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Are We Training in Sustainability in Higher Education? Case Study: Education Degrees at the University of Salamanca

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Abstract: In this work, we analyzed the progress made in learning sustainability competencies by students belonging to the four Bachelor Education degrees at the University of Salamanca: Early Childhood Education Teacher, Primary Education Teacher, Pedagogy, and Social Education. To assess this progress, the instrument we used was the student questionnaire designed by the EDINSOST project. The questionnaire consisted of 18 questions related to the four sustainability competencies defined in 2011 by the Conference of Rectors of Spanish Universities: (1) critical contextualization of knowledge, (2) sustainable use of resources, (3) participation in community processes, and (4) application of ethical principles. The students answered the questions using a four-point Likert scale. The analysis of the answers determined the students' perception of their own learning related to sustainability competencies. A total of 230 first-year and 96 fourth-year students responded to the questionnaire. The comparison between the first- and fourth-year students' answers to each question enabled an evaluation of the improvement perceived by the students in their sustainability competencies. We analyzed the results by using the Mann–Whitney and Kruskal–Wallis U tests. The results show that the students of the Bachelor Degree in Pedagogy are the only ones who achieve a significant improvement in their sustainability competencies. Bachelor Degree in Social Education and Bachelor Degree in Early Childhood Education Teacher students achieve an improvement, but it is not significant. Finally, Bachelor Degree in Primary Education Teacher students do not seem to achieve any improvement. From these data, it appears that the model used to introduce sustainability competencies in the Bachelor Degree in Pedagogy is the only one that achieves good results.

Keywords: Sustainability; education for sustainable development; sustainability map; Sustainability competencies

1. Introduction

In June 1992, the United Nations Conference on Environment and Development took place in Rio de Janeiro, in which 178 countries participated. Agenda 21 was approved at the conference, named in this way for containing an ambitious program of actions for the advancement of humanity towards sustainable development in the 21st century. Composed of 40 chapters, Chapter 36 already stated that "education is of critical importance to promote sustainable development (...). To be effective, environmental and development education must (...) be integrated into all disciplines and use academic and non-academic methods and effective means of communication" [1].

Since the celebration of this Earth Summit and the subsequent summits (Johannesburg 2002, and Rio 2012) until the present day, international meetings and declarations demanding the urgent need to change course towards sustainability in our development model have not ceased. On September 25, 2015, the UN relaunched a Global Agenda for the transition to sustainable development, with its sights set on 2030. This agenda set 17 goals (called Sustainable Development goals, SDG) and 169 objectives. According to the Director of the Sustainable Development Solutions Network (SDSN), Jeffre D. Sachs: "Universities around the world should be at the forefront in helping society find technical solutions to achieve these goals" [2] (p.61).

Universities have been sensitive to this commitment for almost three decades. In 1990, the Talloire Declaration was signed. This was the first statement calling on universities to adopt global leadership in creating, supporting, and maintaining sustainability [3]. This first Declaration has been followed by others, such as the European Association of Universities Copernicus Charter, which in 1993 recognized the critical role of universities in advancing Agenda 21, and promised to incorporate training for sustainability in all degree courses. (This Declaration, by which European universities pledged to support the Program (Agenda 21) that emerged from the Rio Summit (1992), has been endorsed by 326 European universities, showing their commitment to leading change for sustainable development [4]. In 1993, the International Association of Universities signed the Kyoto Declaration on Sustainable Development, in which universities were urged to promote the promotion of sustainable development from their teaching and research activities [5]. Many other statements have followed these statements).

In September 2002, the Conference of Rectors of Spanish Universities (CRUE) unanimously approved the creation of the Working Group for Environmental Quality and Sustainable Development (since 2009 called the CRUE—Sustainability Sectorial Commission), with the aim of promoting Spanish university initiatives related to the integration of sustainability in management, curricula, and research programs [6].

The University of Salamanca (USAL) has been progressively linked to the commitment to sustainability. In the framework of the 2030 Agenda, in June 2018 it organized the "Ibero-American Conference on Sustainable Development Goals". This conference concluded with the Salamanca Declaration, which reinforces the commitment to promote "the transformations necessary to advance in the achievement of the Sustainable Development Goals" [7].

The trend towards incorporating sustainability as a guiding principle for university activity is in line with the modernization process that universities have undergone to adapt to current challenges. The universities have incorporated a "third mission" to the historical teaching and research missions: the "transfer of knowledge and technology", which, apart from transforming knowledge into innovation and competitiveness of the productive sectors, must incorporate social responsibility and sustainable development as fundamental elements in universities [8] (p.23). In this regard, the Technical Commission of the University Strategy 2015, in its publication "The social responsibility of the university and sustainable development", argued that "it is necessary to ensure the incorporation of the contents of social responsibility and sustainable development in transversal competencies of the official degrees" [9] (p.20).

According to the studies carried out by the University Sustainability Assessment Working Group of the CRUE—Sustainability Sectorial Commission (WG-CSSC) [10], the first Spanish initiatives to incorporate sustainability in higher education began after the Rio Summit in the 1990s. Since then, management has been the area that has incorporated the most sustainability criteria, while the integration of sustainability in the curricula is "one of those with the lowest average score in the responses" [11] (p.374).

However, we must recognize the outstanding role played by the WG-CSSC in introducing sustainability into university teaching. In 2005, this group approved the document "Guidelines for curricular sustainability", which has guided the progress in this integration [12,13]. (This document, aimed at addressing "the entire educational process in a holistic way, introducing sustainability

competences in a transversal way so that students learn to make decisions and carry out actions from sustainable criteria", was updated in 2011, presented at the General Assembly of the CRUE in 2012, and sent to the Rectors of all Spanish universities in 2014 [3] (p.2)).

The research project EDINSOST (Education and Social Innovation for Sustainability), to which the results of this work belong, responds to this purpose. A total of 59 researchers from 10 Spanish universities have collaborated on this project: the Universitat Politècnica de Catalunya-BarcelonaTech (UPC), the University of Salamanca (USAL), the Autonomous University of Madrid (UAM), the University of Cádiz (UCA), the Camilo José Cela University (UCJC), the University of Córdoba (UCO), the University of Girona (UdG), the International University of Catalonia (UIC), the Universidad Politécnica de Madrid (UPM), and the University of Seville (US). The main objective of EDINSOST is to explore the actual situation regarding the integration of the sustainability competencies in 13 university degrees, mainly in the fields of education and engineering, in order to improve this integration and equip future graduates with the necessary competencies to advance towards the achievement of the Sustainable Development Goals [14].

In this work, we focus on the fourth objective of the EDINSOST project, aimed at diagnosing the learning status of university students, in order to assess whether, by the end of their undergraduate studies, students have acquired the sustainability competencies necessary to be able to contribute by their personal and professional performance to the advancement in the SDGs. We present herein the results of the four USAL bachelor degrees in education: Early Childhood Education Teacher, Primary Education Teacher, Pedagogy, and Social Education.

The students' learning degree is analyzed in the different domain levels of the sustainability competencies defined by the EDINSOST project [14]. These competencies are defined in a sustainability map, which contains learning outcomes organized from a three-domain level taxonomy based on the Miller pyramid [15]. The sustainability map is a fundamental tool for analyzing the real integration of sustainability competencies in the curricula and for making integration proposals [16,17].

2. Materials and Methods

In this paper, we present a methodology to evaluate the learning achieved in sustainability by students of a university degree in the field of education, a methodology that we applied to the four Education Degrees of the University of Salamanca.

2.1. Research Question and Objectives

In this work we sought to answer the following research question: are students of the education degrees of the University of Salamanca trained in sustainability?

To answer this question, we defined the following objectives:

- Measure the domain level of the sustainability competencies presented by the students of the USAL degrees in education when they begin and when they finish their studies, so that both measurements can be compared;
- Evaluate the degree of improvement in sustainability competencies achieved by the students in each degree analyzed;
- Analyze whether the improvement achieved in sustainability skills is homogeneous or, conversely, students improve more in some aspects than in others.

2.2. Sample

The analysis carried out in this work was quantitative. The sample was made up of 230 first-year students and 96 fourth-year students from four Bachelor Degrees at the USAL:

- Bachelor Degree in Early Childhood Education Teacher (ECE);
- Bachelor Degree in Primary Education Teacher (PE);
- Bachelor Degree in Pedagogy (P); and

- Bachelor Degree in Social Education (SE).

Table 1 shows the distribution of students by course in the four degrees.

Table 1. Distribution of students by course in the USAL Bachelor Degrees Bachelor Degree in Early Childhood Education Teacher (ECE), Bachelor Degree in Primary Education Teacher (PE), Bachelor Degree in Pedagogy (P), and Bachelor Degree in Social Education (SE).

Number of Students	First Year	Fourth Year
ECE	71	9
PE	51	26
P	55	10
SE	53	51
Total	230	9

2.3. Instruments

Sustainability competencies are defined at three domain levels, in the form of learning outcomes that students must have achieved upon completion of their studies. To determine these learning outcomes, we used the sustainability map of the education degrees of the EDINSOST project [17], which we built according to the recommendations for designing a competencies map, as presented in Sánchez-Carracedo et al. [18]. We classified the learning outcomes using a simplified version of Miller's pyramid [15] as taxonomy, in which the two highest levels of the taxonomy were combined. As a consequence, the taxonomy had three domain levels: "know", "know how", and "demonstrate and do".

The learning outcomes are related to the four sustainability competencies defined by the CRUE [13] for all the degrees of the Spanish university system. We described the four competencies in the form of six competency units (competencies described with a lower level of granularity), for which learning outcomes were classified into the three domain levels mentioned. Table 2 shows the relationship between the competencies and the competency units.

Table 2. Competencies and competency units of the EDINSOST education sustainability map.

Competencies	Competency Units
C1: Critical contextualization of knowledge by establishing interrelations with social, economic, environmental, local, and/or global problems.	1.1 Understands the functioning of natural, social, and economic systems, as well as their interrelations and problems, both at a local and global level.
	1.2 Possesses critical thinking and creativity, taking advantage of the different opportunities presented (ICT, strategic plans, regulations, etc.) in the planning of a sustainable future.
C2: Sustainable use of resources and prevention of negative impacts on the natural and social environment.	2.1. Designs and develops actions, making decisions that take into account the environmental, economic, social, cultural, and educational impacts so as to improve sustainability.
C3: Participation in community processes that promote sustainability	3.1 Promotes and participates in community activities that encourage sustainability.
C4: Application of ethical principles related to the values of sustainability in personal and professional behavior.	4.1. Is consistent in actions respecting and valuing (biological, social, and cultural) diversity and committed to improving sustainability.
	4.2. Promotes education in values oriented to the formation of responsible, active and democratic citizens.

The sustainability map developed by the EDINSOST project for the Education degrees of the Spanish university system is shown in Table 3.

Table 3. Sustainability map for the education degrees of the EDINSOST project, as presented in [19].

Related Competencies	Competency Unit	Domain Levels (According to the Simplified Miller Pyramid)		
		Level 1. KNOWING	**Level 2. KNOWING HOW**	**Level 3. DEMONSTRATING and DOING**
C1: Critical contextualization of knowledge by establishing interrelations with social, economic, environmental, local, and/or global problems.	1.1 Understands the functioning of natural, social, and economic systems, as well as their interrelations and problems, both at a local and global level.	1.1.1. Knows the functioning of natural, social, and economic systems and the mutual relationships between them.	1.1.2. Analyzes and understands the relationship between natural systems and social and economic systems.	1.1.3. Is able to imagine and predict the impacts the changes produced in natural systems may cause in social and economic systems and among each other.
	1.2 Possesses critical thinking and creativity, taking advantage of the different opportunities presented (ICT, strategic plans, regulations, etc.) in the planning of a sustainable future.	1.2.1 Knows the procedures and resources to integrate sustainability into educational projects.	1.2.2. Understands and takes advantage of the opportunities that present themselves in educational contexts in order to plan sustainable projects.	1.2.3. Provides solutions to educational projects from a critical and creative viewpoint with the aim of planning a sustainable future.
C2: Sustainable use of resources and prevention of negative impacts on the natural and social environment.	2.1. Designs and develops actions, making decisions that take into account the environmental, economic, social, cultural, and educational impacts so as to improve sustainability.	2.1.1. Has basic knowledge of identifying possible socio-environmental impacts derived from educational actions.	2.1.2. Knows how to develop educational actions that mitigate negative socio-environmental impacts.	2.1.3. Designs and develops educational activities in which negative socio-environmental impacts are taken into account, and incorporates mitigating measures.
C3: Participation in community processes that promote sustainability	3.1 Promotes and participates in community activities that encourage sustainability.	3.1.1. Recognizes himself/herself as an integral part of his/her surroundings and knows the community education programmes that encourage participation and commitment to socio-environmental improvement.	3.1.2. Is able to interact satisfactorily in educational community projects, encouraging participation.	3.1.3. Designs and carries out socio-educational activities in participatory community processes that promote sustainability.
C4: Application of ethical principles related to the values of sustainability in personal and professional behavior.	4.1. Is consistent in actions respecting and valuing (biological, social, and cultural) diversity and committed to improving sustainability.	4.1.1. Knows the ethical principles of sustainability and the importance of respecting diversity in educational intervention.	4.1.2. Understands and integrates the ethical principles of sustainability in his/her actions, considering nature as a good in itself and transmitting the importance of education for a change in the relationship between human beings and the socio-cultural environment.	4.1.3. Is able to design and/or manage educational projects taking into account ecological ethics to improve quality of life and to promote the common good.
	4.2. Promotes education in values oriented to the formation of responsible, active, and democratic citizens.	4.2.1. Takes into account promoting integral and sustainable human development as the basic purpose of the formation of citizenship.	4.2.2. Critically analyzes and assesses the consequences his/her personal and professional actions may have on the integral development of students and on promoting sustainable human development.	4.2.3. Designs and develops educational intervention proposals that integrate the values of sustainability and which result in justice and the common good.

Based on the learning outcomes of the sustainability map, we at the EDINSOST project have designed a questionnaire that allows information to be obtained on the sustainability competencies of the students [19]. Each question in the questionnaire corresponds to a learning outcome of the sustainability map. The questions are statements that must be answered according to a four-point Likert scale [20]: strongly disagree, disagree, agree, and strongly agree. Students answered the questionnaire at the end of the first semester of 2018.

The sustainability questionnaire defined by the EDINSOST project for students of the education degrees of the Spanish university system is shown in Table 4. Responses follow a four-point Likert scale: strongly disagree, disagree, agree, and strongly Agree.

Table 4. Student questionnaire for the education degrees of the EDINSOST project, as presented in [19].

Q1	**I know the interrelationship between natural, social, and economic systems.**
Q2	I analyze and understand the relationships between natural systems and social and economic systems.
Q3	I anticipate the repercussions of changes in natural, social, and economic systems.
Q4	I know procedures and resources to integrate sustainability in the subjects.
Q5	I analyze the opportunities presented in the subjects to plan educational projects to integrate sustainability.
Q6	I design educational projects from the perspective of sustainability.
Q7	I identify the possible socio-environmental impacts derived from my educational activities.
Q8	I know how to develop educational actions that minimize negative socio-environmental impacts.
Q9	I design and develop educational actions in which I take into account the negative socio-environmental impacts and I incorporate corrective actions.
Q10	I know community educational programs that encourage participation and commitment in socio-environmental improvement.
Q11	I know how to develop myself satisfactorily in community educational projects, encouraging participation.
Q12	I design and carry out socio-educational activities in participatory community processes that promote sustainability, feeling myself an integral part of my environment.
Q13	I know the ethical principles of sustainability.
Q14	I understand and integrate the ethical principles of sustainability in my professional and personal actions.
Q15	I design and/or manage educational projects taking into account ecological ethics, to improve the quality of life and promote the common good.
Q16	I consider the promotion of sustainable human development as a fundamental purpose of citizen education.
Q17	I critically analyze and value the consequences that my personal and professional performance may have on the integral development of students and on the promotion of sustainable human development.
Q18	I design and develop educational intervention proposals that integrate sustainability values and result in justice and the common good.

An expert group (made up of 15 experts belonging to the CRUE—Sustainability Sectorial Commission) and a control group (made up of 20 students from the final years of different Spanish degrees with knowledge of sustainability) undertook the validation of the questionnaire. For each of the questions in the questionnaire, the experts and students indicated the degree of relevance and clarity of the question, taking into account the learning outcomes of the sustainability map. They also made suggestions about which questions should be removed or added to the questionnaire. The details of the validation process can be found in Sánchez-Carracedo et al. [21].

2.4. Statistics

Students answered the questions on an ordinal scale that was transformed into four discrete values: 0: strongly disagree, 1: disagree, 2: agree, and 3: strongly agree. In this work, we assumed that students perceived the answers as equidistant. To validate this hypothesis, in previous experiments

with students from other degrees we conducted the Mann–Whitney U test for each question and calculated the size of the effect (Cohen's D). A high correlation was found between Cohen's D and the learning achieved by the students in each question. Learning was measured in two ways: in absolute value (difference between the mean of the fourth- and first-year students in each question) and in percentage [19]. This high correlation suggests that the four responses on the Likert scale were perceived by students to be evenly distributed over the interval [0,3]. Under these conditions, the mean is a valid indicator to visualize the results. However, when working with Likert variables, the median is more appropriate than the means. Data analysis using nominal, interval, and ratio data are generally simple and transparent, but analysis of ordinal data, particularly as regards Likert or other scales in the surveys, is not, because it is not possible to assume that the distances between two consecutive Likert values are the same. Therefore, in the statistical tests carried out in this work to calculate *p*-values, we used the median.

We employed Cronbach's alpha coefficient to study the internal consistency of the instrument. The results show that the scale has a high reliability (0.935). We conducted the distribution test using the Kolmogorov–Smirnov statistic. Nonparametric hypothesis testing for independent samples was used, specifically, the Kruskal–Wallis test. We analyzed the data by using the SPSS Statistics for Windows statistical program, Version 25.0 software (IBM Corp, Armonk, NY, USA).

2.5. Analysis Types

The 18 questions in the questionnaire could be analyzed in six different ways:

- Individually for each question: this analysis allowed us to determine, for each question, the students' perception regarding their own degree of learning at a certain point in their training. The *x1* value associated with the *i*-th question (*Qi*) in each course was calculated using Equation (1). The value *x1 (Qi)* is a number in the interval [0,1], and its value is 0 if all students have answered "strongly disagree" and 1 if they have answered "Strongly agree".

$$x1\ (Qi) = \frac{\Sigma\ discrets\ values\ of\ the\ answers\ to\ question\ Qi}{3 * number\ of\ answers\ to\ question\ Qi} \quad (1)$$

- By competency units: the three questions corresponding to the three domain levels of the same competency unit were grouped into a single value. We assumed that the three questions had the same weight in the value assigned to the competency unit, regardless of the domain level to which they belonged. Equation (2) was used to calculate the *x2* value associated with the *i*-th competency unit (*CUi*).

$$x2\ (CUi) = \frac{level\ "Know"\ CUi + level\ "Know\ how" CUi + level\ "Demo + do" CUi}{3} \quad (2)$$

- By domain levels: in this work, we assumed that all the competency units had the same influence on the results of a given domain level. Equation (3) was used to evaluate the *x3* value associated with the *i*-th domain level (know, know how, and demonstrate and do).

$$x3\ (Li) = \frac{\Sigma\ level\ Li\ \ \forall\ Competency\ Unit}{6} \quad (3)$$

- By competency: if the competency had a single competency unit, the associated *x4* value was the same as that of its competency unit (competencies *C2* and *C3*). If the competency had two competency units (competencies *C1* and *C4*), we calculated the value *x4* as the average of the

value assigned to the two competency units. Equations (4a) to (4d) show these equivalences for each competency of the sustainability map.

$$x4\ (C1) = \frac{x2\ (CU1.1) + x2\ (CU1.2)}{2} \tag{4a}$$

$$x4\ (C2) = x2\ (CU2.1) \tag{4b}$$

$$x4\ (C3) = x2\ (CU3.1) \tag{4c}$$

$$x4\ (C4) = \frac{x2\ (CU4.1) + x2\ (CU4.2)}{2} \tag{4d}$$

- Global: to calculate the global value of sustainability knowledge, *x5*, we assumed that the four competencies had the same weight. The equation used was Equation (5).

$$x5 = \frac{x4\ (C1) + x4\ (C2) + x4\ (C3) + x4\ (C4)}{4} \tag{5}$$

- Comparing the fourth- and first-year results: to assess the degree of improvement achieved in each question (*Qi*), competency unit (*CUi*), domain level (*Li*), competency (*Ci*), and global sustainability, we calculated the difference between the results of fourth-year and first year students. In the case of Likert variables, the difference was a more appropriate indicator than the percentage to make the comparison. Equations (6) to (10) were used according to the parameter to be evaluated.

$$x6\ (Qi) = x1\ (Qi\ fourth\ year) - x1\ (Qi\ first\ year) \tag{6}$$

$$x7\ (CUi) = x2\ (CUi\ fourth\ year) - x2\ (CUi\ first\ year) \tag{7}$$

$$x8\ (Li) = x3\ (Li\ fourth\ year) - x3\ (Li\ first\ year) \tag{8}$$

$$x9\ (Ci) = x4\ (Ci\ fourth\ year) - x1\ (Ci\ first\ year) \tag{9}$$

$$x10\ (Sustainability) = x5\ (fourth\ year) - x5\ (first\ year) \tag{10}$$

3. Results and Discussion

We organized the presentation of the results in accordance with the order of the objectives set out in Section 2.1.

3.1. Sustainability Level of First- and Fourth-Year Students

In this section, we present the results of Objective 1: "To measure the domain level in the sustainability competencies presented by the students of the USAL Degrees of Education when they begin and when they finish their studies, so that both measurements can be compared".

Figure 1 shows the results of the first- and fourth-year students for each question in the questionnaire. The 18 questions are presented on the X axis. The mean value of the answers calculated for each question according to Equation (1) is represented on the Y axis. Figure 1a shows the results of the first-year students of the four degrees, and Figure 1b shows the results of the fourth-year students.

First-year students' results were similar in all four degrees. All of them perceived that before entering university they had already acquired certain learning outcomes to a reasonable level (more than 30%), such as "I am able to foresee the repercussions of changes in natural, social and economic systems" (Q3); "I know how to identify the possible socio-environmental impacts derived from my educational activities" (Q7); "I know about community educational programs that promote participation and commitment in socio-environmental improvement" (Q11); and "I consider promoting sustainable human development as a fundamental purpose of citizen training" (Q16). Among the fourth-year

students, those of the Bachelor Degree in Pedagogy stood out, obtaining higher scores than the rest of degrees in all the questions.

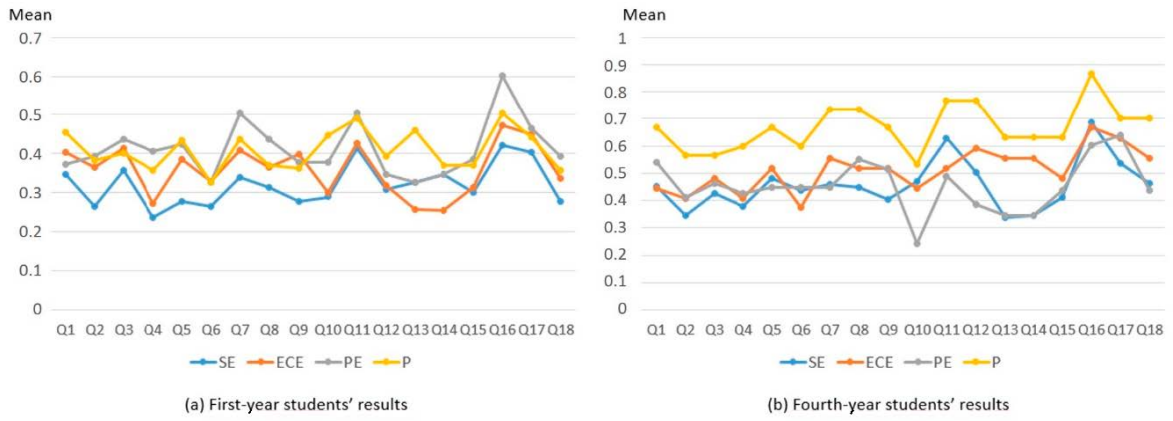

Figure 1. Average of the results obtained in the 18 questions by the first-year (**a**) and fourth-year (**b**) students in the four degrees analyzed.

When analyzing the improvement between the first- and fourth-year results in each degree, we found that significant statistical differences existed in 14 of the 18 questions. Figure 2 graphically represents the average scores of the first- and fourth-year students for the 18 questions in the four degrees studied. In the Bachelor Degrees in Pedagogy, Social Education, and Early Childhood Education, the evaluations of the fourth-year students were clearly higher than those of the first-year students in all the questions. This seems to indicate that the university studies completed enabled students to improve in all the learning outcomes evaluated.

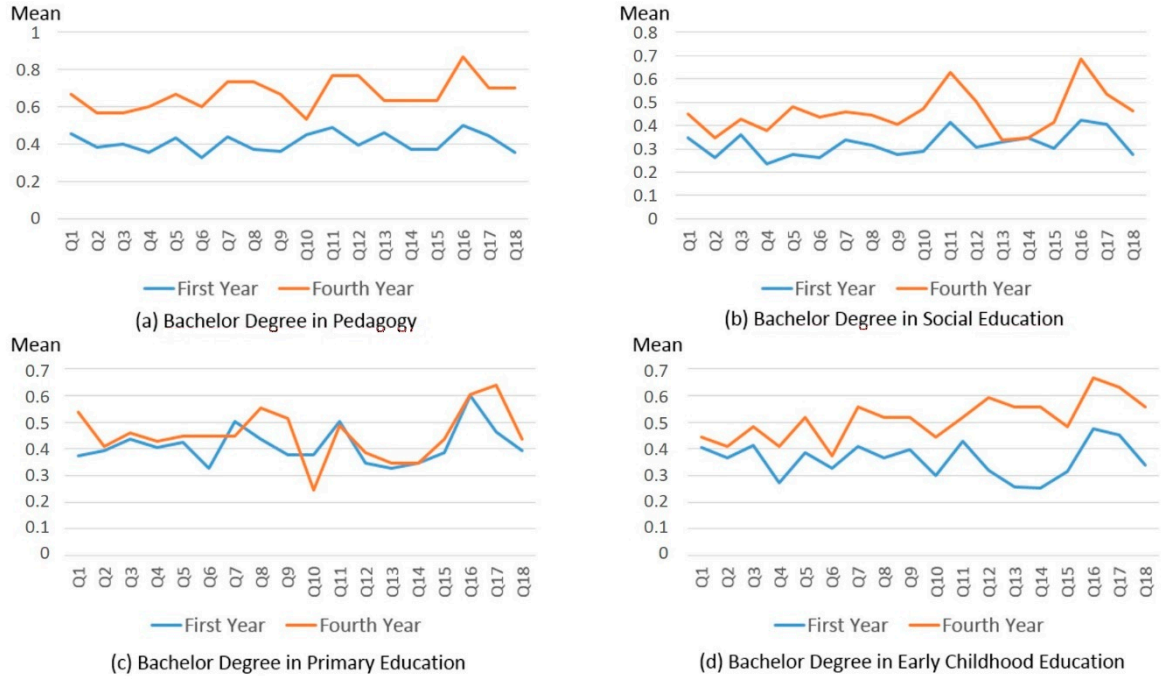

Figure 2. Comparison of the means of the answers to each question of the first- and fourth-year students for the four degrees analyzed.

3.2. Improvement in Sustainability Competencies

In this section, we present the results of Objective 2: "Evaluate the degree of improvement in sustainability competencies achieved by students in each analyzed degree".

Figure 3 shows, for each degree, the difference between the mean values of the fourth- and first-year students in each question (Equation (6)). As can be seen in the figure, in some questions the students of the Bachelor Degree in Primary Education declared worse results in the fourth year than in the first year. This fact could be due to the effect described by Kruger and Dunning [22] as a cognitive bias. According to this effect, students believe that they possess more skills and knowledge than they actually possess when they start the degree. In the first year, they may have a feeling of illusory over-training, derived from previous learning in other stages or educational contexts. However, when they finish the fourth year, they have a greater metacognitive capacity, so they are more critical and analytical, and therefore recognize that they do not know as much as they initially thought.

Figure 3. Learning (in absolute value in the range [0,1]) perceived for each question by the students of the four degrees.

In general, the Bachelor Degree students of Pedagogy showed the greatest improvement. On a detailed analysis of each question, one may observe that questions Q7 (I have basic knowledge to identify the possible socio-environmental impacts derived from educational actions), Q10 (I know community educational programs that promote participation and commitment in socio-environmental improvement), and Q11 (I know how to develop satisfactorily in community educational projects, promoting participation) were the only ones in which negative results were obtained for the Bachelor Degree in Pedagogy.

In order to determine which of the values presented in Figure 3 are statistically significant, Table 5 presents the p-value found for each question in each degree analyzed. The p-values that identify that the improvement observed in a question was significant ($p < 0.05$) are shaded in gray.

Table 5. *p*-values resulting from the analysis of the differences of the medians of each question between the results of first- and fourth-year students in the four degrees.

	***p*-Value**			
Question	**SE**	**P**	**PE**	**ECE**
Q1	0.088	0.022	0.004	0.690
Q2	0.103	0.081	0.761	0.667
Q3	0.209	0.027	0.649	0.395
Q4	0.003	0.003	0.710	0.081
Q5	0.000	0.008	0.813	0.154
Q6	0.000	0.006	0.089	0.516
Q7	0.030	0.001	0.349	0.158
Q8	0.014	0.000	0.064	0.076
Q9	0.009	0.000	0.029	0.175
Q10	0.002	0.481	0.017	0.064
Q11	0.000	0.002	0.763	0.311
Q12	0.000	0.000	0.615	0.002
Q13	0.860	0.045	0.691	0.001
Q14	0.865	0.004	0.938	0.000
Q15	0.016	0.002	0.403	0.047
Q16	0.000	0.000	0.982	0.085
Q17	0.018	0.003	0.010	0.058
Q18	0.000	0.000	0.470	0.009

The statistical analysis shown in Table 5 indicates that the students of the Bachelor Degree in Social Education and the Bachelor Degree in Pedagogy are those who perceive the greatest learning in sustainability (significant improvement in 13 and 16 questions, respectively). In the Bachelor Degree in Social Education, we identified improvements in all questions except Q1 (I know the interrelationship between natural, social, and economic systems), Q2 (I can analyze and understand the relationships between natural systems and social and economic systems), Q3 (I anticipate the repercussions of changes in natural, social, and economic systems), Q13 (I know the ethical principles of sustainability), and Q14 (I understand and integrate the ethical principles of sustainability in my professional and personal actions). In the Bachelor Degree in Pedagogy, on the other hand, we identified improvements in all questions except Q2 (I can analyze and understand the relationships between natural systems and social and economic systems) and Q10 (I know the community educational programs that promote participation and commitment in socio-environmental improvement).

Bachelor Degrees in Primary Education and in Early Childhood Education performed much worse. In the Bachelor Degree in Primary Education, we found significant improvements in just three questions. Specifically, question Q1 (I know the interrelationship between the natural, social, and economic system), question Q9 (I know how to design and develop educational actions taking into account negative socio-environmental impacts and incorporating corrective actions), and question Q17 (I know how to critically assess and analyze the consequences that my personal and professional performance may have on the integral development of students and on the promotion of sustainable human development). The *p*-values indicate that the improvement identified by the means was significant, which seems to indicate that the subjects that make up the curriculum affect the acquisition of the learning outcomes analyzed.

Regarding the Bachelor Degree in Early Childhood Education, the *p*-values indicate that significant improvements existed in five questions: questions Q12 (I know how to design and carry out socio-educational activities in community participation processes that promote sustainability, and feel integrated in part of my environment), Q13 (I know the ethical principles of sustainability), Q14 (I understand the ethical principles of sustainability and I am able to integrate them into my professional and personal actions), Q15 (I know how to design and manage educational projects, and take into account ecological ethics in order to improve the quality of life and promote the common

good), and Q18 (I know how to design and develop educational intervention proposals that integrate sustainability values and result in justification and the common good).

3.3. Analysis of Learning Improvement

In this section we present the results of the third objective: "Analyze whether the improvement achieved in sustainability is homogeneous or, conversely, students improve more in some aspects than in others". While we used data from the means to present the improvement graphically, we calculated the *p*-values from the medians.

3.3.1. Degree of Improvement considering the Competency Units

As shown in Table 3, the sustainability map of the degrees of education has six competency units, each defined in three domain levels, which gave rise to the 18 questions in the questionnaire. Figure 4 shows the difference in the means, for each competency unit, between the results of the first- and fourth-year students in the four degrees studied (Equation (7)).

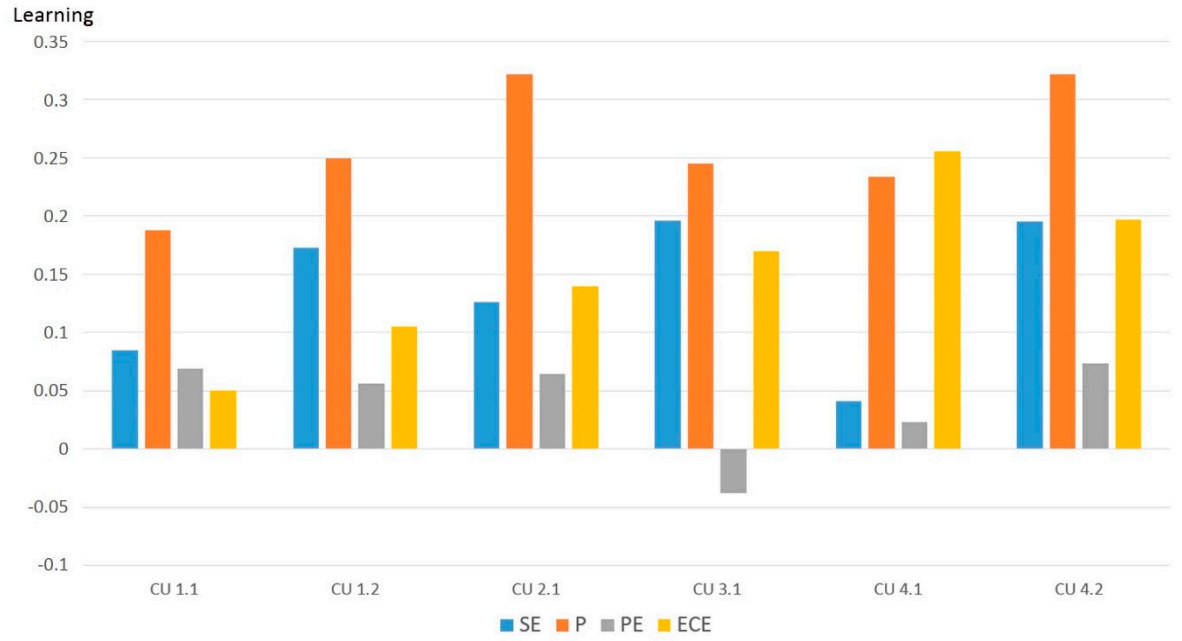

Figure 4. Learning achieved in each competency unit in each degree.

Figure 4 shows that the Bachelor Degree in Pedagogy yielded the best results in all competency units, with the exception of CU4.1 (I am consistent in my actions, respecting and valuing diversity—biological, social, and cultural—and am committed to improving sustainability), in which the Bachelor Degree in Early Childhood Education performed slightly better. The Bachelor Degree in Primary Education presented the worst results in all competency units, with the exception of CU1.1 (I understand the functioning of natural, social, and economic systems, as well as their interrelationships and problems, both locally and globally), in which the Bachelor Degree in Early Childhood Education performed worse. The Bachelor Degree in Primary Education was the only degree that achieved negative results for a competency unit, CU3.1 (I promote and participate in community processes that promote sustainability). The figure clearly shows that from the point of view of competency units there is no shared guideline for improvement in the four degrees. Taking all the data into account, the average improvement achieved was 0.15 (average of the improvements given by each competency unit in each degree). Only the Bachelor Degree in Pedagogy managed to exceed the average level of improvement in all competency units. The Bachelor Degree in Social Education achieved an improvement greater than 0.15 in all competency units except for CU1.1 (I understand the functioning of natural, social, and economic

systems) and CU4.1 (I am consistent in my actions, respecting and valuing diversity). The Bachelor Degree in Early Childhood Education achieved above-average improvements in three of the six competency units, specifically CU3.1 (I promote and participate in community processes that promote sustainability), CU4.1 (I am consistent in my actions, respecting and valuing diversity) and CU4.2 (I design and develop actions, making decisions that take into account the environmental, economic, social, cultural, and educational repercussions to improve sustainability), while the improvements in the Bachelor Degree in Primary Education were below average in all the competency units analyzed.

Table 6 shows the *p*-values associated with the improvements identified for each competency unit. The *p*-values which identify that the improvement observed in a competency unit was significant ($p < 0.05$) are shaded in gray. As can be seen from the table, only the Bachelor Degree in Pedagogy presented significant improvements in all competency units. The Bachelor Degree in Social Education presented improvements in four competency units, the Bachelor Degree in Early Childhood Education in three competency units, and the Bachelor Degree in Primary Education in none of them.

Table 6. *p*-values resulting from the analysis of significant differences in the Competency Units between the first- and fourth-year results in the four degrees.

	***p*-Value**			
CU	**SE**	**P**	**PE**	**ECE**
CU1.1	0.085	0.017	0.171	0.780
CU1.2	0.000	0.002	0.402	0.302
CU2.1	0.006	0.000	0.333	0.067
CU3.1	0.000	0.003	0.481	0.012
CU4.1	0.369	0.003	0.550	0.000
CU4.2	0.000	0.000	0.250	0.016

3.3.2. Degree of Improvement Considering Domain Levels

Figure 5 presents the improvement analysis performed for each domain level of the taxonomy (Equation (8), with L1 = know, L2 = know how, and L3 = demonstrate + do).

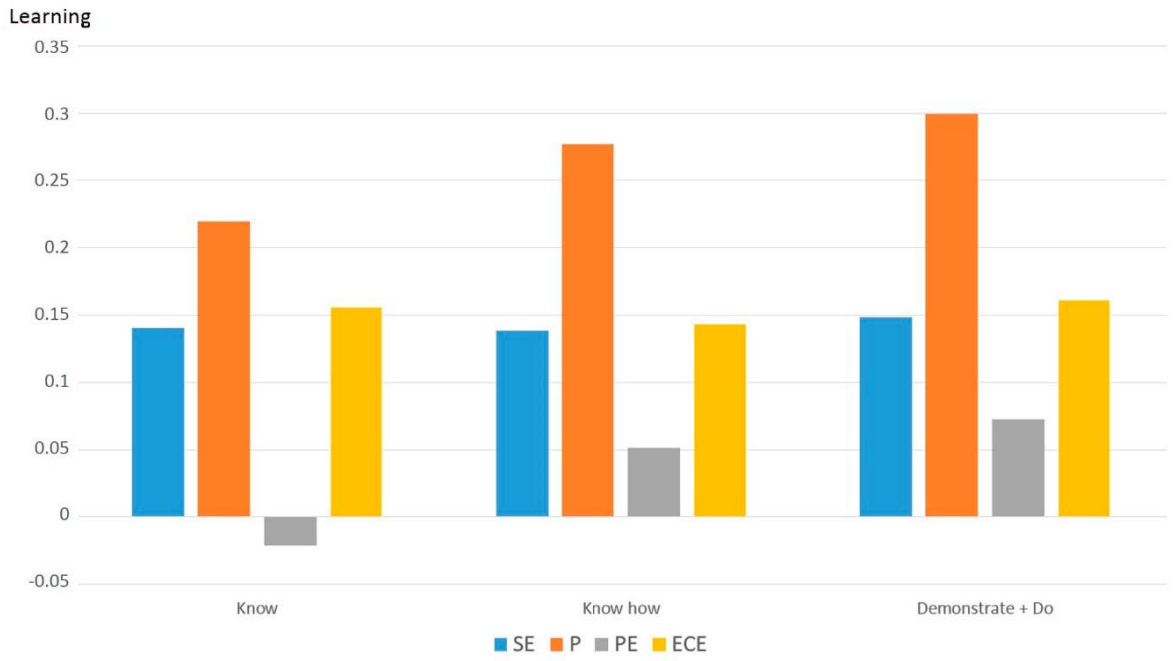

Figure 5. Learning achieved in each degree considering the domain level.

Figure 5 shows that the Bachelor Degree in Pedagogy was the one that achieved the greatest improvement in all domain levels. The Bachelor Degree in Primary Education students reported worse results at the "know" level upon completion of their studies, as well as a slight improvement at the other two levels. The Bachelor Degree in Social Education and the Bachelor Degree in Early Childhood Education presented very similar results at all three levels, hovering around an improvement of 0.15. Finally, level 0.25 was only surpassed by the Bachelor Degree in Pedagogy at levels "know how" and "demonstrate and do". This suggests that (1) the Bachelor Degree in Pedagogy subjects is more focused on working on the higher levels of the taxonomy, (2) the Bachelor Degree in Social Education and Bachelor Degree in Early Childhood Education subjects work in the same depth for the three levels and, finally, (3) the subjects of the Bachelor Degree in Primary Education work only a little on higher levels of the taxonomy.

Table 7 shows the *p*-values associated with the improvements identified for each domain level. The *p*-values which identify that the observed improvement was significant ($p < 0.05$) are shaded in gray. As can be seen in the table, all degrees except the Bachelor Degree in Early Childhood Education showed significant improvements in all domain levels.

Table 7. *p*-values resulting from the analysis of significant differences between the first- and fourth-year results in the four degrees considering the domain levels.

	***p*-Value**			
Domain level	**SE**	**P**	**PE**	**ECE**
L1—Know	0.001	0.000	0.946	0.006
L2—Know how	0.002	0.000	0.417	0.007
L3—Demonstrate and do	0.000	0.001	0.190	0.031

3.3.3. Degree of Improvement Considering Sustainability Competencies

Figure 6 shows the improvement achieved in each of the Bachelor Degrees analyzed for each of the four sustainability competencies (Equation (9)). The figure also shows the degree of overall improvement in sustainability learning (Equation (10), "Sustainability" column).

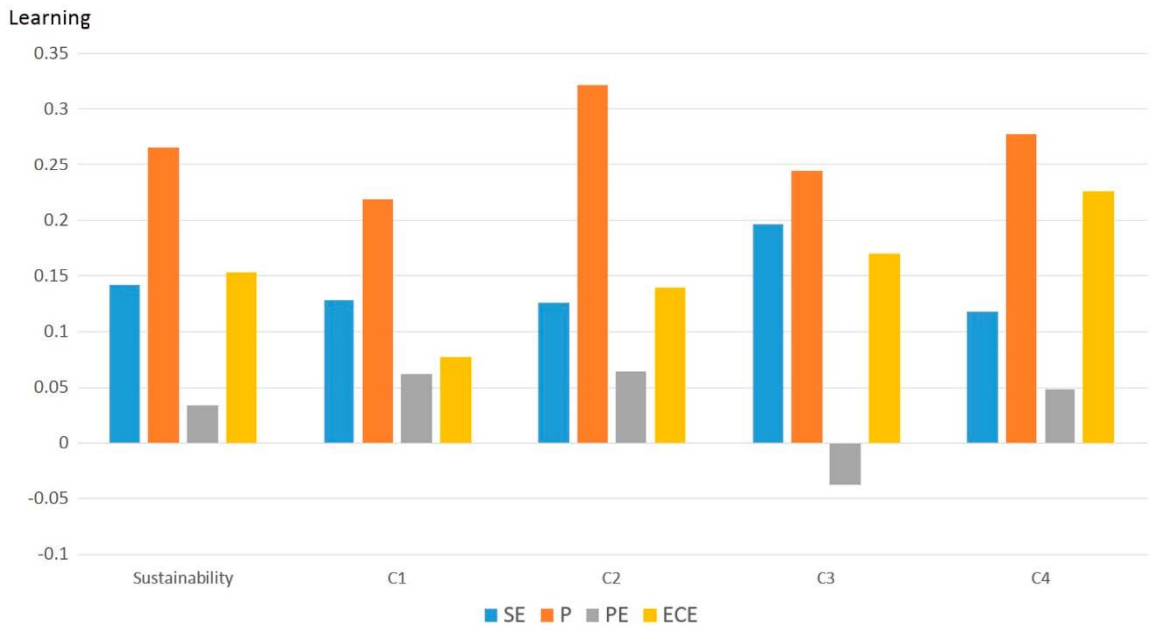

Figure 6. Learning achieved in each degree in general and for each competency.

As shown in Figure 6, only the Bachelor Degree in Pedagogy achieved an overall improvement in sustainability greater than 0.25. In addition, in competency C2 (sustainable use of resources and

prevention of negative impacts on the natural and social environment) the improvement exceeded the value 0.3. None of the other three degrees managed to exceed a value of 0.25 for any of the four competencies. The Bachelor Degree in Social Education and the Bachelor Degree in Early Childhood Education obtained a similar improvement in sustainability (0.14 and 0.15, respectively). The Bachelor Degree in Primary Education was the degree with the worst results, both overall (0.03) and for each competency, and the results of competency C3 (participation in community processes that promote sustainability) were worse for fourth-year than for first-year students.

Table 8 shows the *p*-values associated with the improvements identified for each competency (C1–C4) and for sustainability in general (sustainability). The *p*-values which identify that the improvement observed in a competency (or in general) was significant ($p < 0.05$) are shaded in gray. As can be seen in the table, the only degree that did not present significant improvements in sustainability was the Bachelor Degree in Primary Education, which also did not present significant improvements in any of the competencies. The Bachelor Degree in Social Education and the Bachelor Degree in Pedagogy presented improvements in all four competencies, while the Bachelor Degree in Early Childhood Education presented significant improvements only in competencies C3 (participation in community processes) and C4 (ethical principles), and no significant improvements were found in competencies C1 (critical knowledge contextualization) and C2 (sustainable use of resources).

Table 8. *p*-values resulting from the analysis of significant differences between the first- and fourth-year results in the four degrees, by competency and globally.

	***p*-Value**			
Competency	**SE**	**P**	**PE**	**ECE**
SUSTAINABILITY	0.000	0.000	0.470	0.009
C1	0.001	0.001	0.317	0.750
C2	0.006	0.000	0.333	0.067
C3	0.000	0.003	0.481	0.012
C4	0.006	0.010	0.375	0.000

This research had three objectives: (1) to measure the level of sustainability competencies that the students of the Education degrees present when they begin and end their studies at USAL, so that both measurements can be compared; (2) to evaluate the improvement achieved by students in the sustainability competencies in each analyzed degree; and (3) to analyze whether the improvement achieved is homogeneous or, conversely, students improve more in some aspects than in others.

Regarding the first objective, it seems that the Bachelor Degrees in Pedagogy and Social Education achieved significant improvements in the sustainability competencies of their students. In the Bachelor Degree in Primary Education we found that, in some cases, first-year students reported the perception of a higher level of sustainability competencies than fourth-year students. This may be due to the effect described by Dunning and Kruger [22]: individuals with fewer competencies and less knowledge have an illusory feeling of superiority, considering themselves to be more intelligent than other more prepared individuals.

Regarding the second and third objectives, with the exception of the Bachelor Degree in Primary Education, it seems that the other three degrees achieved improvements in the sustainability competencies of their students, especially the Bachelor Degree in Pedagogy: the students of the Bachelor Degree in Pedagogy were those with the best learning outcomes, and were also more homogeneous.

Although students perceived improvement in their sustainability competencies in the Bachelor Degrees of Social Education, Early Childhood Education, and Pedagogy, only the Bachelor Degree in Pedagogy presented a significant improvement. Perhaps this is because in this degree students study a compulsory subject called Environmental Pedagogy, which includes service-learning practices, which may have an effect on this result. On the other hand, it appears that the subjects that make up the

Bachelor Degree in Pedagogy curriculum integrate the vision of sustainability effectively, as already revealed by other studies [17].

We consider that it is important for the subjects that make up the curricula to introduce training practices that link university training with the professional experiences developed in schools and social centers working effectively on issues concerning environmental and social improvement, as recommended by other authors [23,24]. It is possible that the treatment of social and economic problems in the different subjects of the university curriculum, together with environmental problems, would increase the students' sustainability competency on completion of their studies. However, the differences found between the first- and fourth-grade students may also be influenced by other variables, such as, for example, their capacity for social commitment and participation throughout their studies (previous or university) in youth or student movements, in university or citizen awareness campaigns, attendance at talks and colloquia on environmental and social problems. All this influences students' learning and training in sustainability.

Ethical principles are a benchmark in learning processes in education degrees [25], as are educational values and citizen training [26,27]. However, a greater impact on ethical and deontological training is required in order to produce professionals capable of carrying out educational work aimed at recognizing the value of each individual, as well as seeking harmony with the environment surrounding them and respecting their fundamental rights [28,29]. In essence, it is necessary to redesign the processes promoting sustainability in the education degrees of the University of Salamanca, and thereby the social variable of learning [19,30].

In previous works of both basic and applied research [31,32], it has already been shown that in addition to containing subjects that specifically address environmental education and sustainability, the Bachelor Degree in Pedagogy and Social Education should also encourage participation in community projects through service-learning methodologies that enable students to acquire more experiential learning. To this end, as shown by other research work, the adoption of appropriate didactic strategies is essential to achieve sustainability learning and the inclusion of the SDGs in higher education [33]. The challenge consists not only of redesigning learning processes in pursuit of a university curriculum that is in closer alignment with the challenges posed by the SDGs, but also of preparing teachers in the methods and mechanisms required to integrate sustainability competencies into their subjects.

3.4. Limitations of This Work

This was not a longitudinal study. The two participating samples were separated by four calendar years, and it is possible that the current first-year students have a different sustainability training than the fourth-year students had when they entered university, since they have received training, awareness, and more intensive sensitization in their compulsory and post-compulsory secondary studies. Over recent years, there has been a greater emphasis in Spain on the implementation of educational projects that promote ecological awareness in order to meet the Sustainable Development Goals [34], both nationally [11] and internationally [35].

We calculated the results from the students' responses to a questionnaire consisting of 18 questions, which measured their own perception of their sustainability competencies. This perception may be distorted and fail to coincide with reality.

On the other hand, the sample of students was small, especially that of fourth-year students. The results of this study cannot be extrapolated to other degrees, although the methodology can be used to analyze the level of sustainability competencies of the students of any university degree in the field of higher education.

Finally, in this work the authors carried out a study in a university and in degrees that are part of the same field of knowledge. It is necessary to conduct this type of study in other fields of knowledge and in other higher education institutions. Furthermore, longitudinal studies are required to enable us to determine the evolution of the students throughout the four Bachelor degree courses. This will form part of our future work.

4. Conclusions

In this paper, we presented the results of a partial investigation within a specific higher education context, the University of Salamanca, and in specific degrees: the degrees of education (Bachelor Degrees in Primary Education Teacher, Early Childhood Education Teacher, Social Education, and Pedagogy). These results are part of a larger investigation, the EDINSOST project, which between 2016 and 2019 explored the real situation of the integration of sustainability in 13 degrees of education, engineering, and business at 10 Spanish universities. The results presented correspond to Objective 4 of the EDINSOST project: analysis of sustainability training for graduates of the Spanish university system. In this work we analyzed the level of acquisition by students of the sustainability competencies at the beginning and end of their studies in the four degrees of education taught at the USAL. USAL Students perceived improvement in their sustainability competencies in the four degrees analyzed, but only the Bachelor Degree in Pedagogy presented a significant improvement. Therefore, it appears that the model used to introduce sustainability competencies in the Bachelor Degree in Pedagogy is the only one that achieves good results.

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