education sciences

MDPI

Article

Service-Learning in Environmental Education of Primary Preservice Teachers: Advancing SDGs and Improving Attitudes Towards Sustainable Development

María Diez-Ojeda [1], Marián Queiruga-Dios [2] and Miguel Ángel Queiruga-Dios [1,*]

[1] Department of Specific Didactics, University of Burgos, 09001 Burgos, Spain; mdojeda@ubu.es
[2] Accompaniment Institute, Universidad Francisco de Vitoria, 28223 Madrid, Spain; marian.queiruga@ufv.es
* Correspondence: maqueiruga@ubu.es

Abstract: This research analyzes the effect of implementing a Service-Learning (SL) program in the Environmental Education (EE) subject of the Primary Education Degree. The SL project was evaluated and the change in Attitudes towards Sustainable Development (ASD) of 44 preservice teachers was measured, considering Environment, Economy, Society, and Education as dimensions, using a pretest-posttest experimental design with no control group. The assessment of the SL project was favorable in all items (the purpose of the project, the training aspects, and the logistical and institutional aspects) and a significant improvement in ASD was observed in all dimensions. No significant differences were found in ASD based on the gender variable. It can be concluded that the inclusion of SL projects in the EE program significantly improves ASD while aligning education with the SDGs.

Keywords: service-leaning; sustainable development goals; education for sustainable development; sustainable development; environmental education; teacher training

Academic Editor: Eila Jeronen

Received: 10 December 2024
Revised: 8 January 2025
Accepted: 13 January 2025
Published: 16 January 2025

Citation: Diez-Ojeda, M., Queiruga-Dios, M., & Queiruga-Dios, M. Á. (2025). Service-Learning in Environmental Education of Primary Preservice Teachers: Advancing SDGs and Improving Attitudes Towards Sustainable Development. *Education Sciences*, *15*(1), 98. https://doi.org/10.3390/educsci15010098

1. Introduction

The current climate crisis, along with other environmental sustainability issues, represents a direct consequence of human activities. The accelerated pace of these changes is leading to a massive loss of biodiversity, which is driving the extinction of thousands of species and altering fundamental natural cycles, degrading soils, and generating numerous social and economic consequences. These effects are even threatening the survival of our own species. In recent decades, the natural environment has changed at a rapid pace, producing impacts that are drastic, visible, and increasingly difficult to reverse. For example, two-thirds of the 1 °C global increase in temperature over the past 100 years has occurred since 1975. Furthermore, the annual extraction of renewable and non-renewable resources has nearly doubled since 1980, intensifying the negative impacts on the planet. It is estimated that one million species are currently at risk of extinction and that this loss, together with the lack of conservation of ecosystems, will have catastrophic consequences for both humanity and the environment (EEA, 2023; Hansen et al., 2010; IPBES, 2019; NAS, 2020; UNESCO, 2020). Facing this global challenge requires a profound transformation of current educational systems and social structures, so that the necessary changes are achieved to reach the goal of "The Future We Want" (General Assembly, 2012, 2015; Leibniz, 2024). It is therefore essential to reconsider what, where, and how we learn in order to develop the knowledge, skills, values, and attitudes necessary for all of us to make informed decisions and act both individually and collectively in the face of urgent challenges at local, national,

and global levels. To cultivate a deep relationship with the environment, educational authorities and educators must not only emphasize knowledge, but also incorporate practical skills, awareness of local environmental issues, and a sense of belonging through active participation in community projects (Diez-Ojeda et al., 2024a, 2024b; SEI & CEEW, 2022).

This comprehensive approach will enable students to engage meaningfully with their environment, fostering both a deeper understanding of ecological principles and a commitment to sustainable practices. In this process, higher education institutions and universities play a fundamental role due to their potential as transformative agents of society and the environment. Their role lies in the generation and dissemination of knowledge, as well as the ability to research the impact of their activity. This potential is strengthened by the emergence of new methodologies and teaching innovation strategies that foster learning effectiveness by actively involving students in teaching-learning processes and focusing on the development of competencies (Aramburuzabala & Cerrillo, 2023; Ashida, 2023).

The importance of developing skills is also highlighted in the European Council's recommendations on key competences for lifelong learning (EC, 2018). This document points out that "memorization of facts and procedures is key, but insufficient for progress and success. Skills such as problem solving, critical thinking, cooperation skills, creativity, computational thinking and self-regulation are more essential than ever in our rapidly changing society" (EC, 2018, p. 2). This approach is aligned with the commitments made at the 2009 World Conference on Higher Education, held at UNESCO headquarters in Paris (Ten, 2023; UNESCO, 2010), where the community service role of higher education institutions was highlighted. These institutions were encouraged to promote critical thinking and active citizenship through an interdisciplinary approach, responding to and anticipating social needs, and, in this way, contributing to sustainable development.

The first definition of sustainable development (SD) was established by the Brundtland Commission on Environment and Development, which conceptualized it as a strategy that meets the needs of the present without compromising the ability of future generations to meet their own needs (Aramburuzabala & Cerrillo, 2023; WCED, 1987). This concept of sustainability can be integrated into the field of formal education through Education for Sustainable Development (ESD). According to UNESCO (2017), ESD aims to foster transversal competences in sustainability in students and improve Attitudes towards Sustainable Development (ASD) by transforming their behavior. In this sense, ESD must be of a quality that equips students with values, knowledge, skills, and competences that promote sustainable living and active participation in society. Subsequently, in September 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs) and 169 targets. These SDGs replace the Millennium Development Goals as the reference framework for international development in the period 2015–2030. The SDGs are a blueprint for a sustainable future for all, as they are interconnected and address major global challenges such as poverty, inequality, climate change, environmental degradation, prosperity, peace, and justice (United Nations Development Program (UNDP, 2016)). In this context, Service -Learning (SL) is presented as a valuable tool to involve the university community in the challenges posed. This form of experiential learning takes place in practical environments and addresses social needs through activities designed to promote learning and the development of skills in students (Jacoby, 1996; Narong & Hallinger, 2023; Queiruga-Dios et al., 2021).

This manuscript presents the design and evaluation of a SL project developed in the Environmental Education (EE) subject, contextualized in the SDGs. In this project, students actively participate in the design and have decision-making power, which favors their involvement and commitment. Subsequently, the project was implemented in educational centers and associations. The project is specifically detailed oriented to SDG 13, "Climate

Action", given the magnitude of climate change as a global challenge and its effects on all dimensions of sustainable development, including health, human well-being, food security, economic growth, natural resources, and biodiversity (UNESCO, 2024). In this context, the following research objectives are proposed:

1. Assess the developed SL project in terms of service, learning, and sustainability aspects.
2. Analyze the change in the ASD of the preservice teachers participating in the SL project.

2. Theoretical Framework

2.1. Service-Learning

Some studies (Sotelino-Losada et al., 2021) identify John Dewey as a key precursor of SL pedagogy. Dewey advocated constructivist experiential learning methodologies, promoting the "learning by doing" approach to solve problematic situations. Through this method, meaningful connections were established between the actions performed and their consequences, generating integrated and not isolated learning, which allows a holistic understanding of the relationship between actions and their effects. This process also facilitates the development of skills to act collaboratively, while promoting autonomous thinking and judgment (Dewey, 1916; Giles & Eyler, 1994; Narong & Hallinger, 2023; Sotelino-Losada et al., 2021). However, it was Robert Sigmon (1979) who, in a first attempt to formalize this methodology, formulated the three principles of Service-Learning. These principles hold that: (1) those receiving service should have control over the service; (2) as a result of experience, recipients should develop a greater capacity to serve and receive service; and (3) those providing service should simultaneously be learners, maintaining control over their learning process. Subsequently, Ehrlich (1996) developed a conceptual framework that defines SL as a pedagogy that establishes a strengthening link between community service and academic studies. This link is key to learning, as it allows interaction between knowledge and skills in real-world experiential contexts. Over time, various authors have enriched this definition of SL (Bringle et al., 2006; Felten & Clayton, 2011; Kuh, 2012). Thus, SL can be characterized by certain essential elements: it is a clearly defined, planned, and structured teaching-learning process, which facilitates both academic learning and the development of competencies in students, and it is oriented to the benefit of the community (O'Connor, 2012); it is based on collaborations and connections between various actors and communities (students, teachers, associations, educational institutions, among others) that share common objectives (Olberding & Hacker, 2015); it incorporates solid mechanisms for the evaluation of both learning and the impact generated (Queiruga-Dios et al., 2021; Rubio-Serrano et al., 2015; Salam et al., 2019); and it always includes moments and spaces dedicated to reflection (Furco, 1996; Sotelino-Losada et al., 2021).

The scientific literature strongly supports the multiple benefits that SL provides to students (Faulconer & Kam, 2023). These benefits include improved self-efficacy (Gutzweiler et al., 2022), the formation of civic attitudes (Ahmad & Gul, 2023), as well as an increase in self-esteem and motivation towards learning (Moyano et al., 2020). Additionally, participation in practical activities allows students to develop advanced problem-solving skills, which facilitates a deeper understanding of the social challenges in their environment (Arnold, 2022) and, in turn, translates into improved academic achievement (Gutzweiler et al., 2022).

The practice of SL is defined through three fundamental elements that characterize this type of educational project. First, it is established that the student must be the protagonist of both the learning process and the solidarity action, which implies that their active involvement is crucial for the success of the educational experience (Henderson & Hall,

1946; Basilico & Kelly, 2015). Second, it is essential that there is a clear intentionality to address and solve a real problem, which connects learning with authentic and relevant situations in the community (Faulconer & Kam, 2023; Gutzweiler et al., 2022). Finally, SL must be articulated with the curricular contents and competencies, ensuring that the activities carried out contribute to the development of the skills and knowledge established in the educational curriculum (Moyano et al., 2020; Queiruga-Dios et al., 2021).

From an institutional perspective, the SL approach also generates significant benefits, as it reinforces the image of the institution and contributes to greater student retention (Aramburuzabala & Cerrillo, 2023; Yob, 2011). These aspects have led to the widespread acceptance of SL pedagogy in higher education institutions. In America, these programs have been fully implemented for several decades. For example, in the 1920s, Antioch College integrated real-world experiences into its curriculum through learning and community-building strategies (Henderson & Hall, 1946; Queiruga-Dios et al., 2021). Likewise, SL pedagogy has a long tradition in Latin America and the Caribbean, where educational regulations and policies have included the promotion of student solidarity activities, both in schools and in higher education, establishing collaborative networks between educational institutions and the community (Basilico & Kelly, 2015; Tapia & Ochoa, 2015). More recently, this methodology has been adopted in European universities, gaining relevance thanks to the educational approaches promoted by the common European higher education area, as well as its contribution to the SDGs (Queiruga-Dios et al., 2021; Salam et al., 2019; Sotelino-Losada et al., 2021). Consequently, it is possible to affirm that few educational innovations have achieved such rapid and global success as SL (Deeley, 2016).

2.2. Service Learning, Sustainable Development Goals and Education for Sustainable Development

SL actions not only address specific issues such as the environment, inclusion, and inequalities, but also contribute to questioning the social order and ultimately promoting changes towards a more sustainable future. These actions provide a direct link to the SDGs, with SL being a key tool to advance them. SDG 4, Quality Education, is one of the most direct, as SL promotes inclusive and equitable education by integrating academic learning with community service, which in turn facilitates the development of socio-emotional competencies, values, and critical skills for the comprehensive training of students. This reinforces the educational approach focused on collective well-being and respect for human rights, aligned with transformative education. SL is also closely linked to SDG 17, "Partnerships for the goals", due to its collaborative approach. The success of SL depends on cooperation between various entities: universities, communities, NGOs, companies, and local governments. This collaborative network fosters synergies and the creation of alliances that jointly address social and environmental challenges (Rodríguez-Izquierdo, 2023; Salam et al., 2019). However, and despite the fact that the links between the different SDGs may not be directly evident (Vladimirova & Le Blanc, 2016), the SDG agenda explicitly emphasizes the importance of interdependencies both between and within the SDGs. The SDGs are conceived as an indivisible and integrated set that must be addressed in a balanced way, recognizing the interrelationships between them and between their social, environmental, and economic dimensions (Griggs et al., 2017; Kestin et al., 2017; Kroll et al., 2019; Leal-Filho, 2020).

Furthermore, SL is connected to ESD in that both approaches pursue the acquisition of knowledge and values oriented towards social action and environmental improvement. According to Eriksen (2013), ESD promotes the teaching of values such as equity, social justice, and citizen participation, principles that are also at the base of SL. This makes SL an educational practice that, while developing academic skills, encourages social responsibility and active participation in building a more equitable and sustainable society. Thus,

at the 2009 World Conference on Higher Education, held at UNESCO Headquarters in Paris (Ten, 2023; UNESCO, 2010), the role of higher education institutions in serving the community was highlighted, and they were encouraged to promote critical thinking and active citizenship through an interdisciplinary approach, responding to and anticipating the needs of society, and thus contributing to sustainable development.

ESD involves integrating the three fundamental pillars of sustainable development into educational processes: environment, economy, and society. This is achieved through empowerment and the promotion of democratic participation that harmonizes economic, environmental, and social aspects. In this context, it is essential to emphasize the transversal dimension that education constitutes (represented in Figure 1), given its key role in sustaining and balancing these pillars (Ekpiken & Ukpabio, 2015; Biasutti & Frate, 2017; Martín Bautista-Cerro et al., 2023). In this way, ESD becomes an integral element of the SDG regarding quality education and decisively enables the achievement of all other SDGs (Acosta-Castellanos & Queiruga-Dios, 2022). Thus, ESD must focus on the individual transformation of each student, providing them with the necessary knowledge to develop an awareness of various realities; fostering the capacity for critical analysis to understand their complexities; and promoting life experiences that facilitate an empathetic connection with different situations. In this way, both cognitive and socio-emotional learning will be promoted, together with training aimed at community participation and active citizenship. Therefore, it is necessary to incorporate the concept of SD in all learning opportunities to shape the attitude and behavior of individuals and society as a whole, requiring an assessment of the degree of change in attitude and behavior in the lives of communities and individuals at the local level (UNESCO, 2005, 2019, 2020). In this research, the Biasutti and Frate (2017) ASD questionnaire will be used.

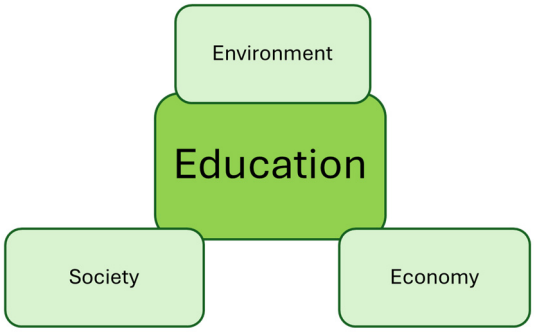

Figure 1. Pillars of ESD. Own elaboration.

3. Methodology

3.1. Sample and Context

The sample was selected using convenience sampling. The participants were 44 students (34 women and 10 men) from the Faculty of Education. This research is based on a quantitative approach and follows a pretest-posttest design with no control group.

The SL project presented as a case study was implemented in the EE subject, corresponding to the fourth year of Primary Education Degree. The SL design was made considering the needs detected in educational centers and in associations related to the teaching of EE from a SD orientation. This is a semester-long subject with a teaching load of 125 h. The curricular content of the course program covers fundamental topics such as the basic aspects of ecology and the environment, ecosystems, and biodiversity, the structure of the Earth and its layers, as well as the main environmental problems. In addition, it includes the analysis of the causes and consequences of these problems, research into them, and the design of environmental projects applicable to the primary education classroom.

The teaching-learning objectives of this subject are to identify the problems that affect the environment both locally and globally; to understand the interrelations between society, science, and nature and their role in building a sustainable environment; as well as to develop the ability to critically analyze environmental problems and propose possible solutions. Given the subject's focus on the training of preservice teachers, students are expected to acquire the necessary skills to design viable and transdisciplinary teaching sequences around EE (Diez-Ojeda et al., 2024a, 2024b).

Among the teaching-learning objectives pursued by the EE subject, the knowledge of the SDGs and the identification of situations to be addressed in the classroom stand out. In addition, it is sought that students acquire teaching-learning strategies that promote critical analysis and problem-solving skills in their future students, using the SL methodology indicated in the subject program. The skills that students are expected to develop are the following:

- Identify the most relevant environmental problems.
- Recognize the interrelations between society, science, and nature to contribute to sustainable development.
- Explain environmental problems (causes, consequences, and solutions) by designing and presenting projects.
- Apply the knowledge acquired in their future profession, demonstrating skills by developing and defending solid arguments, as well as solving problems in their field of study.
- Collect and interpret relevant data to formulate informed judgments, incorporating reflection on social, scientific, and ethical aspects.
- Communicate information, ideas, problems, and solutions clearly and effectively to both specialized and non-specialized audiences.

For students to achieve the competencies defined in the course program, they were assigned the task of designing learning scenarios in EE, with the intention of implementing them in educational centers through a SL program. These scenarios had to be contextualized around the SDGs. Among the 17 SDGs, those that have a direct relationship with environmental issues were selected, specifically:

- SDG 6: Clean water and sanitation.
- SDG 7: Affordable and clean energy.
- SDG 13: Climate action.
- SDG 14: Life below water.
- SDG 15: Life on land.

The selection of these SDGs is based on their thematic relevance to the EE subject and their direct connection with the environmental issues addressed in the classroom. To develop the activity, eight working groups were organized, made up of four or five students, in charge of designing a learning scenario that would favor the acquisition of significant learning in relation to environmental problems related to the selected SDGs. The planning of these scenarios was based on the Experiential Learning Theory (Hung et al., 2023; Kolb, 1984; Kolb et al., 2000; Narong & Hallinger, 2023), used as a pedagogical framework in the design of learning environments in scientific disciplines (Lehane, 2020) and in the field of EE (Diez-Ojeda et al., 2024a, 2024b; Moseley et al., 2020). This theory emphasizes learning through experience from an integrative perspective, with the purpose of students developing problem-solving skills. Based on Dewey's pedagogy (Dewey, 1938; Narong & Hallinger, 2023; Queiruga-Dios et al., 2021; Sotelino-Losada et al., 2021), the theory of experiential learning is structured around two essential processes: the experience of living

and critical reflection on it, which allows for a deeper and more critical understanding of the content worked on.

For the development of teaching-learning activities focused on a specific SDG, students were given the following instructions:

- Linked to the curriculum: The activities must be in line with both the educational curriculum of the school stage where it will be implemented and with the study plans of the participating school or association.
- Context and duration of implementation: The learning activities will be carried out in an educational centre or association and will have a total duration of 2 h.
- Incorporation of scientific elements: The design of learning activities must integrate scientific concepts and phenomena, which must be addressed through manipulative experiences that facilitate the understanding of the scientific foundations underlying environmental problems. These experiences must allow the construction of knowledge from direct observation and experimentation, promoting a deep understanding of natural processes and their relationship with environmental challenges.
- Global understanding: The design of learning scenarios should facilitate a comprehensive understanding of environmental systems and their interrelations, promoting a holistic view of environmental problems and solutions.
- Social impact: It is necessary to integrate educational components that make explicit the impact of environmental problems on human life, highlighting the social, economic, and health implications associated with these problems.
- Encouragement of debate and reflection: It should encourage debate and critical reflection, stimulating the active search for solutions and promoting student commitment to the topics addressed.

Subsequently, a draw was held to assign the SDGs to the different teams of students. The teams were given four sessions of two hours each to develop their projects, during which they received advice and guidance from the teacher. These sessions took place in the laboratory, a space designed to facilitate collaborative work and equipped with the necessary material for practical activities. The students used their own laptops to search for information, record activities and data, and prepare materials and presentations. In addition, the students must work on their projects outside the classroom. In this way, students have a space to work and interact with the teacher during the sessions and can adjust to the workflow by doing work at home. The teams were free to select the most appropriate activities, always in accordance with the established conditions. Later, in a fifth session, the activities were implemented in an educational center or in an Association. The workflow followed throughout the sessions is shown in Table 1.

Table 1. Workflow of sessions.

Session	Work Description
1	Presentation of the SL project. Assignment of SDGs to each team. Search for information on environmental issues.
2	Design of materials or scientific experiments related to environmental problems.
3	Analysis: global effect of environmental problems, impact on society, relationship with other SDGs. Development of teaching materials for transposition to the primary classroom.
4	Review and conclusion of the work: presentation in the classroom and feedback from classmates and teacher.
5	Implementation of teaching-learning activities.

Thus, in session 1, students are told what an SL project is, and they are informed that they are going to design a SL project. They are also given the instructions and conditions that the project must meet. Work teams are formed, and each team is assigned an SDG. Each working team is also given the characteristics of the target audience to which they should direct their intervention. Throughout this and the following sessions, there is continuous feedback from the teacher. The teacher answers questions from all the teams and makes suggestions. Sometimes, the teacher requires the attention of all the students to provide information that can be useful for all the teams. Afterwards, the students have time to search for information and guide their work (Figure 2).

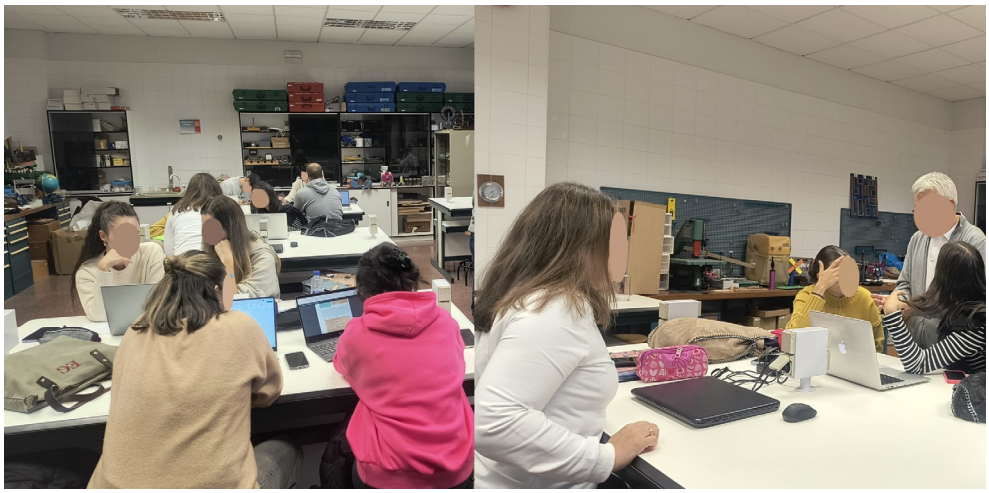

Figure 2. Students work in teams and receive continuous feedback from the teacher.

In session 2, students work in the laboratory with their laptops. They must design simple scientific experiments that are related to an environmental problem in connection with their SDG. The laboratory has materials to carry out experiments and, if required by a team, the teacher can provide the specific materials they need. Students can recreate experiments in the laboratory, or they can prepare them at home.

In session 3, students look for the relationship between local environmental problems and the global impact and how it affects society and how the achievement of the Goal they have assigned affects other Goals, based on the scientific experience they have designed. So, for example, if students wanted to conduct an experiment to model the effect of increased water acidity has on marine life, in relation to SDG 14 "Life below water", they would also know the effects that this environmental problem has on humans, ecosystems, or economies, and which other SDGs it most directly affects. This will allow the students to learn about the connection between the SDGs and, therefore, they will be able to teach their future students about these connections. In addition, during this session, the teams prepare all the materials needed to implement the learning sequences (e.g., posters, models, or workbooks).

In session 4, the final review of the work takes place. All the teams present the work and materials developed and explain how they will be implemented in the classroom. They then receive feedback from their peers and the teacher.

Finally, during session 5, the students must put their teaching-learning activities into practice in the corresponding school or association. This phase is detailed below.

The implementation of the activities by the preservice teachers' teams at the educational center or association, during a two-hour session, was organized following the workflow detailed in Figure 3.

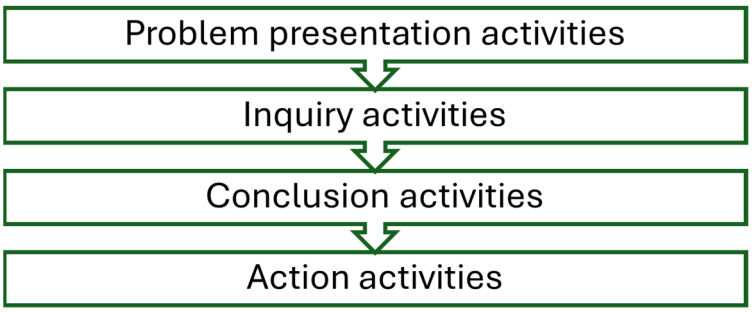

Figure 3. Flow of implementation of activities.

As an example, activities adapted to environmental themes linked to SDG 13, Climate Action, are described below:

- Problem-solving activities: The preservice teachers presented a self-made model of different ecosystems. Through questions, the children were asked to identify relationships between ecosystems and reflect on the factors that can lead to increased temperatures and their influence on natural systems. Although the conclusions were simple, the main objective was for the students to understand the interconnectedness of the planet and the global effects of environmental changes. It was also intended to provide a preparatory context for the questions they would ask during the inquiry activities.
- Inquiry activities: Two inquiry experiments were conducted so that students could explore how certain factors affect the climate and some of the consequences of rising temperatures:
    1. Effect of CO_2 concentration on the greenhouse effect: This activity consists of measuring how the greenhouse effect increases as the concentration of carbon dioxide increases. To do this, a glass of water and a thermometer are placed in an airtight container, and the same is done with another glass of water and its thermometer, placing it in a container identical to the previous one, but in which a carbon dioxide atmosphere has been generated (by making acetic acid react with sodium bicarbonate). Both containers are placed in the sun or under a high-intensity light source. Observation of the thermometers allows participants to draw conclusions.
    2. Rising water temperature: In this experiment, a specific volume of water was measured and then heated until it was close to boiling point. During the process, it was observed that the volume of water increased as the temperature rose. This phenomenon led the students to conclude that warming causes water to expand. A debate was then opened on the effects of rising temperatures on the oceans, with particular emphasis on how this warming contributes to rising sea levels, an environmental problem related to climate change.
- Conclusion activities: Based on the previous activities and through directed questions, students were guided to identify the relationships between the increase in global temperature and its effects on human life and ecosystems.
- Action activities: Finally, students were invited to reflect on individual actions that could mitigate the effects of climate change, formulating and discussing proposals. Some of these ideas were selected, some of which were suggested by the preservice teachers, and a collective commitment was drawn up to promote respectful attitudes towards the marine environment, concluding with the creation and signing of a manifesto in defense of the fight against climate change.

3.2. Instruments

All the participants were informed of the objectives of the study, and they provided their full permission for the case study to be published.

The rubric of Rubio-Serrano et al. (2015) was used to assess the Service-Learning project. This rubric includes 11 dimensions related to the project's purpose (social needs, service, social meaning, and learning), the formative aspects (participation, group work, reflection, recognition, and evaluation), and the logistical and institutional aspects (partners, consolidation, and institutions). Each dimension can be assessed at four levels according to the degree of development achieved by that dimension in the project.

To measure ASD, the Biasutti and Frate (2017) questionnaire was used. The questionnaire uses a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). This instrument is detailed in Table 2. It offers a significant advantage over previous questionnaires, since, in addition to addressing the three classic dimensions of environment, economy, and society (Michalos et al., 2011; Olsson et al., 2016; UNESCO, 2006), it incorporates the educational dimension as a transversal pillar. Its structure of twenty items, five for each of the four dimensions, facilitates its application, in addition to having been validated with a university population, which makes it particularly suitable for the context of this study.

Table 2. Biasutti and Frate (2017) ASD questionnaire.

Dimensions	Item Code	Item
Environment	E.1	When people interfere with the environment, they often produce disastrous consequences.
	E.2	People's quality of life is directly linked to environmental protection.
	E.3	Biodiversity should be protected at the expense of industrial agricultural production.
	E.4	Infrastructure development is less important than environmental protection.
	E.5	Environmental protection is more important than industrial growth.
Economy	Ec.1	Government economic policies should increase sustainable production even if it means spending more money.
	Ec.2	People should sacrifice more to reduce economic differences between populations.
	Ec.3	Government economic policies should increase fair trade
	Ec.4	Government economic policies should act if a country is wasting its natural resources.
	Ec.5	Reducing poverty and hunger in the world is more important than increasing the economic well-being of the industrialized countries.
Society	S.1	Each individual should do a lot to keep the peace in the country.
	S.2	The society should further promote equal opportunities for males and females.
	S.3	The contact between cultures is stimulating and enriching.
	S.4	The society should provide free basic health services.
	S.5	The society should take responsibility for the welfare of individuals and families.
Education	Ed.1	Teachers in educational institutions should use student-centered teaching methods.
	Ed.2	Teachers in educational institutions should promote future-oriented thinking in addition to historical knowledge.
	Ed.3	Teachers in educational institutions should promote interdisciplinary between subjects.
	Ed.4	Teachers in educational institutions should promote the connection between local and global issues.
	Ed.5	Teachers in educational institutions should promote critical thinking rather than lecturing.

3.3. Data Analysis

The assessment of the SL project involved the participation of two external experts of the Service-Learning Program of the University of Burgos. These experts, through analysis of the project design and interviews with the student teams, completed the evaluation rubric (Rubio-Serrano et al., 2015), awarding their grades independently. Subsequently, the experts met with one of the authors to clarify certain aspects of the process and reach a final consensus on the evaluation of the project.

A before-and-after quasi-experimental design without a control group was applied. Data analysis was conducted using the SPSS v.25 statistics package, which calculated the mean, the standard deviation (sd), skewness, kurtosis, *t*-student (*t*-test for independent samples to know the influence of the gender variable and *t*-test for related samples between the pretest and the posttest), and the Cohen's *d* coefficient. Because the sample are less than 50 individuals, the Shapiro–Wilk test was applied to determine if the data shows a normal distribution (de Souza et al., 2023; Royston, 1983). The Shapiro–Wilk test indicated that the difference between the data sample and the normal distribution is not statistically significant ($W(44) = 0.9534$, $p = .0734$; Skewness = 0.1558; Excess kurtosis = −0.07747). Levene's test confirmed that in all cases the variances between the groups are equal ($F = 3.04331$; $p > .05$). Subsequently, the *t*-test for independent samples was carried out to determine the influence of the gender variable. To determine the effect of the designed intervention program, a *t*-student test for related samples was carried out (Hernández-Sampieri et al., 2015) and the effect size was calculated (Cohen's *d*), taking into account that *d* between 0.2 and 0.3 represents a small effect value; $d = 0.5$ means a medium effect value; and $d \geq 0.8$ represents a large effect value (Cohen, 1992).

4. Results

To determine whether the designed project meets the specifications to be a SL project, the evaluation rubric of Rubio-Serrano et al. (2015) was used. Figure 4 shows the result of the project evaluation in each of the items assessed, using the spider chart to represent the results of the rubric.

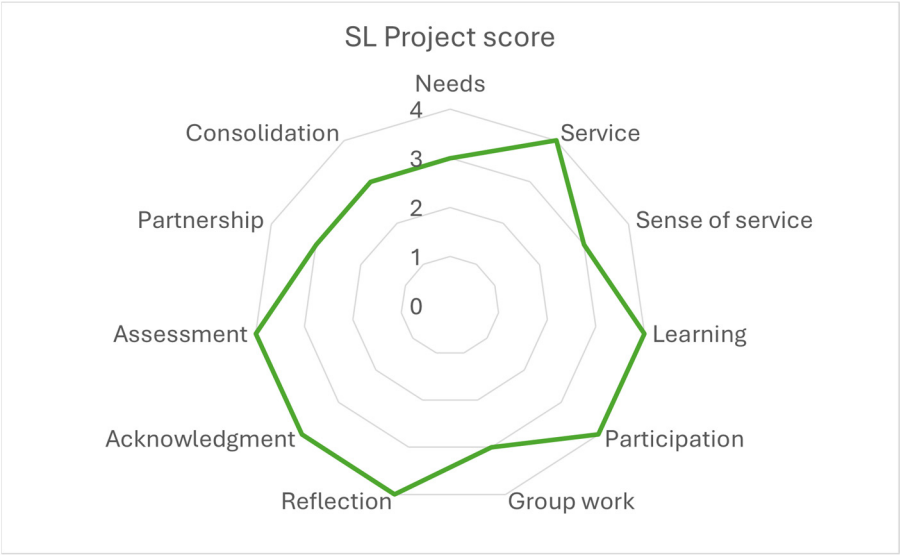

Figure 4. Spider chart with the result of the SL project assessment.

The rating of all items shows a score of 3 or 4, with the items of Service, Learning, Participation, Reflection, Acknowledgment, and Assessment reaching the maximum score of the rubric, indicating an appropriate design for the SL project.

The results of the descriptive analysis (mean, standard deviation) for the pre-test and the post-test can be seen in Table 3.

Table 3. Descriptive statistics.

	Pre-Test		Post-Test	
Dimensions	**Mean**	**sd**	**Mean**	**sd**
Environment	3.44	0.24	3.97	0.24
E.1	2.61	0.49	3.21	0.46
E.2	3.93	0.81	4.39	0.49
E.3	3.18	0.50	3.73	0.66
E.4	3.77	0.42	4.25	0.44
E.5	3.68	0.52	4.30	0.46
Economy	3.76	0.51	4.26	0.26
Ec.1	3.73	0.59	4.18	0.39
Ec.2	3.71	0.51	4.23	0.42
Ec.3	3.71	0.55	4.27	0.45
Ec.4	3.80	0.59	4.27	0.45
Ec.5	3.84	0.65	4.32	0.47
Society	4.27	0.35	4.51	0.30
S.1	3.91	0.64	4.39	0.49
S.2	4.34	0.48	4.55	0.50
S.3	4.46	0.50	4.66	0.48
S.4	4.50	0.51	4.71	0.46
S.5	4.16	0.37	4.27	0.45
Education	4.11	0.20	4.38	0.25
Ed.1	3.64	0.53	4.11	0.32
Ed.2	4.05	0.57	4.27	0.45
Ed.3	4.32	0.47	4.43	0.50
Ed.4	4.18	0.39	4.57	0.50
Ed.5	4.39	0.49	4.50	0.50
Total	3.89	0.19	4.28	0.14

Note. s.d. = standard deviation.

The results of the descriptive analysis show initial scores that exceed the mean score for each item, with an increase in mean values in all dimensions after the intervention. The magnitude of this change is detailed below. Thus, assuming normality of the sample, the *t*-student test for independent samples was used to compare the mean scores as a function of on gender (Table 4).

Table 4. *t*-Student test for independent samples for gender.

	Pre-Test			Post-Test		
Dimensions	***t***	**df**	***p***	***t***	**df**	***p***
Environment	0.06	41	.478406	1.33	41	.09624
E.1	−0.87		.206482	−1.63		.055881
E.2	0.30		.384142	0.10		.461025
E.3	0.13		.448374	−0.69		.247141
E.4	0.23		.410039	0.41		.343169
E.5	0.13		.450649	0.81		.210784
Economy	0.18		.429993	−0.48		.316411
Ec.1	0.44		.330072	0.17		.434579
Ec.2	−0.03		.487421	−0.23		.410039
Ec.3	−0.03		.488416	−0.58		.283775
Ec.4	0.03		.489207	0.26		.415269
Ec.5	0.33		.372964	0.62		.269233

Table 4. *Cont.*

	Pre-Test			Post-Test		
Dimensions	***t***	**df**	***p***	***t***	**df**	***p***
Society	1.56		.063178	1.52		.067715
S.1	1.07		.144414	0.83		.206482
S.2	1.20		.118500	1.11		.137369
S.3	1.04		.152183	1.06		.147906
S.4	0.71		.241703	0.74		.231676
S.5	1.39		.086746	1.02		.157562
Education	1.58		.060322	0.98		.165205
Ed.1	−0.24		.404568	−0.15		.440327
Ed.2	0.34		.367235	1.02		.157562
Ed.3	0.62		.269233	0.49		.315047
Ed.4	1.09		.140501	0.95		.174974
Ed.5	1.59		.05993	1.44		.078617

$p < .05$; *Note.* t = t-test statistics; df = degrees of freedom; p = p-value.

The results show that there are no significant differences based on the gender variable ($p < .05$) in either the pre-test or the post-test; therefore, the sample will be treated as if it were a single group.

To analyze the change in environmental attitudes in students, the t-test for related samples was performed between the results of the pre-test and the post-test. In addition, Cohen's d was obtained. The results are shown in Table 5.

Table 5. t-Test results for paired samples on pre-test and post-test and effect size.

Dimensions	***t***	**df**	***p***	***d***
Environment	15.12	43	<.00001	2.21
E.1	6.72		<.00001	1.27
E.2	5.99		<.00001	0.69
E.3	6.60		<.00001	0.94
E.4	6.27		<.00001	1.12
E.5	8.26		<.00001	1.26
Economy	7.60		<.00001	1.24
Ec.1	5.99		<.00001	0.90
Ec.2	5.52		<.00001	1.11
Ec.3	6.43		<.00001	1.11
Ec.4	5.04		<.00001	0.90
Ec.5	5.04		<.00001	0.85
Society	7.33		<.00001	0.74
S.1	5.37		<.00001	0.84
S.2	3.33		.00181	0.43
S.3	3.33		.00181	0.41
S.4	3.33		.00181	0.43
S.5	2.35		.02355	0.27
Education	8.32		<.00001	1.19
Ed.1	6.27		<.00001	1.07
Ed.2	3.56		.00093	0.43
Ed.3	2.35		.02355	0.23
Ed.4	5.20		<.00001	0.87
Ed.5	2.35		.02355	0.22
Total	15.54		<.00001	2.34

$p < .05$; *Note.* t = t-test statistics; df = degrees of freedom; p = p-value; d = Cohen's d.

The results show a significant difference between the pre-test and the post-test for all items, for each dimension, and for the total. A large effect size is also observed for the

dimensions *Environment* ($t(43) = 15.12$, $p < .00001$, $d = 2.21$), *Economy* ($t(43) = 7.60$, $p < .00001$, $d = 1.24$), and *Education* ($t(43) = 8.32$, $p < .00001$, $d = 1.19$), while for *Society* ($t(43) = 7.33$, $p < .00001$, $d = 0.74$) there is a moderate-high effect size. In addition, most items show a large effect size, so those that obtain an effect size smaller than the value considered as the average effect are indicated ($d = 0.5$). These are within the dimensions of *Society* and *Education*: S.2 ($t(43) = 3.33$, $p = .00181$, $d = 0.43$), S.3 ($t(43) = 3.33$, $p = .00181$), S.4 ($t(43) = 3.33$, $p = .00181$, $d = 0.43$), S.5 ($t(43) = 2.35$, $p = .02355$, $d = 0.27$), Ed.2 ($t(43) = 3.56$, $p = .00093$, $d = 0.43$), and Ed.5 (t(43) = 2.35, $p = .02355$, $d = 0.22$).

5. Discussion

This research shows the design of a program for the EE subject of preservice teachers that incorporates the four pillars of ESD, environment, economy, society, and education (Ekpiken & Ukpabio, 2015; Biasutti & Frate, 2017), through the SL pedagogy. The planning of the activities was based on the Theory of Experiential Learning (Hung et al., 2023; Kolb, 1984; Kolb et al., 2000; Narong & Hallinger, 2023), used as a pedagogical framework in the design of learning environments in scientific disciplines (Lehane, 2020) and in the field of EE (Diez-Ojeda et al., 2024a, 2024b; Moseley et al., 2020).

The assessment of the developed SL projects obtains favorable ratings in the evaluation rubric (Rubio-Serrano et al., 2015). This ensures that the SL project has a correct definition, planning, and structure in the areas of service, learning, and sustainability. Thus, it facilitates the learning and development of skills of preservice teachers, involves different external agents (educational center, associations), and has an orientation towards community benefit, in particular towards children's learning in SD aspects. It also includes project evaluation mechanisms and moments dedicated to reflection, both by the preservice teachers during the development of the activities and by the children who receive the benefits (Furco, 1996; O'Connor, 2012; Olberding & Hacker, 2015; Queiruga-Dios et al., 2021; Rubio-Serrano et al., 2015; Salam et al., 2019).

Regarding ASD, the initial scores can be considered high, since they are above the average score of the scale, and are slightly higher than those found in other studies on preservice teachers (Nousheen et al., 2020), and similar to those found by Biasutti and Frate (2017) in their study conducted by undergraduate students of different degrees (agriculture, engineering, primary education, and psychology). These pretest scores are especially high in the dimensions *Society* (4.27) and *Education* (4.11). After the educational intervention, the mean scores in each of the dimensions rise significantly, being, in this case, *Environment* (3.97), *Economy* (4.26), *Society* (4.51), and *Education* (4.38). Thus, preservice teachers have scored higher in the *Society* and *Education* dimensions compared to *Environment* and *Economy*. This is in line with the study by Biasutti and Frate (2017), which explains the small differences in the mean scores of the dimensions based on the degree that the students are in. For example, psychology students obtained higher scores in the *Social* dimension. However, in the study by Nousheen et al. (2020), after the educational intervention, the preservice teachers obtained the highest score in the dimension of *Environment* (4.43), which could be due to the duration of the course, in this case sixteen weeks, while the development of the entire SL project took a total of five two-hour sessions. This fact, together with the significant changes in environmental attitudes in all items in the project participants, confirms that SL is a pathway to ESD and thus contributes to the achievement the SDGs. This fact is relevant considering the interest of universities in integrating the SDGs (Alcántara-Rubio et al., 2022; Martín Bautista-Cerro et al., 2023) and the few initiatives in higher education that integrate ESD or the education approach for the SDGs into the curriculum (Geng & Zhao, 2020). Thus, the SL is presented as a way to advance SDGs from the EE. Moreover, the large effect sizes obtained also confirm the success of the intervention carried out with

the preservice teachers in improving ASD. This analysis shows that the largest effect size is observed for the dimension *Environment* ($t(43) = 15.12$, $p < .00001$, $d = 2.21$).

In summary, participation in the SL project has allowed future teachers to achieve the academic learning proposed in the course program, such as knowledge of basic aspects of ecology and the environment, analysis of the causes and consequences of environmental problems, research into environmental problems, and the design of educational environmental projects. Furthermore, the development of the SL project, through the sequence of activities, has favored the development of the proposed competences (Diez-Ojeda et al., 2024a, 2024b). In this way, the preservice teachers have been able to identify the main environmental problems of today, and to conceptualize the environment as a set of systems and interactions that make life on the planet possible (Steele, 2010), based on the activities carried out. Also, participation in the project has favored the students' ability to transmit ideas and knowledge to a non-specialized audience, to solve problems, and to ask questions, all of which are academic objectives of the subject. The community has also benefited from the SL project, with an exchange of knowledge and reflections between educational centers and the university, and the improvement of the skills of the agents involved, generating synergies that will give continuity to the project. Finally, the children of primary education level who have participated in the activity have received environmental training that has allowed them to understand some of the environmental problems and how they affect the entire planet, and, at the same time, encouraged them to make a commitment and take action by drawing up and signing of a manifesto.

6. Conclusions

This research addresses the scarcity of scientific studies on the impact of future teachers' participation in SL projects within the SDG framework on improving their ASD. Likewise, the study presents methodological keys to integrate these initiatives into the EE subject curriculum, proposing a basis for a possible framework aligned with ESD. SL activities developed from higher education represent a significant advance towards the SDGs. Furthermore, given that these objectives are interrelated, the design of SL initiatives allows us to comprehensively and flexibly address global challenges from multiple perspectives, aligning higher education with the commitment to sustainability. In this sense, the greatest finding of this research refers to the academic benefits of incorporating SL pedagogy, contextualized in the SDGs, for the promotion of ESD and for the improvement of all ASD dimensions: *Environment*, *Economy*, *Society*, and *Education*.

This study has significant implications for educational policies. In this sense, the authors recommend educational authorities to create institutional frameworks that facilitate the incorporation of SL activities and projects into university educational programs, beyond the EE subject. This would allow the educational advantages that SL pedagogy brings to students, researchers (e.g., improving self-efficacy, self-esteem, motivation towards learning, and skills), and the institution itself (e.g., strengthening the institution's image and increasing student retention) to be integrated into university structures, in turn strengthening ties with society. At the same time, this would be a way to respond to the needs of universities to adhere to the SDGs that would generate an impact on the institution itself, its teachers, and its students, and would also generate an impact on the social environment of the university.

Although the case study presented in this research is a very specific experience of incorporating SL in higher education in the training of preservice teachers, this pedagogy can be incorporated into all university studies and degrees in each of the subjects in real-world contexts, orienting learning towards community service and reflection. To do so, a prior study of the university context is necessary to detect the needs of the communities.

On the other hand, increasing digitalization and increasingly rapid access to large volumes of information allow the concept of community to be expanded, favoring the development of SL projects anywhere on the planet from any location.

This study has some limitations. First, the small sample size of students suggests the need to replicate the study with larger samples and in diverse contexts to obtain more generalizable results. Despite this limitation, the study provides a starting point for future studies exploring the change in ASD in future teachers after participation in SL projects. Furthermore, the specific context of our university limits the generalization of the results to other institutions and countries, so it is advisable to carry out similar research in different academic environments to contrast the findings. Nevertheless, these results may be of interest to researchers and teachers in other contexts, providing an initial basis for future research and experiences in the field of ESD.

As for future lines of research, it is proposed to increase the sample size of teachers in training and design longer SL programs, including field activities, and analyze how this impacts changes in ASD.

Author Contributions: Conceptualization, M.D.-O. and M.Q.-D.; methodology, M.D.-O.; software, M.D.-O. and M.Q.-D.; validation, M.D.-O., M.Q.-D. and M.Á.Q.-D.; formal analysis, M.D.-O.; investigation, M.D.-O. and M.Q.-D.; resources, M.D.-O. and M.Á.Q.-D.; data curation, M.D.-O.; writing—original draft preparation, M.D.-O. and M.Á.Q.-D.; writing—review and editing, M.D.-O., M.Q.-D. and M.Á.Q.-D.; supervision, M.Á.Q.-D.; project administration, M.D.-O. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Bioethics Commission of University of Burgos, with ethics approval reference IO 8/2024.

Informed Consent Statement: Informed consent was obtained from the teachers and students. All of them aged 18 and above, who took part in the study granted explicit consent for the statistical analysis of their data.

Data Availability Statement: Data supporting the results of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Acknowledgments: This study was supported by the Erasmus+ GIRLS project (Ref. 2022-1-ES01-KA220-HED-000089166), co-funded by the European Union. Authors acknowledge students and other colleagues for their support in this research. The authors would like to express their gratitude to the Service-Learning Program of the University of Burgos. The present study is part of the doctoral thesis of María Diez-Ojeda, with title "Didactic approaches for teaching Environmental Education: incorporating citizen science in the Didactics of Experimental Sciences".

Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Acosta-Castellanos, P. M., & Queiruga-Dios, A. (2022). From environmental education to education for sustainable development in higher education: A systematic review. *International Journal of Sustainability in Higher Education*, *23*(3), 622–644. [CrossRef]

Ahmad, I., & Gul, R. (2023). Impact of online service-learning on civic and social justice behavior of undergraduate laboratory-based graduates. *Human Arenas*, *6*(3), 639–654. [CrossRef]

Alcántara-Rubio, L., Valderrama-Hernández, R., Solís-Espallargas, C., & Ruiz-Morales, J. (2022). The implementation of the SDGs in universities: A systematic review. *Environmental Education Research*, *28*(11), 1585–1615. [CrossRef]

Aramburuzabala, P., & Cerrillo, R. (2023). Service-learning as an approach to educating for sustainable development. *Sustainability*, *15*(14), 11231. [CrossRef]

Arnold, M. (2022). Problem-based learning and community engagement: A service-learning project with social pedagogues. In *Hochschullehre erforschen: Innovative impulse für das scholarship of teaching and learning* (pp. 199–214). Springer Fachmedien Wiesbaden. [CrossRef]

Ashida, A. (2023). The Role of Higher Education in Achieving the Sustainable Development Goals. In S. Urata, K. Kuroda, & Y. Tonegawa (Eds.), *Sustainable development disciplines for humanity. Sustainable development goals series*. Springer. [CrossRef]

Basilico, P., & Kelly, L. (2015). Aprendizaje en comunidad: Una herencia latinoamericana. *Actas de la III Jornada de Investigadores Sobre Aprendizaje-Servicio*, *29*, 29–34. Available online: https://www.saltamundoeducativo.com/wp-content/uploads/2018/12/Libro_IIIJIA-S.pdf#page=29 (accessed on 20 November 2024).

Biasutti, M., & Frate, S. (2017). A validity and reliability study of the attitudes toward sustainable development scale. *Environmental Education Research*, *23*(2), 214–230. [CrossRef]

Bringle, R., Hatcher, J., & McIntosh, R. (2006). Analyzing Morton's Typology of Service Paradigms and Integrity. *Michigan Journal of Community Service Learning*, *13*, 5–15. Available online: https://scholarworks.indianapolis.iu.edu/server/api/core/bitstreams/333f814d-16ad-4db2-8ed9-c0f25c1953f5/content (accessed on 20 November 2024).

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155–159. [CrossRef]

de Souza, R. R., Toebe, M., Mello, A. C., & Bittencourt, K. C. (2023). Sample size and Shapiro-Wilk test: An analysis for soybean grain yield. *European Journal of Agronomy*, *142*, 126666. [CrossRef]

Deeley, S. J. (2016). *El aprendizaje-servicio en educación superior. Teoría, práctica y perspectiva crítica*. Narcea.

Dewey, J. (1916). *Democracy and education*. MacMillan.

Dewey, J. (1938). *Experience and education*. MacMillan.

Diez-Ojeda, M., Queiruga-Dios, M., & Queiruga-Dios, M. Á. (2024a). Appreciation of Primary pre-service teachers about the potential educational use of citizen science in Environmental Education. *International Journal of Sustainability in Higher Education*, *25*(9), 474–487. [CrossRef]

Diez-Ojeda, M., Queiruga-Dios, M., & Queiruga-Dios, M. Á. (2024b). Changing Spanish preservice teachers' environmental attitudes with a citizen science program integrated in Environmental Education subject. *European Journal of Education*, *59*(4), e12746. [CrossRef]

Ehrlich, T. (1996). Foreword. In B. Jacoby (Ed.), *Service-learning in higher education: Concepts and practices* (pp. 11–16). Jossey-Bass.

Ekpiken, W. E., & Ukpabio, G. (2015). Environmental literacy awareness and information dissemination among adolescents in Calabar Municipality local government area secondary schools in Cross River State, Nigeria. *Asia Pacific Journal of Education, Arts and Sciences*, *2*(3), 73–79.

Eriksen, K. G. (2013). Why education for sustainable development needs early childhood education: The case of Norway. *Journal of Teacher Education for Sustainability*, *15*(1), 107–120. [CrossRef]

European Commission (EC). (2018). *Council recommendation of 22 May 2018 on key competences for lifelong learning*. 2018/C 189/01-13. European Council. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018H0604(01) (accessed on 20 November 2024).

European Environment Agency (EEA). (2023). *Exiting the Anthropocene? Exploring fundamental change in our relationship with nature*. Publications Office of the European Union. Available online: https://data.europa.eu/doi/10.2800/37883 (accessed on 20 November 2024).

Faulconer, E., & Kam, C. J. Y. (2023). Service-learning in undergraduate general chemistry: A review. *Journal of Experiential Education*, *46*(1), 32–51. [CrossRef]

Felten, P., & Clayton, P. H. (2011). Service-learning. *New Directions for Teaching and Learning*, *2011*(128), 75–84. [CrossRef]

Furco, A. (1996). Service-learning: A balanced approach to experiential education. In *Expanding boundaries: Serving and learning* (pp. 2–6). Corporation for National Service. Available online: https://www.shsu.edu/academics/cce/documents/service_learning_balanced_approach_to_experimental_education.pdf (accessed on 20 November 2024).

General Assembly. (2012). *Resolution adopted by the General Assembly on 27 July 2012*. United Nations. Available online: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_66_288.pdf (accessed on 20 November 2024).

General Assembly. (2015). *Resolution adopted by the general assembly on 25 September 2015 (A/RES/70/1)*. United Nations. Available online: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf (accessed on 20 November 2024).

Geng, Y., & Zhao, N. (2020). Measurement of sustainable higher education development: Evidence from China. *PLoS ONE*, *15*(6), e0233747. [CrossRef]

Giles, D. E., & Eyler, J. (1994). The theoretical roots of service-learning in John Dewey: Toward a theory of service-learning. *Michigan Journal of Community Service Learning*, *1*(1), 7. Available online: https://digitalcommons.unomaha.edu/cgi/viewcontent.cgi?article=1152&context=slceslgen (accessed on 20 November 2024).

Griggs, D. J., Nilsson, M., Stevance, A., & McCollum, D. (2017). *A guide to SDG interactions: From science to implementation*. International Council for Science. Available online: https://pure.iiasa.ac.at/id/eprint/14591/ (accessed on 20 November 2024).

Gutzweiler, R., Pfeiffer, S., & In-Albon, T. (2022). 'I can succeed at this': Engagement in service learning in schools enhances university students' self-efficacy. *Studies in Higher Education*, *47*(12), 2539–2552. [CrossRef]

Hansen, J., Ruedy, R., Sato, M., & Lo, K. (2010). Global surface temperature change. *Reviews of Geophysics*, *48*(4), RG4004. [CrossRef]

Henderson, A. D., & Hall, D. (1946). *Antioch college: Its design for liberal education*. Harper and Brothers.

Hernández-Sampieri, R., Fernández-Collado, C., & Baptista-Lucio, P. (2015). *Metodología de la investigación* (5th ed.). McGraw-Hill Interamericana.

Hung, L. Y., Wang, S. M., & Yeh, T. K. (2023). Kolb's experiential learning theory and marine debris education: Effects of different stages on learning. *Marine Pollution Bulletin*, *191*, 114933. [CrossRef] [PubMed]

IPBES. (2019). *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES secretariat. [CrossRef]

Jacoby, B. (1996). *Service-learning in higher education: Concepts and practices*. Jossey-Bass.

Kestin, T., van den Belt, M., Denby, L., Ross, K., Thwaites, J., & Hawkes, M. (2017). *Getting started with the SDGs in universities: A guide for universities, higher education institutions, and the academic sector*. Sustainable Development Solutions Network—Australia/Pacific. Available online: https://ap-unsdsn.org/wp-content/uploads/University-SDG-Guide_web.pdf (accessed on 20 November 2024).

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2000). Experiential learning theory: Previous research and new directions. In R. J. Sternberg, & L. F. Zhang (Eds.), *Perspectives on cognitive, learning, and thinking styles*. Lawrence Erlbaum.

Kroll, C., Warchold, A., & Pradhan, P. (2019). Sustainable Development Goals (SDGs): Are we successful in turning trade-offs into synergies? *Palgrave Communications*, *5*, 140. [CrossRef]

Kuh, G. D. (2012). High-impact educational practices: What they are, who has access to them, and why they matter. *Peer Review: Emerging Trends and Key Debates in Undergraduate Education*, *14*(3), 28–29.

Leal-Filho, W. (2020). Accelerating the implementation of the SDGs. *International Journal of Sustainability in Higher Education*, *21*(3), 507–511. [CrossRef]

Lehane, L. (2020). Experiential Learning—David A. Kolb. In B. Akpan, & T. J. Kennedy (Eds.), *Science education in theory and practice: An introductory guide to learning theory* (pp. 241–257). Springer Texts in Education. Springer. [CrossRef]

Leibniz, C. (Ed.). (2024). *EU climate pact ambassadors—For a sustainable world*. European climate pact. Available online: https://climate-pact.europa.eu/eu-climate-action-academy/resources/sustainable-world_en (accessed on 20 November 2024).

Martín Bautista-Cerro, B., Castillo-Rodríguez, A., & García-Navarro, J. (2023). Contribution of European University Alliances to Education for Sustainable Development and to the SDGs: A Case Study on the Circular EELISA Community. *Sustainability*, *15*(23), 16181. [CrossRef]

Michalos, A. C., Creech, H., McDonald, C., & Kahlke, P. M. H. (2011). Knowledge, attitudes and behaviours. Concerning education for sustainable development: Two exploratory studies. *Social Indicators Research*, *100*, 391–413. [CrossRef]

Moseley, C., Summerford, H., Paschke, M., Parks, C., & Utley, J. (2020). Road to collaboration: Experiential learning theory as a framework for environmental education program development. *Applied Environmental Education & Communication*, *19*(3), 238–258. [CrossRef]

Moyano, N., Quílez-Robres, A., & Cortés Pascual, A. (2020). Self-esteem and motivation for learning in academic achievement: The mediating role of reasoning and verbal fluidity. *Sustainability*, *12*(14), 5768. [CrossRef]

Narong, D. K., & Hallinger, P. (2023). A Keyword Co-Occurrence Analysis of Research on Service Learning: Conceptual Foci and Emerging Research Trends. *Education Sciences*, *13*(4), 339. [CrossRef]

National Academy of Sciences (NAS). (2020). *Climate change: Evidence and causes: Update 2020*. The National Academies Press. [CrossRef]

Nousheen, A., Zai, S. A. Y., Waseem, M., & Khan, S. A. (2020). Education for sustainable development (ESD): Effects of sustainability education on pre-service teachers' attitude towards sustainable development (SD). *Journal of Cleaner Production*, *250*, 119537. [CrossRef]

O'Connor, A. (2012). Beyond the four walls: Community-based learning and language. *The Language Learning Journal*, *40*(3), 307–320. [CrossRef]

Olberding, J. C., & Hacker, W. (2015). Does the "service" in service learning go beyond the academic session? assessing longer term impacts of nonprofit classes on community partners. *The Journal of Nonprofit Education and Leadership*, *6*(1), 25–46. [CrossRef]

Olsson, D., Gericke, N., & Chang Rundgren, S. N. (2016). The effect of implementation of education for sustainable development in Swedish compulsory schools–assessing pupils' sustainability consciousness. *Environmental Education Research*, *22*(2), 176–202. [CrossRef]

Queiruga-Dios, M., Santos Sánchez, M. J., Queiruga-Dios, M. Á., Acosta Castellanos, P. M., & Queiruga-Dios, A. (2021). Assessment methods for service-learning projects in engineering in higher education: A systematic review. *Frontiers in Psychology*, *12*, 629231. [CrossRef]

Rodríguez-Izquierdo, R. M. (2023). *Aprendizaje-servicio (ApS) como metodología catalizadora para la consecución de los objetivos de desarrollo sostenible en educación superior* (pp. 47–51). Organización y Gestión de Instituciones Educativas en Momentos de Cambio: Avances y Desafíos. Available online: https://www.cioie2023.org/archivos/Organizacion-y-gestion-instituciones.pdf#page=47 (accessed on 20 November 2024).

Royston, J. P. (1983). Some Techniques for Assessing Multivarate Normality Based on the Shapiro-Wilk W. *Journal of the Royal Statistical Society Series C: Applied Statistics*, *32*(2), 121–133. [CrossRef]

Rubio-Serrano, L., Puig-Rovira, J. M., Martín-García, X., & Palos-Rodríguez, J. (2015). Analyze, rethink and improve projects: Rubric for self-assessment and enhancement of service learning projects. *Profesorado, Revista De Currículum Y Formación Del Profesorado*, *19*(1), 111–126. Available online: https://revistaseug.ugr.es/index.php/profesorado/article/view/18610 (accessed on 20 November 2024).

Salam, M., Awang Iskandar, D. N., Ibrahim, D. H. A., & Farooq, M. S. (2019). Service learning in higher education: A systematic literature review. *Asia Pacific Education Review*, *20*, 573–593. [CrossRef]

SEI & CEEW. (2022). *Stockholm+50: Unlocking a better future*. Stockholm Environment Institute. [CrossRef]

Sigmon, R. L. (1979). Service-learning: Three principles. *Synergist*, *8*, 9–11. Available online: https://nsee.memberclicks.net/assets/docs/KnowledgeCenter/IntegratingExpEduc/BooksReports/55.%20service%20learning%20three%20principles.pdf (accessed on 20 November 2024).

Sotelino-Losada, A., Arbués-Radigales, E., García-Docampo, L., & González-Geraldo, J. L. (2021). Service-learning in Europe. Dimensions and understanding from academic publication. *Frontiers in Education*, *6*, 604825. [CrossRef]

Steele, R. (2010). *Reorienting teacher education to address sustainable development: Guidelines and tools environmental protection*. UNESCO. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000189062 (accessed on 20 November 2024).

Tapia, M. N., & Ochoa, E. (2015). *Legislación y normativa latinoamericana sobre servicio comunitario estudiantil y aprendizaje-servicio* (pp. 91–95). Actas de la III Jornada de Investigadores sobre Aprendizaje-Servicio. Available online: https://www.clayss.org/wp-content/uploads/2023/07/ESP_JIAS_3-jornada_2015.pdf#page=91 (accessed on 20 November 2024).

Ten, A. S. (2023). El proyecto social como oportunidad del ApS y los ODS. In *El Aprendizaje-Servicio universitario ante los retos de la Agenda 2030* (pp. 427–435). UNED.

UNESCO. (2005). *Draft international implementation scheme for the United Nations Decade of Education for Sustainable Development*. UNESCO. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000139023 (accessed on 20 November 2024).

UNESCO. (2006). *Framework for the UN DESD international implementation scheme*. UNESCO. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000148650 (accessed on 20 November 2024).

UNESCO. (2010). *World conference on higher education: The new dynamics of higher education and research for societal change and development*. UNESCO. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000183277 (accessed on 20 November 2024).

UNESCO. (2017). *Education for sustainable development goals-learning objectives*. UNESCO. [CrossRef]

UNESCO. (2019). *Framework for the implementation of Education for Sustainable Development (ESD) beyond 2019*. UNESCO. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000370215 (accessed on 20 November 2024).

UNESCO. (2020). *Education for sustainable development: A roadmap. Transforming our world: The 2030 agenda for sustainable development A/RES/70/1*. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000374802 (accessed on 20 November 2024).

UNESCO. (2024). *Greening curriculum guidance. Teaching and learning for climate action*. UNESCO. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000390022 (accessed on 20 November 2024).

United Nations Development Programme (UNDP). (2016). *UNDP support to the implementation of the 2030 agenda*. UNDP. Available online: https://www.undp.org/policy-centre/governance/publications/undp-support-implementation-2030-agenda (accessed on 20 November 2024).

Vladimirova, K., & Le Blanc, D. (2016). Exploring links between education and sustainable development goals through the lens of UN flagship reports. *Sustainable Development*, *24*(4), 254–271. [CrossRef]

World Commission on Environment and Development (WCED). (1987). *Our common future. The report of the World Commission on Environment and Development*. Oxford University Press.

Yob, I. M. (2011). Keeping students in by sending them out: Retention and service-learning. *Higher Learning Research Communications*, *4*(2), 1. [CrossRef]