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Service Learning as an Education for Sustainable Development (ESD) Teaching Strategy: Design, Implementation, and Evaluation in a STEM University Course

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Citation: Martín-Sánchez, A.; González-Gómez, D.; Jeong, J.S. Service Learning as an Education for Sustainable Development (ESD) Teaching Strategy: Design, Implementation, and Evaluation in a STEM University Course. *Sustainability* **2022**, *14*, 6965. <https://doi.org/10.3390/su14126965>

Academic Editors: Marc A. Rosen and Jordi Colomer Feliu

Received: 30 March 2022

Accepted: 6 June 2022

Published: 7 June 2022

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Abstract: The continuous deterioration of the environment is one of the major concerns that societies are facing nowadays. As a response to this challenging situation, the general assembly of the United Nations (UN) created the 2030 Agenda, proposing 17 Sustainable Development Goals (SDGs) to foster sustainable development. Thus, the significance of educating in values related to sustainability and care for the environment must acquire a relevant importance in the education system to provide an Education for Sustainable Development (ESD) in Science, Technology, Engineering and Mathematics (STEM). Therefore, it is necessary to incorporate teaching methodologies that are able to connect with students and to generate enriching experiences. In this regard, it can promote knowledge of the environment and provide a service to the community to ensure sustainable development. This research presents the design, implementation and evaluation of a Service Learning (SL) methodology as an ESD strategy in a university course. Precisely, it describes the development and evaluation of an SL project implemented in a general science subject during a 2020/2021 course taught at the Teacher Training College of the University of Extremadura (Spain). A total of 46 students participated in the study on a voluntary basis. A pre- and post-test methodology was used to assess the suitability of SL as an ESD strategy, resulting in a significant increase in the students' knowledge about the innovative teaching strategies to work with suitable contents after the project, as well as in their knowledge about SDGs. Moreover, the students' participation in the SL project made them aware of the community implications in maintaining the environment and generating benefit for the whole community. In addition, this research shows how the SL teaching methodology is an important tool for the achievement of both curricular competences and environmental awareness, since theoretical knowledge is applied to tangible work to perform a real community service, and therefore is a very suitable teaching strategy to be applied in EDS.

Keywords: service learning; sustainability; STEM; heritage; initial teacher training

1. Introduction

Climate change constitutes an important issue among the problems affecting humanity nowadays. The acceleration of this process in recent decades has become a social reality that severely threatens different ecosystems [1], and generates a series of effects that affects the environmental quality [2]. In fact, the high consumption of energy and the depletion of resources that the current economic system demands is generating a problematic situation between economy and environment [3–5]. These practices, far from progressing towards a sustainable model, continued their course, causing irreversible problems in our environment. Therefore, the concept of sustainable development must be considered to change a devastating dynamic between economy development and the destruction of our ecosystems.

In this context, in September 2015, the General Assembly of the United Nations (UN) created the 2030 Agenda, indicating 17 Sustainable Development Goals (SDGs) and 169 targets with an ambitious vision in the economic, social, and environmental spheres. Governments are expected to assume their responsibility by establishing policies and measures for the implementation of the 2030 Agenda [6].

Among the SDGs, the following are the most related to the project described in this research:

SDG 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

SDG 11. Make inclusive, safe, resilient, and sustainable cities and human settlements.

SDG 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable, and inclusive institutions at all levels.

A fundamental tool for the development of a common awareness to sustainable development is working on sustainability concepts from the early educational levels. In fact, Jickling and Wals [7] point out that the challenge that teachers must face is to find a different way of educating our students, searching for strategies and methodologies that connect with the interests and motivation of the student, allowing them to achieve a meaningful learning. In this sense, the Service Learning (SL) methodology can be an important tool to change this situation. The SL methodology combines experiential learning processes that provide a service to the community [8–10]. These direct and/or indirect services involve students in their community, and take them from their own educational environment to their neighbourhood and/or other nearby municipalities [11]. Performing social actions without the search for material incentives increases the probability of generating positive reciprocity in interpersonal and social relationships [12]. Sigmon [13], cited in Sotelino [14] (p. 60), states that there have been many definitions and approaches used in the general framework of joining service and learning, undoubtedly, as Furco and Billig [15] argue, due to the fact that its multidimensional and multidisciplinary nature adds further complexity to its conceptualisation. Thus, SL could be understood as a pedagogy of teaching whereby students acquire a better understanding of academic content by applying skills and knowledge for the benefit of society [15]. Furthermore, it could be defined as an educational proposal that promotes social commitment, combining learning and community service processes in a well-functioning programme where participants are trained by working on actual needs of the environment in order to improve and transform it [16–18].

1.1. SL and Other Experiential Practices

There are many environmental education initiatives that focus on raising the awareness of pupils about environmental issues, but they are limited to the level of commitment, as awareness-raising actions that do not lead to real participation. To clearly recognise the relationship between SL and other experiential practices, Stanford University created SL programmes [19]. An adaptation of this initiative is shown in Figure 1, and is a widely used tool in the academic bibliography to differentiate SL from other experiential practices (volunteering, field work, etc.), with which it is often confused [20], and to identify which aspects need to be introduced to consider these activities as SL actions.

As shown in Figure 1, four types of educational practices can be found. Their recognition makes it possible to clarify their conceptual clarification and steps to follow, which turn each of these experiential practices into an SL proposal. To analyse the differences and similarities between them, the work of Mayor [21], and Montes, Tapia and Yaber [22] is applied.

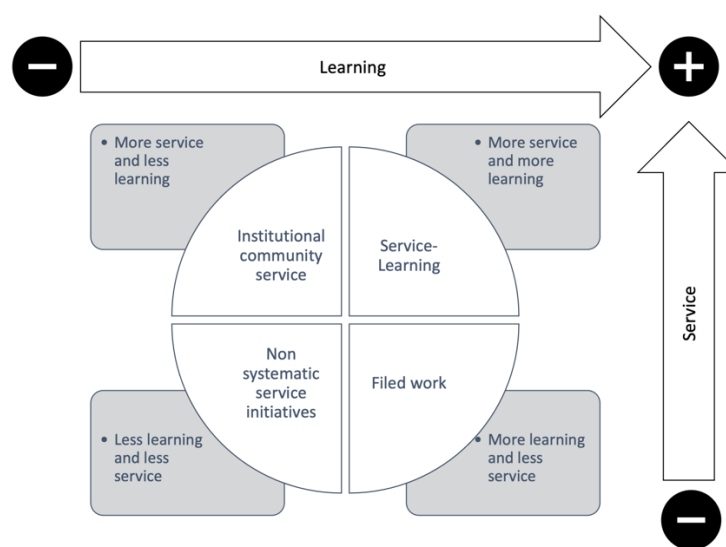


Figure 1. The quadrants of Service Learning (SL) displaying the four types of experiences based on the degree of learning and service reached.

The number of SL projects that have been designed and implemented in recent years has increased in an important way [9]. This increase has allowed us to distinguish large fields of experiential educational practices, and the necessary steps to favour the transition from these educational practices to the formulation of an SL project [21–23]. Thus, to ensure a balance between the curricular or formative learnings and the activities that constitute the service to the community, it is necessary not only to properly design the educational practices, but also the learning activities [9].

The need for a new type of citizen emerging from the universities is defined by a philanthropic profile based on personal responsibilities. For this university-based figure to emerge, learning must balance the academic with the practical [24]. As a result, SL methodology is currently used to connect students' knowledge and skills to provide the service to others, orienting the theoretical aspects, talent, and creativity towards social commitment. Thus, students not only acquire knowledge and exercise their skills, but also contribute to improving aspects of the reality in which they live [16]. From this perspective, SL is a valuable strategy for the inclusion of sustainability in the curriculum at any level of education [24–26].

1.2. SL Methodology in the Study of Science

Over the last years, the number of students taking university studies related to science and the interest of young people in this discipline has decreased significantly. The lack of interest for this discipline is a complex phenomenon and cannot be attributed to a single factor, but rather to multiple factors, such as the social consideration of science and the teaching of science at school [27]. This is causing difficulties in providing a solid scientific knowledge and, therefore, in ensuring a proper scientific literacy in citizens that allows them to participate in the scientific world. Consequently, it is the responsibility of the education system to reverse this situation by advocating methodologies that involve students in their own learning, since, as the National Science Education Standards states, “everyone needs to be able to take part in public discourse and debate on the important issues related to science and technology; and everyone deserves to participate in the excitement and personal satisfaction that learning and understanding the natural world can produce” (p. 32) [28].

One of the biggest difficulties in science teaching lies in the predominance of theory over practice [27], causing an apathy of students towards science and an increase in the lack of interest in science. In this sense, the SL methodology could be an important tool to change this paradigm. SL combines experiential learning processes directed towards

community service, which has shown to increase learning retention, as well as motivation towards school activities. This is, consequently, reflected in higher classroom attendance and an improvement in average grades [8–10]. Besides, positive results are also seen with respect to a higher ability to analyse and synthesise complex information, showing that service learning has an impact on students' academic development [29,30].

The necessity to create a common awareness that can stop the progressive destruction of nature was highlighted over time [31]. Therefore, education should not be placed on the sidelines of this universal problem [32]. In fact, the university, as an open space for thought, reflection, and action, is called to be at the forefront in performing strategies and methods that enable solutions to the multiple challenges at a global and local level [33]. To achieve this goal, different international organisations and programmes, such as The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Environment Programme (UNEP), indicate the importance of intervening at the educational level. Thus, the Education for Sustainable Development (ESD) in Science, Technology, Engineering and Mathematics (STEM) focuses its objectives not only on relating with theoretical aspects, but also on involving citizens through participation. Therefore, ESD combines the promotion of cognitive, socio-emotional, and behavioural learning objectives [6], which is consistent with the new educational paradigm, which understands education as a participatory learning process and a process of construction oriented towards a sustainable ecology [32]. The implementation of the SDGs in education implies the promotion of the development of sustainability competencies, such as critical thinking, ethics and values, and interpersonal skills in students [34–36].

In this context, there are many perspectives and approaches that share the basic aims and principles of ESD, but all agree in the strengthening of civil society [37], i.e., providing participatory structures by conceiving social and educational action as a process of cultural democracy. Nevertheless, as Jickling and Wals [7] state, the real challenge that educators face to achieve a more sustainable future lies in our ability to educate learners differently. In this regard, methodologies such as SL are highlighted. SL, far from being just a tool for educating about and towards sustainability, is also an intrinsically sustainable experience through which students, teachers, and members of the community participate in real, active, and in-depth actions to promote sustainable development.

As a result, the SL methodology is an important tool for the achievement of both curricular competences and environmental awareness, since theoretical knowledge is applied to tangible work to perform a real community service. SL promotes the participants' establishment of links between thought and action, enabling the development of capacities to construct, and applies and transfers knowledge in a meaningful way by placing them in front of problematic situations in their immediate environment, with the intention to promote their active participation in improving them [21].

Only citizen involvement and participation at the local level can broaden horizons, educating towards sustainability and generating sustainable development that goes from the local to the global [38]. Any SL project, regardless of how small it may be, has as its starting point the participation of different entities that coexist in the community. Therefore, SL projects are the backbone of a whole community network that provides a solution to a real problem, acquiring an added value as it conceives communities as a pedagogical resource, promoting development and sustainability as assets in the daily practice of its inhabitants, as socio-educational practices that move from the local to the global. Besides, SL projects offer an opportunity to contribute to the community itself and must also involve the people who are part of it, recognising them as subjects of the action and not as mere objects of attention [31].

1.3. SL Methodology at the University Level

Tackling the lack of motivation among university students is the main challenge facing teachers at this level of education. A way to achieve this goal is implementing a teaching strategy that combines contents and methodology in a practical manner, providing students with the skills and training needed for their future professional career [39].

One way to improve this motivation is to connect theoretical contents with practical situations in which students participate in their own learning. In that way, the interest and the assignment of value to the task make students more cognitively involved [40]. Therefore, the SL methodology contributes to putting the theoretical contents into practice, establishing a connection between the curriculum and the professional reality. The use of SL as an instructional methodology has shown that the students were satisfied with the experience, as they valued it as an advantage in their training, due to being in direct contact with solidarity projects which, in addition to broadening their professional competences, broadened their personal horizons [41]. This being said, and in view of its characteristics and impact on students, SL could be described as a methodology that has attracted the attention of the educational community [42]. This educational community is increasingly focused on bringing theoretical content closer to the realities of the students by creating a new scenario between the university and society, in which the meaning and value of educational practices such as SL, need to be highlighted.

Thus, this research is a descriptive and quantitative evaluation of the students' knowledge of using Service Learning as a teaching methodology for ESD and sustainable education, and their knowledge about SDGs after participating in the SL project as a teaching strategy. In particular, the teaching strategy consisted in the implementation of an SL project through the development of different activities. Accordingly, the hypotheses of this study are:

Hypothesis 1 (H1): *Participating in an SL project allows students to know this methodology and its plausible uses for ESD.*

Hypothesis 2 (H2): *The participation in the proposed SL project increases knowledge about SDGs.*

2. Methodology

2.1. Sample

This research describes the design, implementation, and evaluation of an SL project as an ESD implemented during 2021 in a general science course taught in the Teaching Training School of the University of Extremadura (Spain). Precisely, the research was conducted with pre-service teachers enrolled in the Primary Education programme. A total of 46 students participated in the research on a voluntary basis, with an age range from 19 to 41 years old (mean value 20.2 years old), with a higher proportion of women than men. With regard to the participants' educational background, there were slightly more students with a science background than a social sciences background. Table 1 provides detailed information on the main demographic characteristics of the participating sample.

Table 1. Demographic information of pre-service teachers participating in this research.

N	Gender (%)		Age (%)			Educational Background (%)		
	Male	Female	19–21	22–25	>25	Social Sciences	Science	Technology
46	30.43	69.56	89.13	8.69	2.17	41.32	54.34	4.34

2.2. SL Project as Intervention

The SL project was designed and implemented in a general science subject, compulsory in the Primary Education bachelor's degree at the University of Extremadura (Spain). Among other objectives, this subject seeks to provide pre-service teachers with sustainable

concepts related to resource preservation and environment preservation. In addition, this course deals with training and teaching strategies to apply these concepts with elementary school students. In this case, the teaching strategy implemented was an SL project that students developed during part of the course. Thus, the project lasted two months, in which different activities were implemented depending on the time and knowledge of the students. As it was mentioned before, an SL project is characterized by creating a link between students and their environment. In this case, the interaction of the SL participants (students) and the city of Cáceres was fostered, to work on the preservation of its historical values and environmental protection. The city of Cáceres is among the cities catalogued as World Heritage Sites by UNESCO. Although the city is particularly well-conserved, many places in the old town must be repaired periodically due to vandalism. Therefore, knowing the heritage value of the city and putting the students' work into its dissemination helps young people to protect and enjoy the city of Cáceres in a more sustainable way.

Thus, the SL project was implemented through different activities that took place following the sequence that it is shown in Figure 2.

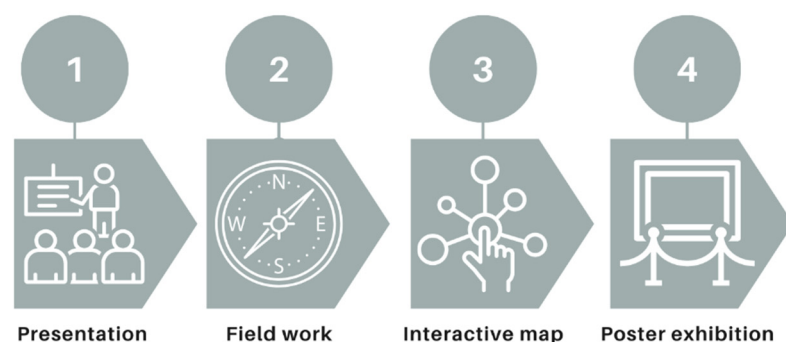


Figure 2. Phases of the project carried out following the SL methodology. Phase 1: Presentation of the project and the SL project; Phase 2: Students' field work about Sustainable Development Goals (SDGs) and the historical town; Phase 3: Students put together all the information and build the service learning goal; and Phase 4: Final discussion and results presentation.

First phase: At the beginning, the basic principles of the SL methodology and its fundamental differences with other experiential practices were explained, as well as a general introduction to the SDGs. For this first activity, the whole group received a lecture with all the activities' details. In addition, students were requested to participate. The whole group took part in this activity and were introduced to the activities that would be developed thereafter, as we must remember that SL projects must be open to the participation and reflection of the students who were involved in them.

Second phase: The students, in a process of enquiry and reflection, had to develop a task that involved studying and visiting the old neighbourhood of the city of Cáceres. Thus, students were able to learn its history, and identify places and situations to work in the context of the SDGs. For the achievement of this activity, students worked in heterogeneous groups. They had to look for information about the cost to the institutions caring for our heritage environment and the numerous acts of vandalism that occur in our city. Once each group had identified different sustainability issues in the city, they were asked to carry out a small project to address them through SL in primary education. In this way, we would ensure that the learners would have an additional tool as future teachers.

Third phase: Following this reflection, in working groups, an interactive map of the old city of Cáceres was created with the help of the Cáceres Historical City Consortium and the City Hall (see Figure 3), which was subsequently disseminated with the aim of raising awareness and valuing our heritage, in order to prevent possible actions that could threaten its conservation. With this activity, students continued working with the same groups, and each of them made a series of videos that were later uploaded to a platform so that the rest of the classmates could watch them. With the information that each group presented in

their videos, a small test was carried out to evaluate the knowledge acquired throughout the project. In addition, once the interactive map was assembled, it was disseminated through social networks and among different entities in Cáceres to raise awareness of the heritage value of the old city of Cáceres.

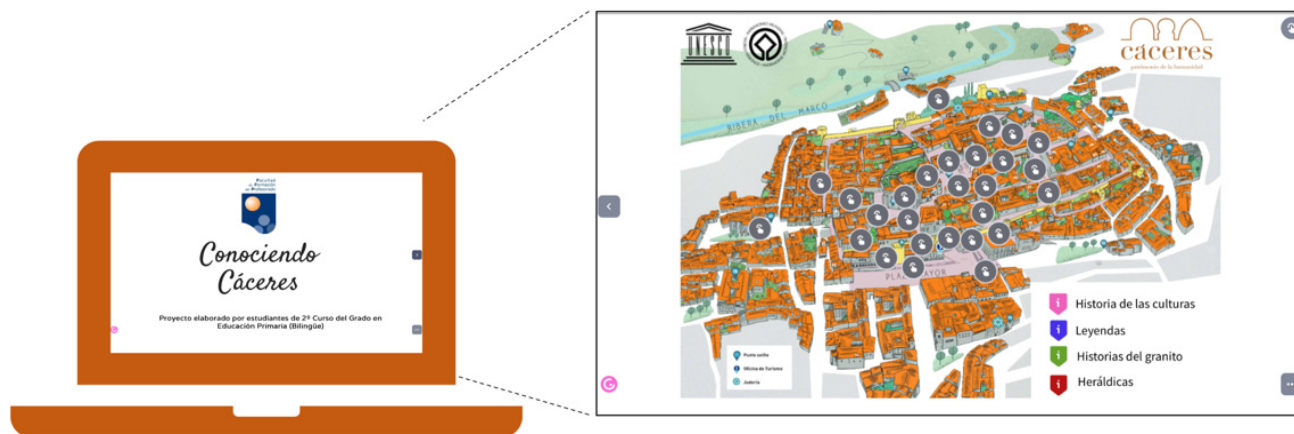


Figure 3. Interactive map of the city of Cáceres. Its location has an interactive video, in which students participating on the SL project explained the relevance of this historical landmark and the relevance of its preservation.

Fourth phase: Finally, students made different panels to disseminate the information about the costs involved in the maintenance of the city and the problems caused by vandalism. These panels were placed throughout the school, so that the rest of the university students could have contact with the reality of the city and the opportunity to critically inform themselves about the needs of the city and its maintenance.

2.3. Instrument

The instrument used to collect data from participants was the questionnaire. The instrument was designed to collect the students' self-assessment of their knowledge about and interest in the teaching methodology implemented that was based on the development and implementation of an SL Project, as well as the students' knowledge about the SDGs and their implementation. The instrument consisted in three sections. The first one was designated to collect the demographic information of the participants. The second one aimed to assess the degree of the participants' knowledge about active teaching methodologies in general, and about SL methodology and its implementation (MK: Methodology Knowledge). This section had a total of 11 items following a five points Likert-type scale (1. Strongly disagree, 2. Disagree, 3. Don't know, 4. Agree, and 5. Strongly agree). Finally, the third part of the questionnaire was intended to assess the students' knowledge about the SDGs and their perception for sustainable development (SDGK: SDG Knowledge). This section consisted of 10 items, again following a five point Likert-type scale (1. Strongly disagree, 2. Disagree, 3. Don't know, 4. Agree, and 5. Strongly agree). The instrument was distributed before the first activity and at the end of the last one, both during class time to encourage maximum student participation. The participation in this research was voluntary and participation consent was obtained before starting. The anonymity of the participants was granted, since no personal and identifying information was obtained from the participants. Finally, before submitting the instrument to the participants, it was validated by means of a panel of experts, and the instrument reliability was measured by means of the Cronbach alpha test. Table 2 summarizes the items used for the second and third sections.

Table 2. Instrument used to collect data from participants regarding the participants' Methodology Knowledge (MK) and SDG Knowledge (SDGK) in this research.

MK Item Questionnaire		SDGK Item Questionnaire	
MK_1	I know the SL methodology.	SDG_1	How familiar are you with the concept of SDGs?
MK_2	I know how to design an educational project with active methodologies.	SDG_2	You have a strong interest in learning about the SDGs.
MK_3	I have sufficient teaching tools/knowledge to teach with innovative methodologies.	SDG_3	I know what the SDGs are.
MK_4	I feel motivated by the tasks I carry out in my teacher training process at the university.	SDG_4	I recognise the necessities of my environment in terms of what the SDGs dictate.
MK_5	I try to involve the community in the educational projects/activities I design.	SDG_5	I am aware of the environmental and heritage problems in my community.
MK_6	I feel calm when I have to make public presentations.	SDG_6	I feel responsible for certain environmental problems around me.
MK_7	I value the city of Cáceres positively.	SDG_7	I participate in activities (e.g., lectures and activities) about sustainability and heritage.
MK_8	I know the history and culture of the city of Cáceres.	SDG_8	I believe that caring for the environment and culture is a high cost for public administrations.
MK_9	I have studied the history and heritage of my city/town throughout my academic training.	SDG_9	I am interested in taking care of my city's heritage.
MK_10	I encourage respect and care for the environment in my teaching activities.	SDG_10	I encourage care for the cultural heritage of my city.
MK_11	I contribute in some way to the care of my city.		

2.4. Statical and Data Analysis

Firstly, a descriptive study of the participant sample was conducted to characterise and describe the study population. Next, prior to the application of the different statistical tests, we analysed both the homogeneity of the sample and the distribution of the data collected (Shapiro–Wilk), concluding that the data were normally distributed and, therefore, parametric tests were applied. To assess the reliability of the instrument, the Cronbach alpha was calculated, which was 0.778 and 0.832 for the second and third part of the instrument, respectively, and therefore the instrument used could be considered reliable. Finally, to assess the influence of the instructions followed (SL methodology) on the different variables studied, a Student's *t*-test was applied. When significant differences were observed, the effect size (Cohen's *d*) was also calculated. For all calculations, the Jamovi 1.6.23 statistical package was used.

3. Results

3.1. Results on Knowledge of SL and Innovative Methodologies

Firstly, before the analysis of the project results, the level of knowledge of the participants in relation to the use of innovative teaching methodologies in general and of SL was analysed. Since the internal reliability of the instrument could be considered as acceptable, a global score for the MK scale was calculated from the second section of the instrument as a summatory of the scores of all individual items of this section of the instrument ($MK_{Total} = \sum_{i=1}^{11} MK_i$). Figure 4 represents the total score before and after the development and implementation of the SL project with the students. As can be seen, a substantial increase was found after implementing the SL project. In fact, the mean value of MK_{Total} after completing the project was 44.9 (std dev = 5.97), whereas the mean value of MK_{Total} before completing the project was 36.9 (std dev = 5.60). A Student's *t*-test showed that the difference among both values was significant ($t(82) = 6.35, p < 0.001, d = 1.34$), suggesting that the implementation of the SL project made a genuine difference in the students' knowledge about active learning methodologies and SL methodology. In addition, the Effect Size ($d = 1.34$) denotes a very high effect.

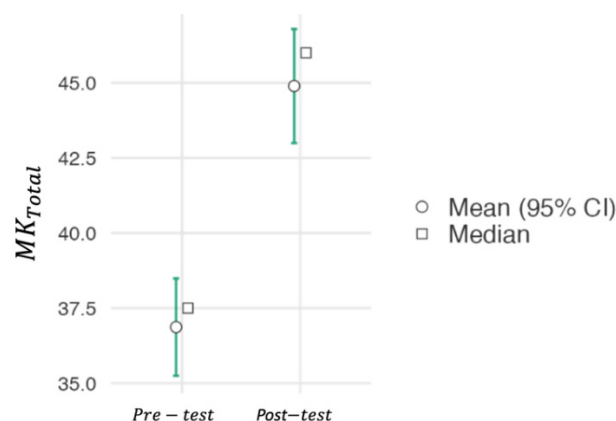


Figure 4. Total score for the MK_{Total} of the participants before (pre-test) and after (post-test) the implementation of the SL project.

3.2. Impact on Knowledge of the SDGs

Another aspect analysed was the extent to which participants were aware of the SDGs. Specifically, Figure 5 summarises the results obtained when participants were asked about the degree of knowledge in relation to the SDGs. As it can be observed in the figure, in all cases, the level of the participants' knowledge about the SDGs increased after the implementation of the designed SL project. A global score for the SDGs scale was calculated as a summatory of the scores of all individual items of this section of the instrument ($SDG_{Total} = \sum_{i=1}^{10} SDG_i$). According to the results, the mean value of SDG_{Total} after completing the Project was 28.8 (std dev = 6.95), whereas the mean value of SDG_{Total} before completing the Project was 37.1 (std dev = 5.71). A Student's t -test showed that the difference among both values was significant ($t(82) = 5.93, p < 0.001, d = 1.30$), suggesting that the implementation of the SL Project made a genuine difference in the students' knowledge about the SDGs. In addition, the Effect Size ($d = 1.30$) denotes a very high effect.

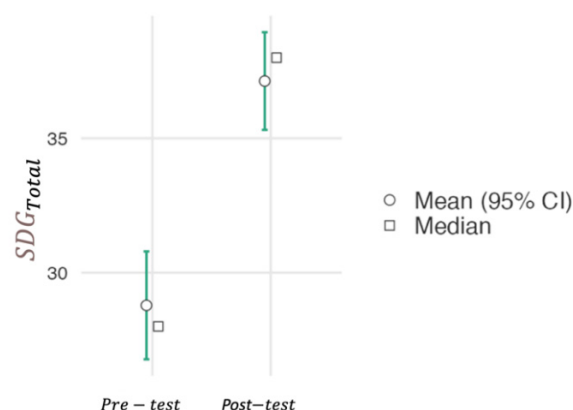


Figure 5. Total score for the participants' SDG knowledge before (pre-test) and after (post-test) the implementation of the SL project.

4. Discussion

The continuous deterioration of our environment is causing a large negative impact on our society that needs to be addressed from different perspectives. Education should not be placed on the sidelines of this universal problem [43]. In fact, different international organisations and programmes, such as UNESCO and the UNEP, indicate the importance of intervening at the educational level [6,32]. Thus, the ESD was set up to involve citizens through participation in educational programmes, in order to foster values and attitudes that enable a more sustainable and fair society for all. Thus, teaching methodologies as SL, which engage students with society by carrying out a service for the community, and

at the same time allow them to achieve the academic and transversal competences, must be highlighted [44]. Thus, SL, far from being just a tool for educating about and towards sustainability, is also intrinsically a sustainable experience through which students, teachers, and members of the community participate in real, active, and in-depth actions to promote sustainable development. SL practices are becoming increasingly important in education systems. Different examples of the success of implementing SL projects for ESD are already available in the literature [45–48].

According to the results obtained in this study, the impact of the implementation of the project has been significant in most of the variables of the study in terms of knowledge of SL and active methodologies. Not only was the effect significant, but also the size of the effect was very large ($d = 1.30$). Thus, the implementation and participation in an SL project could be seen as an appropriate strategy in teacher training [39,49], as the students engage effectively in the learning process. Similar results are also reported for active learning methodologies, such as performing project-based Learning (PBL), and activities that can later be applied in future teaching work [50], among other active methodologies [51–53]. The connection of the students to their community has also proved to engage and motivate them more efficiently in the learning process [54]. In this sense, Castro et al. [55] present different SL projects aimed at providing the students skills for the support of a sustainable society. Their study was carried out with pre-service teacher students, concluding with a high degree of satisfaction of all participants. Since students' demotivation is one of the main causes of current school failure [49], SL is a relevant teaching tool, since participation in SL projects favours the motivation of students, where the impact of the SL project was highly significant. In fact, as Hernández-Blanco et al. [39] indicate, SL could be seen as an educational methodology that not only seeks learning, but also a social transformation. SL allows students to learn while they learn and act on the needs of their environment. Similar results were also reported previously with university students participating in SL projects [39,55]. This is reflected in the data obtained after implementing the SL project, since the activities aimed at increasing the knowledge and care of the environment of the community, and at improving the cultural level of the participating students by fostering a bond with their community [54,55]. On the other hand, according to the results collected, the participants showed a low level of knowledge of the history and culture of the environment in which the project took place. Therefore, SL could be seen as an educational practice that helps young people to acquire service-related knowledge, developing academic and professional skills. Moreover, it acts in two directions—on the environment in which the service has an impact and on the institution that promotes the project [17,54]—as it improves the living conditions of the community by fostering active citizenship, while at the same time generating young people with better teaching tools and a higher cultural level.

Despite the efforts made by administrations to promote the achievement of the SDGs, set out in the 2030 Agenda, the reality shows that without the active participation of citizens, which allows them to be aware of the needs of their environment, these proposals are insufficient [33,43]. In this sense, ESD has come to be essential in contributing to the achievement of global sustainable development, not only by providing knowledge, but also by promoting the acquisition of sustainability competences to implement the SDGs [56]. To help to achieve this goal, students must be involved in learning activities aimed at building a connection between students and community [55], as the active participation in an SL project. Thus, the results obtained in this study, which show a significant increase in the interest shown by participants in learning and knowing the SDGs after participating in the SL project, are statistically significant, with a very high effect ($d = 1.30$). This is a fundamental factor for the achievement of the SDGs [57], as the role of young people is crucial in the new global development agenda [56], both for them and for future generations [58,59]. García-Rico et al. [60] report that the use of SL experiences with students boosted and strengthened the knowledge, comprehension, sensitivity, and compromise in relation to the SDGs. In fact, having a solid knowledge of the SDGs allows students to examine their environment in a more critical way. In this way, students are able to understand the path set out by the UN

for the sustainable development of our cities [43,61]. In this sense, Howell [62] concludes that to achieve an effective education for sustainable development, appropriate pedagogies are required, highlighting the need to engage learners in transformative learning through collaborative and learner-centred activities. Thus, the activities implemented in the SL project aimed at increasing the students' knowledge about the environment. Working directly with the community contributes to generating an awareness with social projection, as was also reported by Castro et al. [55]. It is important that education starts from the experience of its protagonists, with activities that do not focus on them, but that help and nourish them from their environment, generating a benefit for the community [17,61]. The project has had a significant impact on the knowledge and responsibility of the students with regard to their immediate environment.

Intervening in projects with the characteristics of SL gives students the tools to participate and initiate other activities that have an impact on their environment, since SL practices, unlike other training activities, introduce action in the community with the aim of improving it [16,39,63].

5. Conclusions

In this study, an SL project was designed to implement sustainable education strategies in a university science course. After its implementation, this research aimed to assess the participants' knowledge about the use of innovative teaching methodologies applied to ESD, such as Service Learning (H1), and how designing and implementing an SL project helped to connect students with their environment, promoting care and responsibility for it, and their awareness of the SDGs (H2). The SL project was implemented in the Teaching Training School of the University of Extremadura (Spain). Precisely, the study was conducted with pre-service teachers enrolled in the Primary Education program.

The SL project designed in this research aimed to increase the teacher trainer students' awareness about the SDGs and their implementation in a local environment, in addition to knowing a new learning strategy to be used for ESD. Thus, the project was implemented in four phases. In the first one, the project was presented to the participants. The second one consisted in students' field work about SDGs and the historical town. In Phase 3, students were asked to put together all the information and build the SL goal. Finally, Phase 4 consisted of a final discussion and results presentation.

A pre- and post-test methodology, submitted before and after the SL implementation, was applied. According to the results, students' involvement in the design and implementation of the SL project applied to ESD had a significant positive effect. Firstly, students' knowledge about innovative teaching strategies to be applied to ESD has significantly increased. Students' engagement in the design and implementation of the SL project was proved to increase their knowledge about the proposed methodology, but also their motivation towards learning. Thus, the SL methodology applied to ESD is a very suitable tool in the university context, and more specifically for trainee teachers, since the participants not only obtain the benefits of the methodology as participating students, but it also allows them to improve their teaching practice. On the other hand, the development of the SL project had a significant impact on the students' knowledge about sustainable education and the SDGs. Precisely, after completing the project, the students w awareness of environment preservation, and the role of education in sustainable development. Moreover, the students' participation in the SL project made them aware of the community implications in maintaining the environment and generating benefit for the whole community.

Thus, this research shows how the SL teaching methodology is an important tool for the achievement of both curricular competences and environmental awareness, since theoretical knowledge is applied to tangible work to perform a real community service, and therefore it is a very suitable teaching strategy to be applied to EDS.

The main limitation of this study is the impossibility of comparing the results to other methodologies besides SL (no control group was used), due to the characteristics of the sample. Besides this, sample size and more information of subsequent years constitute

limitations of our findings, which would allow us to prove the potential of SL as a teaching strategy in EDS and sustainable education. However, the results presented constitute the preliminary results of projects in which service learning projects are used in EDS and sustainable education.

Author Contributions: Conceptualization, A.M.-S., D.G.-G. and J.S.J.; methodology, A.M.-S., D.G.-G. and J.S.J.; formal analysis, A.M.-S., D.G.-G. and J.S.J.; investigation, A.M.-S., D.G.-G. and J.S.J.; writing—original draft preparation, A.M.-S.; writing—review and editing, D.G.-G. and J.S.J.; supervision, J.S.J. and D.G.-G.; funding acquisition, J.S.J. and D.G.-G. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Consejería de Economía y Agenda Digital de la Junta de Extremadura (Spain) and the FEDER funds grant numbers IB18004 and GR21047 and Ministry of Science and Innovation grant number PID2020-115214RB-I00/AEI/10.13039/501100011033.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of University of Extremadura (protocol code 94/2018 and date of approval 06/07/2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data will be available upon request.

Acknowledgments: Authors are grateful to the Cáceres Historical City Consortium and the Cáceres City Hall for the help provided to accomplish this study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Fleming, L.; Leonardi, G.; White, M.; Medlock, J.; Alcock, I.; Macintyre, H.; Maguire, K.; Nichols, G.; Wheeler, B.; Morris, G.; et al. Beyond Climate Change and Health: Integrating Broader Environmental Change and Natural Environments for Public Health Protection and Promotion in the UK. *Atmosphere* **2018**, *9*, 245. [CrossRef]
2. Yusuf, R.; Fajri, I. Differences in Behavior, Engagement and Environmental Knowledge on Waste Management for Science and Social Students through the Campus Program. *Heliyon* **2022**, *8*, e08912. [CrossRef]
3. Sulich, A.; Sołoducho-Pelc, L.; Ferasso, M. Management Styles and Decision-Making: Pro-Ecological Strategy Approach. *Sustainability* **2021**, *13*, 1604. [CrossRef]
4. Keeble, B.R. The Brundtland Report: 'Our Common Future'. *Med. War* **1988**, *4*, 17–25. [CrossRef]
5. Uvalić-Trumbić, S. New Dynamics of Higher Education and Research for Societal Change and Development. *Organ. Znanja* **2009**, *12*, 128–132. [CrossRef]
6. Water, U.N. (Ed.) Water and Climate Change. In *The United Nations World Water Development Report*; UNESCO: Paris, France, 2020; ISBN 978-92-3-100371-4.
7. Jickling, B.; Wals, A.E.J. Globalization and Environmental Education: Looking beyond Sustainable Development. *J. Curric. Stud.* **2008**, *40*, 1–21. [CrossRef]
8. Gallini, S.M.; Moely, B.E. Service-Learning and Engagement, Academic Challenge, and Retention. *Mich. J. Community Serv. Learn.* **2003**, *10*, 5–14.
9. Dienhart, C.; Maruyama, G.; Snyder, M.; Furco, A.; McKay, M.S.; Hirt, L.; Huesman, R. The Impacts of Mandatory Service on Students in Service-Learning Classes. *J. Soc. Psychol.* **2016**, *156*, 305–309. [CrossRef]
10. Bringle, R.G.; Steinberg, K. Educating for Informed Community Involvement. *Am. J. Community Psychol.* **2010**, *46*, 428–441. [CrossRef]
11. Felten, P.; Clayton, P.H. Service-Learning. *New Dir. Teach. Learn.* **2011**, *2011*, 75–84. [CrossRef]
12. Rodríguez Gallego, M.R. El Aprendizaje-Servicio Como Estrategia Metodológica En La Universidad. *Rev. Complut. Educ.* **2014**, *25*, 95–113. [CrossRef]
13. Sigmon, R.L. *Journey to Service-Learning Experiences from Independent Liberal Arts Colleges and Universities*; Distributed by ERIC Clearinghouse: Place of publication not identified; Council of Independent Colleges: Washington, DC, USA, 1996; ISBN 978-0-937012-12-3.
14. Sotelino Losada, A. *Evaluación y Propuesta de Desarrollo*; Aprendizaje-Servicio En Las Universidades Gallegas: Santiago de Compostela, Spain, 2014; Available online: <https://plataformavoluntariado.org/wp-content/uploads/2019/04/tesese-sotelino.pdf> (accessed on 6 June 2022).
15. Billig, S.; Furco, A. *Service-Learning through a Multidisciplinary Lens*; Advances in Service-Learning Research; Information Age: Greenwich, CT, USA, 2002; ISBN 978-1-931576-80-2.

16. Mayor Paredes, D. El Aprendizaje-Servicio Como Práctica Educativa Que Promueve Relaciones Colaborativas Entre La Escuela y La Comunidad. Estudio de Caso. Ph.D. Thesis, Universidad de Almería, Almería, Spain, 2016.
17. Puig Rovira, J.M.; Palos Rodríguez, J. Rasgos Pedagógicos Del Aprendizaje-Servicio. *Cuad. Pedagog.* **2006**, *357*, 60–63.
18. Martínez-Campillo, A.; Sierra-Fernández, M.d.P.; Fernández-Santos, Y. Service-Learning for Sustainability Entrepreneurship in Rural Areas: What Is Its Global Impact on Business University Students? *Sustainability* **2019**, *11*, 5296. [\[CrossRef\]](#)
19. Carver, R.L. Theoretical Underpinnings of Service Learning. *Theory Pract.* **1997**, *36*, 143–149. [\[CrossRef\]](#)
20. Luna, E. Del Centro Educativo a La Comunidad: Un Programa de Aprendizaje-Servicio Para El Desarrollo de Ciudadanía Activa, Barcelona, Spain. 2010. Available online: <https://dialnet.unirioja.es/servlet/tesis?codigo=85430&orden=3&info=link> (accessed on 6 June 2022).
21. Mayor Paredes, D.; Rodríguez Martínez, D. Aprendizaje-Servicio y Práctica Docente: Una Relación Para El Cambio Educativo. *Rev. Invest. Educ.* **2016**, *34*, 535. [\[CrossRef\]](#)
22. Rahima, C. *Community Service-Learning: A Guide to Including Service in the Public School Curriculum*; SUNY Series; Democracy and Education; Wade, R.C., Ed.; State University of New York Press: Albany, Australia, 1997; ISBN 978-0-7914-3184-9.
23. Tapia, M.N. Civic Service in South America. *Nonprofit Volunt. Sect. Q.* **2004**, *33*, 148S–166S. [\[CrossRef\]](#)
24. Celio, C.I.; Durlak, J.; Dymnicki, A. A Meta-analysis of the impact of Service-Learning on Students. *J. Exp. Educ.* **2011**, *34*, 164–181. [\[CrossRef\]](#)
25. Welch, M.; Billig, S. *New Perspectives in Service-Learning: Research to Advance the Field*; Advances in Service-Learning Research; Welch, M., Billig, S., Eds.; Information Age Publishing: Greenwich, CT, USA, 2004; ISBN 978-1-59311-158-8.
26. Jeong, J.S.; González-Gómez, D. A web-based tool framing a collective method for optimizing the location of a renewable energy facility and its possible application to sustainable STEM education. *J. Clean. Prod.* **2020**, *251*, 119747. [\[CrossRef\]](#)
27. Jeong, J.S.; González-Gómez, D. A STEM Course Analysis During COVID-19: A Comparison Study in Performance and Affective Domain of PSTs Between F2F and F2S Flipped Classroom. *Front. Psychol.* **2021**, *12*, 669855. [\[CrossRef\]](#)
28. National Committee on Science Education Standards and Assessment; Board on Science Education; Division of Behavioral and Social Sciences and Education; National Research Council. *National Science Education Standards*; National Academies Press: Washington, DC, USA, 1996; p. 4962. ISBN 978-0-309-05326-6.
29. Billig, M. Critical Discourse Analysis and the Rhetoric of Critique. In *Critical Discourse Analysis*; Weiss, G., Wodak, R., Eds.; Palgrave Macmillan UK: London, UK, 2003; pp. 35–46. ISBN 978-0-230-55514-3.
30. González-Gómez, D.; Jeong, J.S. EduscIFIT: A computer-based blended and scaffolding toolbox to support numerical concepts for flipped science education. *Educ. Sci.* **2019**, *9*, 116. [\[CrossRef\]](#)
31. Caride, J.A.; Meira, P.Á. Del Ecologismo Como Movimiento Social a La Educación Ambiental Como Construcción Histórica. *Hist. Educ.* **2019**, *37*, 165. [\[CrossRef\]](#)
32. Molano Niño, A.C.; Herrera Romero, J.F. La Formación Ambiental En La Educación Superior: Una Revisión Necesaria. *Luna Azul* **2014**, *39*, 186–206. [\[CrossRef\]](#)
33. Jeong, J.S.; González-Gómez, D. Assessment of sustainability science education criteria in online-learning through fuzzy-operational and multi-decision analysis and professional survey. *Heliyon* **2020**, *6*, e04706. [\[CrossRef\]](#) [\[PubMed\]](#)
34. Cebrián Bernat, G.; Junyent Pubill, M. Competencias Profesionales En Educación Para La Sostenibilidad: Un Estudio Exploratorio de La Visión de Futuros Maestros. *Enseñ. Las Cienc.* **2014**, *32*, 29–49. [\[CrossRef\]](#)
35. Rieckmann, M. Future-Oriented Higher Education: Which Key Competencies Should Be Fostered through University Teaching and Learning? *Futures* **2012**, *44*, 127–135. [\[CrossRef\]](#)
36. Wiek, A.; Withycombe, L.; Redman, C.L. Key Competencies in Sustainability: A Reference Framework for Academic Program Development. *Sustain. Sci.* **2011**, *6*, 203–218. [\[CrossRef\]](#)
37. Jeong, J.S.; González-Gómez, D. Multi-Criteria Decision Analysis Methods for Sustainability Assessment of Renewable Energy Systems and Its Potential Application to Sustainable STEM Education. In *Energy Systems Evaluation*; Green Energy and Technology; Ren, J., Ed.; Springer: Cham, Switzerland, 2021; Volume 2. [\[CrossRef\]](#)
38. Hewitt, N. ; *International Council for Local Environmental Initiatives*. *Guía Europea Para la Planificación de las Agendas 21 Locales: Como Implicarse en un Plan de Acción Ambiental a Largo Plazo Hacia la Sostenibilidad*; Bakeaz: Bilbao, Spain, 1998; ISBN 978-84-88949-25-7.
39. Hernández-Barco, M.; Sánchez-Martín, J.; Blanco-Salas, J.; Ruiz-Téllez, T. Teaching Down to Earth—Service-Learning Methodology for Science Education and Sustainability at the University Level: A Practical Approach. *Sustainability* **2020**, *12*, 542. [\[CrossRef\]](#)
40. López Aguado, M. Estrategias de Aprendizaje En Estudiantes Universitarios. Diferencias Por Género, Curso y Tipo de Titulación. *Educ. Knowl. Soc. EKS* **2011**, *12*, 203–233. [\[CrossRef\]](#)
41. Mella-Núñez, Í.; Quiroga-Carrillo, A.; Crespo Comesaña, J. Aprendizaje-Servicio y Desarrollo Cívico-Social En Titulaciones Universitarias Del Ámbito Educativo: Preparando al Alumnado Para La Práctica de Una Educación Inclusiva. *Educación* **2021**, *57*, 363–377. [\[CrossRef\]](#)
42. Álvarez Castillo, J.L.; Martínez Usaralde, M.J.; González González, H.; Buenestado Fernández, M. El Aprendizaje-Servicio En La Formación Del Profesorado de Las Universidades Españolas. *Rev. Esp. Pedagog.* **2017**, *75*, 199–217. [\[CrossRef\]](#)
43. Zamora-Polo, F.; Sánchez-Martín, J. Teaching for a better world. Sustainability and sustainable development goals in the construction of a change-maker university. *Sustainability* **2019**, *11*, 4224. [\[CrossRef\]](#)
44. Seba, D. The impact of the type of project on preservice teacher's conceptualization for service-learning. *Teach. Teach. Educ.* **2013**, *32*, 87–97. [\[CrossRef\]](#)

45. Hebert, A.; Hauf, P. Student learning through service learning: Effects on academic development, civic responsibility, interpersonal skills and practical skills. *Act. Learn. High. Educ.* **2015**, *16*, 37–49. [[CrossRef](#)]
46. Kahne, J.; Westheimer, J.; Rogers, B. Service learning and citizenship in higher education. *Mich. J. Community Serv. Learn.* **2000**, *7*, 42–51.
47. Melaugh, C.T.; Kindschuh, T. Engaged in waste: Two case studies from Protland state linking operational sustainability and student-community engagement. In *University-Community Partnerships*; Wortham-Galvin, B.D., Allen, J.H., Sherman, J.D.B., Eds.; Routledge: London, UK, 2017; Volume 52, pp. 196–206. .
48. Benning, J.L.; Surovek, A.E.; Shearer, C.R. Engagement in practice: A case study on improving community sustainability through service-learning. In *Proceedings of the 2018 ASEE Annual Conference, Salt Lake City, UT, USA, 24–27 June 2018*; Volume 11, pp. 331–349.
49. Martínez-Valdivia, E.; Burgos-Garcia, A. Academic Causes of School Failure in Secondary Education in Spain: The Voice of the Protagonists. *Soc. Sci.* **2020**, *9*, 11. [[CrossRef](#)]
50. Matzembacher, E.D.; Gonzales, R.L.; do Nascimento, L.F. From informing to practicing: Students' engagement through practice-based learning methodology and community services. *Int. J. Mang. Educ.* **2019**, *17*, 191–200. [[CrossRef](#)]
51. González-Gómez, D.; Jeong, J.S.; Cañada-Cañada, F. Examining the Effect of an Online Formative Assessment Tool (OFAT) of Students' Motivation and Achievement for a University Science Education. *J. Balt. Sci. Educ.* **2020**, *19*, 401–414. [[CrossRef](#)]
52. Jeong, J.S.; González-Gómez, D. Flipped-OCN method in mathematics learning to analyze the attitudes of pre-service teachers. *Mathematics* **2021**, *9*, 607. [[CrossRef](#)]
53. González-Gómez, D.; Jeong, J.S. The Flipped Learning Model in General Science: Effects on Students' Learning Outcomes and Affective Dimensions. In *Active Learning in College Science*; Mintzes, J., Walter, E., Eds.; Springer: Cham, Switzerland, 2020. [[CrossRef](#)]
54. Foshee Holmens, A.; Webb, K.J.; Albritton, B.R. Connecting students to community: Engaging students through course embedded service-learning activities. *Int. J. Manag. Educ.* **2022**, *20*, 100610. [[CrossRef](#)]
55. Castro, P.; Are-Pernas, A.; Depena, A. Service-Learning project in university degrees based on sustainable development goals: Proposals and results. *Sustainability* **2020**, *12*, 7940. [[CrossRef](#)]
56. Günther, J.; Overbeck, A.K.; Muster, S.; Tempel, B.J.; Shaa, S.; Schaal, S.; Kühner, E.; Otto, S. Outcome indicator development: Defining education for sustainable development outcomes for the individual level and connecting them to the SDGs. *Global Environ. Change* **2022**, *74*, 102526. [[CrossRef](#)]
57. Killian, S.; Lannon, J.; Murray, L.; Avran, G.; Giralt, M.; O'Riordan, S. Social Media for social good: Student engagement for the SDGs. *Int. J. Manag. Educ.* **2019**, *17*, 100307. [[CrossRef](#)]
58. Restrepo, E. Cuestiones de Método: «eventualización» y Problematicación En Foucault. *Tabula Rasa* **2008**, *8*, 111–132. [[CrossRef](#)]
59. Armstrong, A.G.; Mattson, C.A.; Lewis, R.S. Factors leading to sustainable social impact on the affected communities of engineering service-learning projects. *Dev. Eng.* **2021**, *6*, 100066. [[CrossRef](#)]
60. García-Rico, L.; Martínez-Muñoz, L.F.; Santos-Pastor, M.L.; Chiva-Bartol, O. Service-learning in physical education teacher education: A pedagogical model towards sustainable development goals. *Int. J. Sustain. High. Educ.* **2021**, *22*, 747–765. [[CrossRef](#)]
61. Molderez, I.; Fonseca, E. The efficacy of real-world experiences and service learning for fostering competences for sustainable development in higher education. *J. Clean. Prod.* **2018**, *172*, 4397–4410. [[CrossRef](#)]
62. Howell, R.A. Engaging students in education for sustainable development: The benefits of active learning, reflective practices and flipped classroom pedagogies. *J. Clean. Prod.* **2021**, *325*, 129318. [[CrossRef](#)]
63. Barth, M.; Adomßent, M.; Fischer, D.; Richter, S.; Rieckmann, M. Learning to change universities from within: A service-learning perspective on promoting sustainable consumption in higher education. *J. Clean. Prod.* **2014**, *62*, 72–81. [[CrossRef](#)]