education in early years education and education for sustainable development were published by Hedefalk et al. (2015). It elucidated the importance of educating children to act for change. This new approach reveals a more competent child who can think for himself or herself, and make well-considered decisions. The decisions are made by investigating and participating in critical discussions about alternative ways of acting for change. In another more recent review, which evaluates studies over a 25-year period, Ardoin and Bowers (2020) elucidate that the primary outcomes documented in those studies include environmental literacy development, cognitive development, and social and emotional development; to a lesser extent, the studies addressed physical development and language and literacy development. Conversely, most of them emphasized the effectiveness of play-based, nature-rich pedagogical approaches that incorporated movement and social interaction. Integrated outdoor environmental thinking with subjects such as math, language, science, and social studies,

while ensuring a collaborative inquiry-based process (Smyth, 2006; Steele, Hives, & Scott, 2016) enhances reasoning, propositional, action-oriented, metacognitive, and emotive pathways, providing insight into the thinking and learning enacted by students. The metacognitive and emotive pathways are less commonly elicited during formal teaching and learning. Hence, it is of huge importance to go hand in hand with the entire educational community and especially with families (Anderson et al., 2010; Swain & Cara, 2017; Weigel et al., 2006) to transfer the schools' methods of teaching literacy into the home and beyond, including behaviors, beliefs, and understandings.

## **2.2. The importance of including sustainable development skills in the training of teachers and educators**

The Council of the European Union held at the end of 2010 recognized that teachers and educators at all levels of education need adequate training and competence in sustainable development skills (Council of the European Union, 2010) to promote and include the underlying principles of environmental education toward sustainable development in their approaches. Subsequently, international principles included in the Education 2030 report, Incheon Declaration, and framework for action (UNESCO, 2016) remarked that teachers and educators made a major contribution to the improvement of students' skills, competencies, values, culture, knowledge, and gender responsiveness. Promoting dialogue, respect for environment and living beings, inclusion, equality, and involvement of communities in the management of schools is fundamental. Environmental education plays a critical role in pre-service and in-service early-ages teachers training. Certain studies revealed a lack of sustainability skills in teachers. Theoretical and practical knowledge in both initial and continuous teacher training is required (Murga-Menoyo, 2015; Nazarenko & Kolesnik, 2018; Pérez-Rodríguez et al., 2017). Additionally, many teachers feel their training is insufficient (Meier & Sisk-Hilton, 2017). Early-ages educators reported that they were least confident implementing nature/science activities compared with activities in other curricular domains (Torquati et al., 2013). Therefore, it is essential to include contents related to science, nature, and environmental education, through the design of practical experiences that help teachers to develop confidence in this area of knowledge (Benayas et al., 2017; Collado et al., 2018; Fernández-Manzanal et al., 2006). In recent decades, a growing number of school and university institutions worldwide are applying educational practices to promote more sustainable solutions, particularly among their local communities. Initiatives and projects have been developed in reference areas of action (UNESCO, 2022a): the development of sustainability policies, the management based on sustainability principles and routines in teaching and learning practices, and the inclusion of sustainability contents in the curriculum at different levels. Thus, universities act as reference models in our societies. Higher education institutions, colleges, and institutes, are beginning to extend the value and impact of their teaching and research at the local level, acting as catalysts for change in their closest communities. Not all universities have the same sustainability policy, nor do they contribute to it in a similar manner. It is clear that the strategy to be followed in each university, as in other areas or actors, will be determined by their own characteristics, and its context. Education on SDGs is an inter-disciplinary and international key issue to achieve a permanent and continuing citizen education. In Spain, the search for new educational settings to conserve and protect the environment has been present since the late 1970s. The 1st Conference on Environmental Education was held in Sitges (October 1983). Thereafter, projects and initiatives to sensitize the Spanish society about the need to manage the environment in a more respectful and sustainable manner (Benayas et al., 2017) were promoted by tens of thousands of educators in different areas, and institutions such as the Ministry of the Environment, or the National Center for Environmental Education. Consequently, a wide and extensive network of environmental education facilities, initiatives, interventions, and reflections emerged. Results were noticed in policies, management of municipal services, and enjoyment of natural environments by people. Naturally, the number of educators teaching activities on this subject increased. Revisions in all university degrees to include sustainability as a transversal competence, and promotion of pro-environmental initiatives were suggested by researchers (Fernández-Manzanal et al., 2015) and institutions. The Spanish National Conference of University Rectors (CRUE, 2005) recommended including sustainability skills in all education degrees. To achieve the SDGs, various initiatives are implemented by the entire university's community participation. It is working tirelessly on the integration and promotion of the SDGs in the university curriculum and also in its fulfillment, by monitoring the 2030 agenda, by carrying out various reports, and activities.

The aforementioned approaches support the idea that environmental education, as a key issue of SDGs is of huge importance in pre-service teachers training. However, this experience was intended to consider such characteristics of scientific activity supported by environmental education, enhancing metacognitive and emotive pathways. This study provides research by developing a case study involving pre-service students of Early Ages of three Education Faculties. Consequently, this work is aimed at their training on environmental education skills toward SDGs achievement, by the design of their own scientific didactic proposals. The research question is: Is the design of scientific didactic proposals

helpful for early-years prospective teachers to acquire environmental education skills toward SDGs?

### 3. Research design and methodology

#### 3.1. Sample, goals and hypothesis

A sample of  $n=540$  students of three Education Faculties participated in a classroom experience along three consecutive academic courses (period September, 2018 to June, 2021). A database was created with the statistical package SPSS for Windows, version 26. A reliability analysis based on Cronbach's alpha coefficient was carried out, following recommendations of Taber (2018). The obtained alpha coefficient was 0.75. Considering the about-outlined theoretical framework, specific learning objectives were contemplated: to explore the initial knowledge and claims of teaching students in relation to SDGs and the importance of working with them in classrooms; designing didactic proposals in relation to the interaction science, technique, society, and sustainable development; to check the acquired competence after designing diverse activities in relation to SDGs values and procedures; to promote the use of scientific knowledge to make decisions and interest and respect for the natural, social, and cultural environment; understanding SDG as sociocultural knowledge, to be implemented by the entire educative community.

We began with the hypotheses that Education students do not have sufficient information about the SDGs. Moreover, they do not include scientific and transversal competence related to these contents in the Education curricula. They will improve their knowledge and awareness by designing their own classroom proposals.

#### 3.2. Didactic proposal structure

The experience had three main steps.

1) Initial session to present the topic and to understand the conceptions and claims of teaching students. In this introductory session, a debate was conducted. Students were asked about their knowledge in relation to the SDGs, its importance as teachers, and the work of our university on this issue. There was a brainstorming session and final recapitulation. It concluded with the importance of assuming and transmitting values, learn by doing, and normalize certain habits and customs, become aware of its importance for the conservation of earth, and the role of teachers in achieving these aims.

2) Formation sessions: Videos and examples of didactic tools and strategies among other activities were conducted. Certain proposed materials were about the importance of knowing and applying environmental education toward SDGs proposals (Entreculturas, 2021; Goikoetxea, 2014; Gómez, 2012; Gosálvez, 2020). Steps to design a scientific classroom activity were conducted, including possible topics to discuss, emphasizing the importance of procedure principles, and the role of pupils and teachers to implement science activity, extending special mention to attitudinal contents and collaborative work. The knowledge and respect for the environment, people, natural resources and physical elements, mental, and social well-being, by controlling emotional impulses and promoting emotional balance and positive self-esteem were also discussed.

3) Practical sessions: Students prepared their own proposals (in groups of 3-5, or individually) including themes, objectives, developed skills, and detailed explanations (April-May 2020).

#### 3.3. Evaluation criteria

The evaluation of the designed proposals focused on the international principles included in the Introduction section (UNESCO, 2016). Professional skills in education for sustainability, SDGs, and science activity of prospective teachers were evaluated. The evaluation was implemented individually, for each student who participated in the experience. The measurement instrument was a Likert scale (from 1, totally disagree, to 5, totally agree). Concepts, values, attitudes, and abilities were taken into consideration according to the exploratory study developed by Cebrián and Junyent (2014). Certain specific questions about the SDGs were also included in the final exam. Additionally, the evaluation was complemented by a voluntary discussion forum in the Educative Virtual Platform Moodle, to collect final impressions about the importance of working on the SDGs from early ages in a transversal manner by implementing scientific activity, and the role of teacher students on citizen education. Selected items, motivated by the proposed learning objectives were:

*Environment and environmental problems knowledge: Item 1:* The students know about SDGs and their relationship with environmental education. *Item 2:* The students consider the SDGs goals, such as recycling and reuse, optimization of natural resources, respect for living beings, diversity, and pollution reduction.

*Individual and collective responsibility: Item 3:* The students are aware of their role as educators in relation to environmental skills acquisition by children; *Item 4:* The students are aware of the importance of their individual actions.

*Commitment and involvement: Item 5:* They give importance to include transversal competence related to environ-

mental education and SDGs in the early-ages Education curricula; *Item 6*: They consider involvement of communities (including families and educational community).

*General techniques to teach environmental education (didactics of science; scientific activity)*: *Item 7*: They consider, initially, what children know and what they want to know about the topic to be taught; *Item 8*: They consider autonomous learning (perception, exploration, experimentation, problem solving, and new term construction); *Item 9*: They promote collaboration, cooperation, respect, dialogue; *Item 10*: They contextualize their proposals (situations in their locality, known problems)

#### 4. Didactic proposal implementation

With the aim of clarifying the results obtained, a review of initial ideas and knowledge acquired by students (design of didactic proposals and evaluation) is included in this section. Neither personal data nor identifiable information is included. Participant data have been anonymized without distorting results.

##### 4.1. Initial session

The initial session demonstrated the hypothesis about the lack of knowledge in relation to sustainable development skills by teachers in training, already confirmed in other studies (García-Esteban & Murga-Menoyo, 2015). Almost none of them knew about SDGs (*item 1*) or about the work of our University about introducing them into their training. However, they considered the importance of their role as educators in relation to environmental skills acquisition by children. Moreover, they extended importance to their individual actions, and to include transversal competence related to Environmental Education and SDGs in the early-ages Education curricula (*items 3 to 5*).

##### 4.2. Design of scientific didactic proposals

Once experience was developed, almost all the students learned the importance of environmental education to reach SDGs (*item 1*) and the work of our University to introduce these contents into their training. They considered their role as educators, their individual actions as citizens, and the importance of Environmental Education and SDGs as transversal competence in Education curricula from an early-age (*items 3 to 5*). Designed proposals revealed that most of the students considered what the initial ideas of children are (approximately 75% of them) however, not what children want to know about the topic to be worked (*item 6*) which was considered by only 7%. Around 25% of them considered science activity by pupils' perception, decision making, critical thinking, and verification of initial hypothesis (*item 7*). About the topics included in the proposals (*item 2*), students considered reuse and recycling (mainly reusing paper and plastics), respect for living beings (animals and plants, biodiversity), pollution reduction (by minimization of residues), and optimization of natural resources (water and electricity). Collaboration, cooperation, respect, and dialogue were taken into account by 80% of the students (*item 8*). However, diversity was considered by only 35% of them. Involvement of communities was considered by 50% of the students, mainly families, to participate in gathering information, or implementation of activities. Furthermore, 67% of them contextualized their proposals by situations in their locality, known problems, by visits and trips, routines (*items 9 and 10*). Figure 1 summarizes these results.

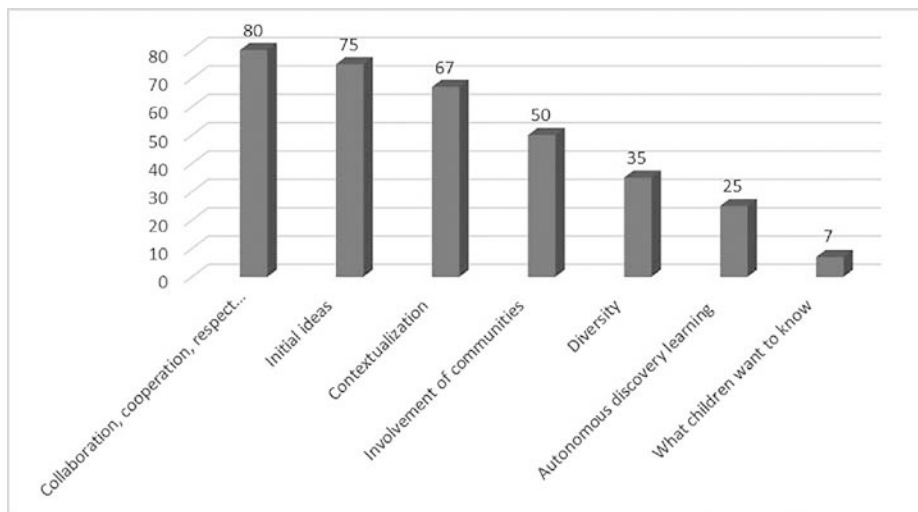


Figure 1. Scientific didactic proposals. Results (%).

### 4.3. Evaluation of students' skills

Evaluation of the students' skills (n=540) after carrying out the experience are provided as supplementary online material. A summary is included in Table 1.

**Table 1. Summary of Likert Scale values for different items (%)**

Likert value	Items									
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
1	10	20	21	19	20	89	80	20	60	61
2	00	0	0	0	0	0	0	0	0	0
3	00	0	0	0	0	0	0	0	0	0
4	40	41	40	41	38	0	0	40	19	21
5	50	39	39	40	42	11	20	40	21	19

Final evaluation results also demonstrated that 90 % of the students were capable of designing environmental education didactic proposals through the scientific activity perspective toward SDGs after implementation of the experience. The virtual discussion forum also highlighted some interesting ideas about pre-service teachers learning outcomes. They learned a definition of sustainable development, considering that it "...improves living conditions in the present without compromising the resources of future generations." All the students gave importance to training as future teachers since they "...must raise awareness among students from early ages and encourage them to participate in it, so that children acquire a mentality of responsibility with the environment." Students considered "to prevent these problems from small actions," by "educating on individual responsibility." "It is about instilling in students, as early as possible, an understanding of the challenges of sustainable development and a sense of responsibility towards the environment around them." Thereafter, students learned about the SDGs, and the role of environmental education to reach them. Activities and tools proposed were mostly collaborative (workshops, talks, games) experimentation with close environment, and routines (optimization of water and energy, and recycling and reuse of materials, among others). The acquisition of appropriate scientific terminology and vocabulary and the participation of families were highlighted in the forum.

### 5. Discussion and conclusions

It can be concluded that proposed learning objectives were achieved. Initial ideas of pre-service teachers corroborated their lack of knowledge in relation to Environmental Education skills (Nazarenko & Kolesnik, 2018; Pérez-Rodríguez, et al., 2017) proposed as initial hypothesis. Activities designed by teaching students revealed that most of them (75%) considered the initial ideas of children, however, not autonomous discovery learning in their didactic proposals (Alfieri et al., 2011). Children's concerns and curiosities were less considered (by less than 10% of students). Around 25% of the students included the verification of initial hypothesis in their proposals. It was not easy for them to understand that scientific activity implies perception and action by manipulation and sensorial activities, including problem solving by exploration, motivation, curiosity, questioning, experimentation, dialogue and reasoning (Cremin et al., 2015) to promote new terms construction. Scientific thinking, stimulation, and personal curiosities are key issues that require reinforcement in the future (Chichekian & Shore, 2016). Teachers should make and promote questions and experiences aimed to differentiate between personal beliefs and empirical evidences (Abd-El-Khalick, Lederman, & Schwartz, 2015) and inculcate a culture of thinking in young children to promote student's construction of knowledge (Salmon, 2008). Moreover, teachers should be co-learners, facilitators, and observers to provide children with the opportunity to deepen their understanding of scientific concepts with the aim of improving their social and communicative skills (Harwood et al., 2015). A significant number of students (more than 50%) highlighted the importance of actions to protect ecosystems life, to prevent climate change, and to foster clean water and sanitation. Involvement of communities and contextualization of their proposals were considered by around 50% of the students. Both, facing real-world challenges and participation of families are highly motivating to children (López-Alcarria et al., 2016; Riddle, 2016). This task can and should be approached from different disciplines. Students mostly agreed with the idea that it is of huge importance to include transversal competence related to environmental education in the Childhood Education curricula.

To answer the research questions set out at the beginning of this study, it can be concluded that, despite some limitations, the design of scientific didactic proposals was helpful for early-years prospective teachers to acquire environmental education skills toward SDGs. The above-outlined results demonstrate that prospective teachers attached importance to promoting conceptual and procedural content in pupils. Nevertheless, they attach less importance to autonom-

ous learning, attitudes, values, and emotions (Cebrián & Junyent, 2014). The didactic value of the proposal has been demonstrated. According to Garzón and Martínez (2017), teachers have the responsibility to provide their students with significant learning. The activities must encourage students to be active learners, stimulated and supported by their teachers. There must be a relationship between the content and the children's daily life. Teachers have to encourage students to ask questions, ensuring motivation, curiosity to learn, and investigation. Particularly, owing to its great importance, to reinforce proactive student attitudinal competence toward the fulfillment of the SDGs, and the importance of their training in their professional future. Furthermore, in future research, it is intended to consider gender differences, and issues related to students' natural sciences knowledge (previous scientific formation, interest in science and emotions felt when working on it).

Building a culture of sustainability at school supposes a continuous process of reflection-action-reflection. It needs to offer real spaces for democratic participation and decision-making, must consider whether an evolution of the teaching role is necessary, should develop communication skills in real scenarios, and make proposals for change and execute them. The SDGs are transversal and not only considered in specific activities, but also in routines to include in the daily schedule of classrooms from an early age. Thus, contributing to the literacy of adult citizens committed to the environment and sustainability begins with childhood training. Permanent and continuing citizen education in SDGs is considered an inter-disciplinary key issue in the international educational context. Therefore, the analysis of contextualized knowledge, which illustrates that teaching is not limited to the transmission of content, becomes a social practice for the formation of social subject, and is essential in the training of prospective teachers.

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The study was undertaken in accordance with the UNESCO Declaration on Science and the use of Scientific Knowledge and the University of Zaragoza Good Practice Guidelines. Confidential and anonymous treatment of participants' data has been considered for the conduct of research. Neither personal data nor identifiable information is included. Participants' data have been anonymized without distorting results. Researchers engaged with participants at the conclusion of the research by eliciting feedback on the findings. Researchers' contact details and information about the characteristics and proposals of the study were provided to participants. Informed consent details are included next. Informed consent under no coercion or bribery of any kind has been obtained from the participants or from the parent or guardian of any participants who are not able to provide full informed consent themselves. Authors confirm that there are no financial or non-financial competing interests to report.

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