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Transformative Education for Sustainable Consumption

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Abstract: Teachers play a key role in the construction of a more equal, fairer and sustainable world. Incorporating education for sustainable consumption into teacher training should therefore be a priority. This education should aim to develop students' awareness of environmental issues, to encourage lifestyle changes, and to promote reducing their personal ecological footprint (EF). Training processes will hence lead to active learning approaches promoting critical thinking about production and consumption patterns, linking the curriculum content to real life, and involving students in activities that reduce their EF. This paper presents research carried out at three Spanish faculties of education. The main goal is to analyse the relationship between active teaching and learning strategies, and the reduction of the students' individual EF. Pre- and post-test questionnaires were used to collect data. A total of 93 primary education degree students took part in this study. The results show the students' individual EF decreased at the end of the learning processes. This proves that active teaching and learning strategies can foster sustainable consumption habits, and more sustainable lifestyles in general, in student teachers.

Keywords: teacher training; sustainable consumption; ecological footprint; sustainable development goals (SDGs); critical learning; active learning; teaching strategies

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1. Introduction

The COVID-19 pandemic seems to be related to Western consumption patterns that result in the accelerated destruction of ecosystems. Sonia Shah, an expert on pandemics, published the article: "Think Exotic Animals Are to Blame for the Coronavirus? Think Again" [1], in which she shows that deforestation and the destruction of natural habitats have made it possible for some pathogenic micro-organisms to adapt to the human body. The global health crisis seems to show that overstepping ecological boundaries has a price, and ethically speaking, that price is too high to pay.

According to the UNDP (United Nations Development Programme) [2], countries with a higher human development index have a larger ecological footprint and produce more greenhouse gas emissions. In contrast, poorer countries are more severely affected by the climate crisis [3], which is not only becoming worse, but also generates new environmental issues in these countries, such as prolonged droughts, floods, and desertification, forcing the population to move to other places. If no action is taken to change consumption and production patterns, irreversible damage will be inflicted on the environment [4].

To address this critical situation, the United Nations (UN) defined one of the Sustainable Development Goals (SDGs) as follows: "Ensure sustainable consumption and production patterns" (SDG 12) [5], which implies revising production and consumption patterns as a strategy that contributes to reducing poverty and hunger, as well as to improving the environmental quality of the planet. However, how can SDG 12 be used to transform it into an opportunity to make people consume in a more sustainable manner, change their views, and have a more global mindset? To many people, consuming less and

better sounds more like a restriction than like an opportunity. People only change their habits and attitudes when the alternatives offered are convincing and produce a benefit [6]. However, it seems to be clear that negative attitudes towards pro-environmental behaviour are due to a lack of this environmental knowledge, and that the provision of information can ultimately lead to behavioural change [7], an aspect that endorses our decision to influence by means of education.

The transition towards sustainable consumption patterns is related to how people see the world, to cooperation, to equity, or, in other words, to people's lifestyles. The current global crisis is a challenge and a call to live differently. A recent study about how food safety concerns affect consumer behaviours and diets in low- and middle-income countries concluded that failing to understand consumers' perceptions and behaviours around food safety issues, and missing the opportunity to do so, could further exacerbate the current unsustainability of food systems observed in low- and middle-income settings [8].

The importance of education in facilitating a shift towards promoting sustainable consumption patterns has been internationally reinforced in the UN's decision through the Global Action Programme on Education for Sustainable Development [9].

In Glavič's works [10] on the evolution and current challenges of sustainable consumption and production, it is concluded that the influence of power should be considered when researching drivers of consumption, or the potential for and barriers to degrowth. In his work, he refers to earlier work by Fuchs et al. (2016) on power: the missing element in sustainable consumption and absolute reductions research and action. The authors distinguish between the instrumental (e.g., financing lobbying or campaigns), structural (e.g., threats of corporations to shift investments and jobs to other countries), and discursive (i.e., values, norms and ideas that influence public debates and political agendas) facets of power.

Consumption choices are powerful decisions made in everyday life; they shape markets and production patterns, and have tremendous impacts on natural resources and ecosystems, as well as on the global community—contributing to issues such as climate change and human rights. Through purchasing choices, people vote in the market by supporting or rejecting certain corporate practices, and they send messages to decision-makers in governments, industries and companies. Education is one of the most powerful tools to help people make the right and most responsible choices, while meeting needs and expectations. Education can reconcile consumption with freedom and responsibility. This pressing ethical need is especially important in the training of future teachers [9] because of the effect this training will have on future generations of students.

Developing a curriculum for teacher training in which sustainability is a core theme does not only consist of introducing environmental content into teaching, but also of training people who are able to critically analyse the interrelationships between environmental, social and economic aspects to choose the most sustainable and socially responsible options in their decisions. This means putting sustainable development into practice. Therefore, the process of incorporating sustainability into curricula does not only affect conceptual contents, but also procedural and attitudinal contents in the development of sustainability competencies [11]. Including an introduction to sustainability implies a change in the educational system, which significantly affects teaching and learning processes [12]. It involves comprehensive training of individuals, and transcends the mere transmission of knowledge. Implementing critical pedagogy for consumption as an educational model aimed at teaching children and young people to be environmentally literate by promoting critical thinking for appropriate and equitable individual and social development is necessary [13].

In this regard, the education of citizens should be aimed at making them more autonomous, critical consumers [14]. It is clear that the educational community plays a key role in this matter, and that teachers are essential agents. Education for sustainable consumption (EfSC) is important because it empowers individuals and social groups, and provides them with appropriate information on the impacts of their daily choices as con-

sumers, as well as with workable solutions and alternatives. Knowing about this impact is the first step towards making informed decisions that encourage a change in lifestyle.

However, teachers are not always trained from this perspective. It is a competency that should be developed. In order to contribute to a more sustainable society from their profession, they should have knowledge, arguments and attitudes in line with what they are teaching [15].

Sustainable and responsible consumption should therefore be addressed at all levels of education. However, EfSC is not highly developed in higher education in general, and in teacher training in particular [16]. Authors such as Esteve and Climent [17] found that future teachers associate responsible consumption exclusively with saving resources and recycling, and with the underlying objective of economic savings and saving resources. It is a simplistic idea of the meaning of responsible consumption, which addresses social criteria in addition to environmental ones from an ethical perspective, since it seeks to ensure consumption of low environmental impact to improve the quality of life of people and other living beings on the planet. This implies consuming less, and making sure that what is consumed is as sustainable and supportive as possible.

The research presented in this study took place at three faculties of education in universities in the two Spanish autonomous communities which, according to reports from the Ministry of Ecological Transition and Demographic Challenge, produce the largest number of greenhouse gases in Spain: Andalusia and Catalonia (State Secretary for the Environment, Spain 2020). This fact was considered the trigger to design and implement specific educational activities aimed at changing the consumption patterns of student teachers in those regions.

Society needs an education system that contributes to putting responsible consumption into practice [12]. It is worth noting that the complexity associated with responsible consumption implies that education for responsible consumption should be considered from a global, cross-disciplinary, and interdisciplinary perspective [18]. The matter of interest here lies in understanding which educational strategies can contribute to these goals.

According to the constructivist perspective, active teaching and learning strategies could be a possible step going in the right direction [19]. This approach involves looking for new ways of teaching and learning through innovative perspectives that deal with socio-environmental issues in all their complexity. Common to all these strategies are the key educational approaches of Education for Sustainable Development (ESD), which are included in the Issues and Trends in Education for Sustainable Development report [20]. Of these, the following principles are highlighted: student-focused teaching that considers students as independent learners and stresses active development of knowledge, learning oriented towards action and reflection on one's own experiences with regard to the planned learning process, and personal development and transformational learning, the goal of which is to enable students to question and change their ways of viewing the world and thinking about it to continue developing their understanding of it [21,22]. This education empowers and helps students make significant changes in their way of interacting with the world, and therefore transforms their lifestyles towards ways of living that are more harmonious with the planetary boundaries.

Several studies analyse the current trend of using active teaching and learning strategies in initial teacher training programmes [23]. These include project-oriented learning (POL) and problem-based learning (PBL) as innovative active strategies that are recommended to develop competencies for ESD [24,25]. PBL and POL allow students, organised into groups, to develop projects, or work on problems based on real situations, with the aim of integrating knowledge, developing high-level intellectual skills, and promoting active, independent learning. These strategies also enable changes in the traditional roles of teachers and students, since the relationships between them are more horizontal than in other traditional methodologies. Some studies show that students of degrees in Education positively value these work methodologies, and perceive they contribute to acquiring pro-

fessional skills, increase motivation, and bring them closer to the construction of functional, global and practical knowledge [26].

These strategies may be complemented with other teaching methods such as Service-Learning [27], which enable students, through community action activities, to connect what they learn in the classroom with a real context, while offering a service to groups that need it.

In essence, teacher education should focus on training that provides students with the knowledge and courage to address the challenges of sustainable development [28], which include SDG12: responsible production and consumption.

Responsible consumption is an increasingly present topic in university education, as shown by several studies [29,30]. The EF has proven to be a useful and powerful tool. The studies that analyse its calculation in training processes show how students tend to overestimate the EF of low-impact actions, and underestimate the EF of high-impact actions [31]. This provides valuable information for the design of new educational interventions. This tool also allows discussing sustainable consumption in the context of daily life, linking students' personal actions to environmental issues and personally experiencing the multi-dimensional nature of sustainability [32]. It therefore generates enriching and meaningful educational processes for students, since they focus on real problems that make sense to them. The EF is a tool with great potential in EfSC and for research in the teaching methodologies used. It is closely related to the SDGs, and more particularly to SDG 12, as it specifies and makes aspects that derive from them tangible. It is often used in the literature as an education tool for sustainability, but in this study, it is also employed as an instrument to analyse if the didactic strategies used generated transformative education in addition to informative education. We thus consider this research to be relevant in the field of training future teachers because it provides primary education degree students with appropriate information on the impacts of their daily choices as consumers, as well as for workable solutions and alternatives. Teachers play a key role in the construction of a more equal, fairer and sustainable world.

This paper presents research carried out at three Spanish faculties of education. It is structured into different sections: the introduction, in which a review of the current status of research on the central theme was carried out and the research problem is presented, followed by the materials and methods section in which the context of the study, the participants, and the methods followed for the data analysis and collection are described. The results and discussion section comes next, and the final section in this paper contains the conclusions.

The main goal is to analyse the relationship between active teaching and learning strategies and the reduction of the students' individual EF.

To that end, the following research objectives are proposed:

(a). Analyse and compare the global EF of the three faculties of education after implementing active teaching and learning strategies.

(b). Examine and compare the components that comprise the students' global environmental footprint (GEF) in each of the faculties of education involved in the study, and how they are related to the use of active teaching and learning strategies.

2. Materials and Methods

Active teaching and learning strategies and teaching methods that focus on transformational learning [33] are used to integrate ESD [19,34,35] and, as a result, the SDGs [36]. However, recent studies [37] show the need to continue conducting research on their effectiveness because publications in this field remain scarce. This study therefore focused on examining how these methodological strategies can contribute to training future teachers in how to teach responsible sustainable consumption. To do so, the individual EF of three groups of university students from primary education degrees at three Spanish universities was measured at the beginning and at the end of different training processes that used these types of strategies. The processes were previously designed by the research group that

developed the study. This research group has long-standing experience in both training in EfS and in research in this field. They are also the coordinators of the subjects in which the research was developed. The training processes developed are described in depth in the Context section.

2.1. Participants

A total of 93 students enrolled in the primary education degree participated in this study. Of those, 43% was from the faculty of education of the Universidad de Sevilla (FEUS), 38.7% from the faculty of education of Universidad de Cádiz (FEUCA) and 18.3% from the faculty of education of Universidad Internacional de Cataluña (FEUIC). Female students comprised 74.2% of the participants, and male students 25.8%.

The levels involved in the research were second, third, and fourth-year undergraduate students. The courses in which this research took place were all related to Didactics of Science, which facilitated the integration of the subject matter of the study, as it was conceptually related to the topics to be studied in these courses.

All the participants were informed that they were part of a study and that the data obtained would be used in a research study.

2.2. Data Collection Instrument and Analysis

Pre- and post-test questionnaires were used to collect data. The myfootprint.org online tool was the instrument used to calculate the students' individual EF. It is an online calculator that provides individual EF data by calculating the different components that comprise it: carbon footprint (CF), food footprint (FF), goods and services footprint (GSF), and housing footprint (HF).

The EF is a popular instrument for calculating consumption [38] and it has been used since the early 1990s [39]. Online programmes developed by non-governmental organisations to measure people's personal EF offer a useful tool for working with university students [40]. It shows the appropriation-production process and its repercussions for the planet, ecosystems, and society [41]. It links the waste generated per person and per year to the area of productive land required to produce the resources that satisfy individual production and consumption. It is expressed in global hectares (gha) per person per year [42].

It can also be used as an instrument to address environmental issues from an educational perspective [41]. Previous studies indirectly show that, by using EF as an attitude indicator, cross-disciplinary training in sustainability can change students' consumption habits [43]. It has been used in different educational and research experiences for sustainability, or, more specifically, for EfSC [44,45], endowing it with accuracy and reliability. As EF has previously been used in the literature, it is considered to be a validated instrument.

In this study, the goal of the EF is two-fold. First, it shows the students their individual impact on the planet in accordance with their lifestyle. In this case, it is an educational tool for EfSC [45]. On the other hand, the EF calculator is a research instrument to measure the effectiveness of the teaching methodologies implemented. It enables analysing the extent to which the teaching methodologies implemented provide information on serious environmental issues and on how to solve them. It also allows measuring whether education has been transformative or not, that is to say, if, through teaching, it has contributed to changing the students' consumption habits or not. The fact that all the students calculate their own EF in class contributes to questioning their own consumption, and looking for ways to promote sustainable behaviour [46]. Obtaining the EF results in a quantitative manner enables making comparisons between their EF at the beginning and at the end of the course. The results show which components of the EF will need to be reinforced in the next courses.

For the data analysis, a comparison was made between the initial and the final global footprint of the three universities that participated in the study, and the footprints of the

different universities were compared. Finally, the different sections that make up the initial and final footprint of the universities were presented and compared.

2.3. Context

This research study took place at the faculties of education of three Spanish universities: Universidad de Sevilla (US), Universitat Internacional de Catalunya (UIC), and Universidad de Cádiz (UCA). As pointed out earlier, the universities involved in the study are located in the regions of the Spanish territory that produce the highest number of greenhouse gases in Spain (Secretary of State for the Environment, Spain 2020), hence the urgency to initiate educational processes for change at universities in those regions.

Prior to the design and implementation of the training experiences, the research team, made up of the teachers responsible for the subjects, agreed on common issues to be considered in them, although each of the designs was adjusted to the characteristics of the context (subject and university) and to the peculiarities of the group of students it was addressed at. The different educational experiences implemented are described below:

Project-Oriented Learning—FEUS

The training experience took place in the context of the Didactics of Experimental Sciences course in the primary education degree at US. The project focused on changing consumption habits to more sustainable habits as an action to mitigate the climate emergency.

The methodological proposal was based on getting involved in alternatives and solutions to real problems by developing projects. It was designed based on the following principles: an analytical approach in which the students critically examined their own consumption habits, and a practical approach that related critical reflection to action. The students worked on acquiring basic knowledge (of an ecological, economic and political nature), and on looking for pertinent information to improve their understanding of the connections between consumption and climate change. It was also based on an experiential approach, where students learned through project-based problem-solving processes. The students carried out an action plan to raise awareness among other students about the socio-environmental problems caused by excessive consumption and the need to shift towards more sustainable consumption patterns.

The methodological proposal was organised into three phases:

(a). Awareness-raising phase: the experience began with a first phase of raising awareness of the socio-environmental issues that concern students the most, and what the possible causes are that originate them. After a group discussion on the students' ideas about the possible consequences of environmental issues, the focus was put on working on consumption. To do this, the activities were aimed at answering two questions: (1) Where do the objects we buy come from and where do they go? And (2) Do we need everything we buy?

(b). Information-research phase: this phase focuses on examining the main strategies that promote conscious and unconscious consumption. The students were asked to carry out a research project based on the question: Why do we buy more than we need? On the one hand, the students conducted a field study in which they collected data in situ on the strategies used by the sales areas (supermarkets, clothing or footwear stores, large hotel chains, etc.) to promote consumption. On the other hand, they analysed what strategies advertising uses to encourage consumption, and how they could be used to counteract consumption. The students made a presentation of the results of their investigation. After sharing their conclusions, a debate was generated in which the main strategies used by advertising to promote consumption were agreed upon.

(c). Action phase: the objective of this phase was to establish an action plan to raise awareness of the socio-environmental issues generated by excessive consumption. The students were asked to design a project aimed at young people for a more conscious and sustainable consumption. They launched an Instagram campaign using the hashtag: @alconsumonomesumo_ [Yo me sumo al consumo].

Including social networks made the action go beyond university classrooms, which generated the following advantages: (a) greater and better access to a young audience, (b) survival of the project over time (as long as feedback is maintained), (c) the possibility of gathering opinions through the comments of the recipients (which allows collecting feedback from the projects), (d) speed and immediacy of access, unlimited reproduction and domino-effect through inviting followers and forwarding.

Project-oriented learning and a cross-disciplinary workshop on sustainable consumption—FEUIC

Project-oriented learning

In small groups, the students had to develop a research project on a real problem related to the consumption aspect of SDG 12. They worked on the projects in the Didactics of Experimental Sciences course for a period of two and a half months. The research project topics were connected to real problems that affected them closely. Some of the projects presented by the students were the following: A small step for humans, a huge change for the planet; What is the relationship between climate change and sea level rise and what are its consequences? Forests: green lungs of our world; Diets and the World of Tomorrow; Give life to the planet; Reuse! Aluminium foil or a plastic lunchbox? Responsible use of water in schools; Sustainable schools: take care of your money and of the planet.

During this period of research and interactive reflection, the student teams had POL tutorials and also connected with stakeholders outside the university such as government officials, experts from different fields of sustainable consumption, and schools. Social learning took place with multiple interlocutors, which allowed for a creative approach to solving problems [47].

Cross-disciplinary workshop on sustainable consumption

All the students carried out research projects related to the workshop topic and presented the results of their research through a scientific poster or interactive workshop. This process encouraged addressing sustainable consumption in a cross-disciplinary manner. After presenting their projects, they were evaluated by a group of experts. Twenty experts on the topic, including lecturers from the university and from four other universities, as well as experts from the Sustainability Department of the Barcelona City Council participated in the evaluation of the projects. All the evaluators used the same data collection instrument to assess the students.

This experience contributed to empowering the students. By carrying out a project in which they related the social and environmental aspects of consumption, the students could critically examine their own consumption habits, thereby facilitating a change in habits toward more sustainable and responsible consumption.

Problem-based learning—FEUCA:

The teaching and learning strategy used at the FEUCA was problem-based learning. Everyday topics related to science, such as nature parks, mobile phones, water, etc. were introduced to the students of the degree in primary education. The students, organised into groups, analysed the topics and agreed on a specific issue to research justifying the issue's educational interest as well as their personal interest. Before starting, the importance of ensuring that the work carried out had a connection to their immediate environment was discussed. Some examples of the issues chosen were the following: what are the main socio-environmental problems of the Los Toruños Natural Park? What animal and plant species live in the park? Does water have an owner? What is the origin of the egg?

After defining the problems, the groups developed explicit hypotheses and designed an action plan to refute or confirm them. In these plans, the students included tasks to look for information from different sources (documents, interviews, questionnaires, visits to key sites, etc.); analyse information (create reports, concept maps, and outlines); and finally, they created answers to the problems they were working on based on the results they obtained. The students worked independently on this action plan, receiving guidance from their teachers who provided resources, cleared up doubts, checked their progress, and proposed new challenges to the different groups.

The last part of the experience consisted in sharing the results with the rest of the class, as well as with the educational community and society. These results were presented in different formats: a blog about the flora, fauna and citizens who inhabit the natural park, which was shared on social networks; a lapbook on socio-environmental issues, which was used as educational material for schools in the area; and a scientific conference where students presented posters that summarised the issues researched. In this congress, the groups presented the results, and answered questions from both the scientific committee made up of a group of teachers from the area of Didactics of Science, and from the rest of their classmates. The groups also assessed the work of the different group by means of a rubric, elaborated by the teachers. This information was sent to each of the groups, and served as feedback on the work carried out.

Working from this perspective allowed the students to make decisions regarding their educational process and their own interests, as they were able to choose the issues they wanted to research and the ways to solve them. During the process, they also gained knowledge through different means, and applied the content studied by sharing their results with society, thus contributing to some extent to establishing connections between the university classroom and society. The aim was to promote the students' capacity for critical thinking and making evidence-based decisions, which could lead to more responsible lifestyles.

3. Results and Discussion

The Results and Discussion section is organised in accordance with the two research objectives. All the global initial ecological footprint (IEF) data were collected before putting into practice the different specific teaching strategies, and the global final ecological footprint (FEF) data after they were implemented.

3.1. Analyse the Global EF of the Three Faculties of Education after Implementing Active Teaching and Learning Strategies

The EF of the university community, and especially of the students could be significant [48]. Therefore, it is worthy of note to know the figures, and use the EF as an educational instrument to promote changes in university students' consumption habits, especially in those students who will be the educators of future generations.

Table 1 shows the results for the global EF of the students at the three faculties of education involved in the study, both at the beginning and at the end of the process. The three cases begin with different global EFs; the FEUS had the lowest global EF (3.47 gha). The highest EF was at the FEUIC (3.89 gha). With regard to the final EF, the FEUS again had the lowest (3.17 gha), while the highest was at the FEUCA (3.44 gha).

Table 1. Global Initial Ecological Footprint (IEF) and global Final Ecological Footprint (FEF).

	FEUS	**FEUIC**	**FEUCA**
IEF (gha)	3.47	3.89	3.58
FEF (gha)	3.17	3.39	3.44

The results reveal that the global EF declined in the three cases studied after implementing the active teaching and learning strategies described in the educational experiences. This shows the strategies implemented may have had a positive influence on the students' consumption habits. These results coincide with prior studies [49] in which the university students' EF decreased, and attitudes toward sustainability improved [50] after participating in educational processes with similar characteristics to those employed in this study. It is important to emphasise that because of the nature of this study, the changes that occurred most likely cannot solely be attributed to the educational experiences, as learning is influenced by several factors [51], and requires time.

This general decrease in the global EF at the end of the process was not equally significant for all the cases in the study. To understand the importance of these reductions,

the relative change in those reductions was calculated with respect to the initial situation, that is to say, the IEF. The results are shown in Figure 1. As can be seen, the largest decrease was at the FEUIC, where the relative change was 0.13, or 0.5 gha less in the global EF than at the beginning of the training process. The second most significant reduction was at the FEUS, which also had the lowest IEF. In this case, the change observed was 0.13, or a reduction of 0.3 gha. Finally, the relative change in the EF for the FEUCA (0.04) equalled a reduction of only 0.14 gha.

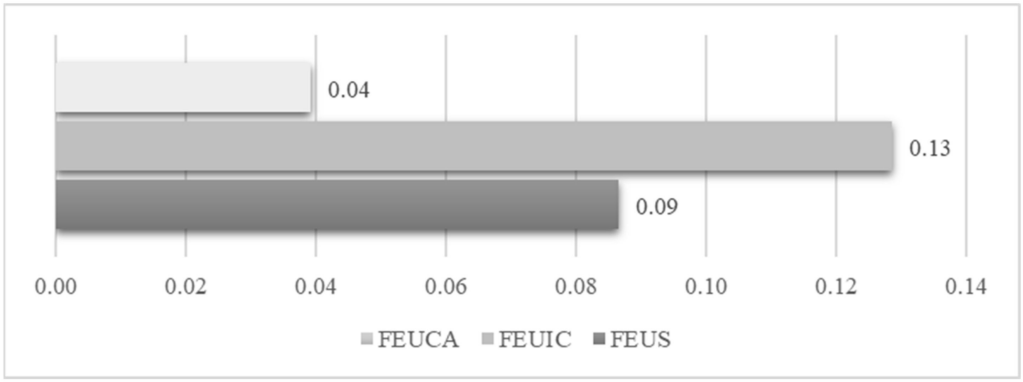

Figure 1. Relative decreases in the global EF in the three cases studied.

To sum up, it can be said that the use of active teaching and learning strategies had a greater impact on the EF of the students at the FEUIC and at the FEUS than on the students at the FEUCA, where the decrease was minimal. This could be due to the fact that although work was done from the same perspective in all three cases, both the FEUIC and the FEUS focused the educational experiences on the topic of sustainable consumption, while the FEUCA worked on a broad range of topics related to environmental and socio-scientific issues, something that may have diverted the students' attention from the central theme of the study. Another influencing factor could be the fact that the FEUIC and the FEUS are faculties that belong to large cities (Seville, approx. 700,000 inhabitants, and Barcelona, 1,700,000 inhabitants), where certain habits and behaviours are much more common, and certain products are more accessible than in Cádiz, which has approximately 120,000 inhabitants. This coincides with previous studies that show how socio- demographic characteristics have a significant influence on a person's ecological footprint [52,53].

3.2. Examine and Compare the Components That Comprise the Students' GEF in Each of the Faculties of Education Involved in the Study

The tool used to calculate the EF allows for an analysis of the different components that comprise it, which are the following: carbon footprint (CF), food footprint (FF), goods and services footprint (GSF), and housing footprint (HF), as explained in the data collection instrument section. It was hence possible to examine which components contributed to the global EF to a greater or lesser extent, and in which components the students have a greater capacity to intervene. This information could further be used to design specific didactic interventions aimed at analysing and working on those areas where the decrease observed was small so as to improve the training processes of university students.

The results obtained in gha for each of the components are presented in Table 2. When analysing the initial situation (IEF), it was observed that in all three faculties of education that took part in the study, the food component was the highest. The results for the FEUCA, which had the highest value for the food footprint (1.60 gha) and the FEUIC (1.50 gha), were similar, while the FEUS obtained the lowest value (1.24 gha).

Table 2. Results of the IEF and FEF obtained at the three education faculties.

	FEUS		FEUIC		FEUCA	
	IEF	**FEF**	**IEF**	**FEF**	**IEF**	**FEF**
Carbon (gha)	0.51	0.47	1.08	0.86	0.81	0.79
Food (gha)	1.24	1.04	1.50	1.38	1.60	1.53
Housing (gha)	1.06	1.01	0.44	0.40	0.47	0.43
Goods and services (gha)	0.67	0.66	0.87	0.78	0.71	0.69

With regard to the carbon component, the FEUS had the lowest value (0.51) of all three participating faculties. This component is essentially linked to emissions resulting from transport. While the highest EFs are due to flights, it cannot be ignored that most daily transport is generated by vehicular traffic. The FEUS is located in the city centre, where there are good public transport connections, as well as a bicycle lane. The FEUCA is located on a campus outside the city, which means that many students drive to school. In the case of the FEUIC, although the faculty is located in the city of Barcelona and can be reached by public transport, 50% of the students come from other towns and drive to campus sharing cars.

As far as the housing component is concerned, the FEUIC and the FEUCA obtained very similar data, while the EF of the FEUS is more than double of the other two faculties (1.06 gha).

With respect to goods and services, the data do not differ greatly between the different cases studied. The FEUIC attained the highest value (0.87 gha).

With regard to the FEF in general, and as pointed out in the previous section, there was an overall reduction compared to the IFE. Here, the food component continued to be the highest for the three faculties. Similarly, the lowest components were the same as in the initial EF for all cases: carbon for the FEUS, and housing for the FEUIC and the FEUCA.

The decreases identified were not of the same magnitude for all cases, nor for each component. The analysis carried out shows how significant these reductions were (see Figure 2).

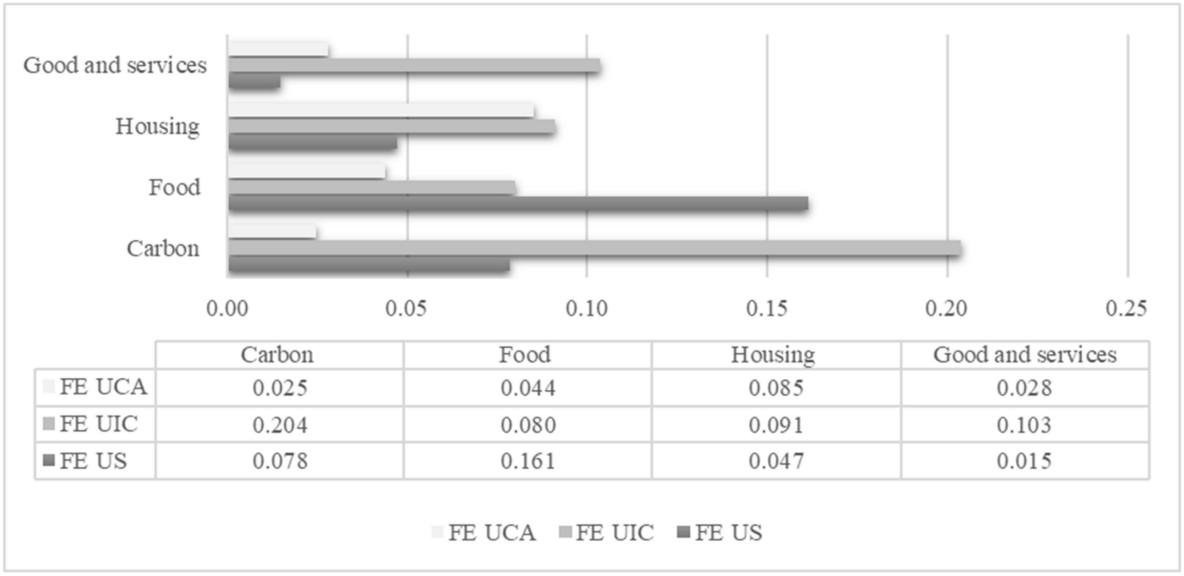

Figure 2. Relative decrease in EF components in the three cases studied.

With respect to the carbon component, the FEUIC experienced the largest relative change, with a 0.204 reduction. For the FEUS, this reduction was 0.078, and 0.025 in the case of the FEUCA, the lowest of the three cases. Compared to the other components and cases in the study, the reduction of the FEUIC is the largest of the entire study. In other

words, the students changed certain practices related to mobility during the course of the experience that resulted in a decrease in their EF. This was not the case for the FEUCA students, as this was the component with the least relative change compared to all the others. In the case of carbon footprint, individuals can reduce their CF by taking measures such as turning off unused devices, using public transport instead of private motorised vehicles, and purchasing organic local products [54].

When examining the food component, the FEUS had the largest decrease. This change is also significantly higher than in the other education faculties, especially in comparison to the FEUCA, which experienced a relative change of 0.044. This decrease was 0.161 for the FEUS. Furthermore, this is the component for which the FEUIC had the smallest reduction. This is also observed in similar research studies [55] in which the results showed that, although students are familiar with aspects such as green packaging, most of them are unaware of fundamental aspects such as life cycle, non-thermal food processing, waste management processes, and green technology itself.

For the housing component, the most significant change was again observed in the FEUIC. However, the difference compared to the FEUCA was not as great as for carbon, as the relative changes were very similar: 0.0901 for the FEUIC and 0.085 for the FEUCA. In this case, the FEUS had the lowest relative change (0.047). It was expected that the changes in this component would be the most complex, given the fact that those aspects do not only require a change in habits, but also changes in infrastructure that are not within the students' power and that are beyond considering the students' energy consumption in their bedrooms, including computers, hair dryers, air conditioning, and other appliances [56]. However, this reduction was the most significant of all the components for the FEUCA.

For the last component, goods and services, the largest reduction was observed at the FEUIC (0.103). This change is higher than the changes identified at the other two faculties of education, which was only 0.028 for the FEUCA, and even less for the FEUS (0.015). This indicates that the students at the UIC made the most changes to their consumption habits related to goods and services after participating in the training process, while this was not the case at the FEUS, where the EF for this component experienced the lowest relative change.

To summarise, the largest reduction took place at the FEUIC for the carbon component. The second most significant reduction was in the food component at the FEUS. In the third place came the goods and services component, again at the FEUIC. Thus, the housing component experienced the least significant change, and the active teaching and learning strategies had the greatest impact at the FEUCA.

4. Conclusions

The sixth report of the IPCC [57] Climate Change 2021: The Physical Science Basis, points directly to the lifestyle of a small part of humanity as being responsible for global warming, and consequently for current climate change. Likewise, it states that it is possible to limit climate change if a substantial and sustained reduction of CO_2 and other greenhouse gas emissions such as CH_4 takes place. This implies a radical change in Western lifestyles that must be approached from different areas and at different levels.

Integrated within an educational process, the EF is a tool that allows students to critically reflect on the consequences of their daily actions as consumers, as it shows them the environmental impact of those actions in a quantitative manner. The consequences often affect them deeply.

This study aimed to analyse how the use of active teaching and learning strategies encourages a change in consumption habits among student teachers at three Spanish universities. To this end, the participants' EF was calculated at the beginning and at the end of three training processes that took place at three Spanish education faculties. The myfootprint.org online tool was used for the calculation.

In general, the results show that the EF of the students at all three education faculties decreased after the different educational experiences described in the Methods section.

This insinuates that the active teaching and learning strategies that have a strong reflective and training for action component had an influence on the participating students' consumption habits.

When students receive an education in which they develop competency for critical thinking, strategic competency, competency for cooperation in heterogeneous groups, and the capacity of solving problems [11], they are able to engage in solving sustainability problems, and in promoting more sustainable consumption patterns in their own lives and in the communities of young people.

The reductions were not of an equal magnitude in the three cases studied; the EF at the FEUIC experienced the largest decrease, while the decrease in the EF of the FEUCA was the lowest. These reductions were due to changes in the students' habits related to the different components that comprise the EF. At the FEUIC, the drop in the carbon component contributed the most to their overall decrease, while at the FEUS it was food, and housing at the FEUCA.

The differences between the faculties could be due to the fact that both the FEUS and the FEUIC worked directly on the topic of responsible consumption, which could be one of the reasons why the reduction in their EF was higher than at the FEUCA. At this education faculty, the topics were related to environmental and socio-scientific issues, and they were not directly linked to consumption. Perhaps, for these training processes to be more successful, it is necessary to combine active learning and teaching strategies with more specific topics related to consumption. In other words, the students should have more in-depth knowledge of the dimensions that constitute responsible consumption, and of the positive consequences this would entail for the quality of life and the health of the planet. This knowledge would facilitate decision-making as well as behaviour change.

Furthermore, the differences between the three faculties of education were expected to be due to the fact that different active teaching and learning strategies were used, and they had their own unique features: specific activities and resources, different organisation of work groups, different use of ICT, etc. However, there is not enough evidence in this study to reach a conclusion in that regard. It shows the need to continue developing educational processes such as those described above in order to carry out comparative studies, and to design new processes that include other active teaching and learning strategies. Those strategies would have to be implemented and analysed in order to know their scope. In general, it is clear that education towards pro-environmental consumption behaviour has a positive effect [58].

Nonetheless, the differences observed could also be due to other factors, such as the fact of being second, third, or fourth year-students, their prior education, or even regional considerations.

With regard to the study's limitations, the time period in which the active teaching and learning strategies were implemented was too short to conclude that the decreases observed were solely due to those strategies. The nature of these strategies requires a longer intervention time [59]. It would therefore be interesting to extend this kind of experiences. Moreover, the tool used to calculate the students' EF presented some difficulties, especially in the housing component, as the students were not familiar with the units of measurement, or with the consumption data for their homes. In future educational experiences, it is therefore key to analyse these questions with the students prior to calculating their EF in order to obtain more reliable results that are closer to the reality of their behaviour. A pre-calculation activity could be to ask the students to bring an electricity bill from their homes to class to break it down and analyse the information it can provide, and then make a calculation using the calculator.

Another issue to consider with regard to the study limitations is that, although previously agreed upon educational sequences were used, implementing them in different universities and at different levels entailed adapting to each particular context, which prevented implementing the same sequence.

Furthermore, from a general perspective, it is considered essential to highlight some key ideas linked to transformative EfSC. The development of active methodologies related to the SDGs allows the development of sustainability competencies that prepare students to face the challenges of sustainability. Recent studies show that when university students work in collaboration with other stakeholders, and use interdisciplinary approaches to sustainability [25], these methodologies contribute to student empowerment, which facilitates decision-making and a change of habits. Finally, it would be convenient to create a network of teachers from different disciplines related to social sciences to develop knowledge and teaching experiences that promote responsible consumption. An example is the experience proposed in this work in which sustainable consumption is addressed in university curricula, and more specifically in teacher training. Working in collaboration with teachers from different universities would allow: (1) greater knowledge of the factors that explain consumption habits, and (2) developing and verifying teaching methodologies that enable modifying those habits towards more sustainable and responsible consumption habits.

It is concluded that humanity's current EF is not sustainable [60]. Urgent measures need to be taken in different fields since the global crisis, which is scientifically proven, is worsening at great speed [61]. Those measures will have a positive impact on the environmental quality of the planet.

EfSC is important because it empowers individuals and social groups, and provides them with appropriate information on the impacts of their daily choices as consumers, as well as with workable solutions and alternatives. The training of future education professionals should be oriented towards achieving sustainable societies, and this training should encourage them to incorporate responsible principles into their own personal consumption habits [62]. Training future teachers in sustainable consumption habits through proposals such as the ones presented in this study is a key and far-reaching action, as these future teachers will include responsible consumption patterns in their way of educating. Those responsible consumption patterns will have an impact on the education of numerous generations, and positive repercussions for the environmental quality of the planet.

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