Education for Environmental Citizenship

Edited by

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MDPI

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About the Editors

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Andreas Ch. Hadjichambis is Chair of the European Network for Environmental Citizenship (Cost Action CA16229), which includes 88 universities and research institutes from 39 countries and more than 134 academics, researchers and scientists. He is the Scientific Director (Research Professor) of the Cyprus Centre for Environmental Research and Education (CYCERE) and a Researcher in the Cyprus University of Technology. Andreas is a biologist (BSc) with an MSc, MEd in education and a PhD. He is Biology Advisor and Coordinator of Environmental Education Programs. He has participated in many European research projects and is co-author of the biology books applied in Cyprus secondary education. His work has received many awards and distinctions in Cyprus and abroad.

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Andri Christodoulou

Andri Christodoulou is an Associate Professor in Science Education at Southampton Education School, University of Southampton. Andri's research focuses on how productive classroom discourse practices and successful science learning can be facilitated within primary and secondary classrooms. She has conducted research on argumentation and dialogic teaching practices within secondary science classrooms, and on how argumentation and inquiry practices can be used as pedagogical approaches within socio-scientific issues-based education. She has experience of working on EU-funded projects (PARRISE, CASSIS, ENEC), as well as leading and coordinating activities within these projects. Andri has been an active member of the Research Group of the UK's Association for Science Education since 2018 and was a member of the International Committee of the National Association for Science Teaching (NARST, 2017–2020). She is currently leading a project focusing on supporting primary school children's engagement with the environment and biodiversity, and is leading the Southampton team working on the H2020-funded COSMOS (Creating Organisational Structures for Meaningful Science education through Open Schooling for all) project (2021-24).

Preface to "Education for Environmental Citizenship"

A series of existing environmental problems (both global and local) constitute the scenery of environmental crises. Environmental citizenship is recognized as an important aspect in addressing global environmental crises (Stern 2011; Ockwell et al. 2009).

Education for Environmental Citizenship (EEC) is the type of education that cultivates a coherent and adequate body of knowledge, as well as the necessary skills, values, attitudes, and competencies that an environmental citizen should be equipped with in order to be able to act and participate in society as an agent of change in the private and public sphere, on a local, national and global scale, through individual and collective actions. It pushes them toward solving contemporary environmental problems, preventing the creation of new environmental problems, in achieving sustainability as well as developing a healthy relationship with nature. 'Education for Environmental Citizenship' empowers citizens to practise their environmental rights and duties, as well as to identify the underlying structural causes of environmental problems, develop the willingness and the competencies for critical and active engagement and civic participation to address those structural causes, and act individually and collectively within democratic means, taking into account both inter- and intra-generational justice (ENEC 2018).

The scope of this Special Issue was to provide a platform for researchers to share their research work on the field of education for environmental citizenship, including aspects of civic engagement and civic participation, democratic action, social and environmental change, individual and collective actions, environmental actions, socio-political actions, environmental justice, inter- and intra-generational justice, and connectedness to nature.

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Article

Unprepared to Deal with Invasion: Pre-Service Teachers' Perception, Knowledge and Attitudes toward Invasive Species

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Abstract: The serious and growing impacts of invasive alien species (IAS) on the planet make it necessary to include this issue with greater determination in educational programs, with the aim of generating citizens capable of dealing with this environmental problem in a sustainable way. Likewise, the management of IAS represents a clear socio-scientific issue (SSI), which gives greater interest to its inclusion in school. At this point, future teachers play a key role, so that their knowledge, perceptions and attitudes on the subject must be evaluated. In order to deal with this objective, a questionnaire was filled out by 400 students of the degrees in early childhood education and primary education of the Universities of La Rioja (UR) and the Basque Country (UPV/EHU), Spain. Our results show that pre-service teachers do not perceive impacts of different types generated by IAS, and they show a clear lack of knowledge about transmission vectors. Likewise, they do not support various control measures, especially slaughter of invasive vertebrates, related to affective dimensions. These results highlight the need to work toward an appropriate integration of this issue at different educational levels, training students and educators, fostering favorable attitudes toward a sustainable management of IAS.

Keywords: invasive alien species; socio-scientific issues; pre-service teachers; impacts perception; vector knowledge; control attitudes

1. Introduction

Invasive alien species (IAS) represent one of the main concerns about the planet's biodiversity [1–3]. The IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) includes IAS among the five main causes of the deep global change that has been occurring in nature during the last 50 years [4]. Likewise, this problem has been intensifying in recent decades [5], so that accumulated IAS records have increased by 40% since 1980 [4]. The effects on biodiversity caused by these species are so intense that they are leading to a process of biotic homogenization of the Earth's surface [6,7]. In the north of the Iberian Peninsula, where the present study was carried out, there are many examples of IAS outcompeting local endangered species, highlighting the American mink (*Neovison vison*) severely affecting the European mink (*Mustela lutreola*) [8], or the signal crab (*Pacifastacus leniusculus*) partly responsible for the recent extirpation of the white-clawed crab (*Austropotamobius pallipes*) in

many streams [9]. However, the generated impacts go further, with important human well-being and socioeconomic effects [10], fundamentally concerning agriculture, forestry, energy and health sectors, generating associated costs for their control and eradication, and reducing ecosystem services [2,11].

Taking into account that IAS entail an intense and growing problem, it is urgent to work from different approaches and disciplines with the aim of reducing their impacts and avoiding new processes of biological invasions throughout the planet. However, public perception of invasive species and attitudes toward their control are controversial [12–15]. In this sense, IAS represent one of the clear and well-documented examples of socio-scientific issues (SSI) [16], a theme that emerges from the nexus of science and society, involves moral, ethical and financial aspects, and generates social conflicts [17,18]. Conflicts around IAS are mainly related to necessary measures for the correct IAS management, such as the slaughter of charismatic animals [19,20] or biosecurity measures for the multiple users of especially vulnerable ecosystems such as rivers [21,22].

These conflicts seem to be related to the scarce knowledge of citizens, highlighting aspects such as the impacts caused by these species or the benefits that their correct management and eradication would imply [23–25]. In this sense, numerous authors have considered that citizenship literacy is the key factor in the development of safe and positive attitudes toward invasive species management programs [26–29]. In accordance with the concept of Education for Environmental Citizenship (EEC; [30,31]), it is necessary to guarantee an adequate level of knowledge around this topic to generate skills, values, attitudes, and competences in students that favor the sustainable management of this problem.

Education about IAS is especially relevant for students during their early educational stages, since childhood represents a key period for the introduction of knowledge related to biodiversity [32,33]. Moreover, children's and adolescents' attitudes about nature are still influenced mainly by television and Internet content, based on a few iconic and charismatic species, generally exotic, that enhance the so-called "cuddle factor" [34]. These aspects, joined together with others such as poor contact with nature [35,36], explain the limited knowledge of students about local biodiversity [33]. It has even been observed that children show greater interest in the protection of these charismatic and exotic species than in the biodiversity of the place where they live [34]. In Spain, the educational curricula for primary school [37], secondary school, and baccalaureate degree [38] deal at different times with the main problems associated with the loss of biodiversity. However, these curricula do not specifically mention invasive species until the first year of baccalaureate in the optional subjects of biology and geology (stage after compulsory education). This scarce training of students regarding IAS has also been observed in other countries [25]. Undoubtedly, it contributes to the limited knowledge around the management of IAS, generalized to all ages and countries [39].

Taking into account the interest in these early educational stages and the potential of teachers to greatly influence students' environmental citizenry, particularly their knowledge, values, beliefs, and actions toward the environment [40], IAS scientific literacy among pre-service teachers is really determinant [41]. Teachers seem to be the key to restructure educational processes and institutions toward sustainable development; therefore, teachers' knowledge and competences are crucial [42]. Remmele and Lindemann-Matthies [39] underlined the importance of pre-service teachers in making their students understand the reasons for certain IAS management programs. However, teaching about biodiversity conservation issues as IAS, which involve ecological, economic, and social aspects, presents difficulties for teachers [43]. The controversial nature of environmental issues and the intrinsically complex and abstract construct of biodiversity [44] might hinder teachers [45].

In order to work toward IAS scientific literacy, it is essential to determine students' knowledge and attitudes about IAS at different educational levels to identify elements that can be introduced in educational programs [25]. However, despite the enormous interest, few studies have dealt with this issue, and they have been barely explored in relation to students' knowledge, perceptions, and attitudes about IAS. In the specific case of student teachers, only in Germany has this matter been recently studied [39]. In Spain, where IAS represent a problem of special relevance [46], García-Llorente et al. [6]

and Bardsley and Edwards-Jones [47] evaluated social perceptions and attitudes among stakeholders and laypeople (over 18 age) in the surroundings of Doñana National Park and Mallorca island, respectively. However, there is no research of this type aimed at students of any educational stage, including pre-service teachers.

Based on these antecedents, the general objective of this study was to determine the perceptions, knowledge, and attitudes of pre-service teachers of early childhood and primary education about IAS. The specific objectives of this research were: (i) to investigate whether pre-service teachers perceive and are aware of the different types of impacts that IAS cause nowadays; (ii) to determine their ability to identify the main types of IAS transmission vectors; (iii) to assess their attitudes toward different invasive animal control methods; and (iv) to determine if a more realistic perception of impacts and knowledge of transmission vectors translate into positive attitudes toward control measures.

It should be noted that this study is part of a wider research aimed at characterizing how pre-service teachers understand the subject of IAS and the problems associated with it as a starting point in order to design novel teaching and learning sequences around SSI related to IAS.

2. Methodology

2.1. Sample

The sample consisted of 400 students (71% female, average age 20) of the bachelor's degree in early childhood education and the bachelor's degree in primary education of the Universities of La Rioja (UR; n = 132) and Basque Country (UPV/EHU; n = 268), all being students enrolled in a science education subject. The universities where this research was carried out are located in bordering regions, and they receive students from a wide geographical area in the north of the Iberian Peninsula, with diverse climatic characteristics but the same environmental problems, such as IAS matter.

Each member of the research team collected the data between April and May 2019 and oversaw the process of completing the online questionnaires with portable devices. Prior to participation, students were informed about the goals of the research, duration, procedure, and anonymity of their data. Participation was voluntary, and it was possible to withdraw participation at any time.

2.2. Research Instrument

As previously commented, this research is part of a broader investigation, for which a questionnaire was designed to evaluate different aspects related to IAS. In this study, the following aspects were developed: (i) perception of the impacts generated by IAS; (ii) knowledge of IAS transmission vectors; and (iii) attitudes toward IAS control. The questionnaire was developed based on various questionnaires previously used by other authors [23,25,48,49]. Several questions were adapted to the specific problems of the study area related to IAS, based on the authors' extensive experience in this subject.

In order to assure the content validity and viability of this research instrument, multiple meetings between the authors were conducted on its design, and it was also previously tested through a pilot implementation with a group of 20 students enrolled in a bachelor's degree in early childhood education at the University of La Rioja. Only a few minor changes were included to improve the final version.

Questions in the final form considered in the present study, after its validation and modification, are shown in Figure 1. The questionnaire included descriptors of different demographic variables (Q1–Q3); questions referring to previously cited topics: (i) perception on the impacts generated by IAS (Q4); (ii) knowledge of IAS transmission vectors (Q5); and (iii) attitudes toward IAS control (Q6–Q9). Q4 (4 items) included the four main types of impacts generated by invasive species, using a Likert scale to indicate the degree of agreement (from "strongly disagree" to "strongly agree"). Q5 included the six main transmission vectors for IAS, all of them described in the study area, with the aim of identifying whether the students recognized them as vectors. Finally, the block of questions related to attitudes

toward the control of these species (Q6–Q9) included general aspects (Q6 and Q9), and other specific aspects about two species widely distributed in the study area, such as the American mink (Q7) and signal crab (Q8).

Descriptors

Q1. Currently you are studying:

- Bachelor's Degree in Childhood Education
- Bachelor's Degree in Primary Education

Q2. What did you study prior to University?

- Baccalaureate of Arts
- Baccalaureate of Humanities
- Baccalaureate of Social Sciences
- Baccalaureate of Health Sciences
- Baccalaureate of Science and Technology
- Upper Vocational Training in the field of nature
- Another Upper Vocational Training

Q3. Do you belong to any organization of the following type? (Check all the items that you consider)

- Ecologist o naturalist
- Hiking, climbing
- Hunting
- Fishing
- Another type of association related to nature
- None of the above items

Perceptions of IAS' impacts

Q4. Indicate the degree of agreement or disagreement in relationship with the following statements (1. Strongly disagree; 2. Disagree; 3. Indifferent; 4. Agree; 5. Strongly agree)

	1	2	3	4	5
IAS damage local biodiversity					
All IAS cause ecological impacts					
IAS have a high economic impact					
IAS have an impact on human health					

Knowledge of IAS' transmission vectors

Q5. What are the entry routes for IAS into a new territory? (Check all the items that you consider)

- Voluntary introduction by citizens
- Releasing of pets to the environment
- Involuntary transportation on objects imported from other territories
- Involuntary transportation on the soles of shoes or other personal items
- Farm escapes
- Introduction of species used in gardening

Attitudes towards IAS control

Q6. IAS should try to be eliminated when: (Check all the items that you consider)

- Causing significant economic impacts
- Causing significant ecological impacts
- Causing significant damage to health
- They must always be eliminated
- They must never be removed

Q7. What methods would you use to control the invasive alien mammal population like the one in the image? (Check all the items that you consider)

- Sterilization
- Trapping and subsequent slaughter
- Capture and return to their natural territory
- None, once they have been introduced, I would leave them in the place where they were found.

Q8. What methods would you use to control the invasive exotic crab population? (Check all the items that you consider)

- Allowing their capture and slaughter by the forest rangers
- Allowing their capture and slaughter by all citizens
- Using of pesticides in the river sections where they are located
- None, once they have been brought in, I would leave them in the place where they were found.

Q9. Indicate the degree of agreement or disagreement with the following statements. (1. Strongly disagree; 2. Disagree; 3. Indifferent; 4. Agree; 5. Strongly agree)

	1	2	3	4	5
Forcing disinfection of all fishing materials each time they are used to avoid the dispersal of IAS					
When a person who is fishing catches an invasive fish, he or she must kill it, without being able to return it alive to the river					

Figure 1. Online form used in this research. Descriptors (Q1–Q3); Perception of impacts generated by invasive alien species (IAS) (Q4); Knowledge about IAS transmission vectors (Q5); Attitudes toward IAS control (Q6–Q9). * IAS shown in the images are the following: Q7, American mink (*Neovison vison*); Q8, signal crab (*Pacifastacus leniusculus*), both widely distributed in the study area.

2.3. Data Analysis

Percentages of the chosen answers given to each question were calculated and bar graphs were created by the SigmaPlot program (v10.0; Systat Software Corporation: SanJose, CA, USA). Likewise, according to the methodology proposed by other authors [23,25,49], a series of scores was calculated for questions Q4 and Q5.

Q4 contained four items and the response possibilities had values from 1 to 5 on a Likert scale, from "strongly disagree" to "strongly agree". The mean value of the four items was calculated for each student, which ranged between 1 and 5, and it was called "Impact Perception Score" (IPS). Likewise, for the same question, the mean value of each of the four items was calculated for all the students. These mean values were plotted, ± standard error, using column graphs made by the SigmaPlot v10.0 program.

In Q5, the number of correct answers was calculated for each student corresponding to the number of vectors identified by each one, and this value was called the "Vector Knowledge Score" (VKS).

Using the IBM SPSS Statistics program (v26.0; IBM Corporation: Chicago, IL, USA), Spearman's correlation analysis was carried out between the two scores (i.e., IPS and VKS) calculated for each student and between each of them with the other responses of the survey. Specifically, correlation was calculated between the IPS and VKS and the following items related to attitudes toward IAS: IAS must be always eliminated (fourth option of Q6); the four answers referring to the American mink control measures (answers to Q7); the four responses referring to signal crab control measures (in Q8); and the two items of Q9. In the case of the answers to Q6, Q7 and Q8, a value of 0 or 1 was assigned to each student, depending on his or her choice: correct (1) or not (0) for each answer. Values of Q9 sections, according to a Likert response scale, were calculated in the same way that was described for Q4, conferring values from 1 to 5, from "strongly disagree" to "strongly agree".

Finally, in order to determine the possible influence of certain demographic aspects, a non-parametric Mann–Whitney U test was carried out between groups using the IBM SPSS Statistics 26.0 program. This test detects whether a median observation in one group is significantly greater/smaller than that of the other group. Comparisons were developed for all the variables mentioned in the previous paragraph (i.e., IPS, KVS, the fourth option of Q6, the four answers to Q7 and Q8, and the two items of Q9) and between the following groups: (i) respondents who studied, prior to university, baccalaureate in natural and health sciences compared to others; (ii) respondents from the bachelor's degree in early childhood education and the bachelor's degree in primary education; (iii) respondents who belonged to any of the natural organization shown in Q3 compared to others.

3. Results

Among the 400 students who filled in the form, 299 were students of the bachelor's degree in early childhood education and 101 of the bachelor's degree in primary education. Prior to university, 81 students had completed a baccalaureate in earth and health sciences, the only one that contains the subject of biology, which included content related to IAS. Only 26 students among the respondents belonged to different environmental organizations, which were included in Q3 of the questionnaire.

3.1. Perception of IAS Impacts (Q4)

Most of the students believed ("agree" or "strongly agree") that IAS cause damage to local biodiversity (82%; Figure 2A). However, their perception of ecological, economic and human health impacts was lower (54%, 48%, and 63%, respectively; Figure 2A). In the perception section, it stood out that 26% of the respondents "disagree" or "strongly disagree" with the fact that IAS cause ecological impacts, despite their close relationship with local biodiversity (Figure 2A). Likewise, 52% and 37% of the students did not recognize the economic damages produced and the damages to human health, respectively, because they did not mark the options "agree" or "strongly disagree" (Figure 2A).
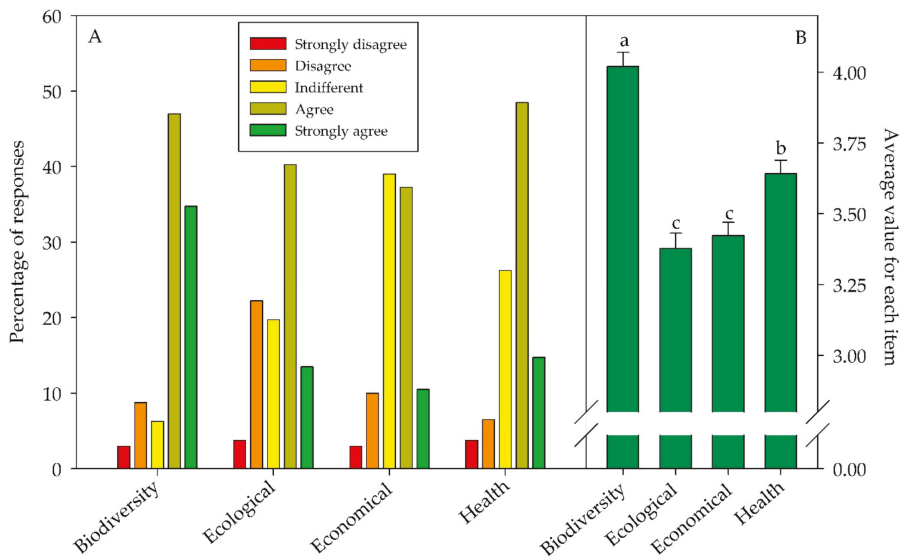
Figure 2. Pre-service teachers' responses about the perception of IAS impacts (Q4). (**A**) frequency (%) of each answer for each item. (**B**) mean value ± standard error of all the responses for each item; different letters (a, b, c) in Figure B indicate significant differences between the mean values of the items ($p < 0.05$).

By calculating the mean value of all the responses related to each of the four items of Q4, the previous observations were statistically confirmed ($p < 0.05$; Figure 2B). Students perceived IAS impacts on local biodiversity with an average value slightly higher than 4 (out of 5), which was statistically higher than the rest of the impacts (Figure 2B). In turn, ecological and economic impacts were the least clearly perceived, with values significantly lower than the impacts on human health (Figure 2B).

3.2. Knowledge of IAS Transmission Vectors (Q5)

Figure 3 shows percentages of choice of the different elements/activities proposed as transmission vectors (Q5). Voluntary release by citizens and involuntary transport of imported objects were the options selected by a high percentage of students, 72% and 77%, respectively (Figure 3). The introduction of gardening species or the release of pets remained in values between 60% and 70% (Figure 3). Finally, fewer than half of the students knew that IAS may be transferred on personal objects such as shoe soles or introduced through the escape of certain exotic species from farms (Figure 3).

3.3. Attitudes about Control Methods (Q6–Q9)

About 80% of the students considered that IAS should be eliminated when causing ecological damage or damage to human health (Q6, Figure 4). This percentage decreased to 42% in the event that IAS generate economic damage, and only 13.5% of the students considered that IAS should always be eliminated. On the contrary, 9% of students considered that IAS should never be eliminated (Figure 4).
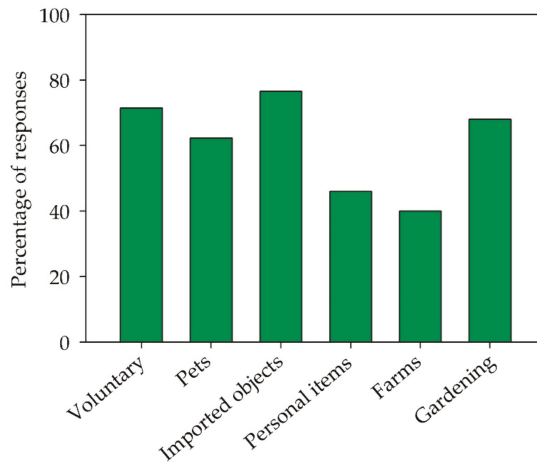
Figure 3. Pre-service teachers' responses (%) about IAS transmission vectors (Q5).
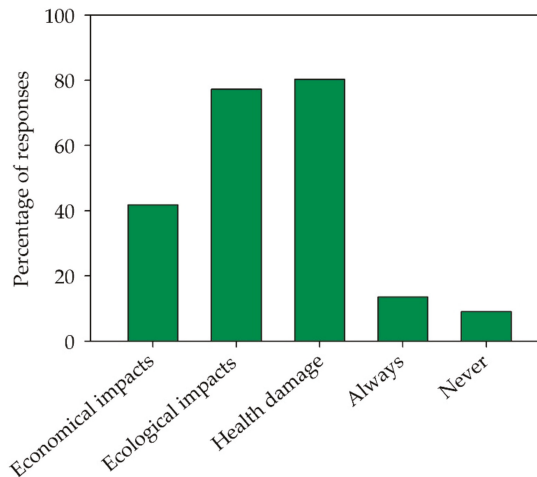
Figure 4. Pre-service teachers' responses (%) relative to IAS control (Q6).

Attitudes toward the control of invasive species were assessed using two widely spread species in the study area, a vertebrate (American mink, Q7) and an invertebrate (signal crab, Q8). Figure 5 shows pre-service teachers´ responses obtained in relation to the control of these two invasive species. Among the three measures proposed for American mink, 75% of pre-service teachers considered that it should be captured and returned to its natural environment, while sterilization (22%) or its capture and subsequent slaughter (3%, the current measure used to control the populations of this species in the study area) were hardly supported by the students (Figure 5A). Sixteen percent of the students considered that no control method should be carried out and minks should be left in the environment where they were found (Figure 5A).

In relation to the signal crab (Q8), the percentage of students in favor of its slaughter was much higher, although it was not the majority (Figure 5B). Almost half of the students (49%) supported its killing by the forest rangers, falling to 11% supporting the killing by the citizens. Eight percent supported the use of pesticides to control this species, while 40% were in agreement with not carrying out any control method (Figure 5B).
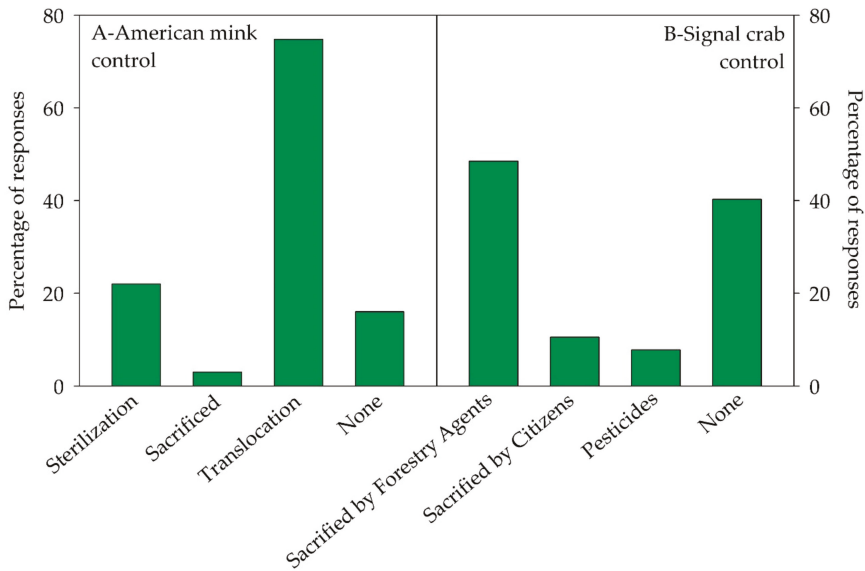
Figure 5. Pre-service teachers' responses (%) relative to the control of IAS American mink (**A**) Q7 and signal crab (**B**) Q8.

Pre-service teachers' attitudes toward the control of invasive species were also assessed by means of Q9. Figure 6 shows the results of the two items of Q9 related to IAS control during fishing activities, which showed very different responses. Sixty-eight percent of the students marked "agree" or "strongly agree" in preferring to disinfect all fishing materials each time they are used to avoid IAS dispersion, and only 11% were against it ("disagree" or "strongly disagree"; Figure 6A). However, the majority of students once again rejected measures related to the slaughter of animals. Only 15% of the students were in favor ("agree" or "strongly agree") of slaughtering an invasive fish when it is caught by an individual without being able to return it alive to the river (Figure 6B).
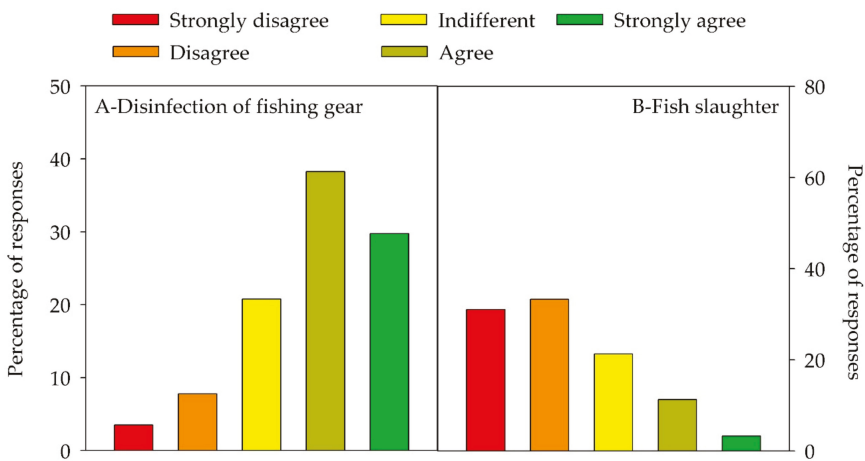
Figure 6. Pre-service teachers' responses (%) related to disinfection of fishing materials and to fishing and slaughtering invasive fish (Q9).

3.4. Correlations between the Different Items of the Survey

Table 1 shows a significant correlation between IPS and VKS scores ($p < 0.05$), although Spearman correlation index (0.307) indicates a weak correlation between them. The rest of the correlations between variables, analyzed pairwise, always showed a coefficient lower than 0.3, although they were significant in some cases, probably favored by the large size of the sample (Table 1). In any case, it was not a strong correlation, but it indicated that those pre-service teachers who had higher IPS and VKS tended to be more prone to always eliminate IAS; they were opposed to maintaining invasive American minks and signal crabs in the ecosystems where they are found, and they were favorable to sterilization and translocation of American mink. Likewise, they were more prone to the killing of signal crab by the forest rangers, to the disinfection of fishing materials, and to the killing of invasive fishes by fishermen (Table 1). However, under no circumstances was a higher value in IAS perception or knowledge scores correlated with support for the killing of American mink or signal crab by citizens.

Table 1. Spearman correlation coefficients between the Impact Perception Score-IPS (based on Q4) and the Vector Knowledge Score-VKS (based on Q5), and the different elements related to attitudes toward IAS control (Q6–Q9). Asterisk * indicates that the correlation was significant ($p < 0.05$).

Item	IPS	VKS
VKS	0.307 *	
Always eliminate IAS	0.197 *	0.089
Mink sterilization	0.117 *	0.136 *
Mink slaughter	0.055	0.093
Mink translocation	0.157 *	0.186 *
Mink none	−0.160 *	−0.205 *
Crab slaughtered by forestry agents	0.150 *	0.229 *
Crab slaughtered by citizens	0.020	−0.023
Crab pesticides	−0.067	−0.086
Crab none	−0.134 *	−0.161 *
Obligating to disinfect	0.298 *	0.242 *
Invasive fish must be killed	0.183 *	0.171 *

3.5. Groups Comparison

Table 2 shows the items of the questionnaire that presented significant differences between some of the groups studied, according to the Mann–Whitney U test. It should be noted that the pre-service teachers who previously studied baccalaureate in natural and health sciences presented higher IPS values compared to the rest (Table 2). Likewise, the student teachers who belonged to different environmental organizations knew how to differentiate among the transmission vectors better. Pre-service teachers who belonged to any of the previous groups were more favorable to American mink sterilization and signal crab slaughtering by citizens, although there were no significant differences compared to the rest among the majority of management measures. Finally, there were no significant differences in any of the items between the students of the bachelor's degree in early childhood education and the bachelor's degree in primary education (Table 2).

Table 2. Results of means comparison using the Mann–Whitney U test for different aspects of the form and different descriptors evaluated. When there are significant differences ($p < 0.05$), it is indicated with a number (0 or 1) associated with the element that had a higher value between the two compared. When significant differences do not exist, it is indicated with a script (-).

Item	Baccalaureate Natural-Health Sciences (0)–Other Baccalaureates (1)	Early Childhood (0)–Primary (1)	Nature Association (0)–No (1)
IPS	0	-	-
VKS	-	-	0
Always eliminate IAS	-	-	-

Table 2. *Cont.*

Item	Baccalaureate Natural-Health Sciences (0)–Other Baccalaureates (1)	Early Childhood (0)–Primary (1)	Nature Association (0)–No (1)
Mink sterilization	-	-	0
Mink slaughter	-	-	-
Mink translocation	-	-	-
Crab slaughtered by forestry agents	-	-	-
Crab slaughtered by citizens	0	-	0
Crab pesticides	-	-	-
Crab none	-	-	-
Obligating to disinfect	-	-	-
Invasive fish must be killed	-	-	-
Score perception of impacts	-	-	-

4. Discussion

Taking into account the intense environmental degradation that ecosystems are currently subjected to, more sustainable environmental behavior and management are necessary to sustain human well-being [50]. With this objective, EEC promotes pro-environmental behavior by means of active participation of citizens in moving toward sustainability [51,52], and therefore an adequate knowledge that favors the acquisition of the necessary skills and attitudes is required [31]. The different aspects that EEC promotes include the knowledge of ecological concepts and processes that provide the foundations for understanding the human impact on ecosystem functioning and ecosystem services [31], as is the case of IAS, which represents one of the main threats to biodiversity worldwide [2].

In the present work, we have determined that future early childhood and primary education teachers mostly perceived that IAS cause significant damage to local biodiversity, although they had limitations when identifying the impacts of another typology. A lower percentage of participants identified IAS as responsible for human health or economic damage, according to previous studies carried out among stakeholders [48] and university students in the US [25]. Pre-service teachers also perceived with less clarity other ecological conditions generated by IAS, which reflected an incomplete view of basic ecological processes and a poor understanding of concepts related to complex natural systems [53,54]. In general, these results showed a limited perception of IAS impacts by the students of the bachelor's degrees in early childhood and primary education, in agreement with previous studies carried out in Spain among the adult population around the Doñana National Park [6] and stakeholders in Mallorca [47].

Pre-service teachers of early childhood and primary education also had difficulties recognizing different IAS transmission vectors, especially the involuntary transport on the soles of shoes and other personal objects, or the escape from farms. It is worth mentioning that the escape from farms has represented the focus of the entry of American mink into Spain since the 1960s [55]. Regarding the lack of awareness of the involuntary transport on personal objects, pre-service teachers seemed not to be aware of their own role as potential IAS vectors. This unawareness was especially relevant in the case of the fluvial ecosystems of the study area, where there are many microscopic IAS or species with microscopic phases in their life cycle that generate important ecological and economic impacts, such as the IAS used as examples in this study (i.e., the signal crab [9]) or other relevant species like the zebra mussel [56] or *Didymosphenia geminata* [57]. Dispersal of these species and others is involuntarily carried out by citizens in their various forms of contact with rivers [58].

Several public administrations in the study area have designed numerous educational campaigns on invasive species since the end of the 20th century. These campaigns have usually focused on species such as the American mink or the zebra mussel, highlighting the educational material of the

project LIFE Lutreola Spain, recently developed in the communities of the Basque Country and La Rioja (http://lifelutreolaspain.com/en). However, the results obtained in the present study indicate that students are still not perceiving the seriousness of the problem. This could be related to the scant and/or sporadic treatment of this topic, almost exclusively in the field of non-formal education or even due to the design behind the educational materials. In this sense, Waliczek et al. [25] indicated the need to include this topic in educational curricula, with the aim of improving students' training. The same authors considered that this topic should pay special attention to IAS impacts and their control [59]. The present results, together with previous evidence (e.g., [39]), highlight the relevance of an appropriate education, either formal or informal, about IAS. This education should lead students and pre-service teachers to understand IAS potential threat to biodiversity and the negative impact on the appropriate functioning of the whole socio-ecological system, including economic and also human health threats. Future teachers, as multipliers of tomorrow, might be better equipped to deal with teaching and learning challenges related to complex biodiversity issues such as biological invasions. In the same way, according to pre-service teachers´ limited knowledge about their own role as potential vectors for involuntary IAS transmission, when treating this issue it is especially relevant to promote the preventive measures related to biosafety, which should always be carried out by all citizens to mitigate IAS spreading [60,61].

These limited perceptions about IAS impacts and the scarce knowledge about transmission vectors also represent obstacles to the development of management programs. In this sense, the European Network for Environmental Citizenship (ENEC, 2018) itself recalls that it is necessary to have an adequate body of knowledge to be able to act and participate in society as a sustainable agent. Likewise, this lack of knowledge detected among pre-service teachers makes it difficult to introduce this topic into the lessons as SSI, despite the fact that its treatment represents a good opportunity to work on scientific education [62]. The inclusion of SSI favors informed decision-making among students, participation in debates, and their own understanding of science as determining elements in their lives [63]. To achieve this goal, teachers require the scientific knowledge necessary for its treatment and reasoning [64], in order to avoid further confusion among students on a complex topic with multiple components to consider.

In line with this scarce knowledge of pre-service teachers, in the present research only 14% of the respondents considered that IAS should always be eliminated. When asked about their possible elimination if they cause a specific impact, this percentage increased significantly, especially if ecological or human health impacts were considered. These results indicate that pre-service teachers are not aware that all IAS, by definition, cause impacts of a different nature and, therefore, their elimination implies benefits of different types. Therefore, these results, together with other recent evidences from Germany [39], highlight the need for pre-service teachers to understand the reasons for carrying out certain IAS management strategies. The scant support for generalized IAS control was different, depending on the species in question. The surveyed students were especially against the American mink's slaughter, despite the fact that this is the measure used to control the populations of this species in the study area, with successful results in recovering European mink populations (e.g., MAGRAMA, 2013; LIFE Lutreola Spain, 2017).

The limited support for the slaughter of American mink is consistent with the greater rejection generated by the control of invasive mammals among society in relation to other taxa [65,66] associated with the "cuddle factor" and these organisms' aesthetics [49]. Likewise, human beings tend to empathize more with species similar to us, fundamentally mammals, for which greater care and conservation efforts are exercised [67]. In contrast, there is a greater social rejection of other types of organisms, mainly invertebrates [68], which could favor greater support for the sacrifice of invasive taxa of this type, according to the present study in relation to the signal crab. However, the percentage of students who would not carry out any action to eliminate this crab from the colonized ecosystems was very high (40%), despite the significant impacts that it generates in the study area [9,69], and unlike the 84% of the students who supported the American mink's control, although rejecting its sacrifice. The greater

resources devoted to conservation of mammals such as the European mink seem to encourage citizens to support the control of other invasive mammal species that reduce their populations. Interest in controlling these species seems logical, taking into account that students especially perceive IAS impact on biodiversity and they feel a greater affinity for mammals.

Rejection of the American mink's slaughter in this study was extended to other vertebrates, such as invasive fish, despite the fact that Iberian Peninsula rivers are ecosystems especially affected by the presence of invasive exotic fish species [70,71], which profoundly alter river functioning and their biodiversity [72,73]. It should be noted that rejection of invasive fish sacrifice occurred despite the existence of species in the area such as European catfish (*Silurus glanis*) in the Ebro River, which receives great attention in the media and whose negative effects on river biodiversity have been widely described [74]. However, the majority of the students agreed on implementing biosecurity measures that try to reduce IAS effects, such as disinfection of fishing materials. Therefore, rejection of control measures was especially related to the sacrifice of living beings, principally vertebrates.

Citizens' rejection of certain IAS control measures has been the subject of debate and study by many scientific researches. Thus, several authors have pointed out that greater knowledge about invasive species, or even about environmental issues, favors the development of positive attitudes toward their control [6,25,39,48]. In the present study, this premise was partially fulfilled. The surveyed respondents who had studied the baccalaureate in natural and health sciences before university showed a higher perception of IAS impacts, as a result of greater training in this matter [38]. In the same vein, the students who belonged to associations related to nature proved more knowledgeable about IAS transmission vectors. Although there are no general differences between the rest of the respondents, these two groups showed greater support for some measures to control invasive species. If we considered all respondents of the study together, a higher perception of IAS impacts and a greater knowledge about transmission vectors were significantly correlated, always proposing to eliminate them from the ecosystems where they were found. Likewise, this greater knowledge was correlated with the majority of control measures proposed in the form, although the Spearman correlation coefficient was always below 0.3, indicating a very weak correlation [75]. In the case of the American mink's slaughter, it did not show significant correlation.

Therefore, greater training in this area inside or outside the class can be, at least partially, translated into greater knowledge of the problem. Likewise, a higher perception of IAS impacts and a greater knowledge of transmission vectors can translate into attitudes more inclined toward IAS control. However, this correlation is not robust enough, so the inclusion of this topic in educational curricula should be directed toward a change in students' attitudes, based on their knowledge around the generated IAS impacts and benefits that their control provides. In this sense, Bremner and Park [23] observed that if the benefits of American mink eradication are explained in detail to the population in Scotland, these citizens tend to support the different control measures.

Final Remarks

Future early childhood and primary education teachers were not able to perceive clearly different types of IAS impacts, such as economic or health nature damages, nor did they know enough about their transmission vectors, such as the involuntary vectors associated with citizens. Different control measures were not supported either, especially those related to the slaughter of vertebrate species such as American mink, mainly related to affective dimensions. This lack of support can pose obstacles to the development of effective IAS management programs, as occurred in the well-known and widely cited case of the gray squirrel in Italy [12], or even appropriate educational interventions.

Therefore, it is urgent to educate students of different educational stages on this subject. It is essential to introduce educational content to promote attitudinal changes from the initial educational stages, which ultimately may allow mitigating the problems associated with IAS. Students must know their role as transmission vectors, the impacts that these species generate, and the benefits associated with their control, which will generate favorable attitudes toward the different management programs.

Taking into account the importance of implementing these attitudes from an early age, the role of future teachers is of special relevance in this matter. Finally, introducing this subject systematically in different educational stages can contribute to overcoming the sporadic treatment of the subject through extracurricular educational activities or specific didactic units designed by organizations and extracurricular programs.

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Teachers' Perceptions on Environmental Citizenship: A Systematic Review of the Literature

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Abstract: As we are living amid an unprecedent environmental crisis, the need for schools to empower students into environmental citizenship is intensifying. Teachers are considered as the main driving force in fostering students' environmental citizenship. However, a critical question is how teachers conceive environmental citizenship and whether their perceptions of environmental citizenship are well-informed. There is an urgent need to investigate teachers' perceptions, considering their crucial role in the formation of students' environmental citizenship. This study examines teachers' perceptions of environmental citizenship through a systematic review and thematic analysis of relevant empirical studies. The selected studies ($n = 16$) were published in peer-reviewed journals during the timespan of the last twenty-five (25) years (1995–2020). The thematic findings of this review revealed that teachers' perceptions: (a) manifest a relatively decreased understanding of environmental citizenship, (b) are narrowed down to the local scale, individual dimension and private sphere, (c) affect teaching practices, (d) are multi-dimensional, defined by inter-related components, (e) vary according to teachers' educational/cultural background and personal identity, (f) affect other environmental constructs defining teachers' professional identity, (g) can be enhanced during teacher education, (h) can be also improved during professional development initiatives. These findings bear significant implications for researchers, policymakers, as well as for teacher educators in the field of Environmental Education.

Keywords: teachers' perceptions; environmental citizenship; teacher education; Environmental Education; Education for Environmental Citizenship (EEC)

1. Introduction

We are currently witnessing an unprecedented environmental crisis. Environmental problems such as deforestation, climate change and ice melt, pollution, waste disposal, loss of biodiversity and depletion of resources are just some of the main challenges that we must deal with [1,2]. Taking into account the scale as well as the impact of these environmental problems, we are now more than ever in need of empowered, active young citizens, who may contribute to the mitigation of these extreme socioenvironmental issues.

Environmental Education could serve as the vehicle towards this goal, as action can be found deeply rooted in its framework. Focusing on the 1977 Tbilisi Declaration, Environmental Education has emphasized, for instance, the development of students who are not only aware of environmental problems, but who also adopt pro-environmental behaviors. In particular, Environmental Education has focused on promoting learners' "practical skills required in the devising and application of effective solutions to environmental problems" [3] (p. 14). Many scholars have also previously supported the notion that the ultimate goal of Environmental Education should be to support students in acting as informed and empowered citizens [4–8].

The aforementioned aims of Environmental Education are well-reflected within the concept of *Environmental Citizenship*. Environmental citizenship is not a novel concept;

however, the concept has started to become more popular in the field of education in recent years, given that prior educational research on environmental citizenship was sparse and fragmented, due to the political, economic and societal dimensions of the concept. According to Hadjichambis and Reis [2], the fragmented nature of the research findings related to environmental citizenship prohibits their effective integration into good practices and policy frameworks in the educational context as well as a well-informed conceptualization of what environmental citizenship entails. Despite the fragmentation of prior research, there is agreement that an environmental citizen is a person who is aware of environmental problems, has relevant environmental knowledge and skills, understands cause–response relationships in the socioecological systems and undertakes responsible environmental action [9,10]. In turn, Environmental Education has been argued to be a fundamental tool that can effectively contribute to the adoption of pro-environmental behaviors, which can eventually be translated into aspects of environmental citizenship [11,12].

However, in order to foster Education for Environmental Citizenship in schools, there is a need to provide constant guidance and extensive training for teachers in order to improve their environmental knowledge, awareness, dispositions and strategies [13,14]. Undoubtedly, teachers play a crucial role in promoting their students' environmental citizenship, particularly their knowledge, attitudes, values, beliefs and actions towards the environment [15–17]. It is therefore essential to determine how current and prospective teachers perceive the concept of "environmental citizenship" [18] and, subsequently, the degree to which they are prepared to take up Education for Environmental Citizenship. Whether teachers implement Education for Environmental Citizenship in the classroom is dependent upon their interest, knowledge and skills [6]. The overall goal of the current study is to explore teachers' perceptions of environmental citizenship by means of a systematic literature review. This overarching goal is distributed and further elaborated in the following research questions, guiding this review:

1. How do teachers conceive environmental citizenship?
2. What are the main characteristics of teachers' perceptions of environmental citizenship?
3. What is the impact of teachers' perceptions of environmental citizenship on their professional identity?
4. How can teachers' perceptions of environmental citizenship be enhanced?

The rest of the manuscript continues by defining Education for Environmental Citizenship (EEC) and explicating the need for investigating teachers' perceptions of environmental citizenship. We then present the methodology of this review study as well as a synopsis and synthesis of our findings, followed by a set of guidelines for future research and practice in the field.

2. Education for Environmental Citizenship

Despite its importance, environmental citizenship has received limited exploration so far, until the last few years [19]. On one hand, this could be attributed to the conceptual complexity of environmental citizenship, as well as to its relations with more established constructs (i.e., environmental behavior, environmental attitudes, environmental literacy, environmental knowledge, awareness and sustainability), which have been often used as complements or substitutes [20]. On the other hand, environmental citizenship has political, economic and societal dimensions, which have contributed to the fragmentation of relevant research. This can also justify the use of the concept under different labels, such as "sustainable citizenship" [21], "green citizenship" [18], "ecological citizenship" [22] or even "global citizenship" and "active citizenship", even though the two latter terms are considered as broader concepts, which encompass a broader sense of citizenship.

Although research related to environmental citizenship is sparse and has been thinly spread across different research disciplines, various scholars and theorists have accumulated and agreed upon on its main attributes [4,19]. For instance, it has been argued that

environmental citizenship encompasses ecological literacy with a focus on the understanding of socioecological issues [23,24], the rights and the obligations of citizens within political communities [25,26], awareness of personal values with respect to the environment and the ability to connect these values with knowledge and skills to take environmentally-oriented decisions [4,27], as well as civic engagement and participation to address environmental problems [28,29]. In its essence, environmental citizenship has emerged as an umbrella concept which includes an amalgam of characteristics, such as the skills, knowledge, attitudes, values and beliefs required to address environmental problems [30], as well as the competences needed for civic engagement and active participation in societies [20].

Educating and empowering young people to become environmental citizens is crucial for addressing current environmental issues and it is a prerequisite of sustainability, which is identified as one of the priorities worldwide [31,32]. However, environmental citizenship, as a comprehensive concept, has been elucidated from collective research efforts, especially in the field of Environmental Education. It is only recently that the concept has started to receive the attention it deserves, in times of environmental urgency. For instance, more than 130 researchers and scholars from 39 countries have joined their forces, during the last two years, in the context of the European Network for Environmental Citizenship (ENEC) [33], trying to establish an inclusive definition of "Education for Environmental Citizenship". This review study adopts this definition, as it provides a concrete basis for the conceptualization of environmental citizenship for 21st century education, and it is briefly presented as follows:

"Education for Environmental Citizenship' is defined as the type of education that cultivates a coherent and adequate body of knowledge as well as the necessary skills, values, attitudes and competences that an Environmental Citizen should be equipped with in order to be able to act and participate in society as an agent of change in the private and public sphere on a local, national and global scale, through individual and collective actions in the direction of solving contemporary environmental problems, preventing the creation of new environmental problems, in achieving sustainability as well as developing a healthy relationship with nature. Education for Environmental Citizenship is important to empower citizens to practice their environmental rights and duties, as well as to identify the underlying structural causes of environmental degradation and environmental problems, develop the willingness and the competences for critical and active engagement and civic participation to address those structural causes and act individually and collectively within democratic means, taking into account the inter- and intra-generational justice".

According to this definition, the ultimate goal of Education for Environmental Citizenship (EEC) is to equip students with a coherent corpus of knowledge, skills, values, attitudes and active behaviors, in order to act pro-environmentally, as "agents of change", as well as to help them understand the urgency of environmental issues and to integrate pro-environmental actions into the core of their political participation and environmental citizenship expressions. Toward this direction, Hadjichambis and Paraskeva-Hadjichambi [20], in their recent work undertaken within the European Network for Environmental Citizenship (ENEC), have attempted to define the pedagogical landscape in which EEC is situated and they proposed eight pedagogical approaches which may, partially, contribute to EEC, as follows: (a) Place-based learning, (b) Problem-based learning, (c) Civic ecology education, (d) Pedagogy for eco-justice, (e) Action competence learning, (f) Community service learning, (g) Participatory action research, and (h) Socio-scientific inquiry-based learning. However, as explained, while the above pedagogical approaches can contribute to EEC, none of them alone can promote the scope and aims of the EEC [34]. Going a step further, Hadjichambis and Paraskeva-Hadjichambi [20] have also summarized the intended outputs of EEC, as follows: (a) Solving current environmental problems, (b) Preventing new environmental problems, (c) Achieving sustainability, (d) Developing healthy relationships with nature, (e) Practicing environmental rights and duties, (f) Identifying structural causes of environmental problems, (g) Achieving critical and active engagement

and civic participation, and (h) Promoting inter- and intra-generational justice. Finally, they have also highlighted that the potential actions which an environmental citizen may undertake are of two *dimensions* (individual and collective), these actions could be applied in different *spheres* (private and public spheres), and they may have an impact at different *scales* (local, national or global). More information is available at the ENEC official website: https://enec-cost.eu/ (accessed on 18 December 2020) [34].

An overview of the EEC model is provided in Figure 1.
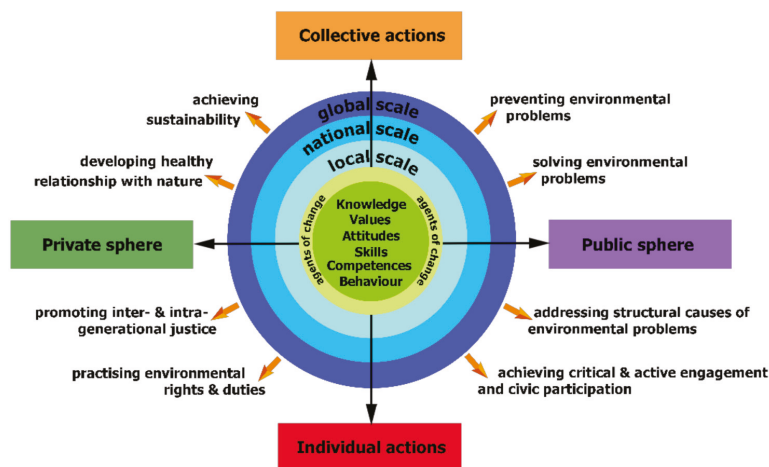
Figure 1. The Education for Environmental Citizenship (EEC) model (Source: Hadjichambis, A. Ch. & Paraskeva-Hadjichambi D. (2020). Education for Environmental Citizenship: the pedagogical approach. In: A. Ch. Hadjichambis, P. Reis, D. Paraskeva-Hadjichambi et al. (Eds.) *Conceptualizing Environmental Citizenship for 21st Century Education* (pp. 260–290). Cham, Switzerland: Springer.).

It is worthwhile to briefly describe the relationship between Environmental Education and Education for Environmental Citizenship (EEC). It has been supported by many studies on Environmental Education that it contributes to the empowerment of well-informed citizens, e.g., [7], and that Environmental Education can contribute to the promotion of environmental citizenship, e.g., [35] Although there are cases in the Environmental Education literature in which this is verified, e.g., [36], it is an unquestionable fact that this is not the mainstream in Environmental Education. Many researchers have argued, for instance, that there is still disagreement and different approaches as to what the main goals, objectives and outcomes of Environmental Education are and how they can be achieved, e.g., [37]. In addition, there is a lot of criticism of the individualistic approach in Environmental Education, aimed mainly at personal behavioral changes, e.g., [38]. In many Environmental Education programs, there is a lack of collective actions both in the private but much more in the public sphere. On the other hand, Education for Environmental Citizenship emphasizes both the individual and the collective dimensions of environmental citizenship but also actions in the private and public spheres which will not be limited only to a local scale but also to the national and on a global scale. All these are emphasized with a deep civic participation and an active, critical and democratic engagement of the citizens in the formulation of the policies and in the decision-making for effective confrontation of the deeper structural causes that create environmental problems. In addition, Education for Environmental Citizenship also attaches great importance to environmental and social justice, including the exercise of environmental rights and duties, as well as to inter- and intra-generational justice. This clarity and integration on the scope, outputs, dimensions, spheres and scales never was at the heart of our educational systems.

Despite these promising research steps, EEC can take place only if teachers are deeply aware of what environmental citizenship entails and are able to put forward successfully these pedagogical approaches. Put simply, classroom teachers are in a unique position to develop student skills and knowledge of environmental citizenship and sustainable environmental behavior through their teaching [39]. In order for this to happen, though, it is essential to ensure that current and prospective teachers' conceptions of environmental citizenship are accurate and well-informed [18]. Responding to this call, the present study reviews and synthesizes the current literature presenting qualitative and quantitative explorations of teachers' perceptions of environmental citizenship. Prior review studies in the field have focused on teacher conceptions of environmental/sustainability education, on their related teaching practices as well as on environmental teachers' training and professional development [40–43]. However, according to our knowledge, there are no published review studies so far dedicated to the examination of teachers' perceptions of environmental citizenship. Our study aims to contribute to this research gap by investigating teachers' perceptions of environmental citizenship, through a systematic review of relevant empirical studies in the field.

3. Methods

3.1. Data Collection

The studies analyzed in this literature review covered empirical and theoretical research published during the last twenty-five years, from 1995 to 2020.

The retrieval of the reviewed studies followed the PRISMA standards for Systematic Literature Reviews (http://prisma-statement.org/) (accessed on 30 September 2020) [44] and was based on a multi-step procedure comprising three sequential stages, as follows: (a) Identification, (b) Screening, and (c) Eligibility (Figure 2).
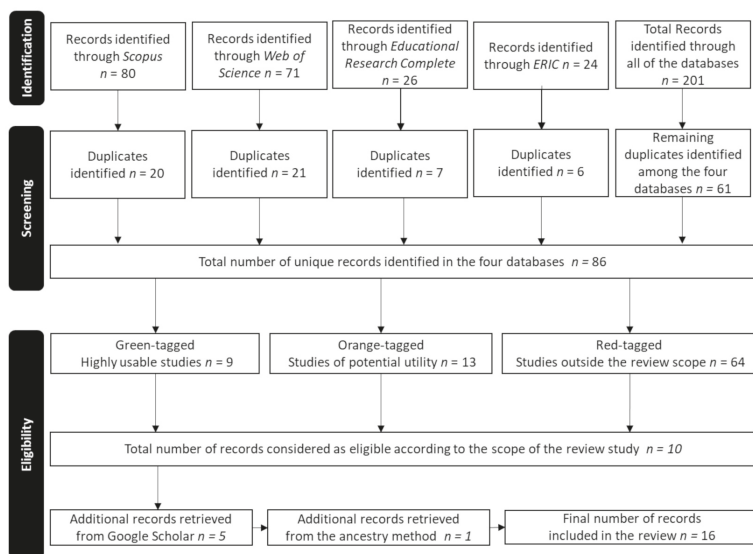
Figure 2. Flow diagram illustrating the review selection process.

Initially, in the first step, the published literature was surveyed using four electronic databases: *Scopus*, *Web of Science*, *Education Research Complete (via EBSCO)* and *ERIC*, which are considered among the most enriched and popular academic databases. The retrieving keywords included the terms, *"Environmental citizenship" OR "Environmental citizen"*, *"Ecological citizenship" OR "Ecological citizen"*, *"Green citizenship" OR "Green citizen"*, *"Sustainability citizenship" OR "Sustainable citizen"*, in combination with the terms *"Teachers"*,

"Educators", "Perceptions" and *"Conceptions".* This ensured that the retrieved results would be mostly focused on pre-/in-service teachers' perceptions of environmental citizenship. After performing all 32 possible combinations, we retrieved a total of 201 records from the four databases.

In the second step, these records were screened and both internal duplicates as well as duplicates between the four databases ($n = 115$) were removed, resulting in a total of 86 records. In the third step, the remaining records ($n = 86$) were filtered, to identify their eligibility, on the basis of four selection criteria. In particular, to be included in the corpus of the reviewed studies, a study ought to have met a number of criteria, as follows: (1) Source type: The study should have been published in English, as a full paper in a peer-reviewed academic journal, between 1995 and 2020; (2) Research focus: The study should be related to teachers' perceptions on environmental citizenship; (3) Research methods: The study should be empirical, providing primary data derived from quantitative, qualitative or mixed designs; (4) Participants: The study participants should be in-service or pre-service teachers.

More specifically, the title, abstract and keywords of the retained, from step 1 and 2, studies ($n = 86$) were filtered according to the aforementioned inclusion criteria. As part of this process, the studies were evaluated in relation to their eligibility, using the following color coding: (a) Green-tagging, for highly usable studies aligned with the criteria posed, (b) Red-tagging for studies outside the review scope, not aligned with the criteria posed, and (c) Orange-tagging for studies of potential utility, given that these studies seemed quite relevant to the scope of this review, but it was not absolutely clear from their title, abstract and keywords whether all the inclusion criteria were met. In this latter case, full-text versions of the studies were also obtained, read and filtered, in order to confirm whether these studies were aligned with the criteria posed or not. This final selection process resulted in 10 publications.

This initial corpus was enriched with an additional search using Google Scholar by combining the same keywords as well as by using the broader conceptual combinations "global citizenship—teachers—environment" and "active citizenship—teachers—environment", focusing on the most prominent hits, which resulted in five additional empirical studies. Finally, the ancestry method [45] was also adopted, according to which we searched the references of the identified research articles for empirical studies that could be included in the present review. This process yielded one (1) additional article. Overall, a total of sixteen ($n = 16$) empirical studies met all the inclusion criteria and were selected for this review.

3.2. Data Analysis

The data collected from the empirical studies, included in this review paper, were analyzed using thematic analysis [46–48]. Thematic analysis was also adopted for similar purposes in prior review studies, which focused on the examination of teachers' perceptions of other concepts (e.g., creativity, STEM education) [49,50]. Thematic analysis is a qualitative analytic method for "identifying, analyzing, and reporting patterns (themes) within data" [47] (p. 79). In this method, each theme captures and presents important information about the data.

The thematic analysis undertaken proceeded through six phases. The first phase involved becoming familiar with the data; in the current study, familiarity with the data was initiated during the data collection process and the eligibility phase of the PRISMA methodology and was completed with a thorough reading of the selected empirical studies, included in this review. The second phase entailed generating initial codes, which in our study comprised the data extraction process. To generate the initial codes, we developed a coding scheme to extract the key data from the 16 reviewed studies. The coding scheme variables included the country and the year in which the study was conducted, the research goals of the study, sample attributes (e.g., number of teachers, grade level and subject taught, in-service or pre-service status), training attributes in case of training interventions

to enhance teachers' perceptions (e.g., training approach, type of activities, professional development or teacher education context, duration), research design, data collection methods and findings.

The third phase included an initial search for themes within the findings of the review studies. As part of this phase, the research questions of this review study guided the searching and classification of themes across four broad categories, as follows: (a) Conceptualization (RQ1: How do teachers perceive environmental citizenship?), (b) Characteristics (RQ2: What is the nature of teachers' perceptions of environmental citizenship?), (c) Impact (What is the impact of teachers' environmental citizenship perceptions on their professional identity?), and (d) Enhancement (Whether and how can teachers' perceptions of environmental citizenship be enhanced?). As part of this phase, the reviewed studies were analyzed, and relevant text segments were extracted and placed into one of the aforementioned categories. Table 1 provides a definition of the categories guiding the thematic analysis.

Table 1. Definition of the categories guiding the thematic analysis.

	Categories	Definition
1	Conceptualization	This category refers to the way teachers perceive both environmental citizenship as well as the potential actions which an environmental citizen may undertake in terms of *dimensions* (individual and collective), *spheres* (private and public spheres) and impact at different *scales* (local, national or global).
2	Characteristics	This category refers to the characteristics of the environmental citizenship perceptions, focusing on their main components as well as on their subjective nature.
3	Impact	This category refers to the impact of teachers' perceptions of environmental citizenship on teaching practices as well as on teachers' professional identity.
4	Enhancement	This category refers to the enhancement of teachers' perceptions in the context of teacher education or professional development programs.

The fourth phase included the reviewing and checking of the themes in relation to the coded excerpts, while the fifth phase included the finalization and naming of the themes. As part of these phases, the authors elaborated collaboratively on the aforementioned classifying categories and identified two main themes per category, capturing more fine-tuned information about the analyzed findings of the reviewed studies. Finally, the sixth phase was the production of a concise report, taking into account all the categories and the emerging themes per category. This report is presented in the following section of this review study.

4. Findings

The empirical studies reviewed for this synthesis ranged in publication dates from 1995 to 2020. Only one study was published between 1995 and 2000 (6.3%), two studies were published between 2001 and 2010 (12.5%), while another two studies were published from 2011 to 2015 (12.5%). A considerable peak in the published studies ($n = 11$, 69%) can be observed during the last five years (2015–2020), indicating the increasing interest in the topic. The research topic has been investigated globally, in Australia, China, Egypt, Israel, Finland, Lebanon, Turkey, the United Kingdom and the United States. The majority of the studies took the form of qualitative case studies, while the rest of them adopted other research designs, such as quasi-experimental design, relational research methods, quantitative research methods or mixed methods. An overview of the empirical studies reviewed for this synthesis is presented in Table 2.

Table 2. Summary of reviewed studies.

#	Author(s)/Year	Country	Research Goals	Research Design	Sample	Data Collection	Major Findings
1	Aarnio-Linnanvuori, 2019	Finland	To investigate teachers' perceptions of environmental responsibility with a focus on environmental citizenship.	Qualitative case study	13 in-service teachers in secondary education	• Interviews	Almost all the in-service teachers mentioned environmental citizenship as an integral part of environmental responsibility. However, teachers conceptualized environmental citizenship on the basis of individualization rather than on the basis of collectiveness. In addition, while the participating teachers were well aware of various environmental citizenship actions, they perceived their students' range of action possibilities as particularly narrow.
2	Abd-El-Aal & Steele, 2013	Egypt	To evaluate the impact of an Environmental Education course, tasking pre-service teachers to investigate and take action with respect to an environmental issue (in the context of a community-based project), on teachers' perceptions and practices of environmental citizenship.	Qualitative case study	38 pre-service teachers	• Teachers' artifacts (from their field work) • Interviews	The community-based projects enacted during the environmental course enhanced teachers' conceptions of environmental citizenship. During their fieldwork, and as acts of environmental citizenship, the teachers strove to find solutions for the environmental problems they encountered in their communities.
3	Avriel-Avni & Gan, 2019	Israel	To enhance pre-service teachers' perceptions of environmental citizenship by using the field mapping approach.	Action research	24 in-service teachers	• In-service teachers' field maps of action as "conceptual maps"	The use of field maps helped the pre-service teachers to better understand the complexity of a social–ecological system as well as to realize their role, as active citizens within it, thus promoting their understanding of environmental citizenship.
4	Bradberry, 2013	Australia	To explore ways in which some examples of children's literature can be used to assist pre-service teachers to develop children's environmental citizenship and understandings of an ecologically sustainable future.	Qualitative case study	5 tutors (and 140 pre-service teachers)	• Surveys • Reflective diaries • Group interviews	Many pre-service teachers do not have the pedagogical content knowledge and skills to promote young students' citizenship in order to achieve environmental sustainability. Children's literature on ecological issues can be utilized in producing future teachers able to transform their students into actively participatory human beings, via fostering their environmental literacy and environmental citizenship.

Table 2. *Cont.*

#	Author(s)/Year	Country	Research Goals	Research Design	Sample	Data Collection	Major Findings
5	Bulut, 2019	Turkey	To investigate the relationship of environmental citizenship with the sustainable development awareness levels of pre-service teachers.	Relational research methods	387 pre-service teachers attending social studies	• Questionnaires	The sustainable development awareness and environmental citizenship levels of females were higher when compared to male pre-service teachers. Both environmental citizenship and sustainable development awareness levels of the pre-service teachers increased as the grade of the pre-service teachers increased from the freshmen to the senior level. Finally, there was a positive correlation between environmental citizenship and sustainable development awareness levels of the participants.
6	Campbell & Davies, 1995	UK	To explore the meaning of environmental citizenship education for pre-service teachers.	Quantitative research methods	93 pre-service teachers, training to become secondary school teachers	• Questionnaires	Environmental citizenship is inadequately conceptualized by the pre-service teachers. A few pre-service teachers gave responses that were categorized as clearly providing the definition and/or aims of environmental citizenship. While the pre-service teachers expressed the need for taking action, they over-emphasized the importance of direct personal action for the environment (largely recycling), neglecting other forms and types of environmental citizenship actions.
7	Chaya & Ali, 2016	Lebanon	To evaluate the impact of an Environmental Education course, which included project-based learning, on teachers' environmental citizenship.	Mixed methods	222 pre-service teachers (162 undergraduate students and 60 post-graduate students)	• Questionnaire • Projects	Before the course, the pre-service teachers had low to average knowledge, practice and attitudes towards environmental citizenship. They showed devalued commitment towards environmental citizenship, which was revealed by the ignorance of their responsibility towards the environment. After the course, the teachers' knowledge, practice and attitudes towards environmental citizenship were significantly increased.

Table 2. *Cont.*

#	Author(s)/Year	Country	Research Goals	Research Design	Sample	Data Collection	Major Findings
8	Gal & Gan, 2020	Israel	To evaluate the impact of an Environmental Education course, which aimed at fostering pre-service teachers' environmental understanding and environmental citizenship.	Qualitative case study	20 pre-service teachers	• Essays • Assignments • Reflections • Interviews	Prior to the course, the pre-service teachers did not display a deep understanding of social–ecological systems or pro-environmental actions. The course increased teachers' understanding of social–ecological systems and encouraged most of them to act as agents of change.
9	Gooch et al., 2008	Australia	To analyze environmentally focused integrated unit plans, developed and implemented by pre-service teachers, to determine the extent to which they contained concepts that promoted environmental citizenship.	Content analysis methods	46 pre-service teachers trained to become teachers in primary education	• Integrated lesson plans	The analyzed lesson plans, in many cases, were lacking any action-oriented knowledge. These findings suggest that pre-service teachers need support for teaching, learning and acting responsibly in relation to complex environmental issues. The teachers should receive guidance in order to be able to empower their students as well as to promote their environmental citizenship.
10	Green et al., 2016	US	To explore how participating in a political environmental action project influenced teachers' environmental citizenship.	Qualitative case study	7 pre-service teachers (undergraduate students)	• Writing prompts • Group discussions • Emails • Focus groups • Observations	At the end of the project, there was a growth in the pre-service teachers' environmental citizenship, including their self-efficacy, values, awareness and ecological and civics literacy. The pre-service teachers recognized energy conservation as a socioenvironmental issue, with local and global implications, and indicated their professional commitment toward action-oriented Environmental Education.
11	Karatekin, 2019	Turkey	To identify the level of environmental citizenship of teachers as well as to investigate the relationship between the dimensions of environmental citizenship and the mediating role of curiosity about the environment and the frequency of participation in environmental activities.	Relational research method	296 in-service teachers at secondary education	• Questionnaires	The teachers' environmental citizenship levels were moderate to low in the dimension of civic participation, moderate in the dimensions of responsibility and sustainability and high in the dimension of rights and justice. Teachers' curiosity towards the environment as well as the frequency of participation in environmental activities positively predicted their environmental citizenship.

Table 2. *Cont.*

#	Author(s)/Year	Country	Research Goals	Research Design	Sample	Data Collection	Major Findings
12	Lummis et al., 2016	Australia	To examine the influence of environmental citizenship and political solidarity on teachers' perceptions of sustainability.	Qualitative case study	18 pre-service teachers	• Interviews	The findings revealed that the pre-service teachers' perceptions of sustainability were influenced by environmental citizenship and political solidarity concepts. However, none of the teachers used these latter terms explicitly during their interviews. The teachers also mixed up some of their ideas within both environmental citizenship and political solidarity.
13	Olsen et al., 2020	US	To evaluate the impact of a Professional Development (PD) workshop on teachers' perceptions of environmental citizenship.	Quasi-experimental design	94 in-service teachers in both primary and secondary education	• Pre-Post survey • Follow-up questionnaire	The PD workshop elicited a statistically significant improvement in teachers' perceptions overall as well as regarding all five components defining environmental citizenship: Ecological Literacy, Civics Literacy, Practical Wisdom, Values, and Self-Efficacy.
14	Paige & Cogan. 2002	US & China	To compare the perspectives of Guangdong, Hong Kong and Minnesota in-service teachers on key citizen characteristics and environmental concerns in the context of a Citizenship Education Project.	Quantitative research methods	405 in-service teachers	• Questionnaires	The results showed that there were areas of agreement as well as disagreement between the three populations, with teachers in Guangdong and Minnesota being the furthest apart on citizen characteristics and the closest together on environmental concerns.
15	Spektor-Levy & Abramovich, 2020	Israel	To evaluate the impact of a Professional Development (PD) program on teachers' environmental awareness, environmental citizenship and leadership.	Quasi-experimental design	46 in-service teachers in pre-school education	• Pre-Post questionnaire • Teachers' portfolios	At the end of the PD program, there was an increase in teachers' environmental awareness, with the teachers exhibiting profound understanding, high values and a deep willingness to act. The teachers reported experiences of empowerment—both on a personal level, and as educators and leaders.

Table 2. *Cont.*

#	Author(s)/Year	Country	Research Goals	Research Design	Sample	Data Collection	Major Findings
16	Ünal, 2019	Turkey	To investigate the environmental citizenship of pre-service teachers in terms of different variables and to determine the variables influencing the environmental citizenship level.	Quantitative research methods	318 pre-service teachers	• Questionnaires	The environmental citizenship levels of the pre-service teachers did not differ significantly in relation to their gender, mother's educational attainment level, father's educational attainment level, membership in non-governmental organizations and membership in pre-service teachers' organizations. Significant differences were found due to the impact of pre-service teachers' educational disciplines (departments) and participation in social projects.

The thematic analysis resulted in eight main themes—two themes per category (Conceptualization, Characteristics, Impact, Enhancement), which appeared across the reviewed articles. Table 3 presents the emerging themes as well as their frequency. Subsequently, we discuss and elaborate further on the themes derived from the analysis of the reviewed studies, per coding category.

Table 3. Frequency of the main themes per category as derived from the analyzed empirical studies.

	Categories		Themes of Teachers' Perceptions	Frequency
1	Conceptualization	1a	… manifest a relatively decreased understanding of environmental citizenship	10
		1b	… are narrowed down to the local scale, individual dimension and private sphere	4
2	Characteristics	2a	… are multi-dimensional; are defined by several inter-related components	3
		2b	… vary according to teachers' educational/cultural background and personal identity	5
3	Impact	3a	… affect teaching practices	4
		3b	… affect other environmental constructs which define teachers' professional identity	2
4	Enhancement	4a	… can be enhanced during teacher education	5
		4b	… can be further improved during professional development initiatives	3

4.1. Conceptualization

The thematic analysis of the reviewed studies resulted in two main themes related to teachers' conceptualizations of environmental citizenship. Firstly, according to their perceptions, teachers manifested a relatively decreased understanding of environmental citizenship (Theme #1, Table 3). Secondly, teachers' perceptions of environmental citizenship were narrowed down to the local scale, individual dimension and private sphere (Theme #2, Table 3). Below, we present each theme, providing supporting evidence from the reviewed studies.

4.1.1. Teachers' Perceptions Manifest a Relatively Decreased Understanding of Environmental Citizenship

The majority of the reviewed papers have emphasized that teachers' understanding of environmental citizenship is relatively limited [6,18,39,51–57]. Focusing on both pre- and in-service teachers' perceptions, it seems that environmental citizenship is not well defined, but it remains a largely unexplored concept.

For instance, the oldest study which has been included in this review belongs to Campell and Davies [18] and has focused on the investigation of pre-service teachers' perceptions of environmental citizenship. As this study has found, only a few pre-service teachers were able to provide clear definitions of what environmental citizenship is or to define the aims of environmental citizenship. Similar findings were presented by the more recent study of Chaya and Ali [53], who reported that pre-service teachers had low to average knowledge, practice and attitudes towards sustainable development and environmental citizenship. In particular, the participating pre-service teachers showed devalued commitment towards environmental citizenship, which was revealed by the ignorance of their responsibility towards the environment.

Likewise, in a different study, Lummis et al. [56] have supported the notion that some of the pre-service teachers who participated in their study seemed to have some initial ideas about what environmental citizenship is and what it entails, by highlighting the issues of preservation, reducing ecological strain and responsibility. However, as they

found, the concept of environmental citizenship was mostly situated in the subconscious of the pre-service teachers, as none of the participants used the term during the interviews. In addition, they reported that pre-service teachers' perceptions of environmental citizenship were fragmented and mixed up with ideas related to political solidarity.

4.1.2. Teachers' Perceptions of Environmental Citizenship Are Narrowed Down to the Local Scale, Individual Dimension and Private Sphere

A significant number of studies have also indicated that teachers' perceptions of environmental citizenship were restricted to a much more narrowed perspective than expected [6,18,39,51]. According to Olsen et al. [39], teachers were more aware of local rather than broader socioecological system issues and felt more confident in developing learning experiences based on those issues. In a different study, Green et al. [6], who investigated qualitatively pre-service teachers' perceptions of environmental citizenship, have found that the teachers had a limited understanding of their political systems and public policy structures, which would allow them to approach environmental concerns in the collective sphere to achieve a "collective impact". Aarnio-Linnanvuori [51], who investigated teachers' perceptions of responsibility, has found that teachers framed environmental responsibility as (a) awareness, (b) relationship to nature, and (c) active citizenship. Focusing on the latter, the teachers conceptualized environmental citizenship in terms of voting (as being a responsible elector), activism (as a method of being an environmentally responsible citizen) and personal influence. However, when the teachers reflected on these actions, they mentioned that their students seldom participated in any of these. Instead, the teachers proposed several actions situated within the private sphere, such as waste management, food and consumption, transfer and energy, and highlighted that these were more feasible for their students. Finally, in a different study, Campbell and Davies [18] have noted that only a few pre-service teachers related environmental citizenship to a more general level of awareness or mainly referred to the concept in relation to personal awareness, neglecting broader dimensions of the concept in terms of the local, national or global scale.

4.2. Characteristics

The thematic analysis of the reviewed studies resulted in two main themes related to the characteristics of teachers' perceptions. Firstly, it appeared that teachers' perceptions are defined by different interrelated components (Theme #3, Table 3). Secondly, according to the reviewed studies, teachers' perceptions differentiate according to teachers' educational/cultural backgrounds and personal identity (Theme #4, Table 3). Below, we present each one of the themes, providing supporting evidence from the reviewed studies.

4.2.1. Teachers' Perceptions of Environmental Citizenship as a Multi-Dimensional Construct, Defined by Inter-Related Components

Three of the reviewed studies have investigated environmental citizenship as a multi-dimensional construct, defined by inter-related components [6,39,55]. This operationalization has allowed more in-depth insights regarding teachers' perceptions of environmental citizenship.

For instance, Olsen et al. [39] have quantitatively investigated pre-service teachers' environmental citizenship via the use of a cognitive/affective framework, defined by: (a) ecological literacy, (b) civics literacy, (c) self-efficacy, (d) values awareness, and (e) practical wisdom. According to Olsen and her colleagues, teachers' understandings of environmental citizenship were particularly decreased in terms of ecological literacy, which reflects the understanding of key ecological systems using sound ecological thinking. As Olsen et al. [39] have argued, teachers "report a gap in their understanding of social-ecological systems, which presents a barrier to developing *environmental citizens*, or those enacting the skills and knowledge necessary for sustainable environmental behavior" (p. 1).

Similar findings were echoed by Green et al. [6], who qualitatively investigated pre-service teachers' perceptions of environmental citizenship, using the same cogni-

tive/affective framework as Olsen et al. [39]. According to Green et al.'s findings, the pre-service teachers showed a general understanding of key ecological systems, lacking a "place-specific understanding, particularly in regard to the social, economical, political, and cultural intricacies of their energy-yielding system and the human roles within that system" (p. 131). At the same time, the teachers indicated low levels of civics literacy, as they manifested limited understanding of public policy and civic responsibility. Lastly, according to Green et al. [6], the teachers had not really identified their personal values or what they were capable of contributing to as environmental citizens.

In a different study, Karatekin et al. [55], who have quantitatively investigated pre-service teachers' environmental citizenship, as defined by (a) civic participation, (b) sustainability, (c) responsibility, as well as (d) environmental rights and justice, have found that according to teachers' scores, their general levels of environmental citizenship seemed to be moderate. However, when focusing on teachers' scores in terms of civic participation, they found that this one was particularly low in comparison with the rest of the components. Finally, Karatekin et al. [55] investigated also the various causality relations among the environmental citizenship components and reported, among others, that the most important variable directly affecting the civic participation dimension behaviors was responsibility, revealing that a higher sense of responsibility leads to higher civic participation.

4.2.2. Teachers' Perceptions of Environmental Citizenship Are Differentiated According to Their Educational/Cultural Backgrounds and Personal Identity

Five of the reviewed studies provided empirical support for the notion that teachers' perceptions of environmental citizenship are subjective, as they differentiate according to teachers' educational/cultural background and personal identity [1,18,55,58,59].

Karatekin [55] has found, for instance, that the level of curiosity towards the environment as well as the frequency of participation in environmental activities positively predicted teachers' environmental citizenship. Bulut [1], who has adopted a relational research method to quantitatively investigate pre-service teachers' perceptions of environmental citizenship, has found that teachers' perceptions are differentiated according to their personal identity, in terms of gender and educational level. In particular, Bulut [1] has concluded that both the perceptions of environmental citizenship as well as the sustainable development awareness levels of the female participants were higher when compared to the male participants. In addition, he has found that both the environmental citizenship and sustainable development awareness levels of the pre-service teachers increased as the grade of the pre-service teachers increased from the freshmen to the senior level.

Contrary to these findings, Unal [59] has found that the environmental citizenship levels of the pre-service teachers did not differ significantly due to their gender, mother's educational attainment level, father's educational attainment level, membership in non-governmental organizations and membership in teachers' organizations. However, Unal [59] has identified significant differences in terms of the pre-service teachers' departments and participation in social projects. More specifically, he has found that social studies teacher candidates outperformed the primary school teacher candidates, while the teacher candidates who participated in social projects outperformed their counterparts who did not. In the same vein, in a prior study, dating back to 1995, Campell and Davies [18] have also found significant differences between pre-service teachers of different disciplines. For example, as they reported, modern language pre-service teachers provided the fuller responses when defining environmental citizenship, as compared to science, mathematics, English and social studies pre-service teachers. Campell and Davies [18] explained that while this finding may simply reflect the expressive confidence of the modern language pre-service teachers, it may be also the case that this could be also attributed to the increased concern of linguists towards other cultures and places.

Finally, Paige and Cogan [58] compared the pre- and in-service perceptions of environmental citizenship at the sites Guangdong, Hong Kong and Minnesota, via investigating their top five citizen characteristics and their top five environmental problems to be addressed. According to their findings, beyond similarities, there were also striking differ-

ences between the three populations. For instance, only the Hong Kong teachers included critical thinking on the list. Likewise, only the Minnesota teachers selected the energy resources and only Hong Kong teachers selected the uneven global resource distributions and the ozone depletion as their top environmental concerns.

4.3. Impact

The thematic analysis of the reviewed studies resulted in two main themes related to the impact of teachers' perceptions on their professional identity. Firstly, according to the reviewed studies, teachers' perceptions of environmental citizenship affect their teaching practices (Theme #5, Table 3). Secondly, we found that teachers' perceptions of environmental citizenship affect other environmental constructs, which define their professional identity (Theme #6, Table 3). Below, we present each one of the themes, providing supporting evidence from the reviewed studies.

4.3.1. Teachers' Perceptions of Environmental Citizenship Affect Their Teaching Practices

Four of the reviewed studies provided empirical support for the notion that teachers' perceptions of environmental citizenship affect their teaching practices [18,39,51,54].

Olsen et al. [39] have found, for instance, that while teachers attempted to integrate socioecological systems in their classrooms, they had not integrated a civic engagement component. At the same time, it was found that teachers were more aware of local socio-ecological system issues and ways to develop learning experiences based on those issues. Finally, when teachers were asked to report whether they believe that they can address socioecological systems through civic engagement in their classrooms, they mentioned several barriers to implementation, such as achieving standards, time, lack of congruence with subject area, energy and money.

In a different study, Aarnio-Linnanvuori [51], who investigated teachers' environmental citizenship through the lens of environmental responsibility, has found that teachers described their students' possibilities for environmental responsibility as narrower than those of adults, comprising mainly private-sphere actions. More specifically, the in-service teachers who participated in in-depth interviews expressed how small personal actions, such as recycling and switching off devices, were more feasible for the students, explaining that environmental citizenship and more impactful actions were out their students' reach.

In their study, Campbell and Davies [18] have found that there were also several pre-service teachers who could not realize the nature or the significance of awareness that should be part of education when teaching for environmental citizenship, thus rendering the environment as an area which may attract thoughtless and undefined action by their students.

Finally, Gooch et al. [54], who have analyzed environmentally focused integrated unit plans, developed and implemented by final year pre-service teachers at an Australian regional university, defined limited concepts which promoted the action competence. Based on these findings they have suggested that pre-service teachers need more preparation and support in order to be able to develop integrated unit plans that empower school students and promote critical thinking, democratic processes and action-oriented knowledge, as important skills for environmental citizenship.

4.3.2. Teachers' Perceptions of Environmental Citizenship Affect Other Environmental Constructs Which Define Their Professional Identity

We found only two studies providing empirical support for the notion that teachers' perceptions of environmental citizenship affect other environmental constructs which define their professional identity [1,56]. More specifically, Bulut [1] concluded that there was a positive correlation between environmental citizenship and sustainable development awareness levels of the pre-service teachers. In other words, as the environmental citizenship levels increased, a moderate positive improvement was observed in teachers' sustainable development awareness levels. Along the same lines, Lummis et al. [56] have found in their study that the pre-service teachers' perceptions of Education for Sustainabil-

ity and the three pillars of sustainability (environmental, economic and sociopolitical) were influenced by both teachers' environmental citizenship and political solidarity concepts as well as by the local context.

4.4. Enhancement

The thematic analysis of the reviewed studies resulted in two main themes related to the enhancement of environmental citizenship perceptions, due to teachers' participation in training initiatives. Firstly, it appeared that pre-service teachers' perceptions can be enhanced during teacher education (Theme #7, Table 3). Secondly, we have found that in-service teachers' perceptions of environmental citizenship can be further improved during professional development initiatives (Theme #8, Table 3). Table 4 provides an overview of teachers' training initiatives undertaken in the reviewed studies (i.e., training approach, target group and context of implementation, duration, indicative activities, focus on EEC). Below, we present each one of the themes, providing supporting evidence from the reviewed studies.

4.4.1. Teachers' Perceptions of Environmental Citizenship Can Be Enhanced during Teacher Education

Five of the reviewed studies provided empirical evidence suggesting that pre-service teachers' perceptions of environmental citizenship can be enhanced in the context of teacher education [6,53,60–62]. These studies presented and evaluated a variety of training approaches, such as *project citizen* [6], *community-based learning* [60], *transformative sustainability education* [62], *project-based learning* [53] or the use of *children's ecological literature* [61].

Abd-El-Aal and Steele [60] have reported, for instance, that pre-service teachers had the opportunity to take part in *community-based learning* which allowed them to reveal environmental problems in their local communities (e.g., water pollution, pesticides, garbage, wasting of environmental resources), while joining forces with the residents to undertake either individual actions situated at the private sphere (e.g., water conservation, use of alternative pesticides, garbage pick-up) or collective actions situated in the public sphere (e.g., sign a complaint to local councils, distribution of informative flyers, organization of symposiums, preparation of posters, purchase of bins). In a different study, Chaya and Ali [53] reported on the participation of pre-service teachers in a problem-based project, which allowed them to identify various environmental problems in their local communities, to collect relevant information and propose solutions. Likewise, Green et al. [6] described pre-service teachers' involvement in *Project Citizen* as a "critical place-based action-oriented approach for integrating environmental citizenship in teacher education" (p. 122). According to this approach, the pre-service teachers identified a local public policy problem (i.e., energy conservation on campus), gathered public opinions about this problem, took an active role within the public sphere to collectively devise an educational policy that promoted energy-saving behaviors within the university campus and, finally, they presented their policy to university decision-makers.

In a different study, Gal and Gan [62] reported that pre-service teachers had the opportunity to take part in a series of field trips, which were grounded in the *Transformative Sustainability Approach*. Each field trip allowed teachers to obtain rich insights regarding the complexity of three different social–ecological systems, introduced major environmental issues threating their sustainability, fostered critical thinking, allowed a deeper understanding of the socioecological systems and motivated teachers to undertake social–environmental actions either within the public or private sphere. Finally, Bradberry [61] reported on how children's ecological literature was used in order to communicate across several environmental challenges as well as to provoke the pre-service teachers' critical thinking regarding the interdependence of all of the elements of any fragile environment and the need to protect these, as well as what needs to be done in order to secure an ecologically sustainable future for our Earth.

Table 4. Overview and characteristics of teachers' training initiatives.

#	Author(s)/Year	Training Approach	Target Group & Context of Implementation	Duration	Indicative Activities	Focus on EEC (Outputs, Dimensions, Spheres, Scales)

1	Abd-El-Aal & Steele, 2013	**Community-based learning:** According to this approach, the pre-service teachers were asked to investigate and take action on environmental issues in their communities. This approach allowed them to take leadership roles in local environmental issues, rather than simply focusing on general knowledge about the environment.	38 pre-service teachers (Teacher education: Environmental Education course)	A semester-long course (the exact duration is not specified)	• Identification of environmental problems in teachers' local communities
					• Fieldwork and semi-structured interviews with community members
					• Development of solutions in collaboration with the community members
					• Preparation of final reports with the fieldwork artifacts (e.g., videos and photographs)
						• **Agents of change:** Investigating and taking action on local environmental issues in local communities
						• **Dimensions:** Individual and collective actions
						• **Spheres:** Private and public sphere actions
						• **Scales:** Local-scale actions
						• **Outputs:**
						  – Solving current environmental problems
						  – Achieving critical and active engagement and civic participation

2	Avriel-Avni & Gan, 2019	**Conceptual mapping:** According to this approach, in-service teachers created three concept maps throughout the course, to map their field of action. Through mapping, the in-service teachers identified their role as environmental citizens within the socioenvironmental system and identified possible ways to influence it.	24 in-service teachers (Teacher education: Environmental Education Master's course)	Two-semester-long course (the exact duration is not specified)	• Identification of environmental problems causing discomfort
					• Group mapping to map the processes that preserve the undesirable reality and processes that can bring change
					• Studying remote and unfamiliar environmental cases
					• Creation of personal maps indicating socioenvironmental problems as well as their driving and preserving forces
					• Joint analysis of field maps and individual feedback on mappings
						• **Agents of change:** Investigating and mapping field of action in relation to a local environmental problem (e.g., waste management)
						• **Dimensions:** Individual and collective actions
						• **Spheres:** Private and public sphere actions
						• **Scales:** Local-scale actions
						• **Outputs:**
						  – Solving current environmental problems
						  – Identifying structural causes of environmental problems
						  – Achieving critical and active engagement and civic participation

Table 4. *Cont.*

#	Author(s)/Year	Training Approach	Target Group & Context of Implementation	Duration	Indicative Activities	Focus on EEC (Outputs, Dimensions, Spheres, Scales)
3	Bradberry, 2013	**Children's literature:** Children's literature with strong ecological themes was selected, analyzed and thoroughly discussed with pre-service teachers as part of this approach. The aim of this approach was to support pre-service teachers in developing children's environmental citizenship for achieving an ecologically sustainable future.	140 pre-service teachers (Teacher education: Environmental Education course)	A semester-long course of 12 weeks (the exact duration is not specified)	• Character focus activities to explore the complexity of socioenvironmental issues • Use of inferential reading and critical thinking questioning strategies • Deconstruction of the text's visual elements • Problem-based learning activities using the narrative text as a catalyst	• **Agents of change:** Reflecting on various role models, characters and potential civic actions in the context of children's literature and ecopedagogy • **Outputs:** – Achieving critical and active engagement and civic participation – Achieving sustainability – Healthy relationship with nature
4	Chaya & Ali, 2016	**Project-based learning (PBL):** PBL required teachers to investigate environmental problems in their communities. It provided opportunities to actively explore and address environmental challenges while developing skills in communication and teamwork, research, data collection and analysis, community engagement and reflection.	222 pre-service teachers (Teacher education: Environmental Education course)	One semester (the exact duration is not specified)	• Identification of an environmental problem • Identification of the most appropriate information-seeking strategies • Synthesis and evaluation of the gathered information • Suggestion of solutions for the problem • Design of student activities relevant to the chosen problem • Communication of the project outcomes through an interactive presentation	• **Agents of change:** Investigating and addressing environmental problems in the context of PBL projects • **Dimensions:** Not specified • **Spheres:** Not specified • **Scales:** Local-scale actions • **Outputs:** – Solving current environmental problems – Achieving critical and active engagement and civic participation

Table 4. Cont.

#	Author(s)/Year	Training Approach	Target Group & Context of Implementation	Duration	Indicative Activities	Focus on EEC (Outputs, Dimensions, Spheres, Scales)
5	Gal & Gan, 2020	**Transformative Sustainability Education (TSE):** TSE served as an effective approach in creating behavioral transformation related to environmental problems. In this study, TSE was employed in context of three field trips; each field trip provided to the teachers insights regarding the complexity of the social–ecological systems in Israel and introduced major environmental issues at local, regional and international levels.	20 pre-service teachers (Teacher education: Environmental Education course)	One semester (the exact duration is not specified)	• Jigsaw activities, where each pre-service teacher studied one part of a topic and then teachers reconvened to bring all parts of the information together • Peer learning during which the pre-service teachers shared their insights from the field trips • Drawings reflecting the social–ecological systems according to pre-service teachers' understanding • Personal and group reflections for each field trip	**Agents of change:** Investigating various socioecological systems and addressing environmental challenges in the context of field trips **Dimensions:** Not specified **Spheres:** Private and public actions **Scales:** Local-scale actions **Outputs:** – Solving current environmental problems – Achieving sustainability – Achieving critical and active engagement and civic participation – Healthy relationship with nature
6	Green et al., 2016	**Project citizen:** A critical place-based action-oriented approach for the integration of environmental citizenship in teacher education. It allowed teachers to address social, cultural, economical and political complexities in their local communities, while also empowering them to explore how their personal experiences and background shape their engagement in democratic processes.	7 pre-service teachers (undergraduate students) (Teacher education: Environmental Education course)	One semester (the exact duration is not specified)	• Identification of a public policy problem in local communities • Collection of information about the various dimensions of the problem • Development of a portfolio which includes an explanation of the problem, alternative approaches and a course of action • Sharing of the portfolio with decision-makers and interested stakeholders • Reflection on the learning experience	**Agents of change:** Identifying a local public policy problem and taking an active role within the public sphere to collectively devise a policy to address this problem **Dimensions:** Collective actions **Spheres:** Public actions **Scales:** Local-scale actions **Outputs:** – Solving current environmental problems – Achieving sustainability – Achieving critical and active engagement and civic participation

Table 4. *Cont.*

#	Author(s)/Year	Training Approach	Target Group & Context of Implementation	Duration	Indicative Activities	Focus on EEC (Outputs, Dimensions, Spheres, Scales)
7	Olsen et al., 2020	**Adventure Learning (AL) approach:** *A hybrid approach which combined an online collaborative learning environment with adventure-based authentic learning experiences for the exploration of real-world issues connected to particular places. This approach was addressed to both local (face-to-face) and distance (online) participants (teachers) and was grounded in experiential and inquiry-based learning theory.*	94 in-service teachers in both primary and secondary education (Professional Development program)	• Online participation: Approx. 20 h • In-person workshops: Approx. 40 h	• In-person workshops about the exploration of local socioecological systems in teachers' communities • Interaction with regional experts, researchers and stakeholders • Investigation of self-selected socioecological topics in small groups • Reflections with off-site participants in the online environment	**Agents of change:** Investigating real-world issues connected to particular places **Dimensions:** Collective actions **Spheres:** Public actions **Scales:** Local-scale actions **Outputs:** – Solving current environmental problems – Achieving critical and active engagement and civic participation
8	Spektor-Levy & Abramovich, 2020	**Environmental Leadership Professional Development (ELPD):** This approach was structured around the teachers' effort to plan an innovative venture related to environmental and sustainability issues and combined five main characteristics, as follows: • Pro-social and environmental activism • Project-based learning • Empowerment and self-efficacy • Greater knowledge—more courage to dare/act • Place-based learning	46 in-service teachers at pre-school education (Professional Development program)	120 h: 15 face-to-face sessions lasting eight hours each	• Meetings and workshops for knowledge enrichment • Project-based learning activities • Surveying and identification of local socioenvironmental problems • Online and offline group discussions and collaborative learning activities • Experiential and reflective learning activities.	**Agents of change:** Planning an innovative venture related to environmental and sustainability issues **Outputs:** – Achieving sustainability – Achieving critical and active engagement and civic participation

Overall, despite their differences, these training approaches were characterized by various learning activities, which contributed to several aspects of the Education for Environmental Citizenship (EEC). In most of these studies, the pre-service teachers had the opportunity to realize that environmental citizenship is manifested via undertaking various actions at the local level, either collectively or individually, within the private or public sphere, to address current environmental problems [6,53,60,62]. Importantly, these studies put forward some of the main outputs, which the Education for Environmental Citizenship (EEC) is striving for, such as: (a) solving current environmental problems [6,53,60,62], (b) achieving critical and active engagement and civic participation [6,53,60–62], (c) achieving sustainability [61,62] as well as (d) developing a healthy relationship with nature [61,62].

4.4.2. Teachers' Perceptions Can Be Enhanced during Professional Development Initiatives

Three of the reviewed studies provided empirical evidence suggesting that in-service teachers' perceptions can be further improved during professional development programs [39,52,57]. More specifically, Olsen et al. [39] presented a professional development program grounded in the Adventure Learning (AL) approach, which combined an online collaborative learning environment with adventure-based authentic learning experiences for the exploration of real-world issues connected to particular places. As part of the program, the in-service teachers had the opportunity to enhance their environmental citizenship perceptions by participating in a variety of activities, such as in-person workshops about the exploration of local socioecological systems in teachers' communities, interaction with regional experts and stakeholders, investigation of self-selected socioecological topics in small groups as well as reflections with off-site participants in the online environment.

In a different study, Spektor-Levy and Abramovich [57] reported on the positive impact of the environmental leadership professional development program, during which the participating in-service teachers were asked to plan an innovative venture related to environmental and sustainability issues. Finally, Avriel-Avni and Gan [52] presented conceptual mapping as an approach, according to which the in-service teachers created three concept maps throughout a Master's course on Environmental Education, to map their field of action regarding waste management, as a socioenvironmental problem. Teachers' mapping provided a useful lens to the tutors of the course to support the in-service teachers to identify their role as environmental citizens within the socioecological system, to conceptualize various collective or individual environmental actions at the private or public sphere (e.g., placement of recycling bins, city campaigns, self-recycling, composting) as well as to explore the driving and preserving structural forces underlying the problem.

Overall, the aforementioned professional development interventions were characterized by various learning activities, which contributed to several aspects of the Education for Environmental Citizenship (EEC). As part of these interventions, a common element was that in-service teachers were asked to conceptualize solutions for local environmental problems that they were asked to investigate and reflect on [39,52,57]. These professional development programs fostered also some of the main outputs, which the Education for Environmental Citizenship (EEC) is aiming at, such as: (a) solving current environmental problems [39,52,57], (b) identifying the structural causes of environmental problems [48], (c) achieving critical and active engagement and civic participation [39,52,57], (d) achieving sustainability [57].

5. Discussion

The goal of this review study is to further extend the field's understanding of teachers' perceptions of environmental citizenship via a systematic synthesis of the literature. To achieve this goal, we reviewed and synthesized the findings of quantitative and qualitative investigations on the topic, published in peer-reviewed journals from 1995 to 2020. Our main findings are discussed below for each one of the research questions guiding this review study.

5.1. Teachers' Conceptualization of Environmental Citizenship

Our first research question focused on the way teachers conceive environmental citizenship. The synthesis of the reviewed research has indicated that teachers' perceptions of environmental citizenship are generally naïve or superficial. On one hand, quantitative studies provided empirical evidence supporting the notion that teacher levels of environmental citizenship were moderate to low [39,55]. On the other hand, qualitative studies showed that many teachers could not provide a clear definition of what environmental citizenship really is [6,56]. Focusing on teachers' perceptions of what environmental citizenship entails, teachers framed environmental citizenship as a potential venue to address issues on local ecosystems and via an individual rather than a collective dimension. At the same time, they related environmental citizenship only with simplistic, daily, personal actions on behalf of their students. In this way, environmental citizenship mostly appeared as the "low-hanging fruit" of individual personal behaviors—recycling, energy saving and home insulation [63]. Indeed, Environmental Education has often been criticized for simply promoting insignificant individual behaviors [5,64]. However, as was posed by Aarnio-Linnanvuori [51], if teachers cannot imagine significant active roles as well as more collective and influential actions towards addressing global environmental challenges, how can they support their students' growth in environmental citizenship?

Overall, the reviewed studies suggest that teachers had limited exposure to and understanding of environmental citizenship. Therefore, teachers should be given the opportunity to become familiar with the concept of environmental citizenship, as was clarified through interdisciplinary interactions between experts [65]. If we hope to educate individuals not only to act pro-environmentally, but to understand the urgency of environmental issues and to integrate pro-environmental actions into the core of their political participation and citizenship expressions, all aspects that comprise environmental citizenship need to be tackled specifically, systematically and precisely within educational dimensions. Of course, teachers are likely to build their conceptual understanding of environmental citizenship on the foundation of their own subject traditions [66]. Nevertheless, earlier studies have shown that if teachers have a holistic understanding of concepts such as environmental citizenship, they will use a broader approach to teaching and learning, while a narrowed understanding is often associated with narrow approaches to teaching [67].

5.2. Characteristics of Teachers' Perceptions of Environmental Citizenship

Our second research question focused on the characteristics of teachers' perceptions of environmental citizenship and our findings shed light on the complex nature of these perceptions. The synthesis of the reviewed studies provided empirical support for the notion that teachers' perceptions of environmental citizenship can be characterized as highly subjective, as they are affected by teachers' educational and cultural backgrounds as well as by their personal identity (e.g., gender, curiosity towards the environment, participation in environmental activities). In a way, this is not a novel finding, as prior literature has reported how teachers' perceptions of various topics vary due to their personal identity [68–71]. However, as teachers' environmental citizenship perceptions are still an emerging topic, further research should be undertaken to specify teachers' remarkable personal identity differences as well as their exact contribution to the formation of their environmental citizenship perceptions. This need is further warranted, considering not only the limited number of empirical studies investigating the role that teachers' personal identity plays on their perceptions of environmental citizenship, but also on their contradictive findings regarding the impact of these differences (see, for instance, how the role of teacher gender differences is reported in the studies of Bulut [1] and Unal [59]).

On the other hand, a subgroup of the reviewed empirical studies [6,39,55] characterized teachers' perceptions of environmental citizenship as multifaceted constructs, comprising various subcomponents (i.e., ecological literacy, civic literacy, practical wisdom, self-efficacy, values awareness, civic participation, sustainability, responsibility, environmental right and justice). This multidimensional characterization revealed a variation

in teachers' level of understanding across the evaluated subcomponents, with the teachers reporting the greatest gap in their understanding of "ecological literacy", "practical wisdom" and "participation". "Ecological literacy" reflects teachers' understanding of key ecological systems using sound ecological thinking, while "practical wisdom" and "participation" reflect action-oriented components entailing skills for decision-making and acting with respect to the environment [4]. These findings are aligned with prior literature reporting that environmental behaviors which require active participation for the solution of socioecological problems are poorly evaluated [17,72,73], and as such, training initiatives should be more targeted towards addressing these less evaluated dimensions.

5.3. Impact of Teachers' Environmental Citizenship Perceptions on Their Professional Identity

Our third research question sought to understand the impact of teachers' environmental citizenship perceptions on their professional identity. According to the synthesis of the reviewed studies, we have found that teachers' perceptions of environmental citizenship are positively correlated with and affect teachers' sustainable development awareness levels as well as their perceptions for Education for Sustainability [1,56]. This finding is significant given the worldwide efforts to foster education for sustainability by UNESCO as well as the main goals and targets which were set by the United Nations towards this direction, to be achieved by 2030 [74,75].

Importantly, the synthesis of the reviewed studies has indicated that the way teachers perceive environmental citizenship primarily affects their current teaching practices as well as the ways they intend to foster their students' environmental citizenship. In short, the teachers' reported practices for promoting students' environmental citizenship remained limited to the use of local socioenvironmental issues and individual actions at the private sphere. As also appeared, teachers had great difficulty in integrating action-oriented knowledge and authentic civic engagement activities as part of their lessons. These findings are not surprising, considering the way teachers perceived environmental citizenship and their limited understanding around the concept. In general, how teachers perceive central educational concepts in the curriculum inevitably affects their interpretation and implementation [76]. In addition, teachers make educational decisions and interpret and deliver the educational content based on their environmental perceptions [51]. Teachers' perceptions may limit their willingness and effectiveness to teach pro-environmental content included in the curriculum [77]. This provides a plausible explanation regarding our findings about the discouraging relationship of teachers' environmental citizenship perceptions with their teaching practices. This situation is worsened due to the fact that environmental citizenship is not an explicit component of a particular subject's curriculum, so far, which makes it more challenging for teachers to address it in their teaching.

5.4. Enhancement of Teachers' Environmental Citizenship Perceptions

Our fourth research question asked whether and how teachers' environmental citizenship perceptions can be enhanced. The synthesis of the reviewed studies provided empirical support suggesting that pre-service teachers' perceptions of environmental citizenship can be enhanced in the context of teacher education courses [6,53,60–62], while in-service teachers' perceptions can be further improved in the context of professional development programs [39,52,57]. This subset of empirical studies is of critical importance given that, while supporting teachers in enacting environmental citizenship is now a prescient concern [20], opportunities for teacher training delivering environmental citizenship education are limited and its effectiveness remains understudied [39]. The reviewed studies provided a range of training initiatives for in-service and pre-service teachers, which tapped into and highlighted various aspects of the Education for Environmental Citizenship (EEC), via supporting teachers in becoming and acting as agents for change. More specifically, in most of the training initiatives, the teachers had the opportunity to undertake or to suggest individual or collective civic actions either at the private or the public sphere, which could contribute to the mitigation of current socioenvironmental issues. Despite their range, these

actions were restricted at the local scale; none of the actions were expanded at the national or global scale. The attention given by the reviewed training initiatives to place-based learning presented the opportunity to teachers to be involved in local-scale environmental problems; however, equal attention has not been given to national- and global-scale environmental problems. These training initiatives fostered also to a great degree some of the main outputs, which the Education for Environmental Citizenship (EEC) is aiming at, such as solving current environmental problems, or achieving critical and active engagement and civic participation, while also promoting to a lesser degree outputs such as identifying the structural causes of environmental problems, achieving sustainability or developing a healthy relationship with nature. However, according to the European Network for Environmental Citizenship (ENEC) [34], the EEC is also characterized by several other outputs, such as: (a) preventing environmental problems, (b) practicing environmental rights and duties, and (c) promoting inter- and intra-generational justice, which were not promoted at all by the reviewed training initiatives and the educational approaches adopted. These findings coincide with Hadjichambis and Paraskeva-Hadjichambi [20], who proposed that none of the existing educational approaches alone can promote the scope and aims of the EEC and, therefore, a more integrated and holistic pedagogical approach is needed.

6. Limitations

Even though the findings of this review study may help flesh out a more comprehensive picture regarding teachers' perceptions of environmental citizenship, some limitations of this work are also important to note. First, a critical issue is the lack of consensus on an operational definition or a model of environmental citizenship in the reviewed studies. Environmental citizenship was often labelled as "green", "ecological" "sustainability" or even "global" and "active" citizenship, signifying also a variation in research conceptions of environmental citizenship and what it entails. This variation in research conceptions makes it almost impossible to compare findings meta-analytically, while in other cases, the differences are not distinguishable [2]. Secondly, the fact that our review included only 16 empirical studies could be perceived as another limitation. This is attributed to the fact that the empirical research on the topic is still emerging. Yet, we proceeded in a well-crafted and analytical synthesis of the available empirical research, with the aim of providing useful directions for researchers in the field.

7. Educational Implications and Future Directions

The goal of this review study was to synthesize the results of empirical research on teachers' perceptions of environmental citizenship. Based on our findings, we propose several areas for future research.

First, the field seems to be still in an exploratory phase. This is not only justified by the limited number of retrieved empirical studies on the topic or by the year of their publication, but also from the research designs they have followed. Most of the reviewed papers have presented, for instance, qualitative case studies in an effort to explore in more depth teachers' perceptions of environmental citizenship. Future studies should therefore seek to validate and replicate prior findings across larger teacher groups and different settings.

Secondly, while the reviewed literature provided some initial insights into how teachers' perceptions seem to vary according to teachers' educational/cultural background and personal identity (e.g., gender, levels of environmental curiosity, participation in environmental projects), more research work is warranted towards this direction. Additional personal identity aspects of interest could include, for instance, teachers' environmental background and content knowledge, professional expertise or their personal levels of environmental activism. At the same time, the reviewed research provided no insights into how teachers' perceptions of environmental citizenship vary by social context and setting. For instance, nothing is known about how teachers' perceptions of environmental citizenship vary across formal or informal educational settings (i.e., teachers' perceptions employed at

formal schools versus teachers' perceptions employed at Environmental Education centers), or across urban, suburban and rural school settings. In addition, nothing is yet known about the social context in different countries, which may affect teachers' perceptions of environmental citizenship. Such research questions could be investigated with the use of experimental research designs, employing control or comparison groups, which were almost non-existent in the reviewed studies.

Third, future empirical studies could be more targeted towards investigating and addressing teachers' perceptions, in respect to the particular weaknesses and gaps identified in this reviewed study. More specifically, it has been found that teachers' perceptions are narrowed down to the local scale, individual dimension and private sphere. Put simply, according to the teachers, environmental citizenship was operationalized as a vehicle to address local environmental challenges via an individualistic perspective, neglecting global environmental problems as well as the significance of collective environmental actions. The evaluation of environmental citizenship perceptions as multidimensional constructs also revealed a gap in teachers' understanding of socioecological systems and action-oriented practices. Taking into account these findings, future training initiatives should include more focused activities in order to empower teachers' understanding of these particular aspects.

Fourth, taking into account that none of the existing educational approaches alone can promote the scope and aims of the EEC, existing and new educational approaches should be further investigated in the context of training initiatives for in-service and pre-service teachers. One potential direction would be the design of training initiatives which combine a variety of educational approaches (e.g., community-service learning, field mapping, and children's literature/ecopedagogy). On the other hand, a more viable approach would be the design and implementation of educational approaches explicitly structured around the model of EEC per se, taking into account its scope and aims. In their latest work, Hadjichambis and Paraskeva-Hadjichambi [20] have developed, for instance, the EEC pedagogical approach, which comprises six stages, as follows: (a) Inquiry, (b) Planning actions, (c) Critical and active engagement and civic participation, (d) Networking and sharing in scales (local, national, global), (e) Sustain environmental and social change, and (f) Evaluation and reflection. According to Hadjichambis and Paraskeva-Hadjichambi [20], the value of this approach is concentrated on the notion that it is placed at the heart of environmental citizenship and it was structured around the model of the Education for Environmental Citizenship (EEC), as this was developed by the European Network for Environmental Citizenship (ENEC) [34]. Despite these arguments, the proposed pedagogical approach has to be tested with pre-service and in-service teachers in the context of future teachers' training initiatives duly designed for this purpose.

Finally, there is also a need for longitudinal research studies and trajectories, reporting how teachers' perceptions on environmental citizenship evolve from their pre-service training into their in-service careers. At a smaller timescale, longitudinal studies could also be used to investigate the short- and long-term impact of professional development programs. Focusing on the latter, future empirical studies should be undertaken investigating the impact of professional development and teacher education initiatives not only on teachers' perceptions on environmental citizenship but also on how these perceptions are reflected on teaching practices, within the school classrooms, in the framework of EEC.

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Article

Environmental Citizenship Education through the Doñana, Biodiversity and Culture Program

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Abstract: While the need to educate for the formation of environmentally committed citizens is something that has always been recognized, currently however it has become an obligation. The present study analyzes the Doñana, Biodiversity and Culture Program from the perspective of its participants. The program is part of the action being carried out with schools intending to teach environmental citizenry using the context of protected natural spaces, in this specific case, the Doñana National Park. The Park's managers and public guides were interviewed, and observation records of the process were collected. These were later analyzed by means of a category table elaborated within the project Patrimonial Education for Citizens' Territorial and Emotional Intelligence, of which this study is a part. The consistency of the informants was verified, as also was the practice observed, showing the importance of the socio-identity framework, of critical thinking, and of socio-affective relationships with the territory.

Keywords: environmental citizenship; Doñana; emotional intelligence; territorial intelligence; identity

1. Introduction

Spain is the country with the third highest volume of assets declared as World Heritage Sites by the UNESCO, among which is the Doñana National Park that was included 50 years ago [1]. In all of these areas, there is a wide range of heritage which needs to be admired and committed to so as to intervene and transform society in favor of that heritage [2]. With regard to natural heritage in particular, this objective can be achieved through the development of environmental citizenship, which [3] defines as a citizenry with pro-environmental behavior in every aspect of their lives, and which considers equity in the distribution of goods and participation in the creation of a sustainability policy. As noted by [4], it is a matter of citizens who participate actively in the path towards sustainability.

Based on the definitions of environmental citizen given by the previous authors, we can affirm that the generation of citizens committed to the environment is basic and of great importance at the time of environmental crisis that we are experiencing [4]. Everything suggests that an environmentally literate society [5] will prevent or provide the means to recover the environment and prevent its further deterioration.

Ref. [6] describes that the best way to get environmental citizens is by involving them in solving environmental problems and not sitting in a classroom listening: "the idea of environmental citizenship can be made real by getting pupils involved in a project that involves part of the school or even all of it" [6] (p. 285). All programs carried out through both formal and non-formal education will be welcomed to achieve more conscientious citizens and, ultimately, a reduction in the loss and degradation of the environment. As [7] warns, environmental citizenship could develop a more sustainable society and world with the transformation of values, beliefs, attitudes, and behavior.

To this, it must be said that more and more schools are betting on developing environmental training programs for their students, designed in the line of achieving an

improvement in their conceptualization and their attitude towards the environment. The literature review reveals the increase in programs in both formal and non-formal education, summarizing their results in the generation of citizens more committed to the environment.

Education is in charge of this task, analyzing and developing didactic proposals through research, in formal and non-formal, transdisciplinary and socio-critical contexts, working from socio-scientific controversies.This promotes the construction of values of identity, intercultural respect, and social change, and leads to the formation of citizens who are socioculturally committed and critical [8,9], but also who have a broad environmental culture [10] developed on the basis of acquiring environmental knowledge from real life and personal experiences [11].

The present study is framed within a project called "Heritage Education for the territorial and emotional intelligence of citizens. Analysis of good practices, design and intervention in compulsory education" (EDU2015-67953), to which has been assigned the DESYM (Didactics of Experimental, Social and Mathematics) research group of the University of Huelva, called EPITEC (Heritage Education for Territorial and Emotional Intelligence of Citizens). This project has been contributing knowledge of the didactic proposals that connect schools with heritage institutions since 2017.

The intention of the study was to gather knowledge about the Doñana, Biodiversity and Culture Program as a path in environmental education for citizenship, working from the Park's Heritage Center with local schoolchildren so as to generate a territorial bond, developing territorial and emotional intelligence.

2. Theoretical Foundation

2.1. The Need for Environmental Citizenship

Today, both globally and locally, environmental problems constitute one of the main issues facing humanity. The dominant economic development model is responsible for the great imbalance that affects both the environment and part of our own society. The consequences in terms of the deterioration of nature are becoming ever more obvious, and are sending a warning alarm to change direction, and even the necessity to retrocede as expressed in the theory of contraction [12,13]. It is clear that this situation needs to be known by every citizen to achieve a more responsible treatment and a citizen profile that is more consistent with today's situation.

If something is clear at present, it is the need to generate environmental awareness in citizens to achieve a change in the relationships, humans have with their environment and their active commitment towards this goal [7]. But it must not be forgotten that we are today more than ever living in a global world, and therefore that, as expressed by [14], the formation of global citizenship is essential if we wish to advance along the path of sustainability.

Education is key to achieving environmental awareness and sensitization [15], to achieving a profile of a citizen who is environmentally congruent with today's reality, who is not only aware of their rights but also of their environmental duties. For this, it is important to achieve sustainability of the curriculum, i.e., to accommodate relevant socio-ecological problems and to use academic knowledge at the service of these problems [16]. But in addition, it is important to apply environmental education programs that promote knowledge and skills to preserve the environment as indicated by [17], as may be the case of the program that is presented, Doñana, Biodiversidad y Cultura. Many programs like this have been carried out, raising awareness of the environment and mitigating environmental deterioration [18,19]. But in addition, some of them incorporate cutting-edge technology, using mobile devices and their applications, such as QR codes, both for environmental education purposes, as well as education for sustainable development [20].

2.2. Natural Heritage and Territorial Intelligence

In recent years, heritage seems to be gaining ever more importance within academic and institutional spheres. There have been numerous research studies dedicated to Heritage

Education and its connections with formal, non-formal, and informal areas [21,22], with a significant increase over the last decade [23]. Research in this area has been a motor driving the development of our country, generating thought, proposals, and advances to give it a role in accordance with the relevance of its assets [24]. Although there is still an important traditionalist weight in how it is treated, there is a movement towards proposals that posit a more open, flexible, interactive, and dynamic heritage communication [5]. There is also the conceptualization of holistic heritage given by [25] and adapted for other related research.

Regarding education and heritage divulgation, according to [26], and applied to the field that concerns us here, transmissive proposals in which information communication comes first must be put aside, and participatory and interactive proposals must be opted for. In these, heritage can be understood as an active part of society, fostering social values related to respect and cultural identity, as well as awakening emotions and allowing the public to develop as persons and as critical citizens [27].

In parallel with the above in the sense of heritage education, ref. [28] establishes that non-formal environmental education has made it possible to mobilize skills, attitudes, and feelings that give meaning to the behaviors that are adopted regarding the environment. This same author defends education in action, and states that [28] (p. 159) "There will never be enough emphasis on the importance of this relationship between what is learnt mentally and what is put into execution through the hands, body, conscious decisions, and participation". In this case, non-formal education meets a requirement that cannot be met by the classroom, although what really needs to be sought is the feedback or active symbiosis between the classroom and nature, relationships that are analyzed in the work of [21,29–32].

The term Territorial Intelligence is used to try to bring together the two objectives—heritage education from a landscape perspective, and environmental education from a sustainability perspective. In particular, because of its relationship with heritage, the term might be appropriate for the aspects that concern us here. It was proposed so as to give a scientific dimension to the "Catalyse" experience [33] which consists of a method and observational tools for the territorial actors who wish to elaborate, argue for, encourage, and assess sustainable development projects.

The concept of Territorial Intelligence defined in [33] revolves around the following three fundamentals: sustainable development as an alternative to development economics; the importance of territories for community action; and information and communication sciences and technologies as a vector of development and a tool for the construction of a collective intelligence.

In sum, this concept aspires to promoting reflection on the economic, social, environmental, and cultural challenges of globalization in the territorial sphere. It therefore cannot be understood as a discipline, but rather as a scientific approach to constructing pluridisciplinary knowledge through the dissemination of multiple knowledge [34].

2.3. Natural Heritage, Identity, and Emotions

Environmental, social, and cultural challenges can be associated with territorial identity and the emotions that underlie its knowledge. Ref. [35] couples the existence of two minds—one that thinks and the other that feels.

It is evident that the conflict between emotion and reason has kept the role of emotions on the sidelines. However, references to them date back more than two centuries according to some exhaustive reviews such as those [36] and [37], or Darwin's references to their influence on his theory of the evolution of the species. They are currently taking on another consideration due to the new contributions from neuroscience [38] and the origins of emotions in the brain (Damasio, 2005) which are offering neurobiological support to the relationship between emotions, actions, feelings, and reasoning. Today, emotions constitute a spearhead linked to teaching and learning. This is sustained because, from a broad perspective, together with various other authors [35,39,40], we can subscribe to the opinion

that behind an action there is always an emotion. We would focus this on the relationship of emotions with education, and specifically with symbolic identity in natural heritage.

The identity we refer to converges into a way of life that signifies part of culture. Thus, this study will consider the Doñana National Park as a symbolic-identity natural heritage. As expressed by [41], the natural and cultural heritage that coincides with a landscape or territorial heritage is an asset in itself which needs to be preserved and improved as a quality. With all certainty, the environment itself arouses emotions in humans as a consequence of their being or having been part of it. What really extends to other social groups or has a greater social breadth is the set of symbols that the environment contains and which are what really produce feelings aroused by the emotions. According to [42], individuals or groups are identified by referring to the properties that make them different from others in a particular frame of reference. But when it comes to the identity which refers to the territory, ref. [41] argues, quoting [43] who includes it as one of his seven types of knowledge necessary for future education (the teaching of terrestrial identity), that this means overcoming barriers through attitudes of solidarity and responsibility with the environment as if it were one's own homeland. In this case, one rediscovers the sense of belonging and of associated identity. However, it is difficult to find in the literature this sense of belonging linked to territorial or environmental feelings promoted by emotions and that entail attitudes of responsibility towards their conservation and improvement.

Ultimately, if emotions define actions, the latter will constitute the most important aspect in terms of education [44]. That is why authors such as [40] argue for early training in emotional education.

3. Materials and Methods

3.1. Characterization of and Approach to the Research Problem

The present research study was qualitative since it describes key incidents in descriptive and functionally relevant terms, contextualizing them in the social environment in which they occur [45]. Its approach is descriptive-interpretive, the aim being to document in maximal detail how the technical team in charge of disseminating knowledge of the natural heritage of the Doñana district in schools through an educational program that they themselves developed so as to form a bond between the pupils and the territory, i.e., to achieve environmental citizenship. In this way, we plan to determine:

- How does the Doñana, Biodiversity and Culture Program plan the education of environmental citizenship?
- More specifically, we propose to determine:
- What were the thoughts of the Doñana National Park technical team, based on the instrument developed by the EPITEC project, regarding the pupils achieving emotional and territorial intelligence and, ultimately, their environmentalization as citizens?
- What type of activities are proposed during the development of the Educational Program, and for what purposes?

3.2. Participants

The cases selected for study are incidental in nature and consist of three parts. On the one hand, there are two managers of public use of the Doñana National Park. They belong to the Environmental Education program for the educational community. Then, on the other, there is one of the guides responsible to the visits to Doñana with schoolchildren. The third pillar of the sample is a school that belongs to the Doñana district, selected after being considered by the technical team as a center with good practices.

Regarding the profile and professional experience of the public use managers, we would note that both had received training in environmental education, with one having a Master's Degree in Environmental Education. Likewise, it is important to note that both are immersed in the world of education, one being a primary education teacher. Regarding the educational background of the guide at the Doñana interpretation center, it should be noted

that he has a degree in Agricultural Technical Engineering as well as having completed numerous training courses taken while working as a guide over the last 30 years.

The school selected for the observation process required by the study was CEIP Marismas de Hinojos (Hinojos, Huelva). The sample was limited to a class of 6th year of Primary. It is important to highlight the geographical location of the school which is very close to the National Park, belonging to what is denoted the Doñana Environment District.

3.3. Description of the Doñana, Biodiversity and Culture Program

The Doñana, Biodiversity and Culture Program is immersed in the line of environmental education intervention within the Aldea Program's Espacios Naturales de Andalucia. It is targeted at pupils of their 6th year of Primary Education. It consists in carrying out a didactic itinerary through an emblematic site of the National Park. Specifically, it comprises two parts:

- Visit of the Park staff to the school, specifically to the 6th of Primary classes. Here, they present the Doñana Natural Area and the activity that will take place.
- Visit to the Doñana Natural Area with the pupils. For four hours, a tour is made of the area, during which, through the different activities (Table 1), the content of natural (fauna, flora, ecosystems) and cultural (history, lifestyles, traditions) heritage and the objectives of the project are worked on, i.e., to create a bond of identity with the territory so as to achieve the education of environmental citizenship.

Table 1. Development of the itinerary "El Rocío from La Vera" as part of the Doñana, Biodiversity and Culture Program.

Category I. Why Natural Heritage Is Taught		
Activity	**Objective**	**Development**
1. Presentation of the Territory	Locate today's reality of the Territory of Doñana	Before entering the Park, but in front of the marsh that belongs to it, the guide briefly introduces the pupils to what the territory is, the municipalities that form it, its uses, its fragmentation, and the consequences of all this.
2. The objective of the outing and the Manecorro route	Raise awareness about the privilege of belonging to that territory and generate an identity bonded with it	Once located at the gate that gives access to the Park, the guide explains to the pupils what the outing will consist of, and makes them aware that they are going to visit an area that is very restricted but that they are there because they themselves belong to the territory.
3. Description of animal tracks	Know and give value to the diversity of fauna that exist in the territory	The guide takes advantage of the tracks that are on the path to work on their interpretation.
4. Dealing with forest fires	Emphasize that people who are from the territory and who live in it, take care of it, thus generating an environmental awareness	Under a fire control tower, the guide works with the pupils about the problems caused by fires in the territory and how there are people dedicated to this issue.
5. Skeleton of a dead animal	Work on the traditional use of the territory by humans and the possibility of living off the territory in a sustainable way	Along the path taking advantage of a landmark that appears in the territory, such as the corpse of an animal. The guide asks different questions about the type of animal that it could be, about how it might have died . . . From there the uses that are currently made of the territory and by whom they are made, such as breeding mares, traditional fishing, charcoal, sustainable housing.
6. Observation and valuing the Territory	Generate the pupils' bond with the territory and create environmental awareness	Once, when they are at an emblematic point of the outing, the guide makes them observe certain outstanding points and aspects of nature that are difficult to observe in other places, and makes them aware of the importance of that place and of the importance and exclusivity of their belonging to that territory.
7. Marked trees	Giving value to the vegetation in the area and working on the traditional uses and the human/nature balance	This activity takes place in front of a cork oak that is marked with a number, and, due to the amazement of the children about this fact, the guide takes advantage of it to work on the vegetation of the territory, its emblematic species, and the use that humans have made of them throughout history.
8. Rest and breakfast	Rest and refreshment. Generating environmental awareness and a respectful use of the territory	While the pupils rest and recover strength, the teachers take the opportunity to refer to healthy eating and selective trash and garbage collection, which is also carried out.
9. Final activity	Recapitulation of what has been observed during the outing	The pupils, in small groups, are asked to make a RAP that collects together what they experienced during the outing. In the end, the best will be voted for and will become the anthem of the outing.

3.4. Instruments of Data Collection and Analysis

In order to collect the necessary information to fulfill the proposed objectives, we chose two types of instruments to use. On the one hand, we used the interview both with the Doñana National Park public use managers and with the guide in order to know how they approach and implement the program. The interviews were open. Very specific topics were addressed, such as information about the program carried out (work dynamics, design, participants . . .), how the pupils perceive Doñana and whether they recognize its importance, whether the schools do a follow-up after finishing the outing (to determine whether it is carried out with educational interest). Other issues arose spontaneously during the course of the two interviews. These were recorded on audio and later transcribed to be analyzed. On the other hand, we used an observation record to address the school pupils' description of the outing, and thus be able to characterize the activities they carried out. To this end, we accompanied these 6th of Primary Education pupils to the Doñana National Park. During the course of this outing, we limited ourselves to using non-participant direct observation, recording the data in a field diary. Likewise, videographic recorders were used to take photographs and videos.

To analyze the information collected during the research process, we used a category system (Table 2). This instrument was adapted from the one used in the EPITEC project (of our own research group), which initially presents five categories. On this occasion, we analyzed three, which are divided into various subcategories, indicators, and descriptors to facilitate the assignment and interpretation of the information units in the analysis process. The category system is generally organized as a development hypothesis, composed of various levels of complexity organized from the simplest to the most complex, except in the case of Subcategory 1 (Towards which approaches the proposal is oriented).

Table 2. Categories, subcategories, indicators, and descriptors used in the information analysis.

Category I. Why Is Natural Heritage Taught?		
Subcategories	**Indicators**	**Descriptors**
1. Towards what approaches is the proposal oriented?	Emotional intelligence	The individual's ability to become aware of their emotions, understand the feelings of others, and develop an empathic and social attitude.
	Civic education	Educate politically and morally active people, who are aware of their rights and obligations, committed to defending democracy and human rights, who are sensitive and solidary with the circumstances of others and with the environment in which they live.
	Environmental education	Educate people to be aware of the deterioration of the environment and the overexploitation of natural resources, committed to the defence and protection of nature and sustainable development.
	Territorial intelligence	Ability of people to combine economic, social, environmental, and cultural objectives within the framework of a sustainable development model in a given territory.
	Scientific and cultural literacy	Not only provide people with a scientific language, but also teach them to demystify and decode the beliefs concerning science and scientists, to ignore their apparent neutrality, to enter into epistemological questions and the terrible inequalities caused by the misuse of science and its socio-political constraints.
2. What is the purpose of the educational process?	Academic	Knowledge of facts and information of a cultural nature, illustrated and/or focused on anecdotal aspects.
	Propaganda	Valuation of heritage assets for political and/or economic interests.
	Practical-conservationist	Heritage values in daily life (economic, identity, etc.) and fostering their conservation.
	Sociocritical	Educating critical citizens committed to defending sustainable development in the field of heritage.
Category II. What Relationships Are Established Between Emotional Intelligence and Natural Heritage?		
3. What dimensions of learning are established?	Cognitive	Focused on content.
	Emotional	Focused on motivations and incentives.
	Social	Focused on interactions.

Table 2. *Cont.*

4. What skills are developed through emotional intelligence?	Intrapersonal intelligence	Emotional self-awareness, assertiveness, self-respect, self-actualization and independence, stress, and mood management.
	Interpersonal intelligence	Empathy, interpersonal relationship, and social responsibility.
	Adaptation to the environment	Problem solving, reality testing, and flexibility.
5. What are the constitutive elements of identity/heritage?	Affective-emotional	Social relationships (family, friends, associates) and patrimonial references associated with them (festive elements, gastronomy, daily life tools).
	Territorial	Natural, spatial, and architectural elements and landscapes associated with socio-historical events.
	Socio-political conventions	Conventional socio-political elements (flag, anthem, coats of arms) and all the patrimonial references typified in the legislation.
	Identity multiplicity	Integration of all the previous elements and giving value and respect to the diversity of identities.
Category III. What Relationships Are Established between Territorial Intelligence and Natural Heritage?		
6. What view of the landscape is worked on?	Musealized	Perception of the landscape as a fixed, immovable, and unalterable photo.
	Sustainable	Perception of human interactions with nature and the problems associated with this.
	Cultural	Valuing the identity and perceptions of the individual in relation to nature. Understanding nature as part of the culture of a society.
7. What view of citizenship is worked on?	Individual citizenship	Personally, responsible citizenship, with a sense of belonging to a community. Recognition of the symbolic and identity value of those heritage elements exclusively that are close-by and directly related to the individual through their personal experience.
	Social citizenship	Active member of organizations and/or initiatives to improve their community. Community identity. Recognition of the symbolic and identity value of heritage elements related to one's own culture.
	Global citizenship	Citizens of the world, who respect and value cultural diversity (intercultural citizenship). Commitment to building a juster society. Recognition of the symbolic and identity value of heritage elements external to one's own culture.
8. What view of the environment is worked on?	Protectionist-conservationist	No involvement in the procedures.
	Activist	Without foundation.
	Sustainable development	Rationale + involvement.
9. What connection with the environment is addressed?	Without connection	No connections between heritage and environment are established.
	Institutional	Connecting links are established with the surrounding heritage institutions.
	Territorial	Connections are established between heritage and the surrounding environment (neighbourhood, village, autonomous community, for example).
	Inter-territorial	Connections are established between heritage and other territorial areas (other autonomous communities and regions).

4. Results

4.1. Analysis of the Managers' Interviews

The results will be presented structured according to the categories that guided the research, highlighting the parallels and divergences, if any, between the thinking of the public-use managers (MAN) and of the park guide (GUI), supported by their occurrences in the activities carried out.

4.1.1. Category I. Why Is Natural Heritage Taught?

In this first category and, considering specifically Subcategory 1 which refers to the foci of the proposal, as indicated above, the indicators do not follow any order of progression, so that they will each be analyzed. The first indicator refers to creating in the pupils emotions of affect towards the territory, by taking them during the outing to a protected place and transmitting to them that they are in that special place because they themselves belong to that environment:

" . . . 6th Primary Education, which for us is key in the program as it is the last year before Secondary Education. We therefore want it to be the moment when they have a unique experience and feel super special (privileged) for being children from the district."

[MAN]

[MAN]

" . . . because they are the ones most involved in the matter, as they are specifically within the Doñana biosphere."

[GUI]

In addition, the proposal is aimed at achieving the pupils' Citizen and Environmental Education, i.e., environmental citizenship, educating persons who are critical with social issues and with the territory, knowing, valuing, and conserving the biodiversity that is present in it:

" . . . we treat them differently so that, in the future, they will help us conserve this."

[MAN]

"Of course, they really don't know what their role is, what their mission in Doñana is, and we have to point it out for them. The first thing we do is take a map and show them their location so that they start to become aware. Afterwards, all this is reinforced with activities, and, in the end, when they are entrepreneurs and adults, they will see Doñana in a different way."

[GUI]

Environmental Education in Doñana has been a milestone since its creation:

" . . . there is another small facet that we have, which is environmental education. It is very very important. We have been doing environmental education for 40 years. It is one of the first environmental education programs in the world . . . "

[GUI]

Working on the territory in this overall and holistic way, socially and environmentally, it is possible to improve the pupils' Territorial Intelligence and Eco-literacy:

" . . . we try not only to see the natural value but also elements of the uses and customs, as well as the history of Doñana."

[MAN]

" . . . we talk about traditional uses, charcoal, pine cones, we comment on the economic part, what is done with the pine nuts (piñones) . . . "

[GUI]

As is notable from the analysis of these information units, the program highlights all these ideas which coincide with the basis of the project as part of which it is being analyzed, and with the principles for the achievement of environmental citizenship.

With regard to Subcategory 2, the purpose of the educational process, we can see that there is a duality within the program. On the one hand, there is the intention to give value to the natural heritage and foster its conservation:

"Through this, for example, we contacted women's associations that value gastronomy, traditional festivals, etc. This was an important and costly task, although of great interest because the pupils get to know the territories, their traditions and history since the starting point is that Doñana is us who live in Doñana."

[MAN]

"We are going to show the value of Doñana and make it known to them. We start with them. Children are the most sensitive population."

[GUI]

On the other hand, the aim is to educate future critical and committed citizens who know and are able to value the environment in which they live so as to preserve it:

"It is they (referring to the children) who, in the future, will have to continue this task of conservation. In fact, Doñana does this. As I say to the children, we want you to know this because, to want to conserve it, first you have to know it."

[MAN]

" . . . for us, it is essential to work with the school population, to consider that the future of a village, a region, a community . . . lies with the children. Therefore, it is very important. . . . For the population to respect and preserve and know an environment, the children have to respect and know it. They have to enjoy it. This is fundamental."

[GUI]

In summary, with regard to Subcategory 2, the program aims to give value to the territory and to achieve critical citizens who know how to take care of it, thus generating environmental citizenship.

4.1.2. Category II. What Relationships Are Established between Emotional Intelligence and Natural Heritage?

To analyze the relationships that arise between emotional intelligence and heritage, three subcategories are established. The first refers to the dimensions of the learning that are established, and, due to what is observed, this can be considered a social vision, i.e., a vision where the cognitive is mixed with the emotional, and their interactions:

(speaking about activities that were carried out in the surrounding villages) " . . . these are very beautiful experiences and every time we pass by we remember the image each village has of Doñana . . . "

[MAN]

" . . . we try the same with the kids, for them to see themselves as part of Doñana and extrapolate this to their village, to say, hey, this is Doñana but that there are areas like these in your village too . . . "

[GUI]

The second subcategory refers to the skills developed through emotional intelligence, both intra- and inter-personally. At the intrapersonal level, an attempt is made to develop a link with the territory by empowering the pupils to belong to it:

" . . . they are children who are closely linked to the territory . . . they are children who know the world of birds, capable of recognizing feathers, fed up with hearing the geese above their house . . . "

[MAN]

" . . . it is very important for us to work with the school population, to consider that the future of a village, a region, a community . . . lies in the children . . . "

[GUI]

Likewise, at the interpersonal level, they work on empathy with the people who use and work and live in the territory as part of it, and their need for it to be conserved so that it survives and can be used by future societies, thus generating an environmental awareness:

" . . . it was interesting to know that Doñana is not only the National or Natural Park, but that Doñana is us who live in Doñana and it is what unites us . . . "

[MAN]

" . . . because they are our children, and if we do not educate them, when they are older, when they are the Mayors, when they are influential people in their villages, they will not look to take care of Doñana . . . we are going to give value to Doñana and we are going to let them know about it . . . "

[GUI]

The last subcategory has to do with the constitutive elements of identity and heritage. This is developed from putting an emphasis on the area's heritage elements—natural, ethnographic, and cultural—and showing the pupils that these elements belong to that territory and are not found outside it, thus becoming symbols that identity the inhabitants of the area and, therefore, they themselves. For them, the Virgen del Rocío belongs to them. Therefore, one way to create identity with the territory is to emphasize that it is necessary to take care of that territory so that nothing happens to the Virgin. Another important identity marker is the Iberian lynx. It is like their banner:

" . . . the particularity of these children is that they live so close to Doñana . . . that they do not consider it anything extraordinary or special . . . they are special because they live where the Virgin lives."

[MAN]

"The outsider and the insider, everyone wants to see the lynx . . . fortunately, almost all the children belonging to the environment of Doñana have seen it."

[GUI]

4.1.3. Category III. What Relationships Are Established between Territorial Intelligence and Natural Heritage?

To address the relationships that are established between territorial intelligence and heritage, we start with four subcategories that refer to the treatment of the landscape, citizenship, environment, and connection with the territory. If we first analyze these four subcategories in an overall way, we can observe that the tendency is to work with the territory not only naturally, but also by joining the natural landscape and humans together as a result of the identity culture of that territory. It is therefore developed from the perspective of Territorial Intelligence.

If we stop to consider the perspective towards the landscape, this is centered between sustainability and culture, i.e., it identifies the human interactions with nature and the problems that they entail, but it also takes into account a view of nature as part of the culture of a society. Thus, an attempt is made to create environmental awareness where, through knowledge of traditional uses, the pupils learn that it is permitted to live off the environment, but that it should be done in a sustainable way:

" . . . in 6th, we have an itinerary called "Doñana, El Rocío from La Vera" where we take the children along a route that is not open to the public, a route that we designed and in which we try not only to see the natural value but also elements of the uses and customs, as well as the history of Doñana."

[MAN]

(referring to the Manecorro activity) "The objective is to spend three or four hours with them, integrating them in nature, integrating them in the country, making them be just one more, and that the country is not an enemy."

[GUI]

The concept of citizenship is not worked on from the reference level, i.e., from a global citizenship level, but rather as a concept of social citizenship, recognizing the symbolic and identity value of heritage elements related to their own culture, because that is precisely the objective set in the program being analyzed:

" . . . a program belonging only to the district of Doñana (heritage elements close-by and directly related to the individual). Since the 1980s, there has been a group called Doñana Environment. This group of educational participations is formed by representatives of 14 municipalities in the Doñana district with their municipal representatives . . . We created a network among the 14 municipalities and ourselves to bring environmental education to the municipalities."

[MAN]

"For the population to respect and preserve and know an environment, the children have to respect it and know it, they have to enjoy it, this is fundamental."

[GUI]

However, in some cases, they allude to the need to extrapolate what the pupils have learnt in this territory to other external ones.

"We focus on Doñana because we are in Doñana. What we are trying to do is give them some guidelines . . . This is Doñana but it can be extrapolated to other towns and villages, their pine forests, their lagoons . . . "

[GUI]

With regard to Subcategory 8 or the vision of the environment being worked on, we can state that there is a double view. On the one hand, they present a protection-ist/conservationist interest in the sense of achieving the durability of the natural space, but without forgetting their view from a sustainable development perspective:

"Yes, they are also the ones who in the future are going to have to continue this task of conservation . . . as I tell the children, we want you to know this in order for you to want to conserve it . . . "

[MAN]

"Therefore, your interest is that this area continues to be as it is? Of course, to preserve it . . . "

[GUI]

"At present it is not like before. Before, Doñana was a kind of enemy, you couldn't build buildings, plant strawberries, . . . Thus it was an enemy. Currently everything is Doñana, Doñana feeds many people, now it really is a friend."

[GUI]

Finally, the connection made with the environment is a territorial connection that links the natural heritage, its uses and customs, emphasizing the need for sustainable use. In this sense, they continue to express the need to create environmental awareness so as to generate future environmental citizenship:

"Yes, we talk about traditional uses, charcoal, pine cones, we talk about the economic part, what is done with the pine nuts (piñones). We comment that this is a very good pine nut, and that the Doñana pine nut is today eaten in Saudi Arabia. We also ask them how they are currently heated at home, and what would happen if the power goes out, we explain that before there was a thing called charcoal."

[GUI]

4.2. Analysis of Activities

If we stop now to consider the analysis of the activities carried out during the outing (Table 1), broadly speaking, these are based on achieving three main objectives aimed at forming future environmental citizenship: showing the value of the territory of Doñana through its fauna and flora, highlighting that since time immemorial it has been a territory used by humans in a sustainable way, and creating a bond between the pupils and the territory by way of generating an identity between them.

Thus, the intention with Activities 3 and 7 is to value the territory or, which is the same, to show the value of the territory through its fauna and flora, as well as to value the human/nature balance by working on the sustainability of the traditional uses of the territory.

In Activity 4, with a fire tower as a landmark, this issue is worked on with the pupils. Advantage is taken of the intervention of a child who mentions that his father works in this sector so as to stress the value the people of Doñana give to the territory. In this way, environmental awareness is being created in the pupils as well as the respectful use of the territory, in sum, educating for potential environmental citizenship.

Activity 5 also has the aim of working on the traditional uses of the territory, and promotes the possibility of living in the territory in a sustainable way.

During Activities 2 and 6, the idea is reinforced of the privilege they have of enjoying the territory, together with the reason that they are there because they are people from that territory. This generates bonds of emotional identity and environmental awareness.

By way of triangulation, when we contrast the objectives that are intended to be reached through carrying out the activities with the categories used to analyze how the program is set out through the thinking of the informants, we see that there is a great confluence. Thus, the first category, which alluded to why is Natural Heritage taught, has as its response, that it is to achieve the pupils' Citizenship and Environmental Education through showing the value of Doñana, of its natural elements, and of its traditional uses, worked on in Activities 3 and 7. Ultimately, how the program is set out and the activities are both committed to achieving environmental citizenship.

With regard to the category that deals with the relationship between Territorial Intelligence and Natural Heritage, knowledge of the territory is addressed not only from a natural perspective but also from one of sustainable use of the territory by those who live in it. This demonstrates that the environment can be used, but in a sustainable way, thus generating environmental awareness in the pupils. Activities 4 and 5 serve to emphasize this fact.

Lastly, the category that relates Emotional Intelligence and Natural Heritage seeks, through emotions, to generate a bond of identity with the territory. It is worked on in Activities 2 and 6. This bond, which should not be exclusive, emotionally fosters the pupils relationship with their environment, influencing their environmental awareness so as for them to want to preserve it, and therefore fostering the generation of future environmental citizenship.

In light of what has been analyzed, and taking together what has been observed, we believe that there is a close relationship between the approach of the program based on the informants thinking that we analyzed and their implementation of the activities. The sole intention was to attain the main objective of the Doñana, Biodiversity and Culture Program. As was detailed above, this is to create an identity bond between Doñana and the pupils belonging to its environment. The idea is that they acquire a responsibility to perpetuating this territory in time and to its conservation by generating environmental citizenship for the present as children who inhabit the territory, and for the future as responsible citizens committed to the sustainable use of the territory.

5. Discussion

As can be seen in the analysis of the results, the proposal aims to achieve citizenship and environmental education of the students, that is, to form an environmental citizenship. The achievement of this objective supposes, as indicated by [6], a change in attitude that will entail a change in the behavior of citizens, with the intention of training critical citizens, with pro-environmental thoughts and with active participation in the path towards sustainability, that is, eco-literate citizens [46].

This need to train environmental citizens is generalized anywhere on the planet, as shown by authors such as [47], but even more so, in those territories of high ecological value such as the one at hand, the Doñana National Park, where the citizen has to live in balance with the system so that it can last over time.

Like [48], we think that creating social identity towards the environment and creating an environmental citizenship can be beneficial to instill prosocial behaviors, to become environmentally sensitive and responsible, generating a Territorial Intelligence in citizenship [49]. Therefore, the study participants are asked to visit an emblematic and protected place of the National Park, making them participate in a restricted territory and which they have accessed as citizens of the immediate environment, with the interest of generating positive emotions towards the himself and unique signs of identity. These signs of identity also favor their intrapersonal level and, the interpersonal, is developed through knowledge

of the relationship that people who live in Doñana have and who make sustainable use of the territory. This, in addition, is linked to developing in them an environmental awareness, which as described by [50], allows them to develop feelings and respect, beyond the environment and in some way should allow a broader sustainable development with social and political implications, economic and cultural.

In short, generating practices of this type, which go beyond the pure preservation of the territory and which include the education of citizens from an environmental and sustainable point of view, can be a good way to ensure that future generations can enjoy the Planet that they find.

6. Conclusions

In view of the data and of the analysis carried out, it can be established that there is a close relationship between the thinking of those in charge of education in the protected area of Doñana and the proposed educational practices. Both are linked to educating and fostering the development of positive emotions towards the territory that determine a love for it, and to generating an identity bond, thus forging an environmental citizenship for the future. This issue coincides with the needs recently stated in the Congress held in Almonte (Huelva) dedicated to Doñana marking its 50th anniversary as a National Park. One of the conclusions most widely agreed upon was that " . . . it is important to redouble the efforts of the environmental education, relationships, and communication of Doñana with the surrounding populations".

However, and in order to not allow the creation of this identity bond in the population to deviate towards an exclusion of those who do not belong to the territory, it is necessary to constantly insist on and encourage tolerance, respect, and appreciation of diversity based on the knowledge of other territories. In this sense, there should be work on searching for links between territories. This is clearly expressed by [32] when referring to the responsibility of caring for humanity's nearby natural heritage because heritage is always global, also considering this to be a fundamental part of citizenship.

The program proposes education that is carried out from the sustainable use of the territory—its traditional uses and its enjoyment. The activities lend support to these issues at all times, taking advantage of the landmarks that appear in the landscape during the outing—hence, the need to foster creativity and to start speaking about education in sustainability rather than environmental education, as was also argued in the aforecited forum.

Sustainability Education focuses on students' abilities to embrace and develop a 'democratic action-competence', whereas Environmental Education is more product-oriented and oriented towards learning specific facts and attitudes [51]; however, some authors argue that, by integrating sustainability issues in a critical sense, Sustainability Education would better be replaced with Environmental and Sustainability Education [52].

What is certain is that there are authors like [53], who think that this approach may lead to forgetting the traditional approach to Environmental Education proposed in the Belgrade Charter, the part of ecological preservation. Jickling and Wals [54] argue that environmental education is being significantly altered by globalizing forces, witnessing the effort to convert environmental education into education for sustainable development. The ideal would be to achieve a balance between the two, since one, Education for Sustainable Development arises from the other, Environmental Education, by wanting to take into account aspects closer to human development. A balance between the two would entail reaching a preservation of nature without losing sight of human development in balance with it. Its basis should be the creation of a more holistic perspective on problems, which requires a deeper insight between the study of the environment and development problems [55]. In this study and, as a conclusion to the analysis of the Doñana, Biodiversity and Culture Program, this holistic treatment of the environment and the use that man makes of it is revealed, with the intention of achieving a balance in development.

With regard to the pupils' achieving emotional and territorial intelligence, both inter- and intra-personal levels were worked on. This fosters the relationship between the

cognitive and the emotional in different interactions of landscape, citizenship, environment, and territory, always with the same objective of identifying the value of the territory and the pupils' proximity to an exceptional asset.

Finally, working with the territory from the perspective of Heritage Education, analyzing the natural, ethnic, and cultural heritage, in short, holistically, must achieve the knowledge and awareness of the value of a territory, creating identity and forming critical citizens who know to value what they have close by them, without any rivalry with other territories. In sum, it is a matter of the formation of critical citizens committed to their environment who are going to champion its preservation, with a well-developed environmental awareness and with the power to promote an increasingly committed environmental citizenship.

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Hypothesis

A Value-Based Framework Connecting Environmental Citizenship and Change Agents for Sustainability—Implications for Education for Environmental Citizenship

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Abstract: Civic agency is acknowledged as a key driver/catalyst for social transformation toward sustainability. Recent environmental citizenship education (EEC) models advocate a transformative approach for addressing environmental unsustainability (addressing underlying structural causes) and the identification of the development of change agents, as both the means for deep social transformation toward sustainability and the outcome of EEC. Given the paucity of studies looking into the psychological attributes of sustainability change agents, this work aims to deepen the theoretical understanding of the motivations that drive individuals to act as change agents and the type and extent of the change that they aspire to effect, with a view to developing competent environmental citizens. To this end, this conceptual work applies Schwartz's theory of universal values to construct a three-level framework of environmental citizenship (EC) (individual-level, community-level, and socially-transformative-level). Each level reflects an increasing level of change agency that is driven by distinct motivational values and competences. The framework shares affinities with qualitative change agency typologies in the literature but claims that these different qualitative types reflect expanding 'levels-of-concern' and an increasing extent of change, as expressed in the EC framework. The paper then discusses curricular implications for the design of meaningful EEC deriving from the framework: Effective EEC entails developing change agency by adapting learning to the EC-level of the learners and the educational organization. The proposed EC/change agency framework provides a scaffold for such curricular adaptation.

Keywords: Schwartz theory of universal values; motivational values; pro-environmental behavior; environmental citizenship; change agents for sustainability; transformative learning; adaptive curriculum; environmental citizenship education

1. Introduction

Among the central challenges confronting education today is how to prepare individuals and societies to deal with the increasing environmental-social problems associated with an industrialized, technological, urbanized, and increasingly multicultural world [1,2], which is termed a VUCA (volatile, uncertain, complex, and ambiguous) world [3]. The COVID19 pandemic demonstrates the turbulence, complexities, and unpredictability confronting citizens worldwide, necessitating responsible and ethical decision-making as an integral part of everyone's daily lives. These immense environmental–social challenges facing humanity in the 21st century are influencing the fundamental nature of citizenship and essentially reforming how citizenship is understood, and environmental issues are increasingly being framed in terms of citizenship [4]. Environmental citizenship (EC) is acknowledged as a key to addressing environmental issues and promoting individuals and

societies empowered to embrace sustainable ways of living and environmentally–socially sustainable economies, technologies, and businesses [4–7]. A recent conceptualization of EC, put forth by the European Network for Environmental Citizenship (ENEC), identifies an environmental citizen as "[. . .] able to identify the underlying structural causes of environmental degradation and environmental problems and as someone who has the willingness and the competences for critical and active engagement and civic participation to address those structural causes [. . .]" [8]. Such current conceptualizations of EC identify the role of citizens not only in individuals' actions, but also in the capacity to look at the bigger picture—to question the systemic socio-political and socio-economic circumstances that have created the environmental problems and take an active role in co-creating sustainable policy [6,9,10]. Some scholars claim that focusing solely on individual action is non-transformative, whereas it is necessary to address the broad structural oppressions related to global capitalism that are the root causes of the environmental problems [5,10,11]. Such positions acknowledge the power of individuals as a political force for positive change at the societal level.

The contemporary understanding of environmental and sustainability education (ESE) emphasizes building the capacities for critical thinking—enabling individuals to raise critical questions regarding what is going on in society and autonomously act on these [12]. Similarly, education for environmental citizenship (EEC) [8,13] aims to develop the individual's capacity, as part of one's identity as a citizen, to contribute to broader societal transformation towards sustainability. This presents an immense challenge for education. Given the complex challenges of transforming societies and changing mindsets toward enhancing pro-environmental behavior (PEB), EEC goes well beyond knowledge transmission (cognitive domain) or promoting sustainable behaviors; it emphasizes developing and cultivating the mindsets (affective domain) and capacities of individuals so that they actively engage in civic participation and have the ability to identify and address the underlying structural causes of environmental problems and function as catalysts of social change. This deeper transformative approach is reflected in the central positioning of 'agents of change' in the recent EEC model [13], which is in line with policy documents that specify civic agency a key to achieving sustainable societies [1,14].

The broad discourse on change agency identifies a range of types and roles of change agents [15,16], connects change agency to motivational values and sources of meaning [17], and specifies the different skills and competences and the different levels or scales in which change may occur in educational contexts [13,18–20]. Given the well-established connection between behavioral change and values [21–26], EEC necessitates reexamining basic assumptions and values [5] by applying transformative learning processes [27–29]. Thus, the capacity to question dominant values as part of one's EC [11] should be central to the development of change agents as both an outcome of, and a means for, EEC [18].

The aim of this paper is to elaborate and expand on the meaning of change agents in the context of EC and, through this, to provide theoretical and practical insights into the roles and implications of change agency for EEC. This will be achieved by presenting and articulating EC as a continuum expressing progressive levels, each reflecting a different degree of change agency for sustainability that is driven by distinct motivational values. The theoretical framework identifies the development of environmental citizens as a development in their capacity to act as social change agents. We begin by providing the theoretical nexus among EC, change agents, and motivational values as the theoretical foundation of the proposed framework. We then present the framework that identifies EC as a continuum, following the studies reported in [9,30], with three progressive levels of EC, which reflect advancing levels of change agency, from the *individual* to the *transformative* (*social*). The framework applies Schwartz's theory of motivational values to articulate the different levels. The discussion reflects on the framework from theoretical and practical perspectives. From a theoretical perspective, we look at how the framework corresponds with other typologies of sustainability change agents. The practical aspect elaborates on the implication of the framework for educational processes through the notion of an 'adaptive

curriculum' that provides the flexibility to adapt and align EEC interventions to different EC-levels, including that of students, educators, and educational institutions.

2. Theoretical Foundations

2.1. Environmental Citizenship

The current environmental crisis is above all a crisis of values [5,31]. Addressing this crisis requires dramatic change in human relationships with the environment, and this involves changing mindsets. A key development in sustainability discourse is the advent of the notions of 'sustainability citizenship' (SC) and 'environmental citizenship' (EC) [6,9,32–35]. Developed within citizenship theory, both SC and EC entail that social and environmental responsibility should be a way of thinking practiced in our lives and daily routines, i.e., a specific mode of citizenship. Such a view of citizenship expects individuals and institutions to behave in ways that maintain the integrity of nature and improve social justice, even if this is not accompanied by a direct personal payoff or reward [6,35]. SC and EC present contemporary modes of citizenship motivated by ecological concerns, which are believed by their proponents to better fit current global challenges [6,9,35]. The citizenship theoretician, Dobson, defines EC as: "Pro-sustainable behavior, in public and in private, driven by a belief in fairness in the distribution of environmental goods, in participation, and in the co-creation of sustainability policy" [6] (p. 6). As such, the notion of EC injects into socio-environmental discourse a robust civic-political perspective that implicates not only how social institutions and organizations address, or should address, sustainability issues, but also, on a deeper level, the ways in which individuals lead their daily lives and engage in promoting sustainability. From this perspective, EC is not merely a social-environmental theory but a profound moral-political orientation of enacting environmentally sustainable behavior in the private, organizational, and public spheres [36] by defining the relationship between individuals and the 'common good'. SC and EC extend citizenship responsibilities to an expanded notion of equity and caretaking and give more weight to universal principles of democracy, human rights, and global commons [9,35,37]. Additionally, they identify the role of individuals as active participants in "co-creating sustainable policy" [6] (p. 6) by focusing on the underlying structural causes of environmental problems, which lie in the economic, social, and political structures that have led to current cultural norms [9]. Thus, some scholars claim that this new version of citizenship has the potential to challenge and change the underlying structural root causes that led to environmental and social justice problems in the first place [9].

EC's commitment to social transformation substantiates that change agency is inherent to EC. For Dobson, EC's key value is "justice between humans" [6] (p. 6). Several key characteristics of EC, according to Dobson's framework, theoretically tie this to change agency: (1) *Other-regarding motivation*—commitment to environmental sustainability as a common good that cannot be achieved through individual self-interest alone, but which requires individual effort for public benefit; (2) *Role of ethics*—in decision-making relevant to PEB, ethical and moral considerations are as important as techno-scientific knowledge; (3) *Responsibilities*—good citizenship entails not only rights, but also environmental responsibilities deriving from other peoples' environmental rights. These responsibilities are intergenerational and international. (4) *Arena for enacting citizenship*—conventionally, citizenship action is associated with the public sphere (e.g., voting or protesting). EC adds the understanding that since practices in the private sphere impact the public sphere, responsible citizenship needs to be practiced in our private sphere as well. (5) *Critique of market-based solutions*—EC works toward achieving behavioral change by changing mindsets, which may prove more sustainable than the common non-normative managerial policy of fiscal incentives, which is a reductive (self-interest) view of human motivation. These characteristics correspond with the recent conceptualization of EC (ENEC, 2018) [8].

Like other constructs relating to human attributes, such as environmental literacy [30,38], EC is not a binary characteristic, but rather a continuum of increasing levels of cognitive, affective, and behavioral capacities applied to an expanding range of human–environment

interactions [30] and 'levels-of-concern' [17]. We argue that change agency is also a developmental construct, which is seen as a progression from *individual* to *socially transformative* change agents.

Clarification is required regarding the terminology. The distinction between EC and SC is blurred. In the context of achieving sustainability, some citizenship scholars use the term EC (e.g., in [4,6,8,32–34]). Some theoreticians use the term SC [9,35]. Barry [9] specifically distinguishes between EC and SC, arguing that EC reflects a narrower, more minimalist approach that runs the risk of "neglecting the economic, political, and cultural dimensions of sustainability" (p. 21), whereas SC reflects a deeper, more ambitious approach that is not satisfied with changing one's lifestyle, but rather looks to "the underlying structural (political, economic, and social) causes [. . .], such as human rights abuses or social injustice" (ibid p. 24). Barry views EC and SC as the poles of a continuum. The notion of EC, as conceptualized by the ENEC, by addressing the underlying structural causes (see above), reflects Barry's notion of SC. Thus, in this paper, the term EC reflects the deeper, more comprehensive understanding of citizenship presented by Barry as SC.

2.2. Change Agents for Sustainability in the Context of EEC

EC highlights citizens' active participation in effecting deep structural change toward promoting environmental–social sustainability. EC thus envisages the engaged citizen as a social change agent [11,13]. EEC acknowledges this by claiming that education should enable young citizens to identify the underlying structural causes of environmental problems and engage (individually and collectively) in addressing them through enacting critical EC-actions [13]. Bringing about change in the values, beliefs, and attitudes of citizens through EEC goes beyond the unproblematic transmission or promotion of certain sustainable behaviors and views them in terms of personal and cultural identity, including the mindset to challenge the epistemological origins of knowledge and question dominant values [11]. Therefore, EC entails a transformative learning process [39]. Linking civic participation and student activism is central to EEC's approach, as indicated in the strategic positioning of change agents in the ENEC pedagogical model [13] (p. 240).

In the ESE literature, the notion of change agents refers primarily to the engagement of students in the educational process, their active participation in real-world projects (e.g., placed-based pedagogies), and their ability to develop the necessary knowledge and skills to spark change and exercise political power in their household and community [19,40–43]. The development of competent and committed teachers as sustainability change agents has also been accentuated in European policy papers and research into education for global citizenship and sustainable development [1,18,19].

Despite the acknowledgment of the need to develop change agents, there are gaps in the EEC and ESE literature concerning the specific attributes of such individuals, the motivations driving them, the objects of their concern, and the type of change they aspire to achieve. In the organizational literature, it is possible to find models and typologies characterizing different types of change agency as a complex landscape of characteristics regarding how these leaders navigate change processes. A leading example is Caldwell [15], who distinguishes between *leadership, management, consultancy*, and *team* models of change agency. The four models provide a multifaceted articulation of the different roles and actions of change agents in organizations. Van Poeck et al. [16] address change agents in the context of promoting sustainability and the implication for learning within the organization. They distinguish among types of change agents in relation to how they relate to two areas of tension in learning: Instrumental vs. open-ended approaches to change and learning and personal involvement vs. detachment from values associated with the issue being addressed. On this basis, they identify ideal typologies: *Technician*, *mediator*, *convincer*, and *concerned explorer*. They demonstrate how change agents may move among types according to specific situations.

Change agency for sustainability in the context of corporate organizations has also been linked to motivational values or 'sources of meaning' [17], particularly self-transcendence

(acting beyond self-interest). This is particularly pertinent to the present context, given the deep connection between motivational values and the propensity to promote deep structural change toward sustainability [5]. An important contribution of Visser and Cranes' work is the recognition that sustainability change agents are not homogenous in terms of their value-motivations or sources of meaning. They distinguish among four types of change agents: *Experts*, who find satisfaction from 'doing' and achievement; their level of concern is the individual, and their source of meaning is impact on the sustainability of a project or personal development; *facilitators*, who focus on relationships rooted in empowering people; their level of concern is the group, and their source of meaning is self-transcendent, enabling people to change their views and thus resonating Mezirow's [39] changing frames of reference; *catalysts*, who focus on creative values and dedication to a cause; they have the "big picture" perspective, their level of concern is the organizational level, and their source of meaning is influencing top management to achieve strategic change; and *activists*, whose source of meaning is also self-transcendent, but in contrast to the facilitator, they focus on broader socio-environmental issues, improving societal conditions and community wellbeing; their level of concern is society at large.

In educational discourse, there is a growing body of research on the skills and competences that sustainability change agents need to possess, particularly in the context of higher education [20,44,45] and teacher education [19]. Relevant skills and competences include system-thinking, interpersonal skills, environmental knowledge and management, conflict resolution, anticipation skills, and social responsibility. There is also an emerging consensus that real-world learning methods are likely to contribute to the interdisciplinary and transformational competencies that sustainability change agents need [19]. For example, problem-and project-based learning have been found to be effective in developing the competences and skills for change agents [46]. Service learning or community-based learning [47] have been effective in promoting deep and reflective learning. Lozano et al. [20] further note that change toward sustainability can span from minor to radical evolutionary changes, which can be applied also in various forms, from non-intervention to radical intervention. Thus, sustainability change processes can be seen as a range or continuum reflecting differing levels of competence and engagement and a different extent of change [20].

The notion that teachers act as change agents is not new [48]. More recent literature [18,19] identifies different levels at which teacher change agency can transpire: The student or classroom (engaging learners in critical reflection, moving beyond knowledge transmission to expose students to different perspectives and designing meaningful learning environments), the school level (reflecting a wider vision by promoting a whole-school approach that incorporates sustainability across disciplines, involving diverse school community stakeholders and networking), and the social level (teachers engage in more controversial, political SD issues and are social activists). The ENEC EEC pedagogical model [13] also identifies three scales of change toward sustainability: Local (school), national, and global, indicating that change agency can be directed to increasing levels of influence. This recent pedagogical model also identifies two dimensions in which actions promoting change can be conducted—individual or collective—as well as two spheres for enacting EC—the private sphere and the public sphere. Thus, this model enables the characterization of EC actions according to three axes: Their dimension (individual/collective), their sphere (private/public), and their scale (local/national/global). According to this model, recycling, for example, is identified as an individual action conducted in the private sphere and at the local level. Writing a letter to a minister is considered an individual action conducted in the public sphere and at the national scale. Organizing an environmental campaign or protesting is a collective action conducted in the public sphere at the national scale. The call of the young environmental activist, Gretta Thunberg, for global leaders to take action against climate change is identified as a collective action for change, conducted in the public sphere at the global scale.

In light of the inherent links between EC and change agency, we argue that EC can be framed as a continuum of progressing levels of change agency that reflect (1) differences in motivational values [17], (2) expanding 'levels-of-concern' [17–19], from the individual (e.g., students), through the group (e.g., school, in-group, local community), to the societal (e.g., broader community or society), as well as (3) an increasing extent of change that is promoted in different contexts and levels-of-concern, from change in individual behavior via actions conducted within the private spheres (e.g., consumption choices), through civic participation in the local environment or community (including participation in decision-making and engagement in the consequent actions), to more socially transformative participation (e.g., environmental activism and involvement in pro-environmental social movements aimed at bringing about structural change). Building on transformative educational leadership discourse, especially that articulated by Shields [3], it is possible to claim that transformative change agency constitutes high-level (societal level) EC.

In order to articulate transformative change agency, we apply Shields transformative leadership theory [3,49], which may be regarded specifically as 'change agent leadership' [50]. Shields [49] conceptually differentiates between transformational and transformative leadership. Whereas transformational leadership is more about changing behavior and the organizational culture, which operates more effectively and promotes greater achievement, transformative leadership is essentially centered on promoting democratic values, countering social injustices, and supporting the ongoing restructuring of power-relations within organizations and in the wider social context. This distinction between behavioral change that works toward a greater effectiveness within the existing structure (i.e., transformational) and more profound change processes aimed at transforming existing structures (i.e., transformative) echoes the distinction between 'shallow' and 'deep ecology' approaches to addressing environmental challenges [5,51,52]. Deep ecology, in contrast to shallow ecology, is not satisfied with treating or preventing environmental problems and neglecting inequalities between over- and under-developed countries; it is rather normative and looks at the deeper issues that raise profound questions regarding the paradigm on which current Western societies are based. Thus, values are critical to deep ecology [5,52]. Furthermore, it aligns with the distinction put forth by McDonough and Braungart [53] between 'Eco-efficiency' and 'Eco-effectiveness' in their 'Cradle-to-cradle' approach. 'Eco-efficiency', as an industrial strategy, does not reach deep enough with respect to changing industrial production toward sustainability; it works within the same system that causes the problem, making it less environmentally destructive. Conversely, 'Eco-effectiveness' is based on a deeper approach that considers the larger picture—the cultural, commercial, and ecological system in which production is embedded—and addresses the deep changes necessary from a systemic perspective.

Moreover, the focus of a transformative approach is not "business as usual" [3] (p. 11). Thus, it better suits a VUCA world. Transformative leadership or change agency consists of the willingness to take personal and professional risks in the name of social justice, particularly as stakes increase and resistance mounts [54]. Kose and Shields [55] have argued that transformative leadership (i.e., change agency) is the leadership type best suited to addressing and promoting sustainability concerns, because: "It [. . .] holds the potential to break through the disciplinary boundaries and lead to what Burns called revolution—'a complete and pervasive transformation of an entire social system'" (p. 278). Kose and Shields specified four basic characteristics that link transformative leadership to sustainability: (1) Effecting deep and equitable change that focuses on emancipation, democracy, equity, and justice; (2) deconstructing and reconstructing knowledge frameworks that perpetuate inequity and injustice, including the inequitable distribution of power; (3) emphasizing both the private and public (individual and collective) good and the need to acknowledge the interdependence of all people and the inter-connectedness with the natural world; (4) balancing critique with promise and exhibiting moral courage. These echo the desirable attributes of what we identify in the proposed framework (see below) as high *social-level* EC or *transformative change agents* (TCA).

2.3. Connecting EC to the Schwartz Theory of Motivational Values

The deep connection between behavioral change and values is well documented in the literature [21,22,24,25,56] and specifically the fact that environmental problems are rooted in human values [5,57]. Schwartz's theory of universal values [25,58] has been widely used to connect PEB to values (e.g., in [23,56,57]) and key leadership constructs to values [59]. The connection of change agency to motivational values, which is central to EC and EEC and is therefore the focus of the proposed framework, has received less attention [17]. Since Schwartz's theory serves to ground our EC framework and its connection to change agency for sustainability, we shall first briefly introduce Schwartz's theory and then note how it has been used in the context of research connecting PEB to motivational values.

Schwartz [25,58] specified ten distinct types of motivational values and placed them on a circular continuum (Figure 1). The organization of these values on a circular continuum implies that the whole set of ten values relates to any other variable (behavior, attitude, age, etc.) in an integrated manner [58]: The closer the ten values are situated on the circular continuum (in either direction), the more similar their underlying motivation. According to the Schwartz model, these ten (later 19) [60] values can be grouped into four higher-order values, forming two dimensions: Openness-to-change (OC) versus conservation (CONS), which reflects the individual's conflict between valuing independence and inclination toward change, as opposed to resistance to change; and self-enhancement (SE) versus self-transcendence (ST), which reflects the individual's conflict between valuing self-pursuit, power, and achievement, as opposed to valuing the concern for and welfare of others. Schwartz's revised 19-value model has been shown to correspond to the original ten-value model (including the two higher-order value dimensions), with additional reference to environmental aspects [60,61].
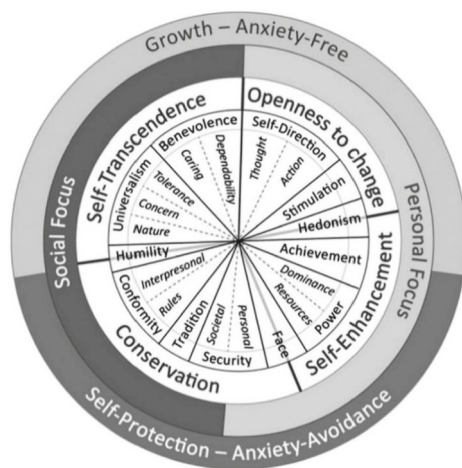
Figure 1. The revised Schwartz 19 value model of universal values (Source: Schwartz et al., 2012), [60].

Previous studies have noted the positive relation between ST and PEB and the negative relation between SE and PEB [57,62]. Apart from a few exceptions [23,57], the connection between PEB and the CONS-OC dimension of Schwartz's model, it has received less attention in the literature. Basing their claims on both theoretical and empirical evidence, some scholars who employ the Schwartz model in the context of PEB claim that it clearly distinguishes between altruistic and biospheric values [62,63], both of which compose the ST higher-order value. In other words, the altruistic and biospheric elements of ST should be treated separately, rather than under a unified ST orientation. Those holding altruistic value orientations are more likely to choose PEB for the benefit of other people, while those holding biospheric value orientations will exercise PEB if it stands to benefit the

ecosystem or the environment. Additionally, biospheric values were found to have the most positive effect on PEB [57,62]. Despite this empirical evidence suggesting the importance of distinguishing altruistic and biospheric value-orientations, in our proposed framework, we do not distinguish between them, based on the following consideration. According to EC-discourse, social issues, problems, and injustices are interconnected with environmental-biospheric issues, problems, and injustices [55]. This may be one reason for the fact that, when analyzed as single value predictors, "biospheric and universalism values behave comparably in their effect on behavior" [62] (p. 243). A basic understanding of PEB (and, more specifically, EC) is the inherent interdependencies between social and environmental issues. While there are differences between anthropocentric and ecocentric values and attitudes in relation to PEB, both orientations are present in a comprehensive understanding of EC. We argue that, from the perspective of change agency for sustainability, the clear distinction between altruistic and biospheric value-orientations does not do complete justice to the notions of EC behavioral-change, and we shall thus refer to the higher-order value of ST to account for behavioral change that targets both social and environmental injustices.

3. A Multi-Level Framework Connecting EC and Change Agency

Building on Roth's three-level conception of environmental literacy, we propose a framework that conceives EC as a continuum of developing motivations for promoting sustainability. The framework applies Schwartz's bi-dimensional organization of motivational values (Figure 2) as a theoretical scaffold to distinguish three levels of EC and articulate corresponding levels of change agency. Each of the three levels is presented in relation to Schwartz's higher-order values: Self-enhancement–self-transcendence (SE-ST) and conservation–openness-to-change (CONS-OC). The combination of the higher-order values of ST and OC is necessary to adequately account for EC and change agency: ST reflects the motivation to act beyond self-interest for the common good [37,49], and OC reflects the motivation to engage in change-oriented actions. Thus, both EC and change agents can be measured against the degree to which citizens are motivated to change, specifically directed to the common good, at times at the expense of their short-term self-interest.
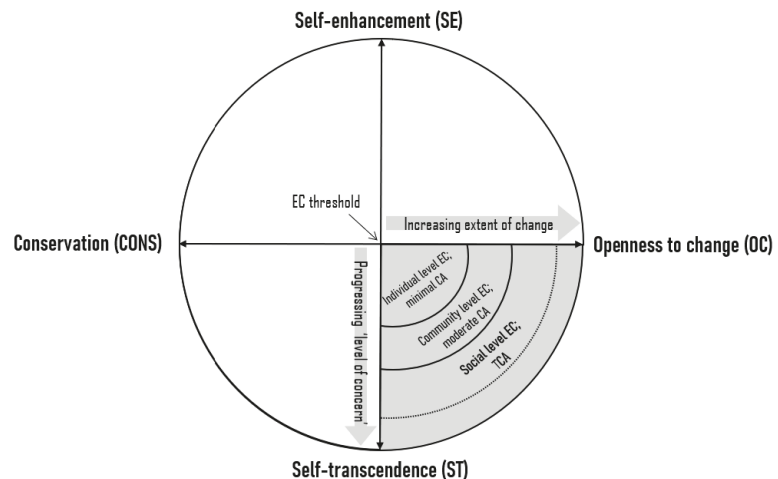
Figure 2. Three-level EC framework applying Schwartz's theory of universal values (EC—environmental citizenship, CA—change agents, TCA—Transformative change agents).

Individual level EC—Regarding the SE-ST dimension, individuals are experiencing some extent of personal change in their frames-of-reference [27,39], leading them to an awareness that their personal lifestyle impacts others' well-being and welfare. Even at this basic EC-level, individuals comprehend that decisions made in one's personal life

have implications for the 'common good'. Nonetheless, the extent to which individuals are willing to act for others' benefit (i.e., are motivated by self-transcendent motivations) is limited to actions that also have personal benefits or do not entail taxing personal tradeoffs. Accordingly, while individuals at this EC-level may exhibit a stronger commitment to OC (self-directed behavior, stimulation, and risk-taking), this commitment is restricted to change that concerns or impacts the individual self. When change is for the benefit of others at the expense of their own personal benefit, they demonstrate more moderate commitments to OC. At this first level, change agency is limited in terms of the levels of concern and extent of change.

Community-level EC—Regarding the SE–ST dimension, individuals are characterized by an increased relative importance of self-transcendence values in relation to self-enhancement values. At this level, the focus broadens beyond the individual self to encompass one's 'in-group', social community, or affiliations. This wider perspective is expressed by a greater propensity toward enhancing and protecting the welfare of those belonging to one's in-group. A person will be willing to make greater behavioral tradeoffs when these favor the 'good' of one's immediate social group, even at the expense of one's own self-interest. Regarding the CONS-OC dimension, the motivation to adopt a change-oriented mindset (e.g., willingness to engage in more demanding behavioral change, risk-taking, and openness to challenges) is enhanced and directed not only to oneself, but also to changing individuals belonging to one's in-group. We claim that the combination of these attributes (in both dimensions) at this level reflects moderate change agency. In educational contexts, for example, a student at this level is motivated to affect the EC dispositions and behaviors of his/her peers (fellow classmates) or family-members. It is emphasized that, in the context of the proposed framework, movement along the CONS-OC continuum must be associated with the SE-ST continuum. Only change-oriented thinking and behavior that is accompanied by a greater tendency toward self-transcendence values constitutes the type of openness-to-change applicable to change agency for sustainability. For example, effecting change within one's workplace (e.g., a more efficient use of the organization's resources) is in line with the meaning of moderate change agency only when such change-processes are associated with ST-values, such as diminishing gender and salary inequalities and promoting equal accessibility to a healthy work environment. A similar example is reducing the school's ecological footprint by providing food services based on locally grown food (reducing the carbon footprint and supporting the local economy) only when these food options are economically accessible to all students and do not exclude students from low-income families.

While a lot of studies use the higher-order value of ST in relation to PEB, some researchers emphasize the necessity to distinguish between the two values that comprise ST: 'Benevolence' (altruism is narrower and directed toward protecting and enhancing the well-being of one's in-groups) and 'universalism' (altruism is broader and directed to the well-being of all people and nature), since each may affect PEB differently [57,62,64]. Our proposed framework aligns with this empirical evidence regarding the behavioral distinctions between these ST-values. At the *community-level EC (moderate-level change agency)*, 'benevolence' outweighs 'universalism'.

Social-level EC—At this level, regarding the SE-ST dimension, self-transcendence values outweigh self-enhancement values: The individual is characterized by an increasingly universal or cosmopolitan perspective [37], according to which the level of concern is society-at-large [17] and expands beyond an intra-generational perspective to include an intergenerational perspective (future generations). For example, establishing a student 'green-council' as a statutory body of the school's organization that will impact future students at the school. The person will be willing to make more taxing tradeoffs at the expense of one's own benefits in terms of the time and efforts that are directed towards promoting the welfare of society-at-large and the environment. Regarding the CONS-OC dimension, the change is deep in the mindset of the individual. At this level, the individual change-agent is not satisfied with only effecting change in others, but also aspires to change

the 'rules-of-the-game', namely, the existing norms that determine socioeconomic infrastructures and political decision-making processes. These actions may include engaging in public policy issues, legislation, and other societal 'leverage points' or social structures affecting people's thinking, social norms, and behaviors [22]. Following the previous examples, a student at this level will be motivated to engage in activism targeting change in the school's policy and organization regarding the adoption of sustainability principles. By seeking profound change, this perspective reflects the 'deep ecology' perspective [5,51,52]. According to the proposed framework, the *social-level EC* reflects *transformative change agency* (TCA), since individuals' motivation and behavior reflect a type of change agent that extensively applies socially transformative attributes, namely, a combination of a high commitment to democratic citizenship values (self-transcendence pole) and a propensity toward deep change (openness-to-change pole), specifically moral courage to confront structural root causes (e.g., top-down school management practices regarding food options that are determined by pre-existing political and economic interests).

Figure 2 visualizes the integration of the three EC-levels with Schwartz's circular bi-dimensional model. The starting point for visualizing the *individual-level* EC is the mid-point on the SE-ST dimension. We postulate the mid-point as the threshold, because commitment-levels to ST below this point 'tip the scale' too far toward self-interest at the expense of the common-good. The mid-point represents a mindset that is still predominantly focused on oneself. A position beyond this mid-point towards the ST-pole reflects an increasing commitment to the welfare of others at the expense of one's immediate self-interest. Similarly, concerning the CONS-OC continuum, we propose placing the threshold for the *individual-level* EC also at the mid-point, since commitment at this level represents a change-oriented mindset that is focused primarily on change concerning individuals' actions. A position below this mid-point represents an excessive commitment to the conservation of existing norms and practices that, in the context of EC, are unsustainable both environmentally and socially. Movement beyond this mid-point reflects an increasing commitment to the type or depth of change. The SE-ST dimension reflects developing change agency mainly in relation to the 'levels-of-concern' (from oneself, through the social group, to the broader society), and the CONS-OC dimension reflects developing change agency mainly in relation to the extent and depth of change (from individual behavior, through engaging in local decision-making, to impacting social norms, policies, and legislation).

Several clarifications or boundary conditions should be made regarding this framework:

(1) The CONS-OC dimension must be linked with the SE-ST dimension: Only change-oriented thinking and behavior that is accompanied by a greater tendency toward self-transcendence values constitutes the type of openness-to-change applicable to change agency for sustainability. For example, at the *community-level EC*, effecting change, such as reducing the ecological footprint of one's organization, necessarily means that one is working on behalf of the *welfare of others* belonging to this organization, rather than for the instrumental benefits of the organization itself or of selected groups within it. Similarly, concerning the *social-level EC*, profound change that is intolerant to the welfare and rights of the broader society or the environment, but promotes the benefit only of certain groups or individuals, cannot be considered as *transformative change agency*. Only when deep societal-institutional change processes are linked to a greater commitment to the values of 'benevolence' and 'universalism' (social justice) are they applicable to the meaning of TCA.

(2) The distinction between 'benevolence' and 'universalism' [25] concerning the different effects these values have on PEB has found empirical support in previous studies [62,64]. Accordingly, in the proposed framework, at the *community-level EC*, the relative importance of 'benevolence' is greater than that of 'universalism', while at the *social-level EC*, the relative value of 'universalism' is greater. Nevertheless, the overall commitment to the higher-order value of ST will be greater at level three, relative to level two.

(3) Each EC-level represents, within itself, a range of motivations, commitments, and change-agency actions. For example, there are various degrees of *social-level EC* that reflect differences in the relative importance of moral concern in relation to self-interest (e.g., economic) concerns. Based on various psychological treatments of moral motivation [65], as well as Shields [3] and Redekop's [66] realistic understanding of what ethical leadership entails, it can be expected that even those acting out of *social-level* ST motivations might be motivated by (albeit weak) commitments to self-interest. In other words, there may be differences in the kinds of actions undertaken and the degree-of-risk that TCAs would be willing to take. The coexistence of self-interest and moral inclination occurs in moral exemplars [65], for which moral action (concern for others) and self-interest (identity development) are reconciled in a model of personal development, since both motivations (care for oneself and care for others) constitute an ego-identity that is freed from inner-conflict. While Schwartz's model positions self-interest values (power and achievement) as conflicting or interfering with other-regarding values, it is certainly plausible that TCAs will also be motivated by self-interest motivations. Having said that, the general orientation of the present framework is that in cases of inner conflict, TCAs are motivated more by self-transcendent interests than by self-interest.

(4) The model assumes, in keeping with the literature, that promoting sustainable development goes together with promoting social justice, i.e., that increasing commitment to change toward more significant PEB is positively related to increasing concern for social well-being. Despite this, in view of the complexity and sophistication of human psychology and behavior, we are aware that there are circumstances that the framework does not account for, reflected in the different placement of the individual on each of the two dimensions: Individuals who are highly motivated by ST values and yet, in practice, exhibit relatively lower levels of OC reflecting *individual-level* change agency. Such cases may occur when external factors (e.g., available infrastructure or economic limitations) or internal factors (e.g., the self-confidence or self-efficacy level) inhibit the individual's motivation to engage in significant behavioral change. For example, individuals expressing a high OC (strong motivation to bring about significant behavioral change accompanied by greater tradeoffs, but who are directed to lower levels of concern (oneself or in-group). Such situations do not refute the model but demonstrate the wide range of possible placements of people along the two dimensions in reality. The framework provides a means to locate such individuals and determine the aspects in which EEC efforts can be directed.

4. Discussion

The discussion examines the proposed framework from theoretical and practical perspectives. From a theoretical perspective, we will discuss how the framework, which looks at EC and change agency as developmental continuums, relates to the literature on change agents [15–17] and motivational values [23,57,62]. From the practical perspective, we will address curricular insights for EEC derived from the framework.

4.1. Tying the Framework to Change Agency Discourse

The framework presented above aligns with other approaches to EC and closely related concepts, such as 'environmental literacy' [30] and 'sustainability citizenship' [9], perceiving EC as a continuum of developing cognitive, affective, and behavioral capacities. According to Roth, environmental literacy represents a continuum of abilities and involves levels of proficiency, i.e., stages of accomplishment along the continuum that reflect increases in knowledge, clarification, and a strengthening of dispositions and refinement of competencies, which together will be expressed in more sophisticated and effective behavior applied to a wider and increasingly more challenging range of human–environment interactions [67,68]. This is also reflected in Barry's [9] distinction between EC and SC: The movement from EC to SC reflects a developmental progression toward deeper and

wider consideration beyond strictly 'environmental' concerns, to include a broader under-standing of the social and economic aspects of EC as well as the social structural causes of environmental unsustainability. As earlier indicated, the meaning of EC in the proposed framework corresponds to how Barry conceives SC.

Empirical support for a three-level EC framework is found in a study that investigated the motives of Higher Education students to elect sustainability-oriented programs [69]. This study found that gaining 'procedural knowledge' (i.e., critical thinking capacities necessary for evaluating alternative courses of action and socio-political skills necessary for citizen participation) was one of their major motives in electing these programs. More pertinent to our proposed framework, this motive was expressed in reference to three expanding 'objects-of-influence': The self, the social group, and the community-at-large. Aspiring toward change in one's own personal lifestyle parallels the *individual-level* EC, influencing the school-community parallels the *community-level* EC, and at the broadest level, developing as environmental activists who influence the community-at-large parallels the *social-level* EC. Thus, the three EC-levels proposed in our framework finds empirical support in the identification of the three 'objects-of-influence' in the study of sustainability-oriented students.

The proposed framework connects EC-levels to change agency. Visser and Crane [17] indicate a gap in the literature on change agents for sustainability concerning a lack of at-tention to the psychological drivers, specifically the *motivational values*, that characterize the mindset and actions of change agents at different 'levels of concern'. The proposed frame-work addresses this gap by applying Schwartz's theory as a theoretical basis for under-standing EC and, particularly, change agency. Whereas most studies applying Schwartz's theory to PEB focus on the ST-SE dimension [56,57,62], connecting EC and change agency with the CONS-OC dimension is less self-evident and has received less attention in the literature on values and environmental behaviors [62]. The present framework also in-corporates the CONS-OC dimension as a theoretical basis to account for change agency attributes. Briefly, the more one is motivated by self-direction, risk-taking, and stimulation (value-attributes of openness-to-change), the more one will be willing to engage in more significant and taxing behavioral change. While some research has found a positive associ-ation between [Schwartz's] conservation values, such as 'conformity', with PEB [62], the proposed framework assumes a negative relation between conservation and PEB values, as these are inconsistent with EC attributes. This does not imply that the value of 'conformity' (to environmentally-responsible norms and regulations) is necessarily inconsistent with PEB; rather, what is implied is that 'conformity' is inconsistent with change agency for sustainability, since EC is inherently critical of the current environmental–social reality, continuously striving to change for the better the entire spectrum of social practices, norms and, at its highest level (TCA), the rules-of-the-game, irrespective of the current sustain-ability baseline. Katz-Gerro et al. [62] claim that future work must explore this connection, since findings regarding the association between 'conformity' and environmental action are inconsistent, which is possibly due to cultural differences. In line with this, we assert that with respect to both traditional and modern societies, the tension between OC and CONS takes on a different form in each type of society. Traditional societies, on the one hand, can contribute 'traditional ecological knowledge' [70] for promoting sustainable management in various areas, thus supporting the motivation toward CONS. On the other hand, the same traditional societies often exhibit, from a liberal-democratic perspective, unjust social norms and practices, such as autocratic authority, gender discrimination, and internal economic gaps [71], which would support the motivation for OC toward enhancing social justice. Concerning modern hyper-consumerist societies, while they may be more open to change on the social justice agenda (particularly regarding cultural minority and gender rights), it is self-evident that the very logic of consumer lifestyles involves the conservation of unsustainable norms and practices. The latter necessitates the changing of values away from CONS toward a greater openness to behavioral tradeoffs (economic or effort) at a personal and societal level, which is necessary for achieving environmental–social sustain-

ability [72]. Two arguments address this complexity concerning the CONS-OC dimension. First, since environmental and social aspects are inseparably interlinked in the concept of sustainability, the conservation of traditional lifestyles that are offensive toward social justice are incompatible with the notion of sustainability. Second, based on the contribution of cultural diversity in promoting a resilient sustainable society [2,5], the acknowledgment of the worthiness of traditional knowledge presupposes *openness* to the value of 'diversity' in the context of a human society. Such a perspective, we argue, reflects a high commitment to openness-to-change.

The framework aligns with current conceptualizations of EC [13] and change agency [17,18] that distinguish between scales or levels of change agency action. Bourn [18], for example, distinguishes between the role of teachers as change agents in the classroom, the school, and the wider society. Visser and Crane [17] identify different 'levels-of-concern': Individual, group or team, organization, and society. The three EC-levels, and their respective change agent levels, identified in the proposed framework share affinities to Visser and Crane's qualitative typology of change agency: The *individual-level* EC/change agency resembles the 'Expert' type change agent described by Visser and Crane in its limited focus on individual development, indicating a less taxing change-oriented other-regarding behavior. The *community-level* EC/change agency of our framework resembles both 'Facilitators' and 'Catalysts' in that it extends the focus to wider social circles (in-groups, the organization, or the community): The focus on relationships, empowerment, and promoting change in others' views ('Facilitators'), as well as the focus on the bigger (organizational) picture ('Catalysts'), resembles the extended level of concern that characterizes *community-level* EC/change agents. The *social-level* EC/*Transformative Change agent level* of our framework resembles the 'Activist' type [17] in that it adopts a critical outlook that addresses social causes of unsustainability and focuses on social injustice issues and promoting wellbeing at the broader societal level. Connecting the proposed framework to the recent EEC pedagogical model [13], the individual-level EC/change agency of the framework proposed herein can be aligned with the individual dimension and private sphere of the EEC pedagogical model, the community EC/change agency level is more aligned with the collective dimension and the private sphere, while the social EC/change agency level corresponds to both the collective dimension and public sphere. Thus, the proposed EC framework offers a comprehensive view that is theoretically grounded on both dimensions of Schwartz's theory of motivational values, distinguishing among qualitatively different change agency types that correspond to the change agency literature but arguing that these qualitatively different types also reflect increasing levels of change agency, which are reflected in expanding levels-of-concern (i.e., individual, community, and society), and an increasing extent of change that is promoted. This contribution also applies to the EEC pedagogical model: we claim that the different combinations of dimensions and spheres of the EEC model can be organized as progressing levels of change agency motivations and commitment. This framework also provides a basis for developing tools for measuring the influence of EEC on individuals' change agency level.

4.2. Curricular Implications of the Framework

Several curricular insights derive from the proposed framework. The framework's contribution lies in two major claims: (1) Developing and cultivating EC is deeply connected to developing change agency through educational processes based on transformative learning, specifically cultivating a critical consciousness and critical cognitive and action skills. (2) Since individuals are positioned differently on the EC continuum, it is necessary to adapt EEC to the learner's EC level. Such an adaptation essentially transforms the curriculum into a dynamic curriculum that changes according to the needs and context. These claims are elaborated in the following:

(1) Developing change agency attributes: Leadership and critical consciousness—The proposed framework highlights the centrality of *leadership personality* aspects that include developing an internal locus-of-action, entrepreneurial character, the ability

to assume responsibility, and, therefore, risks. A curriculum committed to EC is envisioned to work in all its aspects to develop change agents characterized by an *internal locus-of-control* [73], who take responsibility for their actions (including learning), are motivated to bring about change for the benefit of society and the environment, and have the competences necessary to promote collaborative and participatory initiatives. A curriculum that strives to develop value-oriented change agents places at the core of its pedagogical work the development of skills for autonomous thinking and action, creating partnerships, initiating change, and exercising the moral courage to take risks, which are often associated with profound change. Accordingly, the proposed framework implies an EEC curriculum that corresponds with constructivist transformative learning theories, which emphasize the meaningful construction of knowledge via practical learning experiences, namely, engagement in experiences and activities, which is a pedagogical praxis connecting initiated action and reflection [74,75]. Such a curriculum reflects a deep-change pedagogy that develops the learners extended responsibility through the learning process and encourages community involvement based on authentic participation [76–78], which have greater potential for cultivating active EC.

Additionally, the proposed framework underscores the importance of cultivating a *critical socially ethical personality*—a state of mind that is mindful of and alert to one's environment and of situations of social injustice and harm to the social-physical environment. EEC implies a curriculum that develops in the learners, starting from young childhood, an awareness of environmental challenges, of issues of social injustice and importantly, and of the connection between these [2,40,55,79]. The *critical* approach is central in both social justice discourse and EC discourse [9,13,37]. Developing a critical consciousness is dependent on several elements of the learning process: exposing learners to case studies and examples that reveal injustice and exclusion, cultivating a political awareness and critically reflective thinking that ties everyday actions to mistreatment and injustice. Accordingly, the proposed framework implies an EEC curriculum based on a place-based pedagogy, as this makes the local sociocultural, political, economic, and environmental phenomena part of the students' learning experience. Taking this further, an EEC curriculum based on the 'critical pedagogy of place' [40,80], by combining place-based and critical pedagogy approaches, emphasizes looking at how economic and political decisions impact the places where the learners' live and supports developing transformative (*social-level*) change agency attributes. Tying into this, Mezirow [27] aspires to promote critical thinking via two cognitive means: critically reflective thinking and reflective judgement. Nurturing these two qualities, which makes learning transformative, should be central to the curriculum from an early age. From a transformative perspective, enabling behavioral change is tied to change in the individual's awareness of his/her values, and transforming motivational values is the outcome of developing this form of reflective awareness. The framework proposed herein views these pedagogical means (i.e., the 'critical pedagogy of place' and transformative learning) as the foundations for developing change agents. Education that moves from a critical approach directed mainly towards oneself (e.g., exploring one's own ecological footprint) to the motivation and ability to recruit and lead others to such an awareness (e.g., convincing one's family to explore and change its ecological footprint or convincing the school to investigate the school's ecological footprint).

(2) Adapting EEC to the individual's EC level—The movement to adapt learning to the needs, learning abilities, and the world of the individual is not novel; adapting learning has been deliberated in the context of the personalization of public services, including education [81], in the context of adapting education to the individual's autonomy [82] and, more recently, in the context of adapting learning to the 21st century. These and additional aspects are increasingly evident in current educational policy papers, which insist on making curricula more "adaptable and dynamic" so as to reflect the evolving societal requirements and individual learning needs [83] (p. 18). The premise of our framework is that individuals differ in their EC-level,

and EEC cannot therefore be based on a "one size fits all" curriculum [29,78]. Just as learning needs to be adapted to the students' needs and skills, so EEC should be adapted to the diversity in the students' motivational values and EC-competences. An adaptive EEC curriculum enables us to distinguish among students not only by their different levels of academic skills (relatively easily assessed), but also different levels of motivation to act as change agents for sustainability. The given EC-level will influence various aspects of the learning process and student–teacher relations, such as the degree of students' autonomy in the learning process, the environmental–social issues selected as the focus of learning, and the nature of the educational activities in which the students are engaged. The proposed framework, in its multi-level structure, contributes scaffolding to such an adaptive curriculum.

The implications of the framework for curricular design can also be considered from the perspective of educational organization. The extent of adaptability is influenced in part by the location of the organization or school culture on the EC continuum. The higher the organization's EC-level, the higher its ability to adapt the curriculum and organizational processes to the learners' needs, motivational values, knowledge, and competences. This is because there is a connection between the position of the curriculum on the EC continuum and the extent to which it realizes democratic tenets: at the higher (*transformative*) level of the EC continuum, the school is more committed to principles of democracy and values of social justice. This is reflected in its implementing participatory decision-making processes, its less hierarchical internal power structure, and its affording students more autonomy and the ability to actively engage in their surrounding environment. These democratic characteristics allow the educational organization to become more flexible and dynamic in terms of the pedagogical–curricular processes taking place [84].

Viewing EC as a developmental continuum offers EEC flexibility and modularity (i.e., adaptability) and opens up opportunities for adapting the learning to the student's and school's placement along this continuum. While the proposed framework sets the goal of developing the organization, school staff, and students toward the *social-level* EC and *transformative change agency*, the increased flexibility and adaptability of the educational organization at this level implies that it is better equipped to tailor the curriculum and learning processes to the motivational level of the learners, in addition to those exhibiting characteristics of the *individual-level* EC and below.

5. Conclusions

Developing change agency is identified as one of the aspirations of ESE [1]. In line with this, the ENEC EEC model positions change agents as catalysts for promoting sustainability [8,13]. Therefore, it is crucial to take an in-depth look at the essence of change agency and inject it with content and meaning relating to the motivations that drive individuals to act as change agents and the type and extent of change they aspire to achieve. This was the focus of the EC framework proposed herein. Furthermore, we consider the practical implications for implementing meaningful EEC.

The proposed framework also has various conceptual and methodological implications. Conceptually, it advances the understanding of change agency and EC by relating them to Schwartz's theory of universal values, thus providing an additional grounding of the concept of change agents in socio-psychological theory. Specifically, understanding change agency and EC through the two dimensions of Schwartz's model better clarifies the kinds of motivations and practical action tendencies defining change agents. By conceptually linking EC and change agents, the framework provides an analytical foundation for the role of change agents in the EEC pedagogical model [13].

From a methodological perspective, there is a paucity of empirical study of both EC and change agency. The development of validated instruments for measuring these constructs is in its infancy. The new EC questionnaire [85] provides a novel contribution. The proposed connection to Schwartz's model (and instruments) offers fruitful methodological grounds for future empirical investigations, particularly for gaining a better understanding

of the relation between EC and change agency. Additionally, the three-level EC framework offers a methodological tool for investigating the different levels of change agency in different social and organizational contexts.

Aside from the boundary limitations of the framework pointed out above (see clarifications following the depiction of the framework), future work on this EC/change agency framework would be to validate it through empirical research. An initial step would be to explore the correlation between the four higher order motivational values of Schwartz [58,60,61] that provide the scaffold of the proposed EC/change agency framework and environmental values tools, such as the well-established 2-MEV [86]. A following step would be to empirically investigate if individuals' motivational values can be profiled along a three-level scale (individual, community, and social) by employing validated tools for assessing environmental actions. We are currently engaging in empirical study addressing these steps, the findings of which will be the focus of a forthcoming paper.

Two central curricular implications for EEC derive from the proposed framework, as elaborated in the discussion (see Section 4.2 "*Curricular implications of the proposed framework*"): (a) Developing leadership and a socially critical consciousness are essential for fostering change agents, and (b) effective EEC entails adapting the learning to the EC-level of the learners and the educational organization. The proposed multi-level change agency framework contributes a scaffold for this purpose.

To conclude, the framework provides a platform for future work and research on EEC in three channels: (1) Designing effective EEC curricula, given the challenges associated with incorporating EEC in many current school frameworks; (2) developing tools for assessing the change agency levels of schools, programs, and learners, as a component of adapting EEC to different educational contexts and thus supporting more effective EEC; and (3) providing a conceptual foundation for planning teacher training and professional development.

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Article

Design of a Pedagogical Model of Education for Environmental Citizenship in Primary Education

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Abstract: Education for Environmental Citizenship plays an important role in social change toward sustainable development, achieving economic, social, and environmental balance through informed, cooperative, and participative citizens. There are several pedagogical models with the potential to involve students in environmental activities, but no specific model suitable for primary education is found. This article describes the preliminary investigation phase of a Design-Based Research that resulted in the development of the first prototype of a Pedagogical Model of Education for Environmental Citizenship in Primary Education (students aged 6 to 10 years), in Portugal. This preliminary investigation phase was based on a systematic analysis and literature review on the topic (thesis, articles, projects, and curricular guidelines for primary education), seeking to answer the following research questions: (1) According to the current world characteristics, which learning outcomes should an environmental citizen achieve, and which of them can be promoted in primary education? (2) What are the most appropriate teaching methodologies and strategies for promoting environmental citizen learning outcomes in primary education? The methodology used is presented, and the proposed prototype is described, along with the desired learning outcomes that are considered necessary for the formation of an Environmental Citizen and the most appropriate methodologies and educational activities to promote them.

Keywords: education for environmental citizenship; primary school; design-based research; pedagogical model

1. Introduction

Environmental Citizenship is one of the most important factors to achieve both the Sustainable Development Goals for 2030 and the objectives of the EU's economic growth strategy for 2050. Education for Environmental Citizenship enhances the development of active environmental citizens, and given its importance, it must be promoted from the beginning of schooling, according to the principles of Environmental Education set out in the Tbilisi Declaration.

Recently, Hadjichambis and Reis [1] defined Education for Environmental Citizenship as the type of education that cultivates a coherent and adequate set of knowledge as well as the necessary skills, values, and attitudes that an environmental citizen must have in order to act and participate in society as an agent of change, in the public and private sphere, on a local, national, and global scale, through individual and collective actions, solving environmental problems, preventing the creation of new environmental problems, achieving sustainability, and developing a healthy relationship with nature.

Education for Environmental Citizenship is considered a type of continuous education that should start at an early age to create healthy environmental habits in everyday life toward global sustainable development [2–7]. It promotes the practice of citizen's environmental rights and duties and helps in the identification of the structural causes underlying environmental degradation, enhancing the development of skills for critical,

active involvement and civic participation, considering inter- and intra-generational justice [8]. Primary education is the appropriate period for laying the foundation of children's future willingness to actively participate in responsible behaviour at both individual and collective levels, and children at earlier ages are more willing to participate and show better outcomes after educational interventions aimed at developing key values and skills for Environmental Citizenship [7,8].

The integration of Education for Environmental Citizenship in the existing disciplines makes learning more meaningful, as it enables the acquisition of a better understanding of the contents covered from various areas of knowledge [9], promoting interdisciplinary cooperation and student motivation [9–11].

The main objectives of Education for Environmental Citizenship are: to promote student involvement with nature and the environment [1,12]; to promote the acquisition of responsible behaviors and attitudes of defense, environment preservation, and improvement in students daily lives; to promote students' scientific and environmental literacy; to promote active and informed participation in environmental issues by students at the individual and collective level; and to enhance sustainable development [1,12–14].

Since emotional, sensory, and intellectual components are always interconnected, it is necessary to raise the development perception and awareness of students to promote their involvement in a certain situation, event, or learning process [15,16]. In this specific case where one of the objectives is to involve students in issues related to the environment, it is essential to develop feelings such as respect, love, esteem, and empathy for nature and for all beings that cohabit in it (animals, plants), knowing the natural processes of evolution and maintenance, its resources (water, air, soils) and its characteristics, and understanding that they are all interconnected and that the Planet Earth is a community where everyone belongs [17–19]. With this involvement, students will be able to develop moral values, establish an emotional connection, and feel an environmental "moral obligation" that will lead them to adopt responsible and beneficial behaviors and attitudes in their daily lives [17,19–21], contributing in some way to the defense, preservation, and improvement of nature and the environment.

With the acquisition of responsible behaviors and attitudes, the involvement and active participation of students in environmental issues in their socio-cultural environment is thus enhanced [1,16].

Promoting knowledge and skills development in environmental sciences leads to a better understanding of environmental issues, thus enhancing guided, conscious, and informed participation by students. Participation in decision-making, from a social, economic, and environmental point of view, is one of the duties of individuals as citizens. When promoting students' active and informed participation, there is a call to action to solve and/or avoid environmental problems through informed decisions [8]. An informed student has a better understanding of socio-environmental and socio-cultural problems in his community, thus developing his critical thinking and decision-making [1,2,10,16,22–24]. For some authors [21,25], a high degree of environmental literacy along with environmental awareness promotes a vast scientific vocabulary that induces effective and assertive communication when engaging in civic participation in socio-environmental issues.

Achieving sustainable development is the major global objective regarding the economy, society, and the environment. An environmental citizen will be the one who, having an environmental conscience and knowledge, will tend to not only change his behaviors and attitudes to preserve the environment, but also participate actively in private or public initiatives contributing to achieving sustainable development [1,10,16,21].

There are already several pedagogical models used to promote education for environmental citizenship; however, these models are general and without direct application in primary education. This investigation aims to achieve a pedagogical model suitable for primary education, and thus, in this article, the first prototype designed will be described, based on a systematic review of the literature found.

2. Methodology

This study follows a Design-Based Research methodology, with a preliminary investigation phase and three iterations that allow the design, development, evaluation, and review of the prototype of the pedagogical model for primary education whenever necessary and in a real context.

The preliminary investigation phase described in this article is based on a literature review of the areas and aspects to be investigated regarding Environmental Citizenship (step 1) and in the development of a prototype (step 2).

In Step 1, and based on the documental analysis of thesis, articles, and projects related to education, citizenship, environment, educational methodologies in primary education, curricular guidelines proposed by the Ministry of Education in environmental studies, and community projects developed in primary education, the following research questions were answered:

(1) According to the current world characteristics, which learning outcomes should an environmental citizen achieve, and which of them can be promoted in primary education?
(2) What are the most appropriate teaching methodologies and strategies for promoting environmental citizen learning outcomes in primary education?

In Step 2, a prototype was developed based on the information obtained in Step 1.

The research was carried out initially using the Library Database of the Education Institute of the University of Lisbon, which contains the University of Lisbon Integrated Library System (SIBUL), the General Repository of the University of Lisbon, and the Scientific Repository of Open Access of Portugal (RCAAP), to research theses and other digital documents produced by Portuguese Universities and the EBSCO and B-ON portals to access full texts of international and national scientific journals. These portals ensure a thorough literature review. In addition, research was done using Google Scholar, the website of the Ministry of Education, and websites of Environmental Non-Governmental Organizations (ONGA). No criteria were defined in relation to the date of the documents searched; the only condition established was the presence of (at least) one of the following words in the title or in the body of the text: environmental citizenship; environmental citizen; education for environmental citizenship; primary education; educational pedagogies; education; environment; citizenship; sustainable development; education for sustainable development. All the documents identified in the databases were analyzed in a detailed way for relevant information connected to our study and according to the criteria presented in Tables 1 and 2. During this analysis, all double documents were excluded.

Table 1. Literature review process.

Literature Review Process	
Planning	-Research objective identification -Development of search criteria -Selection of databases to be used
Information gathering, evaluation, and prior analysis	-Research, screening, and initial review -Synthesis and characterization of studies - Obtaining preliminary results
Analysis and Interpretation	- Detailed study of the documents obtained - Analysis and interpretation of results
Structuring	- Structuring the information obtained - Analysis writing and data results interpretation

Table 2. Criteria for document selection.

Criteria for Document Selection
Educational proposals within the Education for Environmental Citizenship.
Implementation of Environmental Education initiatives in non-formal, informal, and formal contexts (including environmental programs with the involvement of schools, family, and community).
Research and development of pedagogical models in Environmental Education
Research on issues such as attitudes, behavior, emotions, and decision making in primary education regarding the environment.
Studies on Environmental Education that present innovative pedagogical strategies.
Research methods, theories, and research results within the scope of this project.

The literature review process is briefly described in Table 1.

This review process involved the selection of the documents that met the requirements defined in Table 2.

3. Results and Analysis

3.1. Preliminary Investigation Phase—Step 1: Literature Review

Based on the literature review, it was possible to establish a set of learning outcomes that should be acquired by an environmental citizen and the methodologies used to promote Environmental Citizenship in primary education.

3.1.1. Environmental Citizen Competences

Environmental awareness is considered by several authors [17,26–31] to be one of the most important characteristics of an environmental citizen. There is usually an effective change in behavior and/or attitude in an individual in two ways: when something is imposed on him, or when he identifies with something [15]. By having a perception of how ecosystems work, how they are maintained, their characteristics, and all interactions, students develop feelings of belonging and acquire a real concern and a natural involvement with the environment that surrounds them [17,21,32,33]. This environmental awareness can be developed with sensory activities and nature exposure through free games and play on a regular basis, and if possible, daily [21,34–36].

Environmental knowledge is another characteristic found in the literature and concerns mainly the development of three knowledge forms—namely, action-related knowledge, effectiveness knowledge, and system knowledge [37]—which can be developed through formal, non-formal, and informal education. Knowledge is considered a prerequisite for action and decision making in a conscious and informed way [1,38–40]. According to our literature analysis, the development of environmental knowledge must be carried out based on real situations easily identified by students and preferably linked to the environment where they live and within the community [1,41,42].

Each student, whether a child or young person, has personal characteristics that are intrinsic and that should be considered when applying a particular pedagogy [43]. However, according to our analysis, some personal skills such as communication, critical thinking, and creativity can be developed or worked on, enhancing active participation in environmental activities [44–46]. Activities such as project/research work or in pairs can help students in their development and in the acquisition of a sense of personal, social, and environmental responsibility.

Culture and social environment are important factors in learning because there are normative values and rules conditioning the behavior and attitudes of individuals due to their personal and educational background [40,47]. In our analysis, it emerged in a clear way that the development of socio-cultural competences, such as responsibility, justice, and equity, promote the acquisition of pro-environmental behaviors and attitudes

in our daily lives and are closely linked to the rights and duties of an environmental citizen [1,26,27,48,49].

All human beings have the right to live in a healthy environment and free from pollution, but on the other hand, they have a duty to protect the future of the next generations, to be informed about environmental problems, to participate in conservation and preservation initiatives, and engage in environmental practices in their daily lives [26,27,46,48,50]. All citizens are considered agents of change, and this also applies to children, who have a duty to act to preserve the environment, finding solutions to existing environmental problems and preventing other problems that may arise [1,40,49].

According to Hadjichambis and Reis [1], an environmental citizen has a coherent and adequate set of knowledge, as well as the skills, values, and attitudes necessary to be able to act and participate in society as an agent of change, in the public and private sphere, on the local, national, and global scale, through individual and collective actions aimed at solving contemporary environmental problems, preventing the creation of new environmental problems, achieving sustainability, and developing a healthy relationship with nature. An environmental citizen is an individual who practices his environmental rights and duties, can identify the structural causes underlying environmental degradation and environmental problems, and has the skills for critical and active involvement and civic participation to address these structural causes and to act individually and collectively within democratic circles, taking inter and intra-generational justice into account [51].

Figure 1 briefly elucidates the learning outcomes that are deemed necessary for the practice of Environmental Citizenship according to what was previously mentioned.
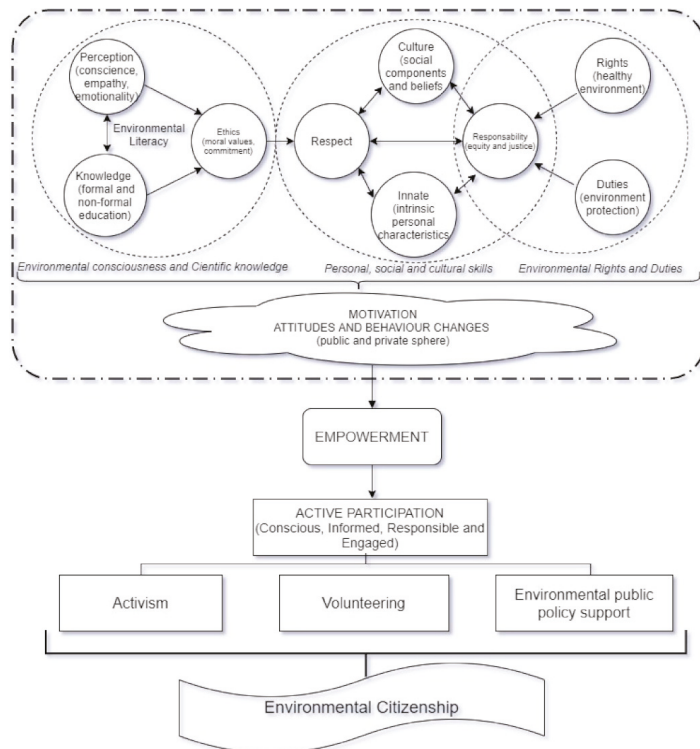
Figure 1. Environmental citizen learning outcomes.

An environmental citizen has an environmental awareness and knowledge about nature and the environment, so he will not only tend to change his behaviors and attitudes to preserve the environment but will also participate actively in private or public initiatives to improve the environment through actions of activism, volunteering, and supporting environmental public policies [1,13,14]. Those actions are triggered by an empowerment acquired through several school experiences where skills such as trust and motivation are developed. The students empowered reveal, in general, decision-making autonomy and a great involvement in environmental activities [52].

In environmental activism actions, it is assumed that individuals are involved and committed to public actions, influencing the behavior of the population in general and the public policy system, participate in environmental events, and have an active involvement in environmental organizations to achieve socio-environmental change and the common good [14]. According to Marques and Reis [46,53], the involvement of students in the development of activism initiatives promotes the acquisition of critical thinking skills, communication, creativity, perseverance, empowerment, and the perception that they can create change in the world.

For Reis [54,55], activism is an important aspect of environmental citizenship, allowing citizens to become active participants rather than simply spectators who depend on the opinions of experts. The involvement of students in activism initiatives represents a key element in Education for Environmental Citizenship, creating an excellent context for the development of knowledge, skills, values, and attitudes that "empower" citizens as agents of change, capable of conceiving and implementing individual and collective actions aimed at solving contemporary environmental problems [8]. Youth activism initiatives allow students to exercise their environmental rights and duties, understand the causes of environmental problems, and develop the skills necessary to develop solutions. According to the same author, through activism actions, students move from a learning position to a new position, with involvement in citizenship and scientific research practices, increasing the potential to strengthen ties between schools and the communities where they live, students, and their families.

In the case of volunteering, individuals are able to participate, for example, in reforestation and cleaning actions and be present at fairs and festivals to publicize environmental activities and themes for the defense and preservation of the environment, supporting causes both socially and culturally that benefit the place where they are located and/or contributing with funds to environmental organizations [14].

Supporting environmental public policies essentially concerns the interest in environmental actions carried out by the government, through the exercise of the right to vote, signing environmental petitions, and behavior change as a consumer, in the case of reducing the use of energy, purchasing products that are "environmentally friendly", plastics reduction, and recycling, among others [14].

Students' motivation is acquired by the perception that their actions can help "to relieve" the environmental threats and restore the socio-environmental values lost, which will enhance their active participation for the social common good, as a part of their own identity [14].

3.1.2. Methodologies to Promote Education for Environmental Citizenship

Currently, there are several methodologies with the potential to integrate environmental citizenship in a school context, giving students the opportunity to become agents of change in their local community and preparing them to actively contribute to a sustainable future, achieving empowerment.

The approach known as Ecopedagogy by Paulo Freire [39,56] defends a school curriculum that links the teaching and learning of environmental concepts to citizenship education. According to this perspective, aimed to involve citizens in environmental issues, participatory pedagogy should be adopted, giving relevance to students' collaboration

and involvement in the understanding of the environmental causes and consequences and presenting solutions for them.

Action-oriented learning is one of the most used approaches in the educational process to promote the resolution of socio-environmental issues and to enhance decision-making [1,57]. According to Jensen [57], this type of learning is based on practical and scientific activities and oriented towards the social sciences, enhancing motivation, interest, and the acquisition of knowledge, promoting a real change in behavior in relation to environmental and/or social problems.

Problem-based learning (PBL) is a socio-constructivist teaching–learning strategy, through which students solve real socio-environmental problems while they gain knowledge about the subjects in question [58]. In this approach, students use their own knowledge and experiences to solve real-life problems. According to several authors [59,60], in problem-based learning, various real-life scenarios are introduced as a starting point for the learning process in which students acquire critical thinking, collaboration, respect, leadership, autonomy, and responsibility.

Recently, there has been a growing interest in the use of collaborative learning activities in almost all teaching–learning contexts. Collaboration has become an important work strategy in the world of education, especially in the development of curricular projects and carrying out educational intervention projects focused on specific problems, such as environmental problems [61–63]. This methodology proved to be a promising strategy for educators to use in primary education [64].

Over the past few decades, socio-emotional learning has been the subject of research, realizing that socio-emotional interactions are essential in the learning process [65–67]. Several studies have shown that emotions are an integral part of learning, influencing student's motivation, cognitive processes, and performance [68–70]. Through socio-emotional learning, it is intended to establish trust and collaborative relationships through associations between school, family, and community, addressing various forms of inequality and enabling children, young people, and adults to co-create prosperous schools and contribute to safe, healthy, and fair communities [67,71].

Critical inquiry learning is another constructivist and student-centered, practical, and integrated approach that promotes the development of scientific and technological competences, thereby enhancing informed, responsible, democratic, and critical decision-making concerning environmental issues [72].

For Bai [73], environmental education must start with the valuation of the world intrinsically, placing the senses at the center of consciousness, instead of continuing in what he calls "abstract linguistic–conceptual mode". In this way, contemplative practices may ultimately be a vehicle for social change, leading to actions of activism, since the awareness of oneself and the others will make students get involved and participate in social justice activities and social causes volunteering [74]. In the context of environmental education, contemplative learning is relevant, because through various exercises, such as yoga and/or mindfulness, among others, students learn to respect their body and senses, understanding life as an integral part of nature [75].

Other methodologies found in the literature refer to community-based learning that combines educational objectives with community service and can provide students with opportunities to make relevant and authentic contributions to the improvement of local environmental issues and to act as responsible citizens [76]. Interactions with the community can raise students' concerns regarding social justice and equality, making them aware of the impact of social and environmental issues on the community and motivating them to actively participate and become agents of change [77,78].

According to Weisberg et al. [79,80], play-based learning is a methodology that involves playful activities, guided by the teacher, and specific learning objectives to promote the cognitive, emotional, and social development of children. Involvement in games/play encourages children to acquire skills such as imagination, creativity, curiosity, enthusiasm,

persistence, exploration, and discovery, enhancing the development of socially competent students capable of facing challenges and creating solutions in their everyday life [81].

On the other hand, outdoor learning promotes understanding, and the acquisition of knowledge by the student himself, motivated by his natural curiosity [16,82–85], promoting his involvement and behavior change related to nature and the environment [16,36,85,86]. For Kuo [87], experiences in nature help students acquire the skills needed by a citizen of the 21st century and that are necessary to make decisions when they actively participate in society.

The recent nature-based solutions (NBS) are economic solutions supported and inspired by nature while providing environmental, social, and economic benefits and helping to build resilience [88]. These solutions recreate in the cities, and in maritime landscapes, natural and diversified characteristics and processes of nature, through systemic interventions, efficient in terms of resources and adapted locally, to benefit biodiversity and combat climate change, among others. There are several learning scenarios developed for the application of NBS, promoted by the European Commission, namely for primary education [89–92].

Hawthorne and Alabaster [40] developed and tested a pedagogical model to achieve environmental citizenship, based on the interrelationships between the components defined "a priori". These components that integrate environmental citizenship include environmental information, environmental awareness, environmental concern, attitudes/beliefs, education and training, knowledge, skills, environmental literacy, and responsible behavior. This model indicated that participation in environmental education and training is the most important prerequisite for environmental behavior, followed by emotionality. However, the complexity of the interactions (Figure 2) that determine behavior illustrates that environmental citizens are not promoted only by education programs, but by a whole set of factors with which education has to interact, such as personal and personality factors that have a strong influence on behavior change.
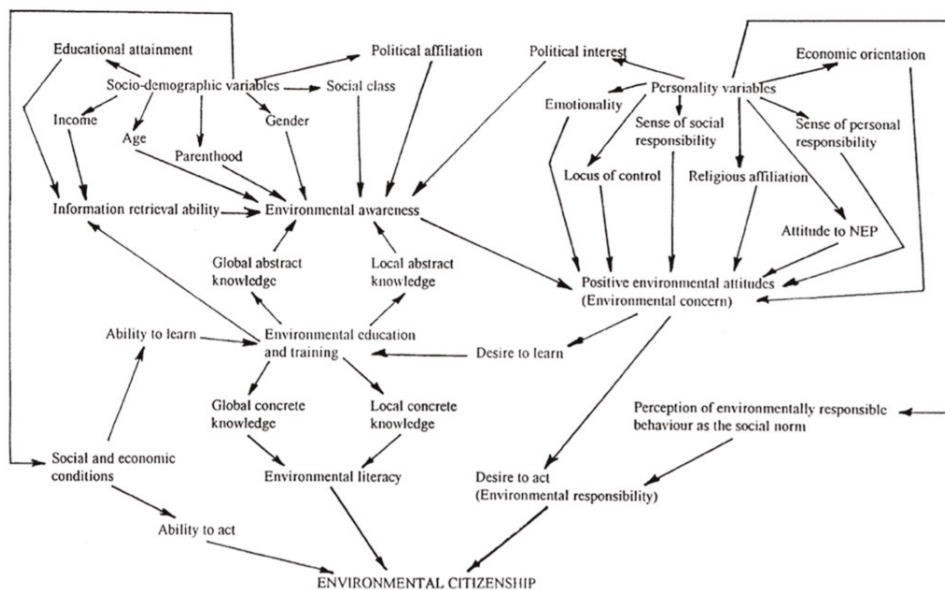
Figure 2. Pedagogical model to achieve environmental citizenship [40] (p. 30).

Recently, Hadjichambis and Paraskeva-Hadjichambi [93], developed a holistic pedagogical model of Education for Environmental Citizenship. In their pedagogical model,

the starting point is a local environmental problem based on the interests and concerns of the students, which the students feel that they have the responsibility to solve, because it is a problem faced by their community. It may be also a global environmental problem, reflected locally, making students feel capable of acting as agents of change. Student's interests can be stimulated through photos, videos, and controversial news. This model includes six (6) steps: research, action planning, critical and active involvement and civic participation, networking and information sharing on a local, national, and global scale, environmental and social change, and evaluation and reflection. According to the authors, the steps are not in a linear sequence, and an entry point can be any of the six, which include different sub-steps, all integrating Education for Environmental Citizenship (Figure 3).

Figure 3. Pedagogical model for Environmental Citizenship Education [93] (p. 251).

3.2. Preliminary Investigation Phase—Step 2: Development of the Prototype

The development of the prototype was based on a literature review regarding Education for Environmental Citizenship.

In this prototype, an environmental citizen is defined as a conscious, engaged, informed, and empowered individual with knowledge of the current political and socioenvironmental panorama, which includes his rights and duties as a citizen, who respects the environment, others, and himself, feels the responsibility and moral duty to act and change his behavior and attitudes, promoting the common well-being of all, and whose individual or collective actions, whether social activism, volunteering, or political–social, contribute to achieving environmental sustainability in his community and in the world. Thus, it is intended to develop in students the following learning outcomes: awareness and consciousness, knowledge, rights, duties, critical thinking, ethics, respect, responsibility, and empowerment. In this way, the methodologies selected are those that the author believes are best suited for the development of the environmental citizen learning outcomes, mentioned above, in primary education.

3.2.1. Methodologies in the Prototype

The principles of Environmental Education, set out in the Tbilisi Declaration, include fundamental elements for sustainable development, such as the need to consider socioenvironmental aspects and consider the relationship between economy, environment, and

development, adopting local and global perspectives, and the promotion of international solidarity [94]. In this way, Environmental Education should have cognitive, affective, and participative components, whose objective should not be limited to the development of knowledge and awareness of environmental problems, but also to dedicate itself to the development of appropriate characteristics and to promote the future participation of students in decision-making, as citizens in their local communities [45]. According to Orr [95], "all education is environmental education", and as environmental issues are complex and global, they cannot be understood through a single discipline and must function as an interdisciplinary theme, using integrated pedagogies.

One of the objectives of environmental education is precisely to promote environmental citizenship [1,96–100]. In this way, a new model of education emerged based on research and action, together with civic involvement, more appropriate for the promotion of the type of citizenship and literacy necessary for sustainable development, also known as Education for Environmental Citizenship [42,96]. Education for Environmental Citizenship, in addition to enhancing social skills and scientific knowledge, also incorporates a more interdisciplinary socio-environmental understanding, promoting results oriented to action and decision-making, which differs from conventional education [38,39].

Currently, there are several constructive, collaborative, critical, and reflective methodologies with great potential for integrating Environmental Citizenship in a school context and giving students the opportunity to become agents of change and preparing them to actively contribute to a sustainable future. Generally, those that involve the cognitive domain, the psychomotor domain, and the affective domain are considered the most relevant and effective, as they allow students to develop sustainability skills [101,102].

Education for Environmental Citizenship, being considered a type of interdisciplinary, formal, informal, and non-formal education, which encompasses several types of pedagogies, strategies, and educational methods and which promotes lifelong learning, must be approached from a perspective that integrates the entire curriculum, enabling students to understand the relationship between socio-environmental issues, socio-political actions, and the local, national, and global environmental effects in today's society.

Bearing in mind that education is an active process that lasts a lifetime, it is understood that there will not be a single pedagogical model that is valid for all circumstances, and the methodologies to be adopted for the involvement of children in these themes must be flexible and adapted, especially for young children [2,103]. Such methodologies, which are sometimes intuitive, necessarily must consider the child's individuality, situational contexts, and the relationship that is formed between the child and the teacher, because strategies that are appropriate for one child may not be appropriate for another [43].

Figure 4 shows the methodologies that were considered for this prototype according to the ages and the cognitive maturity of the students.

Collaborative learning is a particularly important strategy for carrying out educational intervention projects focused on environmental problems [61–63]. Following this learning, collaboration between students is promoted, and the development of interpersonal, social, and communicative skills, such as critical thinking, motivation, self-esteem, confidence, and respect for others, increases productivity and self-realization [62,104–109]. With this learning, it is intended to encourage students to acquire an active voice in the formation and communication of their ideas and values through dialogue, discussion of points of view, construction of solutions, and decision making based on the differences of the members of the group, which may motivate them toward civic participation in environmental issues. It has already been demonstrated through some studies [64,110] that this approach is a promising strategy to be used in primary education.

Figure 4. Methodologies to be adopted in the pedagogical model of Education for Environmental Citizenship in primary education.

Socio-emotional learning is a process that helps children to develop their identity, understand and manage emotions, define and achieve personal and collective goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions [67,71], so it is considered an important strategy to adopt in this prototype. Through socio-emotional learning, it is intended that students acquire self-awareness, self-management, social awareness, inter-help, and responsible decision-making competences [67,111]. According to some studies, [112,113], this methodology is highly effective in younger children, because it is at this stage that their behaviors are most malleable and moldable. One of the main objectives of the primary education curricula is precisely to enhance social and emotional development of students, in addition to developing their scientific and environmental literacy, so it is crucial to acquire socio-emotional skills to promote student's attention and improve memorization and self-regulation through their involvement and motivation [71,114,115].

Considering that the first years of schooling are crucial in the student's involvement in the teaching–learning process and in the construction of knowledge in the most diverse areas, learning by critical inquiry is important for the effective motivation of the student due to his natural curiosity, developing key competences, namely, critical thinking and scientific reasoning, through more practical and integrated learning, enhancing informed, responsible, democratic, and critical decision-making [72,116]. Critical inquiry learning is widely used in Science Education at all levels, enhancing the interest, involvement, and satisfaction of students during the learning process [116,117].

Contemplative learning challenges traditional approaches and it was introduced in this prototype as it is an innovative pedagogy and a useful technique for students to develop attention, emotional balance, empathy, compassion, and altruistic behavior while promoting creativity and learning motivation [118–122]. In the context of Environmental Education, this pedagogy is relevant because students learn to respect the body and the senses, understanding life as an integral part of nature [75], promoting the genuine perception that individuals belong to an ecological community [123,124]. It is intended that contemplative practices cause a change in students' promotion of activism, because

the awareness of oneself and the others and the feeling of unity with Nature, combined with a deep sense of ecological injustice, will cause students' involvement and participation in social justice activities and volunteering in social causes [74,125]. Thus, the implementation of contemplative practices such as mindfulness and/or yoga is suggested to enhance the success of an education for environmental citizenship and consequently for sustainable development.

Community-oriented learning not only promotes ties with the community, but also enhances a greater appreciation for the natural environment, providing students with the opportunity, to analyze, criticize, and improve local environmental practices [126,127], raising concern regarding socio-environmental injustices, making them aware of the impact of social and environmental problems on the community, and motivating them to active participation [78,127]. In this way, students develop their sense of justice, equity, responsibility, and critical and creative thinking, important characteristics of active participatory citizenship [1,21,127–131].

Through play-based learning, critical thinking, creativity, competence for problem solving, the formulation of hypotheses, the understanding of concepts, and the ability to make decisions are promoted [132–134]. In this context, children can explore, experiment, discover, and solve problems in a creative, imaginative, and playful way [133], developing social skills and making students capable of facing and creating solutions to challenges in their daily lives [82].

When it comes to Education for Environmental Citizenship, the first methodology that occurs is undoubtedly nature-based learning or outdoor learning. Through nature-based learning, the development of student's motivation is promoted through feelings of connection to nature in combination with the acquisition of environmental concepts, which effectively produces an involvement and change in authentic ecological behavior [16,36,85,86,135]. Contact and experience in and with nature improve student's attention, lower stress levels, and promote self-discipline, interest, and pleasure in learning, while providing a calm, quiet, and safer context for learning. They help students to acquire the skills needed by a citizen of the 21st century and that are necessary for decision-making within a real-world scenario when participating actively in society [87,136,137]. The combination of nature observation, together with the knowledge acquired in the classroom, is a powerful methodology, especially when it allows students to understand the impact of human action on wildlife and natural habitats [138], functioning in this way as a catalyst for cognitive and experiential learning, especially at earlier ages [36,82,84,86,138].

Although recent, learning through nature-based solutions (NBS) proved to be a promising strategy for educators to use in primary education [89,92]. The application of nature-based solutions (NBS) in the classroom enhances the development of environmental citizenship skills, such as creativity, problem solving, decision making, collaboration, environmental awareness, social justice, respect, and responsibility, and in addition increases environmental and scientific knowledge and the active participation of students. When NBS initiatives are promoted, students become aware of ecosystems, whose relationships can help in adapting to climate change, protecting biodiversity, integrated water resources management, and reducing the risk of environmental disasters [139]. NBS offers the advantage of promoting interventions with economic, social, and environmental benefits, promoting a greener, fairer, more equitable, and more efficient economy and a more resilient society [88,140]. Students "working with nature" and "innovating with nature" can benefit from ecosystems, providing flexible, economical, and widely applicable alternatives to deal with climate change among other environmental problems [140]. Nature-based solutions can and should be used together with other types of interventions to maximize their effectiveness.

Table 3 shows the desired learning outcomes that are developed for each learning pedagogy according to the prototype of a pedagogical model for Environmental Citizenship in primary education.

Table 3. Learning pedagogies vs. desired learning outcomes according to the prototype of a pedagogical model for Education for Environmental Citizenship in primary education.

Learning Pedagogies	Desired Learning Outcomes								
	Environmental Consciousness	Environmental Knowledge	Environmental Rights	Environmental Duties	Respect	Responsibility	Ethics	Critical Thinking	Empowerment
Collaborative learning					×	×		×	
Socio-emotional learning	×		×	×	×	×			
Critical inquiry learning	×	×				×		×	×
Community-oriented learning			×	×		×	×		×
Play-based learning	×	×			×	×		×	
Contemplative learning	×		×	×	×				
Outdoor learning	×	×			×	×	×		
Nature-based solutions learning	×	×			×	×		×	×

3.2.2. Educational Activities

In this prototype, the proposed educational activities were developed considering the curricular guidelines and the contents of the discipline of environmental studies, as well as the model of operationalization of the Citizenship and Development curriculum in primary education developed by the Ministry of Education in Portugal.

The main objectives to be developed through these activities are as follows: develop student's awareness and sensitivity about local, regional, and global environmental problems; increase environmental and scientific literacy that enables a greater understanding of nature and the environment, potential problems, and associated threats; promote behavior and attitude changes that encourage feelings of empathy, concern, and protection of nature and the environment; develop social, personal, and communication skills that can help students, individually or as a group, to identify and seek solutions to environmental problems; promote students' active participation and involvement in socio-environmental issues; recognize the importance of reducing the production of solid urban waste; identify the "5R policy" (Refuse, Reduce, Reuse, Repurpose, Recycle) and recognize its importance in the management of urban solid waste; separate all urban solid waste for recycling and/or composting; distinguish between renewable and non-renewable energies and know their importance for the preservation and conservation of the environment and nature; identify different types of pollution and/or other environmental problems in the local community; identify the main threats to animal and plant species and understand the importance of preserving biodiversity; recognize the importance of water, air, and soil quality, understanding the need for preservation; recognize environmental changes such as deforestation, fires, and silting, and identify their consequences for the environment and living beings; mitigate climate change; develop solutions and actions to the current environmental problems.

Table 4 presents examples of educational activities proposed for the implementation of this prototype in primary education.

Table 4. Educational activities proposed for the implementation of this prototype in primary education.

Proposed Activities	Pedagogies that Can Be Used	Desired Learning Outcomes
Plantation of native species around school and in public places.	Nature-based solutions learning Nature-based learning (Outdoor)	environmental consciousness and knowledge respect, responsibility, ethics critical thinkingempowerment
Construction of vertical and/or roof gardens at school and promotion of these gardens in students' homes and in community public places, like libraries, in collaboration with the Municipal Council.	Nature-based solutions learning Nature-based learning (Outdoor) Community-oriented learning Socio-emotional learning	environmental consciousness and knowledge respect, responsibility, ethics critical thinking empowerment environmental duties and rights
Realization of community exhibitions and markets in collaboration with scientists, environmentalists, agronomists, farmers, NGOs, and environmental centers concerning climate change adaptation.	Collaborative learning Community-oriented learning Socio-emotional learning	environmental consciousness environmental duties and rights respect, responsibility, ethics critical thinkingempowerment
Creation of networking and online platforms in collaboration with other schools in the region/country.	Collaborative learning Socio-emotional learning	environmental consciousness environmental duties and rights respect, responsibility critical thinking
Study visits to natural areas and field activities for fauna and flora observation of the surrounding area, as well as identification of threatened species.	Nature-based learning (Outdoor) Socio-emotional learning Play-based learning Contemplative learning	environmental consciousness and knowledge respect, responsibility, ethics critical thinking empowerment environmental duties and rights
Waste separation games from a set containing packaging, papers, bottles, fruit peels, batteries, oils, and other waste from school.	Play-based learning Collaborative learning	environmental consciousness and knowledge respect, responsibility critical thinking
Conducting a composting point at school and in community, together with the Municipal Council.	Collaborative learning Community-oriented learning Socio-emotional learning Nature-based solutions learning	environmental consciousness and knowledge respect, responsibility, ethics critical thinking empowerment environmental duties and rights
Poster exhibition in schools, museums, and municipal libraries with measures to save electricity and water.	Critical inquiry learning Community-oriented learning Socio-emotional learning	environmental consciousness and knowledge respect, responsibility, ethics critical thinking empowerment environmental duties and rights
Cleaning campaigns in school outdoor spaces and surroundings together with community institutions and the Municipal Council.	Nature-based learning (Outdoor) Community-oriented learning	environmental consciousness and knowledge respect, responsibility, ethics empowerment environmental duties and rights
Dynamics of yoga and/or mindfulness activities through children's stories and games, in collaboration with elderly homes.	Contemplative learning Play-based learning Socio-emotional learning	environmental consciousness and knowledge respect, responsibility critical thinking environmental duties and rights

Table 4. *Cont.*

Proposed Activities	Pedagogies that Can Be Used	Desired Learning Outcomes
Identification of specific urban environmental issues in the community, choosing situations that most concern them, like social inequality and poverty, and acting to improve them, presenting their solutions to local authorities.	Critical inquiry learning Collaborative learning Socio-emotional learning	environmental consciousness and knowledge respect, responsibility critical thinking empowerment environmental duties and rights
Creation of a "laboratory-garden" in collaboration with the Municipal Council, community, and NGOs.	Nature-based solutions learning Critical inquiry learning Collaborative learning Community-oriented learning Socio-emotional learning	environmental consciousness and knowledge respect, responsibility critical thinking empowerment environmental duties and rights

The proposed activities like vertical and roof gardens will improve air quality, reduce heat stress, and isolate the buildings, resulting in less energy use and lower costs, contributing in this way to mitigate climate change. On the other hand, creating social vegetable plots, maintained and managed in a sustainable way by local voluntary citizens, will strengthen community bonds, while vegetables and fruits can be distributed to the less favorable people, increasing social justice, equity, and social inclusion.

It is necessary to connect nature, science, and art, and this can be done through "laboratory-gardens", where it is possible to demonstrate sustainable agricultural techniques, enhancing the exchange of knowledge, skills, mutual help, and dialogue, through educational activities and workshops for the whole community.

Activities between students and the Municipal Council help to encourage the civic participation of children in the development of interactive initiatives for sustainable development together with community. In addition, these initiatives also aim to enrich the school program with curricular and extracurricular activities ranging from environmental education to active citizenship, and can be promoted in primary education, adjusted for each year and to specific contexts.

Proposing actions and demonstrating their impact on the community to the Municipal Council and other independent parties like NGOs will facilitate the resolution of problems from the bottom up, while promoting student engagement in scientific and policy processes. Thus, it creates links between education, science, and politics, strengthening the community and allowing students to participate in authentic problem solving of environmental issues from their direct surroundings and representation in socio-political actions, strengthening their environmental citizenship.

3.2.3. Prototype Stages

When talking about a pedagogical model, the elaboration of steps/stages for its construction is assumed. In this prototype, the stages are mainly based on the 5 Es of the project/investigation work presented by Bybee [141]; engagement, exploration, explanation, elaboration, and evaluation. When all stages are applied, it is expected that students acquire characteristics that an environmental citizen should have and that they manifest good practices of environmental citizenship.

Figure 5 shows a scheme with the stages of the prototype that are considered necessary for the promotion of Education for Environmental Citizenship in primary education.

Figure 5. Stages considered in the prototype of a pedagogical model for Education for Environmental Citizenship in primary education.

Several studies show that contact with nature during childhood has positive effects throughout life regarding environmental issues, and according to Asah [32], children's self-exposure to nature is the factor that most contributes to environmental citizenship. At this stage, it is intended that students perform an autonomous and independent exploration of nature, as well as observe plants, animals, and other elements present and their relationships, in a free, spontaneous, and interested way. In this way, teachers/educators should interfere as little as possible in the way children experience nature, giving them the necessary freedom and accepting their choices while also guaranteeing their safety [142]. Thus, they will have the opportunity to create a connection with nature and perceive the existing relationships between all those who live in it, whether living beings or not [17], in addition to developing their personal and social skills, such as sharing, negotiating, resolving conflicts, working in groups, exercising self-defense, creativity, and autonomy [142,143]. Activities such as outdoor walks, visits to educational farms, picnics, or simply playing outdoors are the proposals of this stage. It may eventually be suggested to them to collect some plants, flowers, and other elements present in the place, according to their choices. To be effective, this step must be provided to students as many times as possible and on a regular basis [143].

The survey of environmental issues or problems should arise spontaneously, or if not, it should be proposed by the teacher who will guide students in searching for solutions for the problems found. At this stage, questioning problems, there is a call for individual action in terms of behavior change, as well as collective action. The activities that can promote this stage should be video and image views, sharing of experiences by the students, and knowledge about local community projects related to local environmental problems. The search for content stage can be carried out at the same time using information and communication technologies and consultation of books, newspapers, and magazines.

It is up to the teacher/educator to provide the appropriate material to stimulate communication and dialogue between students, using strategies such as educational games, films, or images. At the explaining facts and structuring ideas stage, it is intended that students share their experiences and perspectives, stimulating their communication regard-

ing nature and the environment and developing their knowledge, based on observation, comparison, and analysis of similarities and differences, structuring their ideas in this way.

The development of solutions based on issues or problems related to nature and the environment must be fully carried out by the students and should also attend the inherent economic viability. Students should be the main actors, and the teacher should only guide and advise them throughout the process. Students who engage in environmental activities that benefit their community learn while addressing issues of social and environmental justice. Children have the right to act on local environmental problems that concern them and should be encouraged to engage in practical activities that include, in addition to research, the implementation and communication of actions, thus becoming active participants in all the processes.

The evaluation of the actions carried out, as well as their implementation in the school and in the community, is the last proposed step, in which it is intended that students reflect on the effectiveness of the solutions found for environmental problems and are able to show feasible alternatives for the protection of the environment, considering their participation from the beginning until the implementation of the actions that they propose and elaborate.

4. Final Considerations

Climate change, threats to biodiversity, and the reduction of natural resources, among other environmental problems, placed the topic of sustainable development on the world agenda as a priority, leading global efforts to develop several strategies to achieve it, thus ensuring environmental sustainability.

Environmental citizenship appears as a complementary way to promote sustainable development, and according to some economic and political strategies around the world, the education on environmental issues is considered essential and should be promoted at early ages.

The aim of this article was to present a prototype of a pedagogical model for Education for Environmental Citizenship for primary education, based on a systematic survey of the available literature, whose objective is to develop informed, and conscious environmental citizens, enhancing their active participation in political and socio-environmental issues. According to the analyzed literature, the learning outcomes considered important for environmental citizenship that can be developed in primary school students are awareness and consciousness, knowledge, rights, duties, critical thinking, ethics, respect, responsibility, and empowerment.

To achieve the learning outcomes previously listed, some active, socio-constructivist, and student-centered methodologies can be applied and combined into a pedagogical model to maximize their effectiveness as follows: collaborative learning, play-based learning, critical inquiry learning, community-oriented learning, contemplative learning, outdoor learning, nature-based solutions learning, and socio-emotional learning. This pedagogical model has the potential to develop in students the ability to think critically, make informed and conscious decisions, and enhance active participation, leading to changes in society related to socio-environmental problems.

The activities must be selected and developed by the students according to the local or global socio-environmental problems they would like to address through their actions. All activities should be realistic and based on concrete situations, allowing students to develop and apply knowledge to situations and problems they consider socially relevant.

This prototype includes seven (7) stages that the authors consider to be necessary at least to structure the activities proposed, as follows: exploring the environment; questioning problems and searching contents; explaining facts and structuring ideas; proposing solutions; elaborating and communicating actions; reflecting and evaluating. The stages are not in a linear sequence, and the entry point can be any of the seven. When these stages are applied together with the methodologies and the activities proposed, it is expected that students develop the characteristics of an environmental citizen and manifest good practices of environmental citizenship.

Figure 6 shows a resumed scheme with the design of the prototype for Education for Environmental Citizenship in primary education.
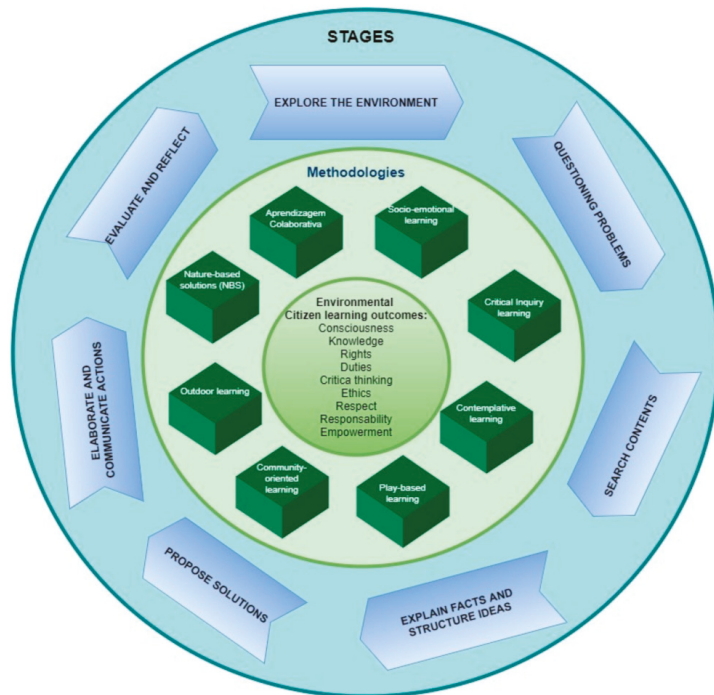
Figure 6. Prototype design of a pedagogical model for Education for Environmental Citizenship in primary education.

It is intended that this prototype can represent a guide for the implementation of methodologies for Education for Environmental Citizenship in primary education. This prototype continues to be an object of improvement and discussion through interactions with primary education specialists, environmental education specialists, and government and NGO bodies. Possible limitations from this model will be scrutinized and criticized by the experts (on environmental education or education for sustainability, on primary education, and primary school teachers) involved in the next development cycles of this DBR study, allowing for the improvement of this pedagogical model for Education for Environmental Citizenship in primary education.

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Review

A Systematic Literature Review on the Participation Aspects of Environmental and Nature-Based Citizen Science Initiatives

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Abstract: It is commonly argued that, despite the tremendous resonance Citizen Science (CS) has shown in recent years, there is still lack of understanding of important aspects defining citizens' participation and engagement in CS initiatives. While CS initiatives could provide a vehicle to foster forms of participation contributing to the democratization of science, there is still limited attention paid to the "Citizen" component of the Citizen Science term. For the purpose of this work, we systematically reviewed the available literature for empirical studies in respect to citizens' participation in environmental and nature-based CS initiatives established during the last two decades, using the PRISMA methodology. The participatory facet of the retrieved 119 CS initiatives was analysed on the basis of: (a) exclusion and inclusion demographic factors, (b) CS models and practices, (c) facilitators and constraints of citizen's participation, and (d) environmental citizenship. Our findings show that the majority of the CS initiatives did not place restrictions on gender participation; however, we have identified that mostly highly educated adults participated in the reviewed initiatives. In addition, most of the CS initiatives reported in the literature were situated in the EU and USA, were mostly limited to the local scale, and primarily followed the contributory model. Academic institutions were found to coordinate the majority of the CS initiatives examined. By using digital technologies, academic scientists were able to control and increase data quality, as well as to engage a broader audience, even though they were mostly treating volunteers as "data collectors", desiring their long-term engagement. Therefore, it will be of CS benefit to be better aligned with the mentality and needs of citizens. In this direction CS initiatives should trigger citizens' learning gains and interpersonal/social benefits and personal, environmental, and social motivations, but also to shift their goals towards contributing to science and citizens' connection with nature. On the other hand, there is a need to overcome any design and implementation barriers, and to enhance democratization through a more participative engagement of active and aware citizens, thus promoting environmental citizenship.

Keywords: nature-based citizen science; environmental citizen science; participation; inclusion; exclusion; facilitators; constraints; models and practices; environmental citizenship; systematic literature review

1. Introduction

Public participation in scientific research has a long history, with the use of non-experts as the primary source of collection of large amount of data on behalf of professional scientists [1,2]. Nowadays, the term Citizen Science (CS) describes the involvement, engagement, and communication of the public (e.g., volunteers, students or activists) with professional scientists, in collecting data and gathering information in various fields of science, such as nature, ecology, and the environment [3–7]. The interaction between the public and scientists can be seen as an amphidromic procedure promoting public participation in science, where among other things the former gain knowledge and skills throughout data

collection and the latter use these large-scale data, that may not be easily gathered with other techniques, for the common good, thus resulting in a win-win situation [8,9].

Despite the long history of CS, there are still several limitations in the underlying models and frameworks, which guide the public participation in CS initiatives. In many CS initiatives, the citizens are merely treated as "data collectors" or "passive" participants [10], instead of "active citizens" [11]. This finding is not surprising, given that CS research is not focused, for instance, on how CS can help the public to understand and appreciate the power of science for socio-political and socio-cultural action [6]. However, CS can be an excellent venue for the democratization of science, by achieving an "inclusive" and active engagement of citizens in the scientific process.

As CS has blossomed in recent years, many professional networks have been founded around the globe (e.g., International, European, US-based and Australian Citizen Science Association), aiming to advance the proper design of methodologies for the effective implementation of nature-based and environmental CS initiatives. In addition, these associations aim at addressing any inaccuracies for who is counted as "scientist" and who as "citizen", while also attempting to connect more effectively citizens with nature, as well as ensuring the appropriate use of citizens' data towards decision- and policy-making, for a more sustainable environment [12,13].

Aligned with the aforementioned concerns and remedial actions, this study presents a systematic review of the available empirical research on citizens' participation in environmental and nature-based CS. More specifically, the participatory aspects of a total of 119 CS initiatives were analysed on the basis of: (a) exclusion and inclusion demographic factors, (b) CS models and practices defining citizens' participation, (b) facilitators and constraints of citizen's participation, and (d) participation forms for the achievement of environmental citizenship. The rest of the manuscript continues with (i) providing an overview of environmental and nature-based CS initiatives, (ii) defining the participatory aspects of CS initiatives, and (iii) reflecting on how CS initiatives can serve as a venue to foster Environmental Citizenship. This theoretical background motivates the research questions guiding this review effort, which will be presented in the following sections.

1.1. Overview of Environmental and Nature-Based CS Initiatives

When the term "citizen science" was coined in the 19th century it was not well defined, but there are many examples of environmental and nature-based CS initiatives, which were carried out by volunteers without professional training in science [14]. In recent years, environmental and nature-based CS initiatives mainly deal with public monitoring for data collection from trained non-specialist citizens, aiming to address various environmental problems as well as to contribute to nature conservation. These include but are not limited to CS initiatives related to air pollution (e.g., Air Sensor Toolbox, Smoke Sense), bird monitoring (e.g., Galaxy Zoo (http://www.galaxyzoo.org/, accessed on 28 June 2021), eBird (http://www.ebird.org/, accessed on 28 June 2021), NestWatch (https://nestwatch.org/, accessed on 28 June 2021), FeederWatch (https://feederwatch.org/, accessed on 28 June 2021), Big Butterfly Count (https://bigbutterflycount.butterfly-conservation.org/, accessed on 28 June 2021), biodiversity conservation (e.g., GBIF (https://www.gbif.org/, accessed on 28 June 2021)), and water quality (e.g., bloomWatch (https://cyanos.org/bloomwatch/, accessed on 28 June 2021)) [15]. For instance, bird monitoring and butterflies' observation by volunteers are considered among the oldest nature-based CS initiatives [16,17]. In fact, during the last few decades there has been an increasing emphasis on CS initiatives focusing on: (i) improving citizens' understanding on ecology and nature by providing place-based experiences, (ii) developing citizens' scientific practices and scientific knowledge, and (iii) promoting conservation actions with reflect on policy- and decision-making [3,8].

Framing CS initiatives involves several risks due to the various differences attributed to the different fields explored, and the different methodological approaches followed in relation to the development, implementation, and evaluation of each initiative [8]. Various research groups have already attempted to understand CS models and practices regarding

citizens' engagement [14,18–20]. However, the derived outcomes should be carefully correlated with all the inclusive and exclusive factors affecting citizens' participation.

1.2. Participation Aspects of CS Initiatives

Citizens' participation in CS initiatives has been raised by various research groups in the literature, underlying the importance of several participation aspects for those involved (e.g., social, individual, civic, civil participation, etc.), from different perspectives and angles [2,5,18,21–23]. However, there is a limited number of CS initiatives focusing on the promotion of an inclusive participation which can ideally lead science towards democratization [24]. Considering the classification of Shirk et al. (2012), and the attempts to address socio-cultural and socio-political theoretical frames within CS initiatives, different degrees of public participation have been identified so far, classifying the levels of citizens' involvement into "contractual", "contributory", "collaborative", "co-created", and "collegial". In contractual CS initiatives, the scientists conduct, for instance, an investigation requested by the communities. On the other hand, contributory and collaborative CS initiatives are designed by scientists; however, in the former case, citizens take part as "data collectors", while in the latter case the citizens also contribute to the design, data analysis, and/or dissemination of the outcomes. Co-created initiatives are co-designed by both scientists and citizens, and they are characterised by the active participation of citizens throughout the whole duration of the project. Collegial initiatives are the ones where citizens conduct an investigation independently, while expecting recognition from scientists. Despite the significance of designing collaborative and co-created initiatives, in which citizens are actively engaged, there are many CS initiatives which use contributory approaches, where citizens are simply taking the role of "passive sensors" providing the required data to the scientists [11,25,26].

It is also of paramount importance to mention that there are also some factors known as "facilitators", which may increase the interest of citizens in participation, and conversely factors known as "barriers", which may prohibit citizens' participation in CS initiatives. In a CS initiative that took place in Rwanda, as an attempt to control malaria under the Environmental Virtual Observatories for Connective Action (EVOGA) multidisciplinary project, the authors reported that the engagement of citizens along the continuation of the project was facilitated by the ease of using observational materials (i.e., in-depth interviews, mobile phones, workshop) on their reports, but also from the fact that the participants were feeling useful to the program, as their efforts were well recognized by the scientists and the community [27]. On the other hand, in a hypothetical Australian marine CS initiative, it was revealed that a major barrier for citizens to participate in the initiative was their insufficient knowledge of marine species, which made it difficult for them to contribute effectively [28]. Stakeholders (e.g., scientists, community actors, NGOs, etc.) in CS initiatives should better understand citizens' benefits, motivations, goals, and constraints, along with the use of best practices incipient from the design and implementation of their initiatives [18,29–34]. Therefore, it becomes imperative to systematically examine the facilitators and barriers, which may affect positively or negatively, respectively, citizens' participation in CS initiatives [35].

The development of digital technologies has also contributed to the growth of CS, providing an easily accessible source of communication with and among participants, from data collection towards the analysis, interpretation, and dissemination of outcomes to a broader audience [36]. Digital technologies have increased the visibility of CS initiatives and given opportunities to unidentified and underrepresented groups to participate and contribute to science [37]. However, the use of digital technologies carries risks as it: (i) focuses primarily on the data collection aspects of the CS initiatives, and (ii) creates population imbalance due to the digital divide, excluding those who do not advanced ICT (Information Communication Technology) knowledge or the infrastructure needed [38,39].

Besides that, it is crucial to identify how CS initiatives are designed, managed, and implemented (i.e., existing CS models and practices) with respect to citizens' participa-

tion as well as the approaches used to eliminate any inclusive or exclusive demographic factors, such as gender, age, and education [40–42]. As reported in the literature, there are several discrepancies due to the impact of demographic factors, which deter citizens from participating in CS initiatives [29,43]. Thus, the necessity to carefully and thoroughly design and manage CS initiatives to unrestrictedly engage citizens beyond the collection and submission of data, is imperative [18,29–34]. Therefore, there is a need now more than ever to focus on the active involvement of citizens and promote environmental citizenship, where citizens will be benefited and motivated via their contribution to science and nature conservation [44].

1.3. Participation in CS Initiatives as a Venue to Cultivate Environmental Citizenship

Existing models and practices of CS initiatives, place the emphasis on the "science" rather than on the "citizen" component [44]. However, when it comes to CS initiatives, it is also of paramount importance to give the necessary emphasis to the "citizen" component in the "Citizen Science" term [23,45]. This change will also shift the focus of CS initiatives from citizens as "data collectors" to citizens as "active participants". In turn, this will also contribute to the empowerment of citizens' knowledge, values, attitudes, skills, competences, and behaviours in order to promote their ability to undertake socio-environmental and environmental citizenship actions [46–48]. Environmental citizenship is defined as a multifaceted concept, which deals with pro-environmental behaviour and citizens' attitudes towards the environment. According to the recent definition given by the European Network for Environmental Citizenship (ENEC, 2018):

> "*Environmental Citizenship is defined as the responsible pro-environmental behaviour of citizens who act and participate in society as agents of change in the private and public sphere on a local, national and global scale, through individual and collective actions in the direction of solving contemporary environmental problems, preventing the creation of new environmental problems, achieving sustainability and developing a healthy relationship with nature. Environmental Citizenship includes the practise of environmental rights and duties, as well as the identification of the underlying structural causes of environmental degradation and environmental problems and the development of the willingness and the competences for critical and active engagement and civic participation to address those structural causes and to act individually and collectively within democratic means, taking into account inter- and intra-generational justice.*"

Within this context, an emerging question is whether CS initiatives, and especially environmental and nature-based ones, can endorse forms of participation which can support and promote environmental citizenship. In their review study, Wiggins and Crowston [20] constructed a matrix of CS typologies, after examining 30 CS initiatives in relation to the nature of citizens' participation. Therein, the reviewed CS initiatives were clustered into five mutually exclusive and exhaustive types of initiatives including action (2 CS initiatives out of 30), conservation (7 out of 30), investigation (10 out of 30), virtual (7 out of 30), and education (4 out of 30). By definition, action-related CS initiatives are using bottom-up approaches (scientific research) to encourage participant intervention in local concerns and support civic agendas. Therefore, action-related CS initiatives could potentially contribute to the cultivation of environmental citizenship and enhance the engagement of participants through encouragement as a way to address socio-political and socio-cultural issues. In addition, such CS initiatives could potentially promote citizens' active participation as a venue to address large-scale environmental issues, prevent new ones, as well as to achieve sustainability and a healthy relationship with nature [49–51].

1.4. Study Overview and Research Questions

The present review study aims into systematically examine the participation aspects of nature-based and environmental CS initiatives by following the PRISMA methodology [52]. In particular, our aim was four-fold and it is reflected in the following research questions (RQs):

- RQ1: Which are the main exclusion and inclusion demographic factors, defining citizens' participation in nature-based and environmental CS initiatives?
- RQ2: How do existing CS models and practices define citizens' participation in nature-based and environmental CS initiatives?
- RQ3: Which are the main facilitators and constraints of citizen's participation in nature-based and environmental CS initiatives?
- RQ4: Do nature-based and environmental CS initiatives provide a participation venue that fosters environmental citizenship?

2. Methodology

2.1. Data Collection

The studies analysed in this literature review covered empirical research published within 2000 to 2020, in English language, as a full paper in a peer-reviewed academic journal. The retrieval of the reviewed studies followed the PRISMA standards for Systematic Literature Reviews [52] and was based on a multi-step procedure comprised of three sequential stages, as follows: (a) Identification, (b) Screening, and (c) Eligibility (Figure 1).
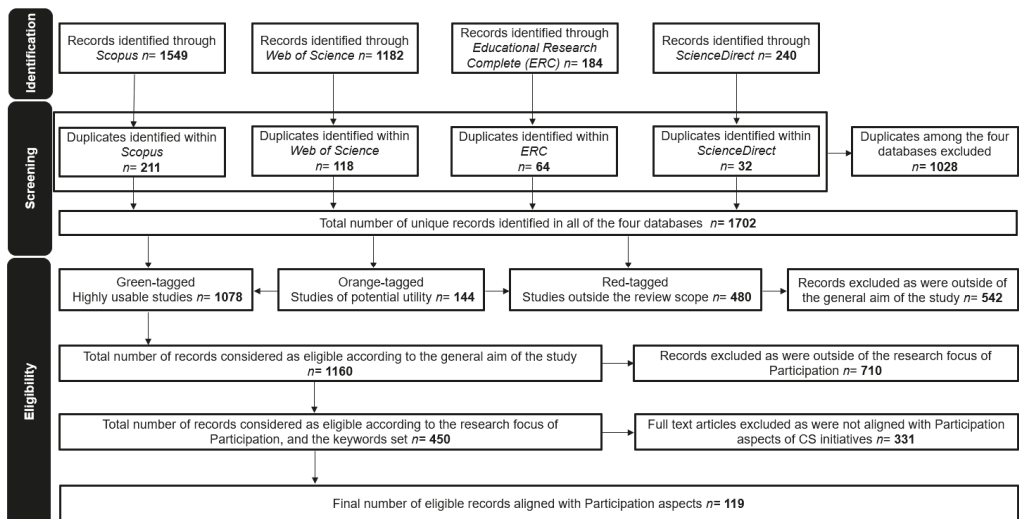
Figure 1. Flow diagram illustrating the review selection process.

Initially, at the identification step, the published literature was surveyed using four electronic databases: *Scopus*, *Web of Science*, *Education Research Complete (via EBSCO)*, and *ScienceDirect*, which are considered among the most enriched and popular academic databases [53]. The keywords checked on the title/abstract/keywords included the terms "citizen science", "open science", "public science", "participatory science", "civic science", and "community science" in combination with the terms "nature", "ecology", and "environment" (e.g., "citizen science" AND "environment", "civic science" AND "nature"), leading to 18 combinations. This ensured that the retrieved results would be mostly restricted in the context of nature-, ecology-, and environment-related CS initiatives. After performing all possible combinations, a total of 3155 papers were retrieved.

For the second step (screening), these records were screened and both internal duplicates within each database, and duplicates between the four databases were removed, resulting in a total of 1702 records.

For the third step (eligibility), the remaining records were filtered, to identify their eligibility, according to their *Research scope*; the study should report on the design, implementation, and/or management of at least one nature or environmental-based CS initiative.

Getting more in-depth, as part of this process the title/abstract/keywords of studies were evaluated using the following color coding: (a) Green-tagging, for highly usable studies aligned with the criteria posed, (b) Red-tagging for studies outside the review scope, not aligned with the criteria posed, and (c) Orange-tagging for studies of potential utility, given that these studies seemed quite relevant to the scope of this review, but it was not absolutely clear whether all the inclusion criteria were met. In this latter case, full text versions of the studies were also obtained, read, and colored as green or red. Overall, the first part of this eligibility procedure resulted in the selection of 1160 green-tagged studies. The selected publications were further evaluated according to their *research focus* and *research methods*. More specifically, a filtering was performed to ensure that the CS initiatives were explicitly related to the aspects of participation (*research focus*), as these were outlined in the introduction of the study. For this filtering, a second group of 10 relevant keywords was deployed to search within the title/abstract/keywords of the retained papers, as follows: "participation", "engagement", "involvement", "inclusion", "benefit", "goal", "barrier", "motive", "motivation", and "obstacle". This filtering process resulted into 450 journal articles.

Finally, the filtering process was concluded with the thorough study of the 450 articles, and their separation based on their *research methods* into: (i) empirical papers, reporting on one CS initiative with a focus on participation, and providing primary data derived from quantitative, qualitative, or mixed designs, (ii) review papers, and (iii) theoretical/conceptual papers, which did not include any empirical data. This latter filtering led to exclusion of any theoretical/conceptual and review papers lacking any empirical data. Therefore, we concluded with one hundred and nineteen empirical articles (*N* = 119), hence 119 CS initiatives, which were fully analysed in order to extract all relevant information related to the research questions posed.

2.2. Data Analysis

The 119 retrieved empirical studies were analyzed by using a semi-structured checklist including a matrix of CS participation-related typologies, aligned with the four research questions guiding this study.

The first matrix of typologies consisted of various *exclusion and inclusion demographic factors*, aimed to capture relevant information for the demographic make-up of participants in the reviewed CS initiatives (e.g., gender, age, educational level). In addition, this matrix of typologies also included general demographic characteristics in relation to CS initiatives, such as the geographical scale and region of each CS initiative, as well as the initiatives' coordinator.

The second matrix of typologies was related to the *CS models and practices* which may define and affect citizens' participation. Relevant information such as the overarching aims of the CS initiatives as well as their goals in relation to science learning [54] were captured. This matrix of typologies also included information related to the data collection process (e.g., level and modes of data collection, frequency, and duration of data collection) as well as the forms, activities, and types of citizens' contributions in CS initiatives. In addition, typologies addressing the modes and topics of communication with and among participants in CS initiatives were included.

The third matrix of typologies was related to the *facilitators and constraints of citizen's participation* in CS initiatives. With this matrix we aimed at collecting relevant information regarding the factors which may act as facilitators for participation in CS initiatives such as the citizens' benefits and motives, as well as the citizens' goals guiding their active involvement in CS initiatives. On the other hand, with this matrix we also aimed at collecting relevant information regarding the factors which may act as barriers for citizens' participation in CS initiatives.

The fourth matrix of typologies was related to *environmental citizenship*, as it aimed to capture information regarding the potentials of current CS initiatives to support forms of participation fostering environmental citizenship. More specifically, with this matrix

we aimed at collecting information regarding the dimensions (individual and collective) spheres (private and public), and scales (local, national, global) of the actions promoted by the CS initiatives towards environmental citizenship, but also regarding the outcomes of environmental citizenship.

Further data analysis was performed over the retrieved results to shed light on the participation-related aspects of the CS initiatives, falling into the four aforementioned matrix of typologies. Specifically, for each typology, the Relative Frequency (RF, %) was estimated by using the following Equation (1) [55]:

$$\text{Relative Frequency (\%)} = (A/B) \times 100 \qquad (1)$$

where A is equal to the exact number of appearances of a specific option of each typology (known as absolute frequency), and B is equal to the total number of appearances of all the options of each typology (N). For instance, for the *initiatives' coordinator* typology in CS initiatives (see the *first matrix of typologies*), the option "Academic institution" was found in 33 articles. Considering that "NGO" (11 articles), and "Governmental organization" (8 article) options were also observed, the number (N) of appearances of the *initiatives' coordinator* typology was raised to 52. Thus, the relative frequency of Academic institution within the *initiatives' coordinator* typology, estimated via Equation (1), is RF (%) = (33/52) × 100 = 63%. All the percentages from now on in this paper use the above-mentioned relative frequency to draw a clear picture on how each typology was reflected in the reviewed studies, without weighting on who proposes the statements coded, or how many participants there were. In addition, the total number of appearances (N) for each typology is reported in figures' captions. It is noteworthy to mention at this point that the whole procedure was screened and confirmed by two reviewers of the current study. To increase inter-rater reliability, any differences among the two reviewers were further discussed and resolved by all five authors.

3. Results

3.1. Exclusion and Inclusion Demographic Factors

Demographic data can be treated as descriptive statistics of the participants in the reviewed CS initiatives. However, at the same time, demographic data can provide a valuable resource of important information regarding the inclusion/exclusion factors affecting public participation in a CS initiative. As it can be seen in Figure 2a, most of the participants were adults (71%); however, 29% of CS initiatives were using participants under the age of 18 (U18). In line with our findings, as also reported during the evaluation of a long-term CS initiative which took place in Northern Spain (MONITO) " ... *ages range between 23 and 77 years old*" [56] (p. 394). As shown in Figure 2b, there were no issues preventing participants from contributing to a CS initiative due to their gender, as both males and females were found to participate in the vast majority (97%) of CS initiatives. For example, a questionnaire developed to retrieve information regarding the motivations and scientific attitudes from past participants of the Manitoba Nocturnal Owl Survey revealed that "*Respondents were fairly evenly split by gender*" [57] (para. 15). The educational level of citizens participating in CS initiatives (see Figure 2c) seems to clearly illustrate that most of the participants had, at least, high school diploma (22%) and were educated with a bachelor's degree (21%). Nevertheless, there is also a measurable number of postgraduate MSc or PhD holders (27%), as opposed to middle school and primary education participants (17%). The latter trend is in line with the results presented in Figure 2a regarding the age of citizens participating in a CS initiative. In other words, based on our results, 61% of the participants, were at least college degree holders. In line with our findings, the Great Pollinator CS initiative which was based on survey outcomes, reported that "*More than three quarters had obtained a college degree*" [58] (p. 42). Additionally, based on demographic information from the Smoke Sense CS initiative, it is specifically mentioned that "*Participants of Smoke Sense during the pilot study were younger (30.2% age*

18–29; 25% age 30–39; 19.3% age 40–49; 18.9% age 50–64; and 6.5% age 65+), more educated (71.6% had at least a college degree)" [59] (p. 447).
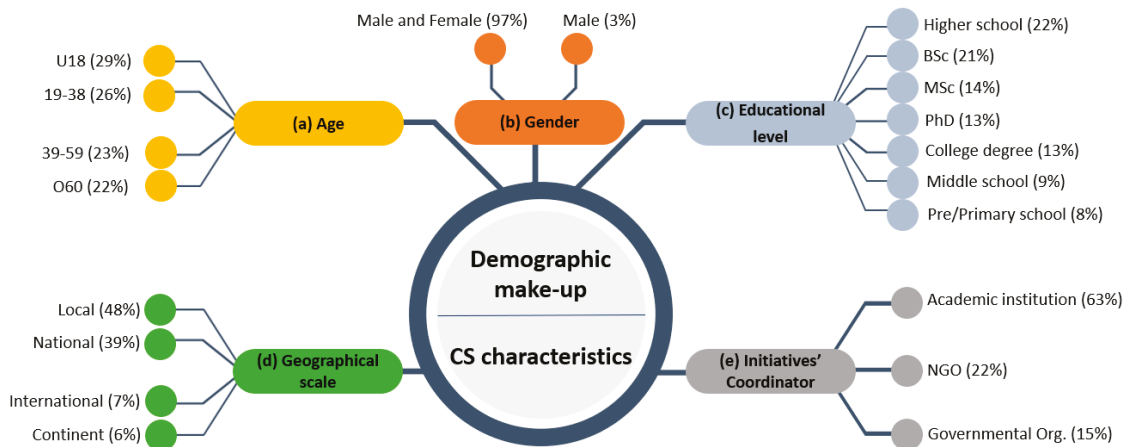
Figure 2. (**a**) Gender (N = 37), (**b**) Age (N = 26), (**c**) Educational level (N = 33) of citizens, (**d**) Geographical scale (N = 95), and (**e**) Coordinator (N = 52) in CS initiatives.

Figure 2d,e and Figure 3 present additional general demographic characteristics of CS initiatives, in terms of the geographical scale, the region, and the initiatives' coordinator. As shown in Figure 2d, most of the CS initiatives reported in the available literature, were locally oriented (48%), with a measurable quantity taking also place at national level (39%). On the other hand, only a few studies were expanded more broadly on the continental and international level (6 and 7%, respectively). "*Involving local communities in conservation initiatives increases a community's appreciation*", as clearly shown in an article exploited during our literature review, related to a case study from the DeHoop Nature Preserve in South Africa [60] (p. 1196). The coordination of CS initiatives was mostly (63%) undertaken by academic institutions (Figure 2e). However, 37% of the CS initiatives, were also found to be coordinated either from a non-governmental (NGO) or a governmental organisation.

American and European countries seemed to have a more leading role in CS initiatives (38 and 36%, respectively), opposed to the Oceanian (15%), African (6%), and Asian (5%) ones (see Figure 3). It is worth mentioning that CS initiatives identified in Russian Federation, were situated in the European part of it (as far as the Ural mountains imaginary line separation), rather than the Northern Asia part. However, for uniformity purposes, all Russian Federation is shown within Europe. Similar trends were also observed in The School of Ants Project, where the authors explicitly state that "*Most visits were from people in the United States (84.9%)."* [61] (p. 4).
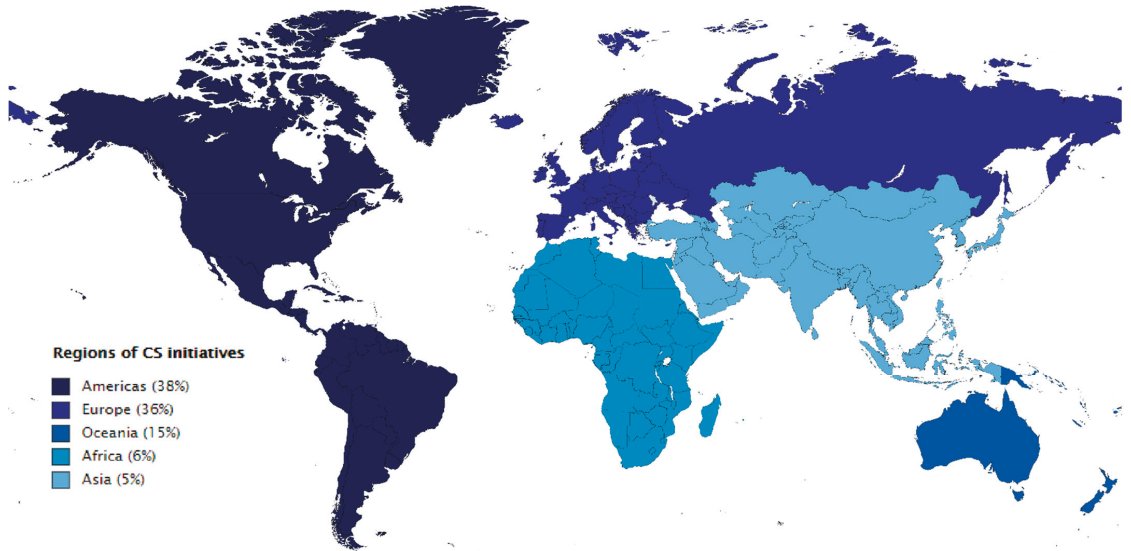
Figure 3. Region (N = 85) of CS initiatives.

3.2. CS Models and Practices

In order to study the components of CS models and practices in relation to public participation, we initially analyzed the available information regarding the overarching aims of the reviewed CS initiatives, as well as their science learning related goals (see Figure 4). It can be clearly seen that "nature conservation" and "awareness" were among the prioritized overarching aims of CS initiatives (~20% each category), with "education" and "environmental management" to closely follow (16 and 14%, respectively). In contrast, 30% of CS initiatives reported that their overarching aim was to contribute to "social and economic research", and to provide data towards "actions" or "improving methods".
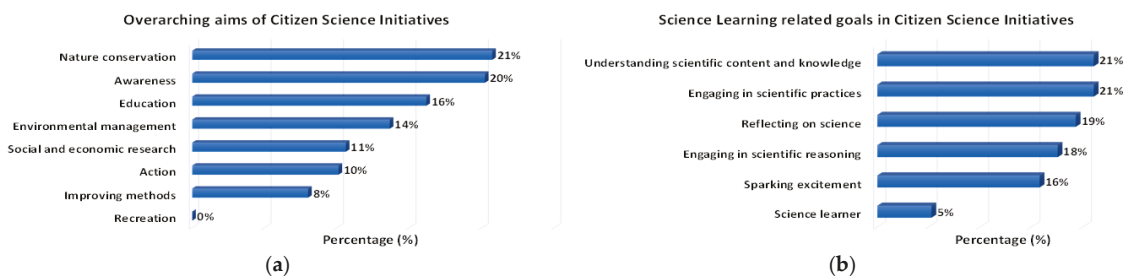
Figure 4. (**a**) Overarching aims of CS initiatives (N = 73), and (**b**) Science learning related goals in CS initiatives (N = 26).

The studies identified in the literature referring to science learning related goals were limited (N = 26). In particular, as it can be seen in Figure 4b, "understanding of scientific content and knowledge", and "engaging in scientific practices", were the main science related learning goals of CS initiatives (21% each category) followed by "reflecting on science" (19%), "engaging in scientific reasoning" (18%), and "sparking excitement towards science learning". For instance, in a very recent publication reviewed in our study, regarding a contributory CS initiative named Helsinki Urban Rat Project, the following statement is remarkable: "*The students described multiple ways that participation led to an*

increase in their interest and resulted in diverse learning outcomes . . . as a way of increasing personal interest in science" [62] (p. 333).

Our review also highlights the data collection processes within the CS initiatives focusing on the level, frequency, and duration of the data collection process outlined in each CS initiative. In addition, we aimed into identifying the modes of engagement and for how long citizens were engaged in CS initiatives.

Specifically, as illustrated in Figure 5a, the majority (58%) of the CS initiatives involved a single person as the data collector. Additionally, there was also a plethora of CS initiatives using small groups of citizens (33%). On the other hand, only a limited number of CS initiatives preferred pairs of citizens (8%), with almost zero initiatives to pursue entire communities as data collectors (1%). One of the major forms of citizens' participation, with reports in more than 87% of CS initiatives, is that of volunteering (see Figure 5b), as individuals had the chance to join, retain, or leave a project at any time without any consequences. However, there was also a small number of CS initiatives (11%) supporting citizens' participation through compensation, which was at least preferable to the pay-to-participate (2%) form of citizens' contribution. Additionally, 74% of CS initiatives reported that citizens were reporting multiple entries over an extended time period (Figure 5c), as opposed to the one-time only reports (26%). Regarding the modes of engagement shown in Figure 5e, 80% of CS initiatives reported that citizens were engaged only with data rather than actively engaged (20%) by putting personal physical or intellectual effort. As shown in Figure 5f, participants in 70% of CS initiatives were contributing, for the purposes of the project, from 1–10 h in total (minimum duration), however some initiatives (22%) required maximum duration (> 24 h) and few of them (8%) reported that the contribution from citizens was in the range of 11–24 h (medium duration). On a recent publication for the evaluation of CrowdHydrology CS project, included in our review, it was stated that "*One-time participants are helpful and may be all that are needed in the case of monitoring a specific event in real-time. However, for developing historical trends at a site for monitoring long-term change, requires transitioning one-time participants into champions.*" [63] (p. 6).

Another important finding from our literature review relates to the citizens' activities, and types of citizens' contributions in CS initiatives. Conducting and monitoring observation along with the collection and submission of data were the primary citizens' activities (~35% each category), reported in the reviewed CS initiatives (see Figure 5g). However, a limited number of CS initiatives indicated that citizens' activities were also related to the receiving of training (14%). It is noteworthy that only few CS initiatives reported citizens' activities related to the advice on the analysis or the design of the study or protocol (<5%). The latter results are also in very good agreement with the types of citizen contributions in CS initiatives, as presented in Figure 5d, as the majority of the reviewed initiatives tended to include contributory (46%) and contractual (36%) involvement from citizens, rather than collaborative, collegial, or co-created type of contribution (<20%).

Figure 6 illustrates the internal and external communication with and among participants. The modes of communication, as shown in Figure 6a, were primarily performed via web-based platforms (40%), and to a lesser extent through in-person meetings (17%). However, some CS initiatives preferentially chose the use of written information, social media, graphical display, telephone, and regular newsletter, as the way of communication with and among participants. The topics which participants were communicating with each other included mostly the initiative's data (31%), or aspects related to training and recruiting (21 and 15%, respectively), rather than the discussion of results, actions, or socializing between them (see Figure 6b). For example, as reported for the purposes of the Great Pollinator Project, in a recent article exploited during our review, "*Throughout the season, project coordinators stayed in touch with volunteers* via *email and blog posts to encourage data submission and highlight seasonal observations*" [58] (p. 41). It is important to note that most of the CS initiatives were using digital technologies as the primary source of communication, either for controlling data quality or improving data collection, or as a way to motivate volunteers and engage broad audiences.

(a) Level of data collection

· Single person (58%)
· Small group of citizens (33%)
· Pair of citizens (8%)
· Entire community (1%)

(b) Forms of citizens' participation

· Volunteering (87%)
· Compensated (11%)
· Pay to participate (2%)

(c) Frequency & Duration of participation

· Multiple times over an extended period (74%)
· One-time (26%)

(d) Types of citizens' contribution

· Contributory (46%)
· Contractual (36%)
· Collaborative (18%)

(e) Modes of engagement

· Engaged only with data (80%)
· Actively engaged (20%)

(f) Duration of engagement

· Minimum duration (70%)
· Maximum duration (22%)
· Medium duration (8%)

(g) Activities citizens involved

· Conducting and monitoring observations (37%)
· Collecting and submitting data (35%)
· Receiving training (14%)
· Advising on analysis (4%)
· Designing study or protocol (3%)
· Using data as evidence in decision making (2%)
· Drawing conclusions and desiminating results (2%)
· Defining the problem, issue or question (1%)
· Asking new questions and taking actions (1%)
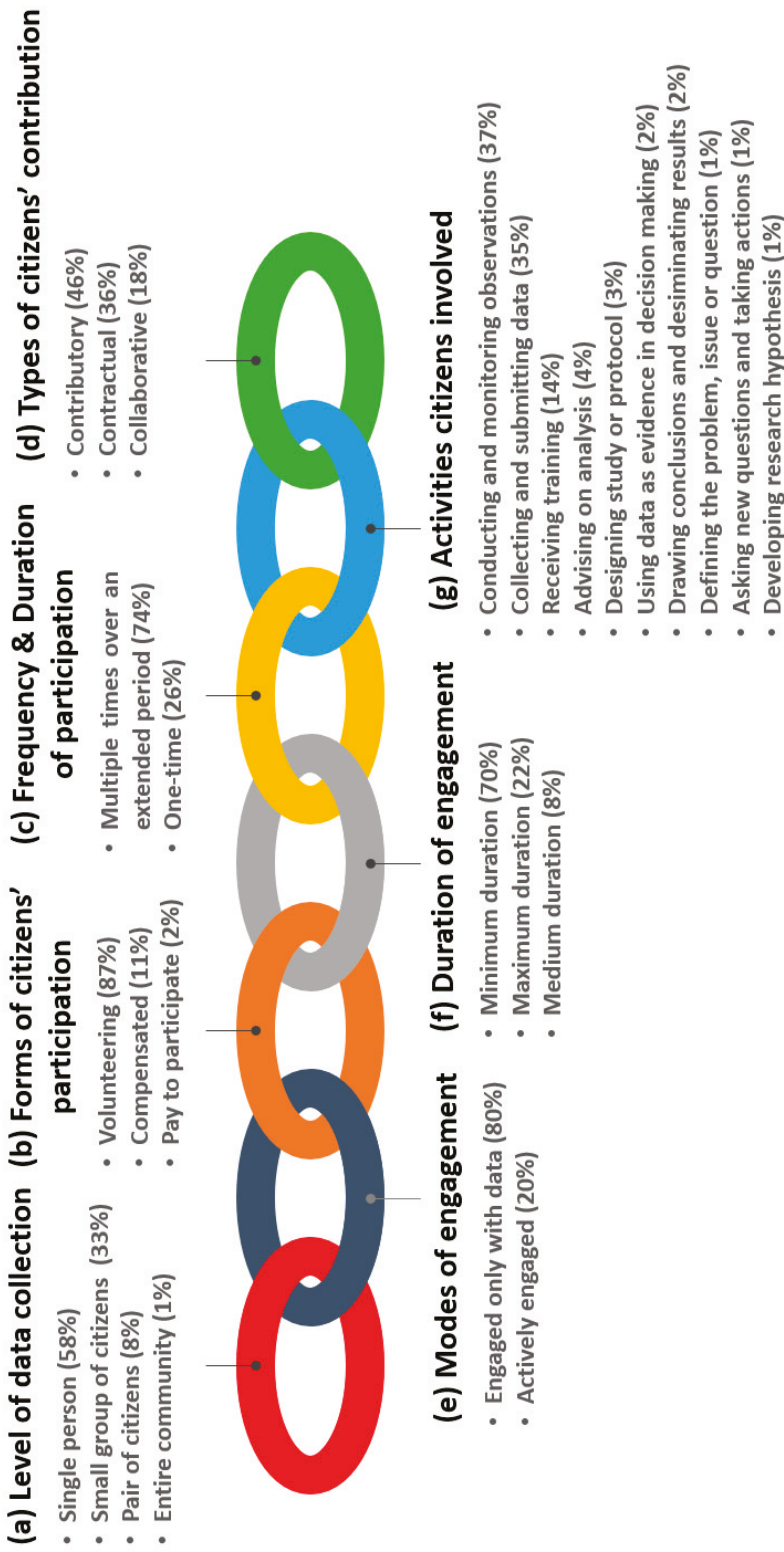· Developing research hypothesis (1%)

Figure 5. (a) Level of data collection (N = 68), (**b**) Forms of citizens' participation (N = 74), (**c**) Frequency & duration (N = 68) of citizens' participation, (**d**) Types of citizens' contributions (N = 65), (**e**) Modes of engagement (N = 57), (**f**) Duration of engagement (N = 50), and (**g**) Citizens' activities (N = 63) in CS initiatives.

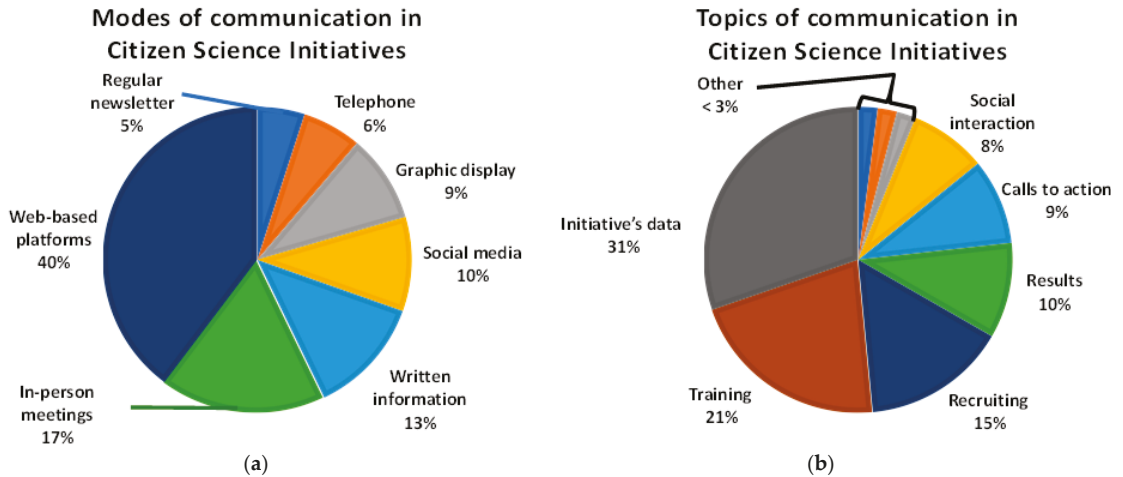**Figure 6.** (**a**) Modes of communication (N = 75), and (**b**) Topics of communication (N = 88) of participants in CS initiatives.

3.3. Facilitators and Constraints of Citizens' Participation

Concrete results revealed trends on important aspects defining citizens' participation in CS initiatives, related to various facilitators (e.g., citizens' goals, benefits, motivations), and constraints (e.g., extensive time requirements, limited funding sources). To start with, citizens' benefits were operationalized as a significant facilitator enhancing the public participation in CS initiatives. As a general statement, we identified that CS initiatives were aiming to benefit the participants, but also to contribute to the development of science as well as to the preservation of socio-ecological systems. More specifically, Table 1 clearly illustrates that citizens provided emphasis on educational (34%) and interpersonal/social benefits (29%), rather than targeting on their emotional/physical/personal development or other hobby-related benefits (~5–15% in each category). Aligned with these findings, one of the reviewed studies reporting on the Project FeederWatch, highlighted that "*The main benefit many interviewees (N = 60) perceive . . . include personal benefits (such as enjoying the experience or finding it relaxing), experiencing nature, and sharing the experience with others (i.e., social interactions).*" [64] (p. 302).

On a different note, as shown in Table 1, the main motivation underlying citizen participation in nature-based/environmental CS initiatives, was the personal, psychological, and physiological enhancement (18%), along with the desire of participants to contribute to the environment (16%), followed by the social support (16%), the educational (12%), and understanding (11%) motives. The least reported motivations included fun, and other protection and value-related motives (<10% in each category).

The main goals mentioned by most of the participants were to contribute to science (23%), connect with nature (21%), and achieve stewardship of the natural world (20%), with learning goals (21%) being an integral part, as opposed to any physical goal from their participation in a CS initiative (<10%). A questionnaire created to evaluate Sea Search members' motivations, benefits, and goals, exploited during our review, reports for instance on the following outcomes [65] (p. 450): (i) "*Sea Search volunteers agreed that they feel good emotionally and mentally during an activity*" (ii) "*Sea Search volunteers also agreed that being in the marine environment during an activity is peaceful and gives a sense of calm*" (iii) "*Volunteers enjoy being part of the Sea Search group and socializing with other volunteers during the monitoring activity*".

Table 1. Relative frequencies and indicative statements for the typologies of "Benefits", "Motivations", "Goals" and "Constraints" of citizens in CS initiatives.

Typology	Relative Frequency (%)	Indicative Statements
Benefits of Citizens in CS initiatives	**88 articles (100%)**	
Educational Learning gains	34%	"There is certainly benefit to be gained (and earned) by all parties if built collaboratively through mutual sharing, dialogue, understanding, learning and collaboration" [66] (p. 7).
Interpersonal and Social	29%	"Managing the relationships with citizen scientists so that the interactions between them and the researchers are mutually beneficial is vital for future success." [67] (p. 67).
Emotional development	14%	"Volunteers responded that their participation in Sea Search activities made them feel good emotionally and mentally" [65] (p. 447).
Personally meaningful	10%	"First, potential volunteers are passionate about the marine environment, which holds special meaning and importance in their lives." [68] (p. 688).
Hobby	6%	"Interpersonal interactions and contributions to a conservation project were each described by 22% of respondents, followed by general enjoyment or "fun" (17%)" [57] (p. 5).
Physical development	5%	"The findings of this study suggest that in recreational forests, visitors experience beneficial mental effects such as stress reduction in addition to physical exercise." [69] (p. 1).
Financial benefits	1%	"Lion Guardians has given us the opportunity to gain formal, gainful employment" [70] (p. 473).
Satisfying curiosity	1%	"The teachers reported that eMammal engaged their students and provoked their curiosity and that the students were more willing to participate in eMammal than in other classroom activities." [71] (p. 76).
Motivation of Citizens in CS initiatives	**57 articles (100%)**	
Personal, Psychological, Physiological enhancement	18%	"… most respondents (72%) selected "personal reasons" to describe their original motivation." [57] (p. 5).
Environmental motives	16%	"The most consistently high-ranking motivations are the opportunity to contribute to nature conservation" [72] (p. 5).
Social support	16%	"Social bonding is also an important component of place attachment, and we found evidence that engagement with community was both a strong motivator for participation in the project as well as a key outcome of the experience" [51] (p. 5).
Educational motives	12%	"(… enrollment in a scientific program and potential for increasing knowledge are common motivations)" [73] (p. 399).
Understanding motives	11%	"…the two strongest motivations underpinning participation, … are 'Values' and 'Understanding'." [74] (p. 1).
Value motives	8%	"… contribution to citizen values and well-being" [75] (p. 185).
Protective motives	7%	"Our literature review highlighted several important motivations for participating in nature-related citizen science, including […] helping the environment, and connecting with nature and place." [76] (p. 2832).
Fun	4%	"Among the most important factors for participating in the program were great opportunity to learn about STEM, new experiences, and topics that sounded interesting and fun." [77] (p. 7).
Curiosity	3%	"This study found that some individuals on Bonaire and Curaçao were collecting data independently, this is, out of personal curiosity and for their own use." [78] (p. 121).
Economic motives	3%	"According to these preliminary data, Saba's fisheries have a proportionally higher economic importance than fisheries in the other two islands." [78] (p. 118).
Career motives	1%	"Younger volunteers rated the "career" motivation much higher than the other age groups" [79] (p. 8)

Table 1. *Cont.*

Typology	Relative Frequency (%)	Indicative Statements
Teaching	1%	"… desire to teach others about bees or citizen science" [58] (p. 42).
Competition	N/A	-
Goals of Citizens in CS initiatives	**44 articles (100%)**	
Contribute to science	23%	"Wanting to 'contribute towards research efforts' was the most frequently mentioned theme" [74] (p. 4).
Connect with nature	21%	"wanting to work close to nature" [80] (p. 116).
Learning goals	21%	"I need to learn more about small bird ID, this will help me" [64] (p. 299).
Contribute to stewardship of the natural world	20%	"This was often spoke of in terms of wanting to engage more closely with the waterfront and to bring others into processes of environmental stewardship." [51] (p. 5).
Educate others	9%	"A total of 98% (n = 306) of active COASST participants surveyed self-reported communicating to others about the program … " [81] (p. 483).
Physical exercise	3%	"The citizen scientists then leveraged their findings to advocate with local decision-makers for specific community improvements to promote physical activity." [82] (p. 1).
Relaxation	3%	"Private users usually observe nesting online for relaxation, and they may also participate directly in analysing the videos." [83] (p. 5).
Constraints of Citizens Participation in CS initiatives	**38 articles (100%)**	
Design and other implementation issues	31%	"The present study didn't evaluate the long-term effectiveness of the participation in the monitoring program, since the post-questionnaire was filled in during the last day of the volunteers' holiday." [84] (p. 12).
Time consuming	15%	"In general, personal costs in terms of time, energy (i.e., effort) and financial resources to be spent were seen as an obstacle" [78] (p. 124).
Biases	15%	"… a small number expressed concerns about targeting of marine species by others" [85] (p. 1).
Lack of recognition of citizens' contributions	9%	"The most common aspect was a lack of reward." [62] (p. 330).
Specialist equipment and knowledge	8%	"Limitations of our system include … different orientations of the badge and camera to the lighting source while capturing an image for calculation." [86] (p. 577).
Funding	7%	"… this was partly due to lack of funding" [87] (p. 163).
Lack of scientific expertise	6%	"… nearly a quarter cited a need for more training and general difficulty in following the protocol" [58] (p. 43).
Lack of best practices	5%	"The present study didn't evaluate the long-term effectiveness of the participation in the monitoring program" [84] (p. 12).
Technological difficulties	2%	"That is, the most frequently mentioned potential barriers were considered to be the technical design" [85] (p. 9).
Limited communication between participants	2%	"… provides limited communications between scientists and volunteers." [63] (p. 4).
Institutional politics	N/A	-
Disabilities/Special educational needs	N/A	-

On the other hand, as part of this review study, we aimed to shed light on the barriers affecting citizen participation in a CS initiative. In this context, during the decoding of the reviewed studies referring to the constraints of citizen participation in CS initiatives (Table 1), it is clear to see that the design and other implementation issues (31%), along with time limitations (15%), were among the major barriers in CS initiatives. In addition, biases related to data validity (15%) and lack of recognition (9%), the use of specialist equipment and knowledge (8%), and lack of funding (7%) were also reported, as opposed to the least significant constraints (<6%) which relate to the scientific expertise and the use of best practices by the CS initiatives. On this matter, as also highlighted in a recent study included in this review, for the purpose of the FeederWatch CS initiative, "*The fee may be a barrier for some potential participants. While many interviewees admitted the amount is not substantial, some were surprised a fee is charged at all.*", "*Time is the leading barrier to interviewees' involvement* [64] (p. 304).

3.4. Environmental Citizenship in Citizen Science Initiatives

An emerging question in our study is whether CS initiatives can endorse forms of participation which can support and promote environmental citizenship. An overview of the dimensions, scales and spheres of the environmental actions reported in the reviewed CS initiatives is shown in Figure 7. During our systematic literature review, it was found that most of the CS initiatives targeted the "individual" (66%) over the "collective" (34%) actions of environmental citizenship. In addition, these environmental actions primarily took place on the "local" scale (63%) and to a lesser extent on the "national" and "global" scale (28 and 9%, respectively). The actions of environmental citizenship reported in the CS initiatives were mostly included in the "private" sphere (70%) rather than in the "public" sphere (30%). A relevant work exploited for the purposes of our review, related to a survey and an interview of participants in the COASST citizen science project, precisely states: " ... *conservation literate citizens develop a schema to prioritize impacts to their local environment, which allows them to move from a nonspecific sense of fear about environmental degradation to a sense of which action or actions are practicable and efficacious. Such a schema might be based on the greatest impacts at a larger scale (regional and global), the greatest impacts at the local scale, or impacts the individual has some ability to combat.*" [81] (p. 485). The promotion of Environmental Citizenship outcomes are also identified and presented in Figure 7, where (i) developing healthy relationship with nature (40%), (ii) solve environmental problems (31%), and (iii) prevent new environmental problems (24%) were the top three outcomes reported in the reviewed CS initiatives.
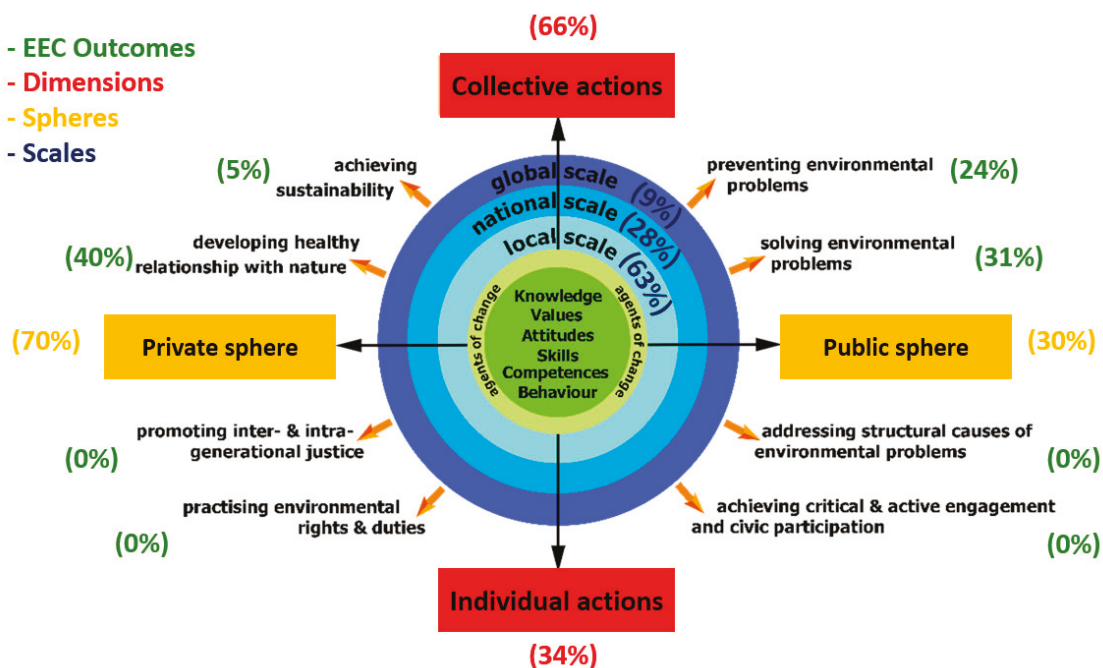
Figure 7. Dimensions, spheres and scales as the environmental citizenship actions (N = 33) as well as the environmental citizenship outcomes (N = 17) promoted by the reviewed CS initiatives (Source Modified: [49]).

4. Discussion

CS initiatives, and especially environmental and nature-based ones, have become an established scientific practice in recent decades. They can serve as a springboard towards the increase of citizens' participation in scientific processes, and the democratization of science, while also contributing to a broader, more inclusive, and more active socio-political participation of citizens. In this context, this study presents a systematic review of the available empirical research on citizens' participation in environmental and nature-based CS. More specifically, the participatory aspects of a total of 119 CS initiatives were analysed on the basis of four research questions set, to shed light on: (a) exclusion and inclusion demographic factors, (b) CS models and practices defining citizens' participation, (c) facilitators and constraints of citizen's participation, and (d) participation forms contributing to environmental citizenship. What follows is the discussion of our findings per research question, guiding this review study.

4.1. Exclusion and Inclusion Demographic Factors
4.1.1. Highly Educated Younger Adults and U18 People without Gender Limitations

At first, we sought to examine the demographic make-up of citizens participating in CS initiatives, as this could lead to potential inclusion and exclusion factors. During our systematic literature review, we did not find any limitations in terms of gender, as both males and females were able to participate in CS initiatives. However, based on the available literature, there are cases of gender inequalities within CS initiatives. For example, in two ornithology CS initiatives operated in the UK, which were studied by Edwards et al. (2018), 83% of respondents were male [88]. This shows the need for more "inclusive" approaches which would be of benefit for CS initiatives, avoiding any discrimination and inequality. In addition, according to the results of our review, most of the participants were adults, and the number of initiatives where U18 people participated was three times

lower. This finding underlines that environmental and nature-based CS initiatives, until now, do not focus on school age participants to an extended degree. These results were also discussed in other studies with similar findings [88]. However, as other recent studies have argued, CS initiatives have great potential as an educational tool which can be used more widely and in more depth for educational purposes as well as for school-age children [89]. The educational level of citizens participating in CS initiatives seems to also be a crucial factor. In fact, and in line with Edwards et al.'s (2018) findings, where 67% of respondents hold a university degree, our findings also provided empirical substantiation that educated people (>80% with at least higher school diploma) mostly participated in CS initiatives. Our demographic findings are also in agreement with the findings derived from a survey contacted by the PEW Research Centre in the USA [90], where younger, more educated U.S. adults were more likely to participate in CS initiatives. In addition, in an evaluation of the educational impact of CS project conducted by the Cornell Lab of Ornithology, it was revealed that the age of seed preference is in the range of our findings, where participants tended to be older and well educated than the general population, with an interest in science [91]. Overall, it seems that the results of this review confirm the trend that nature-based and environmental CS initiatives were dominated by "elite" highly educated groups of people [6]. This fact refers to cultural hegemony of the well-educated academically skilled proportion of the population [92].

4.1.2. EU and American Domination of Mainly Local Scale CS Initiatives

The CS initiatives reported in the majority of the reviewed articles appeared to be local and national based. However, it is of importance to cover a greater geographical scale via the formation of continental and international CS initiatives, in order to reduce discrimination and in parallel to increase uniformity at the environmental level [93]. This geographic imbalance was raised by the fact that most of the CS initiatives were applied in America and Europe, with very few initiatives taking place in Oceania, Africa, and Asia. As described in the literature [29,43,94], and also as found during our systematic literature review, the geographic discrepancy on citizens' participation might be attributed to the lack of national funding and other continental constraints, including but not limited to demographic and socio-political factors [95]. In the same line, participants originated from certain ethnic, racial, and socio-economic groups, which are historically underrepresented, are less likely to contribute in CS initiatives [96]. For instance, in a study with more than 300 biodiversity CS initiatives examined, the participants were white (88.6%), while 6.1% were Hispanic and 4.6% were Asian [97,98]. Thus, a possible explanation, given once again in the literature, indicates that this discrimination might be due either to lack of funding or due to limited impact that citizens have on decision- and policy-making on these geographic regions and continents [99]. This is not the case in Europe and the US, as key players with a central role in the field of CS, dedicating funding for research and development of CS initiatives as well as for capacity building activities.

4.1.3. Academic Driven CS Initiatives

During our review study, we identified that most of the nature and environment-based CS initiatives were coordinated by academic institutions, followed by NGOs and to a lesser extent by governmental organisations, with most of the funding derived by the latter two organisations. This is important, especially after considering that national governments are the ideal level to promote public awareness and decision-making, not only within nations but also on a broader dimension [43]. In addition, the fact that academic driven initiatives are leading to more publications, in comparison to the NGOs-coordinated ones, is that the latter might not have the time or motivation to write scientific articles about their initiatives. Even though CS initiatives are mostly grounded on a volunteer base, the financial support is still very important during all the stages of the initiative (pre- and post- related activities, such as data collection, data control, training, dissemination, etc.). Therefore, in order to achieve sustainability and enhancement of scientific and societal learning, co-funding

(among different sources or countries) should be considered imperative [29,100]. As the National Research Council (NRC) of the US states in the "Ecological for the nation" book, in order to achieve long-term sustainability of a CS initiative, multiple funding sources are needed, especially derived from universities and NGOs [101].

4.2. Emerging Models and Practices of CS Initiatives

4.2.1. Nature Conservation and Awareness Prioritization towards Scientific Content and Knowledge

In order to effectively design CS initiatives and to establish an engagement framework, it is important to track all the current and emerging models and practices along with the forms of participation. Most of the CS initiatives studied had as overarching aims nature conservation, awareness, education, and environmental management, on the local scale. The gravity of each of the above-mentioned overarching aims was also drawn in the Word Cloud by Cunha et al. (2017), where conservation, education, and environmental management were of high priority and mostly reported in the peer-reviewed papers analysed by the authors [43]. Additionally, during our systematic literature review we were able to identify few science learning related goals within the CS initiatives, which were aiming towards understanding the scientific content and knowledge and engaging citizens in scientific practices. In these few cases, science learning promoted scientific literacy in a way that citizens acquire knowledge, understanding the nature of science and raising awareness, as previously raised by various research groups [102,103].

4.2.2. Participation as Individuals Acting as Data Collectors in the Long-Term

Data collection, mostly derived from citizens, is an important aspect for a CS initiative, as it can affect its data quality and reputation [104,105]. Based on our findings, the majority of CS initiatives used single persons or small groups of citizens for the collection of data, multiple times, over an extended time period. This finding has also emerged in the review studies of other research groups, which focused on different research scopes and contexts [43]. It can be understood that these findings also fit very well with the forms of citizens' participation (i.e., volunteers), the duration of engagement (minimum, 1–10 h) as well as with the main constraints reported (time consuming process), as according to Bloom and Crowder (2020), citizens prefer to manage their time and their participation in the CS initiatives according to their schedule with the least possible commitment [106]. On the other hand, as well reported in the literature, contributions are primarily driven by those who return for multiple days, increasing in that way the quality and quantity of data collection, and its impact towards CS outcome expectations [107].

4.2.3. Citizens in Volunteering form Following the Contributory Model of Participation

Our findings regarding the forms of citizens' participation, reveal that citizens were mostly involved on a volunteering basis and were engaged only with data, rather than actively engaged with all the stages of the process underlying the CS initiative. Additionally, most of the reviewed CS initiatives were contributory, and to a lesser degree contractual and collaborative, with no reports on co-created and collegial ones. The latter trend is in agreement with citizens' views on what can hold them off into participating in a CS initiative, as collaborative initiatives are by definition designed by scientists with citizens to contribute mostly on data gathering, data analysis, and dissemination of results, as will be discussed in the following section [2]. These results are in line with other relevant studies [7]. More specifically, there are various studies reporting that citizens were involved only in data collection, rather than data analysis and interpretation, which was performed by professional scientists [61]. The active engagement of citizens throughout the whole duration of the CS initiative, including decision making and management of the CS initiative, it is a relatively recent trend and becomes mandatory in order to increase the impact of CS and decrease the discrimination factors affecting citizens' participation, thus leading to more inclusive and democratic science procedures [2,108].

4.2.4. Digitalisation as the Media of Communication

The use of digital technologies is considered crucial nowadays, as it (i) can engage non-traditional audiences, (ii) stand for communication purposes with and among participants, and thus (iii) have a direct impact on the participatory aspects of CS initiatives [109]. Based on our review, various modes and topics of communications were identified, while the use of digital technologies seemed to improve the control and quality of the data collection. At the same time, according to our findings, digital technologies seemed to motivate citizens, thus contributing to the engagement of broader audiences. Web-based platforms and in-person meetings emerged as the primary means to support the communication of the CS initiatives' participants on aspects such as data collection, training, and recruiting, replacing the more traditional communication venues such as the regular newsletter and the telephone. In addition, previous studies showed that communication among participants is considered one of the main motivational aspects for the continuation of a CS initiative [110]. Therefore, emerging technologies constitute an ideal choice towards the promotion of a CS initiative as well as towards speeding decision-making [111]. For this reason, emerging technologies are well explored in the recent literature for their influence on data collection, management, control, and communication in CS initiatives [112–115].

4.3. Facilitators and Constraints of Citizens' Participation

4.3.1. Citizens Are Motivated by Learning Gains along with Interpersonal and Social Benefits

The majority of the reviewed articles reported that citizens had mainly educational, interpersonal, and social benefits, instead of physical development or hobby and entertainment benefits. These results are in line with the existing literature, in which it is repeatedly reported that it is vital to identify facilitators (motivations, benefits, goals) affecting citizens' participation in CS initiatives [116–119]. According to our results, the primary motives underlying public participation in a CS initiative were the citizens' personal enhancement, as well as environmental and social support. The citizens were motivated towards participating in a CS initiative for their personal development, but also for learning more about various environmental issues as well as for being socialised. It is worth mentioning that our findings are in agreement with the literature [120–122]. For example, McDougle et al. (2011) reported that young adults were motivated to volunteer for social reasons [123]. Our results are in accordance with other studies which showed that face-to-face interactions, the level of personal investment and motivations to socialise can positively influence the level of participation in a CS initiative [124,125]. The specific interest in a particular scientific topic could be also an important motivation for public participation in CS initiatives. For example, an intrinsic interest in birds can attract participants in bird monitoring CS initiatives [126].

4.3.2. Contribute to Science and Connecting with Nature as Citizens' Primary Goals

Considering citizens' goals for participation, most reviewed studies reported that citizens were aiming to contribute to science, connect with nature and take actions towards the stewardship of the natural world, along with the personal learning gains. As recently reported in a book chapter titled "Citizen Science: Connecting to Nature Through Networks", and in-line to our findings, the main goals of participants in CS initiatives were to contribute to science research and connect with nature [127]. Therein, a framework was set in order to promote partnership between participants and to endorse participation based on citizens' personal interests and goals. Complementarily, in an interesting CS initiative (*Connect with Nature programme*) designed and implemented by the Emirates Nature-WWF, 2020, the stakeholders were particularly aiming towards connecting United Arab Emirates residents with nature, thus promoting active participation and contribution to science.

4.3.3. Constraints Arising from the Design to the Implementation of CS Initiatives

Citizen Science, nowadays, is widely used in academia as method of retrieving research data from the crowd, and thus various limitations and biases should be targeted

and controlled [121]. Additionally, as the case studies published in the available literature referred to successful CS initiatives which were mostly beneficial for the participants, there is still limited understanding of the barriers leading participants not to participate or abort from the initiative. Based on our findings, the highest constraints of citizens' participation in CS initiatives were attributed to the design/implementation issues as well as the fact that the initiatives required significant time spent from the participants, leading them in this way to aversion. Similar trends were observed in a recent crowdsourcing systematic review report published by Strang and Simmons (2018), where interviewees pointed to the importance of having clear instructions, consistency on the feedback from the initiative coordinators, and meeting the time frames set during the design of the initiative. However, in the same study, only 20% of the participants completed the initiative, with the rest aborting it at various stages [34]. Thus, inadequate design and implementation of a CS initiative, by compromising funding sources and the time requirements, could potentially lead participants not to be satisfied from the initiative. In this way, data quality might be impacted [128,129]. On the other hand, careful design and implementation of CS initiatives could be the opportunity to contribute to the active engagement of environmentally concerned citizens [130].

4.4. Citizen Participation in Citizen Science for Environmental Citizenship

The degree of inclusiveness, the depth of democracy and participation, the issues of equality as well as the issues of intra- and inter-generational justice in CS initiatives are of particular importance for the promotion of environmental citizenship [49]. Based on the results of this literature review, CS initiatives related to environmental and nature-based issues mainly promote efforts to develop a healthy relationship with nature, as well as to solve existing or prevent new environmental problems (e.g., biodiversity loss, air pollution, etc.). However, their focus on environmental citizenship as well as their attempt to fostering a deep civic participation and active engagement with society could be further integrated. In addition, their contribution to the suppression of the structural causes of environmental problems, but also to the promotion of intra- and inter-generational justice, is almost absent. Focusing on the level of environmental citizenship actions, the reviewed CS initiatives deal mainly with environmental citizenship actions lying at the individual dimension, while ignoring collective actions as well as actions in the public sphere. Based on our results, we recognize that, in many cases, CS initiatives contribute to a local connection with local civic actions (place-based approach) or sometimes to national actions, but there are only few CS initiatives promoting environmental citizenship actions on the global scale.

5. Limitations of the Study

Although we aimed at providing a comprehensive systematic literature review, in order to contribute to the improvement of future nature-based and environmental CS initiatives and to conceptualize the whole spectrum affecting participation in CS initiatives, some limitations should not be overlooked. The use of search engines for retrieving scientific articles by filtering the available literature with specific keywords has risks, and should be treated carefully in order to draw valid conclusions [32]. In addition, our approach resulted in the review of academic articles in English language within the last two decades (2000–2020), without covering other languages. This approach led us to retrieve articles from various areas with newly established scientific data mostly from academia [131,132]. However, the filtering of studies according to time of publication and English language might lead to chronological and geographic discriminations, respectively [133].

6. Conclusions, Implications and Future Research

There has been an increase of interest in the design and implementation of nature and environmental-based CS initiatives in the last two decades. However, there is still a lack of understanding of important aspects in relation to citizens' participation. Due to the multifaceted complexity of CS, participants have to converge their views and needs,

understand each other, and thus jointly and actively support the establishment of such inclusive and participatory CS initiatives which can act as a venue of citizen empowerment towards environmental citizenship.

Based on our findings, nature and environmental-based CS initiatives applied in the last two decades present several weaknesses, and it seems that future endeavours in the field should take into consideration various aspects affecting citizen participation. Notably, since most of the prior research has not attempted to review, synthesize, and compare projects and best practices focusing on the concept of participation, many of our outcomes could be treated as unique, to the best of our knowledge.

Focusing on the inclusion and exclusion demographic factors, CS initiatives aiming to cover greater geographical scale should target on a more continental and global scale. In this way it will be possible to engage more Oceanian, African, and Asian populations, thus limiting any geographic discriminations. Demographic trends also revealed the necessity to engage more U18 citizens, and in the cases where CS initiatives aim towards education, further adult participation, thereby forming a society educated from an early age. Particular attention should also be given to more inclusive approaches, avoiding any discrimination such as those of gender, educational level, and access in digital technology. Additionally, it is noteworthy to be mentioned that it is important for CS initiatives to give voice to underrepresented groups and societies, in groups with disabilities, and low skilled/low achievers' groups. The learning potential of CS initiatives is of great significance and should be given more emphasis in future research studies, as it can allow scientists and communities to have access to further insights, thus facilitating policy- and decision-making. Strengthening the coordination and funding sources of CS initiatives is considered of paramount importance. These decisions should not be only made by academic institutes but also by NGOs and governmental organisations, as the latter two constitute an ideal leverage for the promotion of public awareness, policy- and decision-making, though lag on disseminating their findings in the form of scientific publications.

Considering the emerging models and practices of CS initiatives identified during our systematic literature review, it seems that CS initiatives should direct their overarching aims towards "actions" and "improving methods and tools" required for better data management and quality. The latter highlights the importance of setting certain overarching aims on a CS initiative, including but not limited to the nature conservation, awareness, education, and environmental management. Additionally, considering the science learning related goals of CS initiatives, these should be also designed in order to spark the excitement of citizens, and along with scientific literacy and knowledge gains, to contribute to an increase in their understanding of the nature of science. Therefore, future research can focus on the needs of citizens and the design of models and practices, which can be valuable for key stakeholder to design and implement CS initiatives. Such models and practices will promote citizens' activities in addition to "passive" data collection and submission.

Understanding the facilitators (e.g., benefits, motivations, goals) and the constraints of participants in CS initiatives will advance the design and implementation of future research in the field, while following important scientific practices. As shown in this review, citizens reported that their primary benefits were to educate and socialise themselves. Thus, in combination with the main motives identified during our review, we propose that future CS initiatives should take into account the personal, psychological, and physiological aspects of participation, as well as the citizens' educational, and social expectations. Recognizing citizens' benefits and motivations will help CS initiatives efforts towards approaching citizens' goals such as the contribution to science, stewardship of the natural world, and connection with nature. To reveal positive and negative impacts of CS initiatives, it is also important first to overcome (at least) the main reported constraints related to the design and implementation issues and to create CS initiatives with less time requirements.

Enhancement of democratization of CS initiatives is of particular importance. Broadening citizens' participation through more participative and co-design models of participation is crucial. Future CS initiatives should not target engage citizens only with data but with the

whole process, thus achieving a long-term engagement. The latter might also be enhanced by the appropriate design of models and practices of CS initiatives which primarily will use not only single persons as volunteers, but also groups of citizens or communities, thus creating a sustainable, pleasant, and productive environment. In addition, incorporating socio-political and socio-cultural actions will help to promote awareness, nature conservation, and develop environmental citizenship with more focus on environmental citizenship actions situated in the collective dimension, public sphere, as well as on the national and global scale. Therefore, based on our findings, much more efforts should be made in order to achieve a sustain contribution and engagement, which can eventually lead to more aware citizens, participating actively (either physically and/or intellectually) throughout the whole duration of the project.

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Article

Secondary Science Teachers' Views on Environmental Citizenship in The Netherlands

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Abstract: Environmental Citizenship (EC) is a promising aim for science education. EC enables people not only to responsibly make decisions on sustainability issues—such as use of renewable energy sources—but also to take action individually and collectively. However, studies show that education for EC is challenging. Because our understanding of EC practice remains limited, an in-depth, qualitative view would help us better understand how to support science teachers during EC education. This study aims to describe current EC education practices. What do secondary science teachers think sustainability and citizenship entail? What are their experiences (both positive and negative) with education for EC? A total of 41 Dutch science teachers were interviewed in an individual, face-to-face setting. Analysis of the coded transcripts shows that most teachers see the added value of EC but struggle to fully implement it in their teaching. They think the curriculum is unsuitable to reach EC, and they see activities such as guiding discussions and opinion forming as challenging. Furthermore, science teachers' interpretation of citizenship education remains narrow, thus making it unlikely that their lessons are successful in fostering EC. Improving EC education therefore may be supported by explicit representation in the curriculum and teacher professional development directed at its implementation.

Keywords: environmental citizenship; lower secondary level; science education; science teachers; education for environmental citizenship

1. Introduction

Societies are dealing with complex environmental issues such as climate change, energy crises, and degradation of natural areas. These issues create a need for citizens who are analytic, who can make decisions based on personal, social, and scientific considerations, and who are able to put these into practice. In other words, these issues raise the need for Environmental Citizenship (EC). The importance of EC is shown by educational programs of large international organizations across the globe. For example, the Lifelong Learning Competences of the EU explicitly feature sustainability elements in their description of citizenship competence [1]. Another example is the Sustainable Development Goals, set by the UN, in order to globally align policies and development plans with the sustainability agenda [2]. Finally, the UN organized the Decade of Education for Sustainable Development, which lasted from 2005–2014, and aimed to push the sustainability agenda on schools worldwide [3].

However, this focus on EC in educational policy does not necessarily result in more EC being implemented in the classroom. In education, much depends on the choices of the teacher. When science teachers do not see the value of EC, chances are slim for their students to develop EC on their own. Previous large scale, quantitative studies have shown that many science teachers feel unprepared and unsure when teaching about sustainability and its related SSIs [4,5]. However, because most of these studies adopted a quantitative approach, there is a need for in-depth interview study to provide a qualitative view on science teacher's perceptions on and experience with teaching sustainability at the

secondary level [4]. If we would better understand what teachers are struggling with and what possibilities they foresee, we would be better equipped to support teachers during EC teaching. Hereby, we would improve chances of fostering EC.

In this paper, we aim to describe the current situation of education for EC in the Netherlands at the lower secondary level by answering the following questions: What do Dutch science teachers think sustainability and citizenship entail? What are their experiences (both positive and negative) with education for EC in classroom practice? Describing this current state is a first step in better understanding what challenges exist, and where the research community could support science teachers in education for EC.

1.1. Definitions of EC and Related Concepts

The last decades of research on sustainability education have resulted in insights in teacher experiences with EC in science education. Results from these, mostly quantitative, studies will be discussed in this section, but not before making a statement as to the interpretation of EC and its relation to sustainability, sustainable development, and educational approaches towards these topics.

Although many definitions of sustainability exist, one of the most widely used is the Brundtland definition, from the famous Our Common Future report. This report defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [6] (p. 41). To make this sustainable future into a reality, citizens need a specific set of knowledge, attitudes, and behavior that enables them to deal with sustainability issues in their daily lives. This form of citizenship consists of diverse competences such as systems thinking, normative competences, future thinking, and strategic thinking. An Environmental Citizen performs these actions individually and in groups, both in private and public spheres, and on local, national, and global scales [7]. In doing so, environmental citizens aim to solve contemporary issues, prevent new ones, and achieve sustainability through this, among others. EC thereby encompasses elements of all three types of citizen as defined by Westheimer and Kahne [8]: (i) the personally responsible citizen, who acts responsibly, is law abiding, and honest; (ii) the participatory citizen, who actively participates and takes leadership positions in existing systems; (iii) and the social-justice oriented citizen, who questions, debates, and changes these existing systems.

Two common teaching approaches that can foster EC are Environmental Education (EE) and Education for Sustainable Development (ESD). Despite sharing certain aspects, they differ considerably in their ideological focus [9]. EE explores humanity's relationship with nature and aims to preserve natural areas. It focuses strongly on scientific content knowledge. ESD, on the other hand, adopts a broader view which also considers social, economic and cultural elements. A common theme in ESD is the triple bottom line of sustainability, which consists of people, planet and prosperity [10]. This broader focus of ESD, and especially its supposed overemphasis of economic aspects of sustainability issues, has received criticism from scholars. They argue that by moving away from EE towards ESD, the inherent value of nature no longer has a place in the science classroom [11]. Other researchers see EE and ESD next to each other, both with their own niche and focus [9]. A third form exists, which combines elements of EE and ESD, in such a way as to address "knowledge, skills, values and affective issues for a changing future without losing sight of the imperative for understanding and valuing conservation of the biophysical world" [12] (p. 104). This form is called Education for Sustainability (EfS). A synthesis of the concepts EE and EfS, with a special focus on citizenship, is Education for Environmental Citizenship (EEC), which aims to empower students to become responsible environmental citizens [7].

1.2. Teachers' Conceptual Understanding of Sustainability and Citizenship

There have been several quantitative studies looking into teachers' conceptual understanding of sustainability, i.e., [4,13–15]. Judging by these, sustainability is a difficult

concept for teachers to define. In a large questionnaire study with over 3000 Swedish teachers, many different teacher interpretations of sustainability were found, and many teachers reported they were uncertain of its meaning [4]. Most teachers saw sustainability issues solely as knowledge problems, often altogether disregarding the social, ethical, personal, and economical aspects of sustainability. In doing so, they almost exclusively focused on the scientific facts and models behind sustainability issues.

In other studies, this omission of the citizen aspects of sustainability teaching has been found as well [13]. Traditionally, science education focused on the environmental aspects of sustainability (i.e., processes of climate change, toxicity of compounds, energy efficiency of different fuels). Only 15% of the 123 pre-service teachers that filled in a questionnaire on sustainable development used a combination of the people, planet and prosperity elements, whereas three quarters of the participants named planet aspects to be central to sustainability. This oversimplified understanding of sustainability is widespread, with a holistic view of sustainability often being absent [14]. Findings like these prompt researchers to call for a broader focus on multiple perspectives, critical thinking, added complexity, and socialization or repoliticizing sustainability issues in the classroom, of course combined with rational and scientific ways of thinking [15].

Recently, a review study has been carried out looking into pre- and in-service-teachers' perceptions of EC [16]. From these mostly quantitative studies, the researchers concluded that teachers adopt relatively narrow definitions of EC, focusing on local scale issues, the individual dimension of EC and remaining in the private sphere. The researchers conclude that these perceptions influence educational practice, and are thus worth looking into.

These studies are all based on quantitative data. A qualitative view on science teachers' understanding of sustainability is desirable. With this, we could better describe their rationale behind their interpretation of the complex and multifaceted concepts of sustainability and EC. This could provide a stronger foundation from which to support science teachers during teaching EC.

1.3. Current EC Teaching Practice

Several themes can be identified about current EC classroom practice. In recent years, a shift from EE towards ESD has been observed in science education policy documents [14,17]. Some researchers criticize this shift in focus, expecting this to be counterproductive for the transition towards a sustainable society [11]. However, despite this shift in policy focus, classroom practice seems as of now unaffected. While EE focuses strongly on ecocentrism, ESD introduces anthropocentric tendencies. Findings from a large, international comparison study show that science teachers in developing countries mostly adopt anthropocentric views, whereas ecocentric views still prevail among teachers in developed countries [4,18].

Zooming in on the Netherlands, the Dutch curriculum for lower secondary science education [19] (Kerndoelen 'Mens en natuur', core aims 'Humanity and nature', p. 10) does not explicitly mention EC or citizenship. It does, however, refer to citizenship aspects such as making informed decisions and behaving in a sustainable manner. Perhaps this relative under-represented role of citizenship in the Dutch curriculum has led to relatively poor results for the country in international comparison studies such as the International Civic and Citizenship Education Study [20].

Concerning sustainability, ESD, EE, and EfS, the Dutch lower secondary curriculum aims contain many examples, such as, for instance, "The student learns that people, animals and plants are in connection with each other and their surroundings (environment), and that technological and scientific applications affect the sustainable quality of these surroundings in both positive and negative ways" [19] (core aim 30, p. 11). In the Netherlands, the lower secondary curriculum aims form a set of guidelines; it is not an obligatory rulebook. This means that in the end, the teachers are the ones who decide what curriculum aims are pursued. From previous studies it became clear that not all science

teachers think ESD is important [4]. Furthermore, teachers from different subjects show different willingness to teach ESD [4]. Therefore, to better understand the current state of EC teaching in the Netherlands, it is necessary to look into the choices teachers make and their rationale behind those decisions.

Next to the national curriculum, teachers formulate their own learning aims for students. In ESD, three different approaches to learning aims have been defined by Kelly [21]: (i) a focus on science theory, discarding emotional aspects entirely to prevent indoctrinating students with their own opinions; (ii) raising awareness of environmental issues; and (iii) showing the complexity and controversial nature of sustainability issues with the aim to promote responsible decision making. Reasons for picking the first strategy commonly include the focus of national exams on theory, a focus that creates the risk of painting too narrow a picture of sustainability issues [15]. Neglecting or glossing over negative emotions in sustainability debates has been deemed a common and undesirable trait of current science education practice [22]. Exploring teacher-initiated learning aims related to sustainability could further improve our understanding of current EC practice.

1.4. Challenges of Teaching EC

Previous studies have found a diverse range of challenges with teaching EC at the lower secondary level. A review study on teaching EfS shows that secondary teachers generally feel they lack skills to effectively integrate it into their regular classroom practice [12]. Teachers say they are used to teaching scientific facts, whereas they are uncertain with teaching ethical and social issues in the science classroom [23]. Because sustainability issues are often controversial in nature, they benefit strongly from teaching methods that involve discussion and dialogue, yet science teachers feel less secure in applying these activities [13].

Another main issue for science teachers is the multidisciplinary character of sustainability issues. This complicates teaching because many teachers come from highly specialized backgrounds. Interdisciplinary teaching would enable students to develop EC competences, whereas focusing on individual topics is counterproductive to reach EC [14]. Teaching about sustainability in a holistic manner, thus showing interconnectedness of topics, makes EfS difficult [24]. Next to holism, pluralism is important when teaching about sustainability issues. In a pluralistic classroom, multiple perspectives on issues are considered. Pluralism, like holism, has been found to be hard for science teachers [25].

Other, more practical, complicating factors for teaching sustainability were found in the previously mentioned study by Borg and colleagues [4]. In this study, teachers reported that teaching sustainability issues was made difficult by a lack of time and space in the curriculum, a lack of inspiring examples, a lack of time to adapt existing teaching activities to make them more suitable, and a lack of perception of learning aims for sustainability education. Similar conclusions are drawn in other studies, e.g., [12].

As can be seen from many of these data sources, most of what we know about current-day science teachers and their views towards sustainability, their current EC teaching practice, and the challenges they experience with teaching EC stems from quantitative studies. A qualitative, in-depth view would improve our understanding of what support science teachers need when teaching these topics.

2. Method

For this study, 41 science teachers were interviewed in a face-to-face setting. The interviews lasted for 31 min on average.

2.1. Participants

Teachers were approached from the researchers' network. Participants were selected to ensure a representative topographical spread, gender ratio, and subjects taught. Table 1 shows background data of the participants. The final sample slightly over-represented

rural areas when considering the urbanization ratio of The Netherlands, which lies at 91.5%, with 15% of the interviewed teachers being from rural areas [26].

Table 1. Background data of the interviewed teachers, showing age, gender, teaching experience, current subjects taught, and type of school (rural or urban).

Category	Background Data
Age	Average: 44.2 Minimum: 25 Maximum: 64 20–29: 9 30–39: 7 40–49: 8 50–59: 11 60 and above: 6
Teaching experience (years)	Average: 11.9 Minimum: 1 Maximum: 40 0–9: 19 10–19: 18 20–29: 1 30 and above: 3
Gender	Female: 19 Male: 22
Current subjects taught (number of teachers)	Biology: 26 NASK [1]: 16 Science [2]: 6 Other [3]: 19
Urbanization level of school area (number of teachers) [4]	Rural: 6 Urban: 35

[1] Abbreviation of *Natuur-scheikunde* (Physics and chemistry), a subject that some schools teach at the lower secondary level. [2] Some schools teach this subject, which focuses on scientific inquiry through problem-based learning and question-oriented learning. [3] Other subjects include mathematics, home economics, IT, and research-based subjects. [4] Based on number of addresses per 500 m^2.

2.2. Instruments and Data Collection

A semi-structured interview approach was used to gather the data (for interview scheme see Supplementary Material, available online). The interview scheme was constructed to cover a broad range of teacher activities, including their conceptual understanding of sustainability and citizenship, whether they think it is important for their teaching practice, learning aims, lesson design, and carrying out EC lessons in the classroom. Furthermore, to explore their aims and teaching approaches with EC, we asked them in what way they recognized EC concepts in the national curriculum aims. After this, we asked them about challenges they experience with applying EC in the classroom, and their levels of confidence when teaching EC. To fortify our understanding of their confidence with teaching EC, the interview ended with questions regarding incorporation of other socio-scientific issues in their lessons, and three self-efficacy questions. The self-efficacy questions were based on the three self-efficacy themes defined by Tschannen-Moran and Woolfolk Hoy [27]: (i) classroom management, (ii) ability to motivate students, and (iii) availability of teaching and learning activities, all seen from an EC angle.

2.3. Data Analysis

All interviews were audio recorded and transcribed verbatim, omitting vocalized pauses to enhance readability of the transcripts. Common themes were sought in the transcripts based on the constant comparative method [28]. This method consists of several cycles of coding all the transcripts, with each cycle further specifying and tightening the

coding scheme. During the first cycle of coding, the data are coded in as many categories as necessary. Notes about emerging themes were made, which informed subsequent cycles. During these following cycles, the coding scheme was narrowed down, ultimately leading to a tight, cohesive set of codes that shows common themes in the data (see Supplementary Material, available online, for the final list of categories and their descriptions). A second researcher coded 12% (five interviews) of the data using the developed coding scheme, and after discussing the two analyses, 98% of agreement was reached. This indicates nearly perfect agreement [29]. Percentage of agreement is an applicable intercoder reliability measure in this case because in the current study, each code can be given only once to each teacher [29]. Based on the discussion, the coding scheme was finalized and the whole dataset was coded accordingly.

3. Results

The following common themes were found after analysis of the science teacher interviews.

3.1. Science Teacher Definitions of Sustainability and Citizenship

When teachers described their definition of sustainability, planet aspects were by far the most common of the triple bottom line, with about half of the teachers' answers falling in that category (19/41, Figure 1). In contrast, prosperity aspects were mentioned by less than one tenth of the teachers (3/41). One teacher summarizes:

"Well, kind of, reuse of resources. Good for the environment, little CO_2 emissions. Yes, something like that? It is kind of a vague concept, isn't it? Students think so too, by the way."
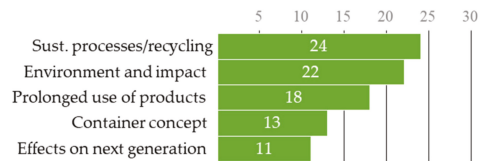
(Teacher 11)

A few teachers give a definition of sustainability that fits closely to the Brundtland definition (7/41). Most teachers focus on sustainable processes and recycling when defining sustainability instead (24). About half of the teacher definitions of sustainability included references to the environment (22/41) and prolonged use of products and materials (18/41). Another common theme is effects on next generations (12/41). As the following quote illustrates, 13 teachers mentioned sustainability is a container concept:

"Sustainability concerns, it is a very broad concept, a container concept that contains a great many things. Sustainability is about for instance sustainable energy. It is about all kinds of resources that nature offers us, and using these in a sustainable manner. So using them in such a way that we can use them again. Kind of. It is about leaving a sort of Earth that can be used again. On which you do not exhaust all kinds of resources, but with which you, where you can use them but use them in such a way that next generations can use them too. Kind of a vague story, but. And then you can talk about solar energy, well, apart from the materials where that is made out of, what do you do with that?"

(Teacher 23)

How would you define sustainability?

N = 41
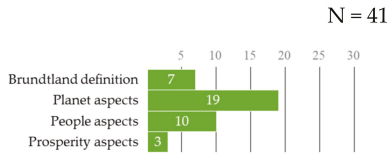
Categories per teacher: 2.1

Sustainability is about…, N = 41

(**a**)

How would you define citizenship?

Categories per teacher: 3.0

Citizenship is about…, N = 41

(**b**)

Figure 1. Definitions of: (**a**) sustainability, including categorization on Brundtland and triple bottom line of sustainability (people, planet, prosperity); and (**b**) citizenship, according to the 41 interviewed teachers. Numbers in the bar graphs represent total number of teachers whose answers fell in the respective categories.

Concerning citizenship, three quarters of the teachers define it using terms that describe the relationship between the personal, the individual, with society (30/41). According to half of the teachers, citizenship deals with socially desirable behavior (18/41), caring for your surroundings, being involved and conscious about your place in society (18/41). One teacher says:

"I find that a very difficult question, but yeah, I see that as learning from each other, how you find your way in this society and, how you develop, in such a way that you add something to society and your surroundings and people around you, and that can be very broad but it can also be very small, in a smaller circle. Yes, summarizing, adding something to your surroundings."

(Teacher 39)

Citizenship is seen as being part of 21st century skills by seventeen teachers. A quarter of the teachers says it has to do with the development or maturation of the students (12/41) and with norms, values and ethics (10/41). A total of 11 teachers think citizenship is a complex and difficult concept, with three other teachers going further by claiming they do not know how to define it at all.

3.2. Curriculum and Classroom Practice

Twenty-five teachers think there is a lack of sustainability in the national curriculum (Figure 2). They think the curriculum overemphasizes the theoretical side of sustainability (12/41) and that sustainability is incorrectly represented in the current curriculum (9/41). Describing this, one teacher says:

"The disadvantage of school is you have a program, […] with physics lessons, sustainability isn't at all an item there. But as soon as we discuss solar panels and solar energy,

then suddenly it is. So I think it is an important theme, but I could do a lot more about it. [. . .] Because learning is not only for your test or the exams, it is also life-learning. [. . .] You don't always have the time for that, [. . .] not the societal part, and that is a pity, it only is the technical aspect [. . .] Look, that whole discussio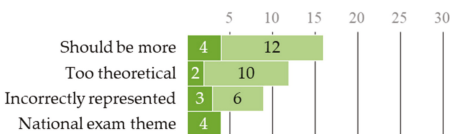n now, about, we have a climate treaty [. . .] And then the question immediately presents itself: how are we going to make that workable? What can we do with it? That whole kind of thinking, look, students know very little about that."

(Teacher 34)

Do you recognize sustainability in the national curriculum?
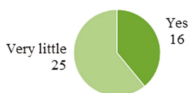
Further comments, N = 41

Categories per teacher: 1.0

(**a**)

Do you think sustainability is important for your lessons?

Why? N = 41
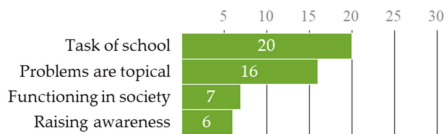
Categories per teacher: 1.2

(**b**)

Do you incorporate sustainability in your lessons?
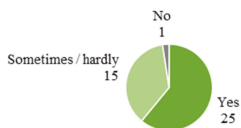
Further comments, N = 41
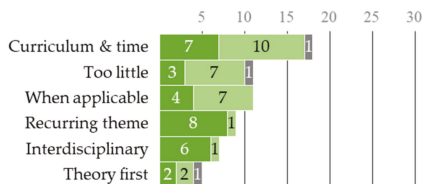
Categories per teacher: 1.5

(**c**)

Figure 2. Teacher perceived (**a**) curriculum presence, (**b**) importance in the classroom, and (**c**) teaching occurrence of sustainability, as described by the 41 interviewed teachers. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories. Colors in the pie and bar graphs correspond.

Despite this general lack of sustainability in the curriculum, all interviewed teachers think sustainability is important for their lessons. Twenty teachers feel that it is a task of the school to teach about sustainability. Sustainability issues are typified as urgent and topical (16/41), so they should be taught at school. Seven teachers think that students need to know about sustainability to function in society. One teacher explains:

"I think it is a very important theme, because you see it a lot around you of course. [. . .] You see it everywhere, this is sustainable, that is sustainable, on fashion brands, or sustainable wood, you know, on these stickers and labels, you find them all the time. I think it is important that we pay attention to this during biology lessons, because it kind of is a term that is used regardless of whether it is appropriate or not, even though it is kind of a difficult concept. What actually is that, sustainable? [. . .] Where does the sustainability come from then? I think it is a subject, certainly for biology and mainly in lower secondary level, [. . .] that everyone should learn something about."

(Teacher 13)

Despite the criticism on the curriculum, over half of the teachers (25/41) incorporates sustainability in their lessons. Nine teachers claim it is a recurring theme for them. Reasons for only occasionally incorporating sustainability in their teaching include a lack of time and a full curriculum (11/41), and a focus on theoretical subject knowledge first for the lower secondary level, before more complex topics such as sustainability can be taught in the higher secondary level (4/41). This is illustrated by one of the teachers, saying:

"Currently on my schedule is sustainable energy. We discuss energy use, gas and electricity, energy at home, energy transport, [. . .] and at a certain moment you discuss how do you produce electricity? Yeah, you don't just discuss coal plants then, but you also have to explain wind turbines and discuss the energy transition and explain that. I think this belongs in the curriculum. Next to that, you hope that children learn more than what is written in the textbook, but that they become kind of critical citizens of the world, in a way, and that, that is kind of a side effect that I hope to achieve in my lessons, but it is not part of the program. And I try to stimulate them and because I like this subject I talk about it sometimes, but I do not always receive the response that I like. Then I think yeah we have subjects such as philosophy and big thinkers, let them discuss these themes there as well. And I think that this belongs there more, and in chemistry, I think, yeah you should discuss plastics and recycling and such, the actual content belongs here, but the moral stuff belongs on a higher level."

(Teacher 12)

Only one teacher says they never teach about sustainability, with reasons for this including the curriculum and this focus on theory first.

In contrast, about half of the teachers do not recognize any citizenship in the national curriculum (18/41, Figure 3), with a further quarter of them only seeing very little citizenship in the curriculum (12/41). Elements of citizenship that are there are connected to sustainability (10/41) or related to opinion forming (10/41). Eight teachers feel there should be more citizenship in the science curriculum, and seven teachers feel citizenship is mainly connected to other subjects or should be mainly taught at the school level. One teacher says:

"I think there is nothing about it [citizenship] in there [the curriculum]. I cannot remember at least. I should have a look at that, if there is something in the chemistry curriculum about citizenship. But I cannot remember it being there. [. . .] Actually, I would be surprised if it is there, very honestly. But in a way I would think it is good if it is there, because I think chemistry plays a role in that too. [. . .] But I think it is kind of limited, because it actually only fits with sustainability, because all other subjects [. . .] I could not think of another subject that could fit with it [. . .] polymers perhaps, plastics, but those again connect to sustainability. So all of it is sustainability related then."

(Teacher 8)

Do you recognize citizenship in the national curriculum?

Further comments, N = 41
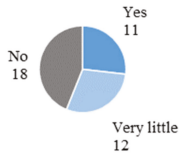
Categories per teacher: 1.6
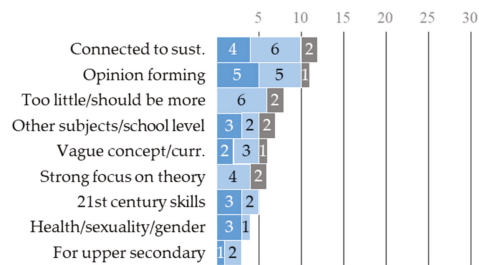
(**a**)

**Do you think citizenship is important for your lessons?**
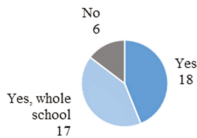
Why? N = 41

Categories per teacher: 1.7

(**b**)
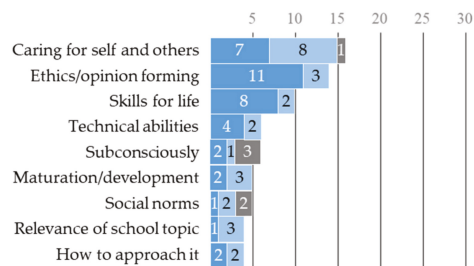
Do you incorporate citizenship in your lessons?
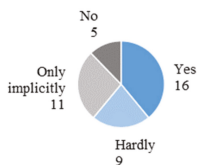
Further comments, N = 41

Categories per teacher: 2.8
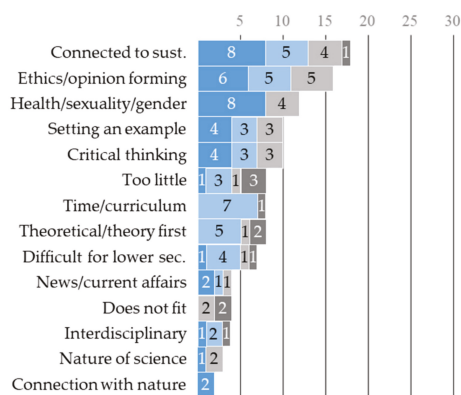
(**c**)

Figure 3. Teacher perceived (**a**) curriculum presence, (**b**) importance in the classroom, and (**c**) teaching occurrence of citizenship, as described by the 41 interviewed teachers. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories. Colors in the pie and bar graphs correspond.

As can be seen from Figure 3, some teachers say citizenship is a vague concept. Again, teachers describe the theoretical focus of the science curriculum, leaving little room

for topics such as citizenship. Three teachers think that citizenship is more suitable for the upper secondary level.

Many teachers think citizenship is important for their lessons (18/41), while other teachers do agree with this, adding that it is important for all subjects (17/41). Fourteen teachers think it is important because it is about care for oneself and for others. Other reasons include ethics and opinion forming being important (14/41) and citizenship being a necessary skill for life (10/41). Describing this in further detail, one teacher says:

"Yes I think indeed, students at school, they do not necessarily, do not see the use of lessons very often. Even though I think that when you show the use to yourself and of the world around you, without that, we cannot live. [. . .] I think we have an important societal role or responsibility as biology teachers. But [. . .] I think that citizenship should be more prominent in that."

(Teacher 32)

Just under half of the teachers actually incorporate citizenship in their lessons (16/41), with a further nine claiming to do so hardly ever, and eleven others only doing so implicitly. Five teachers never teach citizenship at all. Time or room in the curriculum is seen as a limiting factor (8/41). Teachers want to focus on theory first (8/41) and feel citizenship is too difficult for lower secondary level students (7/41). Four teachers think it does not fit with their subject at all. In answering whether they incorporated elements of citizenship education in their lessons, one teacher says:

"No, not that much. Concerning this, chemistry is a very technical subject. You learn several things and you learn how you can deal with certain conditions but you do not learn how to prevent issues. And you learn how you can potentially solve issues, but critical thinking, would you do this or that, yeah, much, much less. Chemistry is a subject that is very much anchored in protocols and rules. You have the twelve principles of green chemistry, that concerns how you can use chemistry in a green manner, [. . .] so, chemistry that is as sustainable as possible, that does lead to as little waste as possible. These are rules and formulas and you can in a way calculate [. . .] how green something is, how sustainable something is. With this, a critical view, that isn't at all a thing. You just do what is written down. You follow the recipe. Totally at the end, you could incorporate a critical view on, you have two processes, a and b, and the end result is this and that. Compare the two and which one is the greenest? But yeah, is that critical? I don't think so. Because critical thinking means you make your own judgement, and think about it yourself, and reason about stuff, and that happens very little, [. . .] yeah that isn't a thing at all."

(Teacher 10)

Reasons given for incorporating citizenship in science education include its connection to sustainability (17/41), or to ethics and opinion forming (16/41) and because citizenship connects to many issues about health, sexuality and gender (12/41). Ten teachers aim to set an example for their students and stimulate critical thinking, both of which are perceived to be elements of citizenship in their classroom practice.

3.3. Teaching and Learning Activities and Learning Aims

Teaching and learning activities that teachers deem suitable for sustainability issues vary greatly (Figure 4). About two fifths of the teachers use discussion, research, and videos or documentaries during teaching about sustainability. With these activities, over half of the teachers aim to raise awareness (24/41). Many teachers aim to show the impact of our behavior or to show the bigger picture (15/41). For a third of the teachers, opinion forming and decision making is an aim, so are teaching theory and 21st century skills. One teacher says:

What teaching and learning activities do you employ during sustainability education?

Categories per teacher: 3.7

N = 41

	5	10	15	20	25	30
Discussion		17				
Research		17				
Authentic examples		17				
Video/documentary		16				
Regular teaching activities		13				
Stakeholders/experts		12				
Design/creative		10				
Footprint calculation		10				
Unspecified group work		10				
Theory	8					
Student behaviour	7					
Solutions	7					
Game/competition	5					
Not yet applicable	2					

(**a**)

What are your learning aims when teaching about sustainability?

Categories per teacher: 3.1

N = 41

	5	10	15	20	25	30
Raising awareness			24			
Impact of behaviour		15				
Bigger picture		15				
Opinions and decisions		14				
Theory		13				
21st century skills		13				
Focus on behaviour	9					
Sustainable way of life	8					
Citizenship education	8					
Solutions and possibilities	6					
No clear learning aims	1					

(**b**)

Figure 4. Sustainability (**a**) teaching and learning activities and (**b**) learning aims, employed by the 41 interviewed teachers. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories.

> "*You also want that, sometimes, that they can see there is a problem they cannot solve. That in itself is a very important learning aim, [. . .], that they have to choose between multiple solutions none of which are the perfect solution. Well, such a soft learning aim, [. . .] that they see that this is an interdisciplinary problem, that you have to deal with many people, with different parties, yeah, and you can, depending on the topic or where you are in the curriculum, there are also sustainability concepts that you can have as learning aims, but I feel that, why I think it is important, that is because of the softer learning aims.*"

(Teacher 36)

Teaching and learning activities during citizenship education often feature discussion (13/42, Figure 5) and resemble regular teaching and learning activities (13/41). Ten teachers do not teach citizenship at all. Half of the teachers mention learning aims dealing with 21st century skills and opinion forming or decision making. One teacher explains:

What teaching and learning activities do you employ during citizenship education?
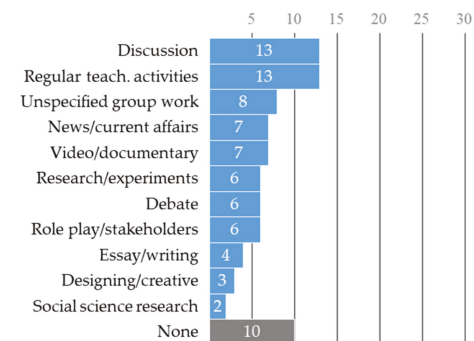
Categories per teacher: 2.1

N = 41

(**a**)

What are your learning aims when teaching about citizenship?

Categories per teacher: 1.4

N = 41
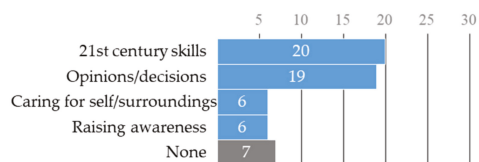
(**b**)

Figure 5. Citizenship (**a**) teaching and learning activities and (**b**) learning aims, employed by the 41 interviewed teachers. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories.

> *"Especially the development of an educational approach [. . .] in secondary education that is very underdeveloped. That I think is challenging [. . .], I just mentioned complexity, there are a few competences that belong with that, right, [. . .] such as systems thinking, but also future thinking, painting scenarios from the future. And, paying more attention to the moral aspects of issues, because, it isn't like something is right, something is wrong, desirable or undesirable, but by whom, etc., and what do you do with that? So I think developing a moral compass on that front is very important."*
>
> (Teacher 37)

3.4. Challenges and Confidence with Sustainability and Citizenship in Science Education

Fourteen teachers feel less confident about teaching sustainability than other topics (Figure 6). The most common reason for this is the different opinions that exist on the topic (10/41). The other teachers do feel confident with teaching sustainability, with the most common reason being their inherent interest in the topic. Teachers are also able to come up with real life examples, often from their own surroundings.

In relation to other topics, how confident are you with teaching about sustainability?

Why? N = 41

Categories per teacher: 1.1
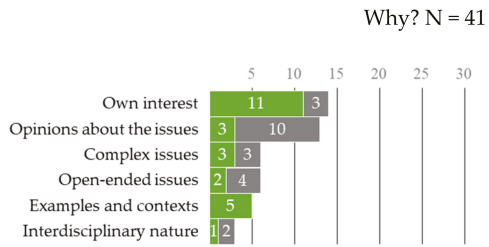
(**a**)

What challenges are related to teaching about sustainability?

N = 41

Categories per teacher: 2.8

(**b**)

Figure 6. Teacher (**a**) confidence with and (**b**) challenges when teaching sustainability. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories. Colors in the pie and bar graphs correspond.
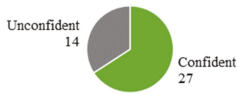
When asked to name the biggest challenges with teaching about sustainability, more than half of the teachers mention three main issues. The first one is difficulties with student involvement. Teachers think students are not interested in sustainability, or perceive it as something that is far off for the students, as this teacher describes:

"*Maybe, when I think about it now, when I teach about these topics [sustainability], I experience an enormous distance between the world of the students, who do not at all look at it this globally, they only see their daily lives. I would almost say, they do not even look further than their own table, [. . .] they do not see anything. And this is a global look on things, where you look at how do they do this for society at large [. . .], and that distance is really big. And that way, I can only very difficultly connect with the world of the students. [. . .] That truly is a field with opposing powers. That means I have to work really hard to accomplish something here.*"
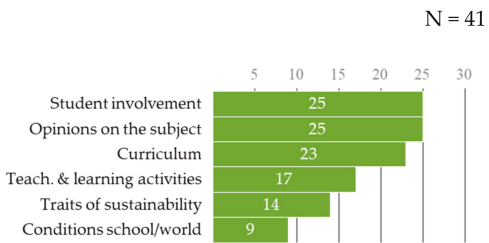
(Teacher 16)

Equally as challenging are the many different opinions that exist among the students regarding sustainability. These opinions can sometimes be experienced as very harsh or strong, involving strong emotional responses. The third biggest challenge according to these teachers was the curriculum. It pays too little attention to sustainability, and it takes a too theoretical approach. Less common reasons include difficulty with finding suitable teaching and learning activities, and specific traits of sustainability issues making it less easy to implement, for instance, because issues are abstract and play on such a large scale. Nine teachers felt that conditions in the world or at school, for instance, dealing with colleagues who did not think sustainability was important, made teaching about sustainability challenging.

Science teachers seem to feel less confident about teaching citizenship, with half of them feeling confident (21/41), two fifths feeling less confident (14/41) and six saying they

never implement citizenship at all (Figure 7). Teachers feel most unconfident about guiding discussions, followed by less common answers such as lack of prior knowledge, inexperience, and the necessity of preparation before teaching these lessons. One teacher explains:

In relation to other topics, how confident are you with teaching about citizenship?
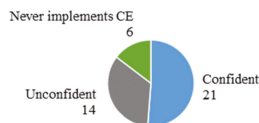
Why? N = 41

Categories per teacher: 0.9

(**a**)
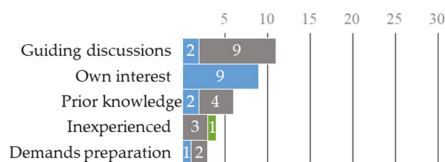
What challenges are related to teaching about citizenship?

N = 41

Categories per teacher: 2.0
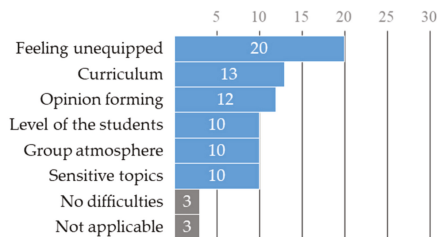
(**b**)

Figure 7. Teacher (**a**) confidence with and (**b**) challenges when teaching citizenship. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories. Colors in the pie and bar graphs correspond.

> *"Maybe I feel more confident with other topics, because those are of course mainly theoretical. When you tell how to name a molecule. Yeah, there is little discussion possible about that. But when you talk about sustainability, then... I think I am also a little less trained for that. So, yes, I think I am a little bit more unconfident the moment I talk about sustainability, also because more discussion can arise then, you can never exactly know what might happen."*

(Teacher 8)

Eleven teachers are confident because they are interested in citizenship aspects of their subject.

The most common challenge for science teachers with integrating citizenship education in their lessons is that they feel unequipped to teach citizenship (20/41)—for instance, because of difficulty with guiding discussions and being unsure about assessment and evaluation of citizenship. One teacher says:

> *"I think it is difficult for instance to guide a discussion. [. . .] That is not something I am trained to do, and I know that other teachers are way better at this, so I try to avoid it a little bit. And that does make me feel a little insecure. [. . .] And I think it is difficult to gain insight in student opinions. Because it usually are the same students who quickly form an opinion. [. . .] To make them say what they feel, their opinion, that is pretty difficult. [. . .] And the fact alone that I do not really know what citizenship education means, that tells you something about how confident I am about this. [. . .] It is a very vague concept. [. . .] And I also do not know when it is good enough or something. With*

sustainability you can just show some examples, but with citizenship, I just don't know when I have sufficiently reached these students. [. . .] It is way easier to set learning aims for sustainability than for citizenship education."

(Teacher 7)

Other common themes that create challenges are the curriculum, difficulty with external influences on opinion forming, such as parents or politicians. Finally, teachers say an experienced lack of cognitive level of the students is challenging, as well as creating the right atmosphere in the group, and difficulties with sensitivity of citizenship topics. Three teachers do not experience any difficulties whatsoever with citizenship.

3.5. Sustainability and Citizenship and Other Socio-Scientific Issues in Science Education

All science teachers agree that the combination of sustainability and citizenship is logical (Figure 8). Reasons for this include both of these topics concerning making choices or decisions and involving social and societal aspects.

Would you say the combination of sustainability and citizenship is logical?

Why? N = 41

No data
2

Yes
39

Making choices/decisions 17
Social asp./part of society 17
Effect on surroundings 8
Consumer behave./choices 3
Similar class. activities 3

Categories per teacher: 1.2
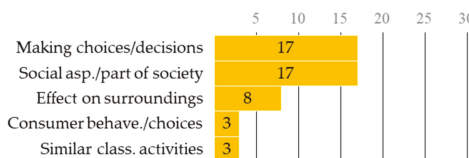
(**a**)

Do you incorporate other socio-scientific issues than those related to sustainability in the classroom?
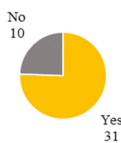
If yes: What issues? If not: why? N = 41

No
10

Yes
31

Curriculum 16 5
Sex/sexuality/gender 18
Technology and society 15
Medical issues 12
Ethical issues 9
Theoretical subject 5 4
Life style 7
Food industry 6

Categories per teacher: 2.4
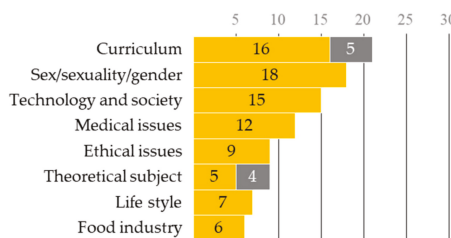
(**b**)

Figure 8. Comments on (**a**) the combination of sustainability and citizenship, and (**b**) use of nonsustainability related socio-scientific issues in the classroom, according to the 41 interviewed teachers. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories. Colors in the pie and bar graphs correspond.

A total of 31 teachers incorporate societal issues other than those related to sustainability in their teaching. The most common issues relate to sex, sexuality and gender (18/41), the relationship between technology and society, for instance with genetic modification or radioactive energy (15/41), and medical issues, for instance related to genetic screening (12/41). All ten teachers who did not incorporate societal issues besides those dealing with sustainability were chemistry teachers. No biology teachers or teachers who taught both biology and chemistry fell in this category. Reasons for not teaching about issues other than sustainability related ones include no such issues being present in the curriculum (5/41)

and the subject being heavily focused on theory (4/41). Only one of the teachers mentioned evolution as a societal issue about which they teach that is unrelated to sustainability (Teacher 29).

3.6. Self-Efficacy: Classroom Management, Student Motivation, and Availability of Teaching and Learning Aims

Teacher self-efficacy aspects related to EC varied. A total of 27 teachers think classroom management is at least a little harder when teaching about sustainability and citizenship education then other subjects (Figure 9). Reasons for this are that discussion and opinions are difficult to manage (19/41), and that creating a safe classroom atmosphere costs effort.

Compared to other topics, how easy is classroom management during sustainability and citizenship education?
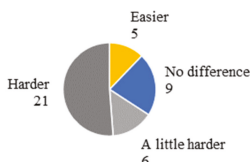
Categories per teacher: 2.0
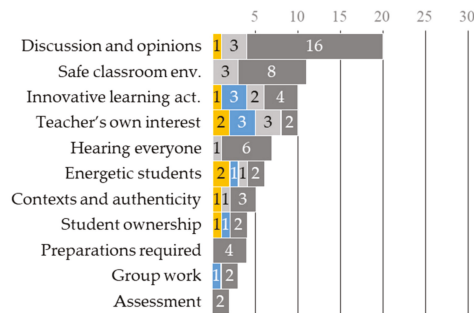
(**a**)

Compared to other topics, how easily are you able to motivate students during sustainability and citizenship education?
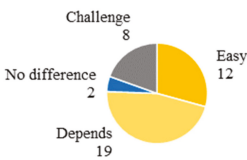
Categories per teacher: 1.9
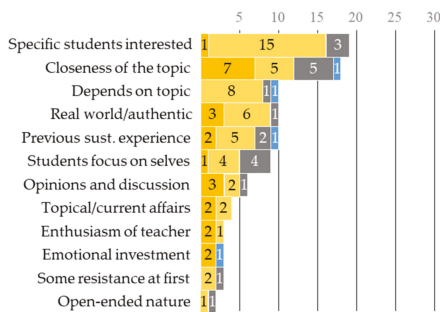
(**b**)

Compared to your colleagues, how many teaching and learning activities do you use during sustainability and citizenship education?
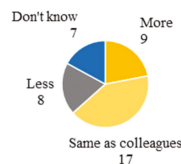
(**c**)

Figure 9. Self-efficacy elements: (**a**) classroom management, (**b**) student involvement, and (**c**) number of available teaching and learning activities related to EC education, according to the 41 interviewed teachers. Numbers in the bar graph represent total number of teachers whose answers fell in the respective categories. Colors in the pie and bar graphs correspond.

(11/41). Five teachers think that classroom management is easier for these topics. This is mainly caused by the teachers' own interest in these fields, innovative teaching activities, and energetic students. The nine teachers that did not see any difference in classroom management mainly said that learning activities are innovative, but this was something they liked.

According to nineteen teachers it is not easy to say whether students are more easily motivated during sustainability or citizenship education compared to other topics, whereas twelve teachers think it is easier to motivate them. Eight teachers think motivating students for sustainability is a challenge. Inhibitors for student motivation are students being focused on themselves at this age (8/41), and students being tired of sustainability because they hear it everywhere (8/41). One teacher says:

> *"That differs strongly per topic, because I see that these kind of teaching and learning activities, sometimes they work brilliantly, but I think that depends strongly on the topic and not on the activity. For instance with sustainability, that is really trending right now, and if you discuss that now, depending on how you do it by the way, because when you only talk about theory that they already know than they don't care at all, but because it is a very trendy topic they want to talk about it for sure, but for instance, at a certain point things such as bio-industry they have hear about this so many times, they don't want to hear about it anymore."*

(Teacher 5)

Motivation strongly depends on the type of student, with specific students being more interested in these topics (19/41), and on the sustainability issue or citizenship aspect that is discussed (10/41). Teachers do not agree whether sustainability and citizenship issues are topics that are close to the student world, with about equal quantities claiming these issues to be close (7/41) and far removed from the student's world (5/41). The twelve teachers who think students are easily motivated for sustainability and citizenship teaching think this is caused by the opinion forming activities (3/41) and the authentic nature of the issues (3/41), among others.

A total of 26 teachers felt they had at least equally as many teaching and learning activities at their disposal for teaching about sustainability and citizenship as their direct colleagues. Eight teachers thought they could incorporate less teaching and learning activities than their colleagues for this type of teaching, and a further seven were unable to judge this.

4. Discussion

In order to better support science teachers when teaching EC, we need a better understanding of current EC practice, and teacher interpretations of EC. Based on the findings from this study, current EC practice among the interviewed teachers seems as diverse as the concept itself.

4.1. Definitions

Teacher definitions of sustainability most commonly revolve around planet aspects. These teachers mostly focus on the environmental side, with only seven teachers using a full sustainability view, based on the Brundtland definition. This finding corresponds with previously reported findings in the literature [16,30]. It thus seems that Kopnina's [11] criticism regarding the shift from EE to ESD does not yet manifest itself in Dutch science teachers with highly economic or societal ideas about sustainability. Most teachers still seem to use an environmental approach [16]. This is further cemented by the most popular connotations of sustainability being impact on the environment, using products for prolonged times and sustainable processes regarding energy use and production efficiency in general. As a side note, many teachers believe sustainability is a container concept, so they might hint at it being broader than a purely environmentalist view.

According to the teachers, citizenship relates to the relationship between a person and society, with socially desirable behavior, and being active and caring for your surroundings.

To many teachers, citizenship can be seen as a 21st century skill. These definitions most strongly show aspects of Westheimer and Kahne's [8] personally responsible citizenship, with some occasional signs of participatory citizenship. Personally responsible citizenship, while important, is not the only ingredient for a more socially just and sustainable world [31]. Aspects from social-justice-oriented citizenship, which most strongly relates to EC, are not seen in these teacher definitions of citizenship.

Based on these teacher definitions, it would be overly optimistic to assume that EC is effectively incorporated in science lessons of these teachers. Many teachers use a strong focus on recycling and small, at-home behaviors in their explanation of sustainability, which leads to an oversimplified view on how to solve sustainability issues in the long run. For this, a broader approach that also includes governmental or other collective actions is pivotal [32]. Teachers who do not include public-sphere behavior and the global aspects of EC that are necessary to reach a sustainable future in their EC teaching is a common theme in literature [33]. Our study adds to this knowledge base.

4.2. Curriculum Presence, Importance and Classroom Occurrence

Whereas all interviewed teachers think sustainability is important, only just over half of them clearly state they incorporate it in their teaching. The national curriculum seems a limiting factor here, as previously found in the literature [12], because teachers hardly recognize sustainability in the curriculum, and they are critical towards its overly theoretical representation. Citizenship education is even less common, with only one quarter of the teachers recognizing more than a little citizenship in the science curriculum. Just like with sustainability, a majority of teachers thinks citizenship is important, but this does not translate to classroom practice, with just under half of them clearly stating they incorporate it in their teaching. For these two concepts, it becomes clear that teachers are unable to put their views into practice.

The interviewed teachers' learning aims for EC mostly fall in the second and third categories of Kelly's [21] framework, these being raising awareness and promoting responsible decision-making. Only a quarter of the teachers mention learning aims dealing with theory behind sustainability, which would fall into Kelly's first category. The general lack of this learning aim contrasts with the strong theoretical bias that teachers experience with sustainability in the curriculum. It thus seems there is a mismatch between the theoretical approach of the Dutch curriculum and the learning aims of the teachers when sustainability issues are concerned.

Just like with the teacher definitions, the citizenship learning aims further strengthen the idea that Dutch science teachers adopt Westheimer and Kahne's [8] personally responsible and participatory views on citizenship, while largely ignoring the social-justice oriented citizenship which is necessary for true EC. This social-justice-oriented citizenship correlates strongly with EC's aim of public sphere, collective action taking, which could lead to fundamental changes in existing unsustainable structures and processes. Judging by their learning aims for EC, changing these existing structures seems to be beyond the scope of what science teachers in the Netherlands want to reach with their EC education at the lower secondary level.

4.3. Confidence and Challenges

Teacher confidence with, and challenges during, EC education found in this study add to the existing research base. The teachers most commonly identify opinion forming activities and guiding dialogue as challenging. These results are in line with previous studies which showed that science teachers generally struggle with implementing humanities-based teaching activities [23]. Finding a way to deal with student opinions during EC is the third most common element that lowers confidence of the interviewed teachers. They identified strong emotional responses of the students as challenging during sustainability and citizenship education. Previous studies link this to the value-laden character of EfS [12]. Many science teachers feel unequipped to teach citizenship in their science

lessons, which mirrors findings from a large qualitative study with Swedish teachers [4]. Interestingly, the commonly reported difficulties with examination of EC [12] are only sporadically mentioned by the interviewed teachers.

Another common challenge for successful implementation of EC is the national curriculum. Teachers feel there is too little time for EC education in everyday practice. Furthermore, the curriculum is believed to misinterpret sustainability because it focuses too strongly on theory. Previous studies show that the curriculum is one of the biggest hurdles for teaching about sustainability issues [4,12], and socio-scientific-based education [34].

Common with sustainability thinking is a general feeling of hopelessness on the one hand, caused by the idea that it already is too late to turn the tide [22]. On the other hand, people might underestimate sustainability issues because effects of sustainability issues are often not felt close to home, which results in feelings of apathy and resignation [24]. Dealing with this emotional duality is difficult for teachers [22]. They feel that some of their students are unmotivated towards sustainability because students at the lower secondary level are focused strongly on their own developments and do not think about the world outside of their immediate surroundings. This shows in the data too, with about equal numbers of teachers thinking students can be easily motivated for sustainability, and teachers thinking that motivating students for these issues is a challenge.

Next to these challenges and uncertainties, a substantial group of the interviewed teachers is inherently interested in sustainability and citizenship. These teachers thus feel confident about teaching EC. Illustrating this, three quarters of the teachers incorporate other societal issues than those related to sustainability in their science lessons. All ten teachers who do not implement other societal issues in their lessons are chemistry teachers. It seems that biology teachers are more used to teaching about societal issues than their chemistry colleagues. However, such an indication needs to be subject to further research.

4.4. Limitations

When looking at the total science teacher population in the Netherlands, or, indeed, worldwide, this study only used a relatively small group of teachers. This should be taken into account when interpreting the results. Differences exist between countries, depending, for instance, on the curriculum or school system in general, so these data might only reflect the Dutch situation. Additionally, a general lack of teachers with more than twenty years of experience is seen among the participants. Finally, the participants slightly over-represent teachers from rural area schools, with urban schools being marginally under-represented. However, despite these limitations, this study still adds valuable qualitative data to the knowledge base about teaching EC at the lower secondary level, and it provides an in-depth sketch of the Dutch EC landscape.

5. Conclusions

When looking at EC education in the Netherlands, there seems to be a mismatch between the curriculum on the one hand, and the aims, ideas, and wishes of science teachers on the other. Despite a relatively narrow definition of sustainability and citizenship, Dutch science teachers aim to promote different aspects of EC through their teaching. Complicating this wish, teachers interpret the curriculum as being focused too strongly on theoretical aspects of EC, largely ignoring those areas that they wish to include. Furthermore, science teachers struggle with the social aspects of EC teaching, including dialogue, discussing emotions, and guiding opinion forming and decision making. Their understanding of EC does not yet involve many aspects of social-justice-oriented citizenship, and some teachers do not really see a place for citizenship education in science lessons at the lower secondary level at all. Additionally, teachers' views remain limited to the private sphere and to individual actions. However, what does become clear is that the majority of the interviewed teachers are passionate and motivated about helping their students deal with EC issues that riddle our daily lives. A supportive rather than limiting national educational strategy, that focuses on the broad concept of EC, would give them the room to implement

EC more successfully. With a more suitable curriculum that includes opinion forming, ethics and other normative aspects of sustainability, a stronger focus on the competences needed for EC, and more opportunities to train their citizenship education skills, science teachers will have a higher chance of fostering EC with their lessons.

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Article

Evaluating an Educational Intervention Designed to Foster Environmental Citizenship among Undergraduate University Students

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Abstract: Taking its primary interest in active environmental citizenship, this paper aims at eval-
uating a case of an educational intervention designed to foster environmental citizenship among
undergraduate students at a technological university. The study employs a survey methodology
implementing a recently validated environmental citizenship questionnaire. A randomized pre-
group –post-group quasi-experimental survey design explores students' environmental citizenship
attributes before and after the intervention course, 'Sustainable Development', in comparison to
students who participated in a general elective course, 'Media Philosophy'. The results show that
the participation in the intervention course induced positive change in students' environmental
citizenship in comparison to the control group. Additional analysis indicates that environmental
citizenship is significantly related to environmental attitudes, nature experiences during childhood
and adolescence, and gender. The article provides a timely contribution shedding light on how
specific pedagogical approaches in higher education can foster environmental citizenship.

Keywords: environmental citizenship; education for environmental citizenship; pedagogical
approaches in environmental education; sustainable development; promoting sustainability in higher
education; connectedness to nature; nature experience

1. Introduction

1.1. Environmental Citizenship in Higher Education

The primary interest of this article is active environmental citizenship (EC) and the
ways that it could be achieved through higher education settings. Environmental citizen-
ship, as an idea and area of study, is situated within citizenship theory and reflects the
understanding that active involvement in achieving the aspirations of sustainable develop-
ment and promoting societies committed to sustainability is one of the responsibilities of
the citizen. The environment is increasingly being framed as a matter of citizenship and,
likewise, citizenship is increasingly being framed to include the environment [1]. A recent
conceptualization of EC put forth by the European Network for Environmental Citizenship
(ENEC) identifies EC as the active participation of citizens, in the private and public sphere,
through individual and collective actions, toward solving current environmental problems
and preventing the creation of new ones, parallel to developing a healthy relationship

with nature [2]. The ENEC's conceptualization not only acknowledges the individual's exercise of environmental rights but also acknowledges the responsibilities that derive from other people's environmental rights. Corresponding with Barry's [3] deep perspective of sustainability citizenship, the ENEC's conceptualization of EC emphasizes the capacities and commitment for addressing the structural causes of environmental degradation [3,4].

Despite rich theoretical discourse on EC, mainly by citizenship theoreticians, education for environmental citizenship (EEC) is a relatively novel field of study. It is theoretically related to the concepts of environmental education [5], science education [6], citizenship education [7], and especially education for sustainability [8]. Yet, it has its distinctive features [4], emphasizing collective actions and participation in the role of agents of change as an inherent component of citizenship.

This article pays attention to the ways that EEC could be effectively implemented. It explores the impact of a unique undergraduate sustainable development (SD) course on the students' EC attributes, implementing a recently developed instrument for measuring the dimensions of EC [9]. University students comprise a crucial target audience for EEC due to their anticipated future roles both within citizenry and within work environments [10]. In an increasingly complex, uncertain, and ambiguous world characterized by environmental and social challenges, institutions of higher education have an ethical responsibility to break outdated paradigms and be leaders of change to advance societies who are committed to the principles of sustainability and are equipped to realize the goals of sustainable development [11–13]. Consequently, these institutions have a vital role in developing environmentally literate graduates equipped and empowered with the competences necessary for addressing these challenges—graduates who are committed to and capable of bringing an environmental perspective into their future career and of acting as influential environmental citizens and professionals in society [12,14,15].

Interventions designed within higher education settings are acknowledged as significant facilitators of needed EC transformation. The most often studied designs of interventions have included infrastructure developments [16–18], organizational culture change [19,20], communication campaigns [21], or curriculum integration and pedagogical approaches [22–25]. This study follows the research stream focusing on the curricula and educational approaches for developing SD competences. Relatively few studies have addressed curricular-related or pedagogical-approach-related interventions for cultivating EC, even though these play a crucial role in student's learning [26] (p. 1). Lozano et al. [15] also claim that less research has explored the connection between how courses are delivered and their influence on the development of sustainability competences. Literature also provides empirical grounding for assuming that environmental and social competences that are learned within the context of formal education can foster action taking outside that context, i.e., in the private and public domains [27].

While several studies have investigated the effect of university education on several of the EC attributes [28–30], this study is the first attempt to use the recently validated holistic EC measurement instrument, the Environmental Citizenship Questionnaire (ECQ) [9], in the context of higher education students. This tool addresses competencies associated with EC in the cognitive (knowledge, conceptions, and skills) and affective (attitudes, values) dimensions and engagement in actions associated with EC in both private and public spheres currently and with a future-oriented perspective (likeliness of involvement in the future). In view of the novelty of this tool, in addition to exploring the students' EC attributes, we also conducted various analyses in the aim of exploring the validity of this instrument in the context of higher education (HE) students.

1.2. Factors Associated with Environmental Citizenship

The literature indicates that many factors influence individuals' engagement (or lack of) in pro-environmental actions and behaviors [31]. Generally, these can be categorized into demographic factors (e.g., gender); external factors (such as the existence of supportive infrastructure, economic factors, and sociocultural factors); and internal factors

(e.g., cognitive, such as environmental knowledge, affective, such as values and attitudes, awareness, which straddles the cognitive and affective domains, and the locus-of-control and sense of efficacy) [31]. Additionally, research indicates that experiences in nature during childhood are influential for an individual's environmental values and sensitivity [32,33]. This study tapped into the involvement of the demographic variables of gender and nature experiences.

Concerning the influence of background factors on dimensions of environmentalism, despite inconsistencies in the empirical literature, several studies indicate the phenomenon of gender differences, whereby females report more pro-environmental attitudes and greater concern for the environment as compared to men. This has been found with adults [34,35] as well as in youth [34,36–38]. Arnocky and Stroink [35] found that this is mediated by empathy, in line with socialization and gender role theories asserting that females are raised to value and empathize with the needs of others. Females also report greater involvement in pro-environmental behaviors/actions [34] and are more willing to cooperate around environmental resources, while men reported greater competitiveness around ecological resources [35]. On the other hand, boys outperformed girls both in objective environmental knowledge [37] and subjective knowledge of environmental issues [38]. Understanding the relationship between such demographic variables provides valuable information for promoting environmentally oriented individuals/environmentalism.

The literature supports that environmental issues are strongly linked to a disconnect from nature and that developing a sense of connectedness to nature is an important aspect in promoting pro-environmental behavior [39,40]. Positive experiences in the natural environment and creating a sense of place are important for developing positive feelings regarding the environment (e.g., respect, concern, care), and these emotional connections with nature leverage motivating the individual's commitment to the environment and willingness to adopt environmentally responsible behavior [33]. In her review of the research on the connection with nature in childhood, Chawla [33] also reports that young people who had more access to and experience in nature express higher levels of connection to nature, and this extends into adulthood—a greater connection to nature in adults is associated with more access and interaction with nature during childhood.

1.3. Environmental Citizenship in the Curriculum at Kaunas University of Technology

This paper investigates a case study from Kaunas University of Technology, Lithuania. Following the United Nations 'Decade of Education for Sustainable Development' [41] and responding to the UN call for 'The Decade of Action and Delivery for Sustainable Development' [42], also in compliance with EU Green Deal targets [43], the Kaunas University of Technology has undergone a major review of the general competences developed through general elective courses. A T-shape model [44,45] of education for sustainable development [46–48], infused with ideas of education for environmental citizenship were taken as conceptual backgrounds. Starting with the 2019–2020 academic year, all first-year university students are entitled to freely choose a general elective course of either "Sustainable Development" or "Media Philosophy". The students enrolled in either of the courses in the Fall semester of 2020 constitute the population of this current research. The intervention case includes participation in the course "Sustainable Development" during that semester.

The intervention course "Sustainable development" aims to develop global, critical, and reflexive awareness of the social, economic, cultural, and environmental contexts in which the graduate will act and an ethical position based on the principles of sustainable development. Thus, the intervention course targets the attributes of environmental citizenship [4] and indicates the competence aspect of the competence-learning-intervention-assessment model (CLIA-model) [26]. The control group course ("Media Philosophy") focused on a critical reflection of media and technology developments, including digital cultures and artificial intelligence.

In terms of learning methods and teaching approach of the CLIA model [26], the intervention case bears the following characteristics: a holistic and multidisciplinary approach; focus on group-work and practical seminars; and active learning methods (elaborated further on). The course content covers social, economic, environmental, and engineering content, with emphasis on the interconnections among the topics. The course is taught by a multidisciplinary team of lecturers, including sociologists, economists, philosophers, and staff with expertise in environmental studies, sustainable design, and civil engineering. The content of the learning materials addresses both national and global contexts (e.g., social welfare and climate impacts). Connections with the past and future are well established through the provision of historical data on development trends and then presenting the megatrends that define the future development scenarios [49]. The course focuses on group-work and practical seminars: this six ECTS course includes only 16 h of lectures, while 48 h are devoted to practical supervised learning, and another 96 h of independent learning. Active learning methods applied during practical supervised learning sessions (seminars) and independent learning included design thinking, role play, problem-based learning, mind-mapping, case study, and socio-scientific inquiry-based learning. These facilitate pluralistic approaches to teaching and learning, recognized by Sinakou et al. [26] as one of the key aspects of education for sustainable development. The fourth element of the CLIA model is assessment. Assessment in the intervention course includes problem-solving tasks, a competency portfolio, reflection on action, as well as midterm and final exams.

The aim of this study was to investigate the effectiveness of this course on developing the students' EC. Toward this end, it compared the changes in EC attributes/variables between the students who participated in the Sustainable Development course and students who participated in the parallel elective Media Philosophy course. Thus, this study provides a response to the shortage identified by Lozano et al. [14,15] of studies exploring the connection between the pedagogical approaches of sustainable development courses in higher education and their influence on developing SD competences. The results of this evaluation contribute insight regarding the effectiveness of a uniquely designed educational intervention conducted as a university-wide general electives course. Thus, this article provides a timely contribution, shedding light on how specific pedagogical approaches can foster EC. Additionally, by employing the environmental citizenship questionnaire (ECQ), it provides a first time implementation of this new tool in the context of higher education and contributes to exploring the validity of this tool in different contexts.

2. Research Questions and Hypotheses

To address the influence of the above-described intervention on the environmental citizenship attributes of the participating students, we put forward the following four interconnected research questions:

RQ1. Is the ECQ a reliable and valid instrument for measuring HE students' EC?

RQ2. What are the EC characteristics of first year undergraduate students in a large technical Lithuanian university?

RQ3. How do the EC characteristics correlate with background variables such as gender and nature experience?

RQ4. What is the impact of students' participation in a general elective course 'Sustainable development' on their environmental citizenship?

The research questions together build up to test the overall hypothesis of the current study: the general elective course focusing explicitly on sustainable development (by implementing it through learner-oriented pedagogical methods identified as effective in developing SD competences) will foster increased EC in participating students. To test this, we conducted a quasi-experimental, randomized, pre–post group design to compare the EC variables between students participating in the SD course and students participating in the media philosophy course. The students in this design belong to one of four groups: the Pre-Intervention Group (PIG), the Pre-Control Group (PCG), the Waiting (post) intervention group (WIG), and the Waiting Control Group (WCG), allowing us to isolate the effect of the

intervention. The groups are defined based on (a) the students' choice of one of two general elective courses: either 'sustainable development' or 'media philosophy'; and (b) a random split-group assignment of students that participate in the questionnaire either before their course had started or after their course had ended. To test RQ4, four specific hypotheses were put forward. If all four hypotheses are confirmed, the effect of the intervention course can be considered significant.

Hypothesis 1 (H1). *Students that were assigned to either one of the two groups that took part in the survey before the courses took place (PIG, PCG) show similar levels of EC.*

Hypothesis 2 (H2). *Students that were assigned to either one the two groups connected to the control group (PCG, WCG) show similar levels of EC.*

Hypothesis 3 (H3). *Students that were assigned to the group that took part in the survey after the intervention course took place (WIG) report higher levels of EC than the students assigned to the pre-intervention group (PIG).*

Hypothesis 4 (H4). *Students that were assigned to the group that took part in the survey after the intervention course took place (WIG) report higher levels of EC than the students assigned to the waiting control group (WCG).*

3. Methodology

The study employed a survey methodology implementing the recently validated EC questionnaire [9]. A randomized quasi-experimental pre-group–post-group design explored the target group students' EC attributes before and after the educational intervention, in comparison to control group students. The survey data was collected during November 2020–January 2021 through a SurveyMonkey platform (CAWI surveying technique) and is made open access via http://www.lidata.eu/data/quant/LiDA_KITI_0347 (accessed on 23 July 2021). Ethical approval was granted by the Institute of Social Sciences, Arts and Humanities at Kaunas University of Technology (protocol no. V19-1253-7-1). It has to be noted that the quasi-experiment was conducted under COVID-19 pandemic conditions that included internal and cross-border movement restrictions and fully online learning.

3.1. Participants and Sampling Procedure

The study was conducted with first year university students from different study areas (humanities, social sciences, arts, technology, science, engineering, or mathematics) at Kaunas University of Technology, Lithuania. The participants represent two populations. The first population consists of the students who chose the 'Sustainable Development' course as their general electives option in the Fall semester, 2020 ($N_1 = 205$). This is the intervention population, in which we expect changes in the students' EC as a result of studying the course. The intervention population participants were randomly assigned either to the pre-intervention group (PIG) or the waiting intervention group (WIG). The second population of students ($N_2 = 268$) are those that chose the 'Media Philosophy' course as their general electives option in the Fall semester, 2020. This serves as a control group. The control group participants were randomly assigned either to the pre-control group (PCG) or the waiting control group (WCG). The majority of participants were engineering sciences majors (47.1%), technological sciences majors (20.7%), physics majors (10.1%), social sciences majors (7.1%), and arts majors (5.0%). The remaining 10% studied in diverse disciplines (mathematics, computing, humanities). The average age of the participants was 19.5 years (SD = 2.9 years) with a median and modulus of 19 years. The two youngest participants were 17 and the oldest and second oldest participants were 50 and 26 years, respectively. Gender distribution was 46.4% males, 50.7% females, and 2.9% who preferred not to state their gender (the option "other" was not selected). Background data of the participants are presented in Table 1.

Table 1. Gender, age, and study programs of the participants.

Categories	Frequency	Percentage (%)
Gender (Valid N = 140)		
Female	71	50.7
Male	65	46.4
I'd rather not say	4	2.9
Age (Valid N = 137)		
17–18 years	20	14.6
19–20 years	104	75.9
21–22 years	7	5.1
23–25 years	4	2.9
26–50 years	2	1.5
Program (Valid N = 140)		
Engineering sciences	66	47.1
Technological sciences	29	20.7
Physical sciences	14	10.0
Social sciences	10	7.1
Arts	7	5.0
Mathematical sciences	5	3.6
Others	9	6

Comparability of the intervention group and the control group is the major prerequisite for valid conclusions in experimental designs (Engel and Schutt, 2014). We thus checked for the bias and found no significant differences between the intervention and the control group participants in terms of their residence prior to university studies (urban/rural), the gender structure, the study fields, frequency of nature experience, positivity of nature experience, connection to nature, and interest in nature during childhood and youth. Male and female participants were distributed equally in both courses, excluding missing gender information (Chi-square test, df = 1; p = 0.864).

The pre-test questionnaire was administered in November to 103 students in the SD course and 134 students in the media philosophy course. The same post-test questionnaire was administered in January 2021 to 102 students in the SD course and 134 students in the media philosophy course. Participation in the questionnaire was anonymous. We should note here that the students in the pre and post conditions are not the same students. Students were, rather, randomly appointed to either a pretest or a posttest survey. At both measurement occasions, the response rates for the pre-test and post-test of students in both courses was circa 50%, therefore, the total final number of respondents was 206.

3.2. Instrumentation

Background data—Students' gender, age, major field of studies, socioeconomic class (lower, working class, middle class, upper class), current employment (yes/no), native tongue and that most used currently.

Environmental Citizenship—The students' environmental citizenship characteristics were investigated with the 'Environmental citizenship questionnaire (ECQ), developed and validated for secondary school students by Hadjichambis and Paraskeva-Hadjichambi [9]. The questionnaire includes the following EC areas (variables), organized in Table 2, and employs Likert-type scales with four possible scores. Reported Cronbach alpha values range from 0.703 to 0.903 [9]. All scales are 4-point Likert-type scales with the answer options ranked from 1—low to 4—high, except the scale 'past actions' (which has answer options ranked from high to low). For this reason, in the calculations of scale means, etc., the items of the past action scale were inverted.

Table 2. EC variables, number of items, and exemplar items of the ECQ. All variables were explored with Likert-type scales with four possible responses.

EC-Variable	No. of Items	Exemplar Item
Past and present EC actions	6	Have you ever been involved in activities of an environmental organization outside school or university? (INV *)
EC knowledge	11	Before entering university, to what extent have you learned what are the environmental rights and duties of a citizens?
EC conceptions	12	In your opinion, how important is participating in activities to benefit the environment for being a good citizen?
EC skills	6	How well do you think you would do, now as a student, in arguing your point of view about a controversial environmental issue?
EC attitudes	8	To what extent do you agree that companies in rich countries should give employees in poor nations the same conditions as in rich countries
EC values	15	How important for you personally is it that every person has equal opportunities?
Future actions inside university	4	If you were given the chance, how likely is it that you would take part in environmental discussion in a student assembly, if offered at your university?
Future actions outside university	11	As a citizen would you take stage a protest by blocking traffic?
Agents of change	3	How likely is it that you would actively participate in decision making and also engage in action-taking?

* INV = inverted items.

General environmental attitudes—Students' general attitudes regarding the environment were assessed with six statements (for example, 'For the sake of the environment, we should all be prepared to reduce our current standard of living'; 'The importance of environmental problems is greatly exaggerated by many environmentalists') to which the respondents rated their extent of agreement on a Likert scale with 4 possible responses. The brief General environmental attitudes scale formed by these items was developed and applied in previous research by Hansmann and Binder [50].

Experience with nature—This section explored: (1) the type of environment the student grew up in (clearly urban, rather urban, in-between, rather rural, clearly rural) as a child (age 6–14) and as a youth (age 15–18); (2) Extent of experience in nature (very rarely, rarely, rather rarely, rather frequently, very frequently) in these two age periods; (3) How positive their experience in nature was (very positive, positive, rather positive, rather negative, negative, very negative); and (4) Sense of connection to nature (very distant, distant, rather distant, rather close, close, very close) in these two age periods; (5) Extent of interest in nature (not at all, to small extent, to moderate extent, to large extent, to very large extent) in both age periods.

Subjectively reported university-based and external influences. These two items aim to isolate the influences of the complex educational intervention from other possible influences. The first question measured the subjectively reported university-based influences: 'Thinking about the time you have spent in the university, in which university courses did you learn about: environmental values, issues and/or behaviors; citizenship related topics' (only in my general electives course, mainly in the general electives course but also in other course/es, equally in the general electives and other course/es, mainly in other excluding the general electives course/es, in none of my courses). The second question measured subjectively reported external influences: 'In the last few months, to what extent have you learned about these topics in extra-curricular activities (not based on formal university courses): environmental values, issues and/or behaviors; citizenship related topics' (not at all, to a small extent, to a moderate extent, to a large extent).

Attitudes towards instruction and learning methods. In order to better understand if the intended instruction and learning methods were effective, we introduced the question 'How helpful were these course-related elements for your learning?' (theory lectures, activities based on design thinking approach, team of lecturers from different disciplines,

group work with my peers, topics and/or activities that required my analytical thinking, topics and/or activities that made me to think of relations between different real-world issues, topics and/or activities that made me to reflect upon my value system, topics and/or activities that made me to reflect upon my ethics and behaviors, topics and/or activities that made me think about my future, game-based activities, other). Possible responses ranged from 1—not important at all, to 4—very important, and an additional response 5—I did not notice this in my course.

3.3. Data Analysis

All statistics were conducted using the IBM Statistical Package for Social Sciences (IBM SPSS 26). To map the psychometric qualities of the EC instrument in this novel context, several estimates were used. The scale's reliability was estimated by calculating Cronbach alpha values for the construct as a whole as well as for each individual subscale, tapping into the different attributes of EC. Convergent validity was tested through calculating Pearson's correlations between EC and environmental attitudes. Similarly, the external validity of the EC instrument was tested by estimating gender differences (*t*-test) and Pearson's correlation with nature experiences. Descriptive statistics (mean, standard deviation) were calculated and differences among student groups were investigated with ANOVA and post-hoc analyses. For the computation of the EC scale values, missing values of some persons in single items were imputed with mean values of each item to decrease an accumulation of missing values resulting in data exclusion. Therefore, all analyses involving the overall EC scale include imposed values for some persons in some items. The share of imputed missing responses of the valid participants in the 73 items of the EC questionnaire ranged from a minimum of 0% to a maximum of 32%, and the average share was 21%. The overall mean was used as an imputation method because it does not change the overall sample mean for the EC items. Furthermore, using the overall mean as an estimate is conservative in the sense that between group differences are not artificially (or randomly) enlarged by it. Subgroup means are directed towards the overall mean by this estimation technique so that the resulting bias tends to be conservative and tends to prevent random significances in between group comparisons.

4. Results

4.1. Psychometric Quality of the ECQ and Descriptives of Students' Environmental Citizenship

This subsection presents with reliability, convergent validity, and external validity measures of the ECQ as used in our study. Table 3 shows the results of the descriptive statistical analyses for the entire dataset of 206 students, as well as the number of items for each scale and its internal consistency. Cronbach's alpha values ranged from 0.836 to 0.929 across the different scales, indicating excellent reliability of the scales, in line with scale reliability reported by Hadjichambis & Paraskeva-Hadjichambi [9]. For each scale, we report the mean values and the standard deviation on the number of students that provided responses. Evident from the table, the number of respondents decreases with each next scale. This is linked to the order of the scales in the survey, and, therefore, reflects the increasing drop out as students progressed through the survey.

The correlations of EC scale with general environmental attitudes (EA) were analyzed to investigate the convergent validity of the EC. The average value of the participants on the general environmental attitude scale was M = 3.0 (SD = 0.48) on the four-point scale. A moderate but significant correlation (r = 0.35, $p< 0.001$) between environmental attitudes and EC was found, which indicates the relationship between both concepts: Through its focus on pro-ecological socio-political behaviors, cognitive competencies, and future orientations, EC represents a much broader concept (construct) than environmental attitudes and values, but EC entails environmental attitudes as an inherent component facilitating EC behaviors [50–52]. A medium- to high-level correlation between EC and environmental attitudes, as observed in this study, could hence be expected.

Table 3. Descriptives and Cronbach's alpha for the entire dataset of student's EC (score range is 1–4).

Scale			All Data		
Construct	Items	*α*	*n*	*M*	*SD*
Environmental citizenship	76	0.929	206	2.45	0.57
Past actions (INV [1])	6	0.832	206	1.45	0.67
Knowledge for EC [1]	11	0.916	183	2.52	0.60
Conceptions for EC	12	0.836	167	3.07	0.42
Skills for EC	6	0.852	160	2.45	0.62
Attitudes for EC	8	0.856	151	3.39	0.45
Values for EC	15	0.834	145	3.1	0.42
Future actions in school	4	0.864	144	2.17	0.66
Future actions outside school	11	0.863	141	2.18	0.52
Agents of change	3	0.866	141	2.82	0.66

[1] EC = Environmental Citizenship, INV = inverted items.

4.2. Environmental Citizenship Attributes of the First Year University Students

Table 4 presents the mean values for the EC variables as well as the overall mean EC value for each of the research groups. The overall mean for EC indicates a slightly below moderate level of environmental citizenship. A deeper look into the different EC competencies indicates a complex picture concerning the different dimensions of EC. In the behavioral domain, the students report insignificant previous involvement in environment-related actions (over a year ago to no involvement). Furthermore, they report limited intention to be involved in the future in environment-supportive actions associated with EC either within the campus or in their personal lives, but slightly higher intentions to function as social change agents of sustainability. In the cognitive domain, they report less than moderate (exposure to) knowledge of topics relevant for EC and feel that they would do less than fairly well in various skills associated with EC. On the other hand, in the affective domain, despite their limited reported involvement in actions associated with EC, they perceive EC-related behaviors to be important, demonstrate pro-environmental attitudes/positive attitudes concerning social-environmental aspects related to EC, and positively identify with social-environmental values associated with EC.

Table 4. Descriptive statistics for EC attributes of students from the four groups (Score range is 1–4).

Scale	PIG [1]			PCG			WIG			WCG		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Environmental citizenship	54	2.41	0.52	60	2.38	0.59	47	2.68	0.52	45	2.43	0.39
Past actions (INV)	54	1.43	0.69	60	1.43	0.57	47	1.39	0.69	45	1.44	0.74
Knowledge for EC	49	2.41	0.57	55	2.55	0.58	37	2.67	0.68	42	2.46	0.59
Conceptions for EC	46	3.05	0.38	50	3.03	0.46	33	3.04	0.49	38	3.17	0.32
Skills for EC	44	2.41	0.58	48	2.3	0.64	32	2.94	0.67	36	2.58	0.56
Attitudes for EC	41	3.42	0.42	47	3.34	0.52	29	3.29	0.46	34	3.46	0.35
Values for EC	40	3.04	0.36	46	3.04	0.41	27	3.16	0.5	32	3.18	0.4
Future actions in school	40	2.14	0.62	46	2.03	0.71	27	2.29	0.58	31	2.29	0.71
Future actions outside school	40	2.14	0.49	45	2.14	0.6	25	2.23	0.57	31	2.22	0.41
Agents of change	40	2.82	0.57	45	2.71	0.78	25	2.84	0.65	31	2.93	0.57

[1] PIG = pre-intervention group, PCG = pre-control group; WIG = waiting intervention group; WCG = waiting control group, EC = Environmental Citizenship, INV = inverted items.

4.3. Correlations between Students EC and Their Background Variables

Analyses of gender differences and differences according to nature experiences in childhood and youth were employed to investigate the external validity of the ECQ. The average value of EC among females was M = 2.73 (SD = 0.32) and of males M = 2.54 (SD = 0.41). This difference was statistically significant (*p* = 0.002). Females also showed significantly (*p* = 0.007) stronger positive EA (M = 3.10, SD = 0.42) compared to males (M = 2.85, SD = 0.52). The higher values of EC in female students compared to male students is consistent with previous studies on students as well as on general populations, which found more pro-environmental attitudes and environmentally responsible

behaviors of females compared to males [10,37,38,53,54]. The current study thus confirms stronger pro-environmental orientations and social and behavioral competencies of females regarding the ECQ scale.

Growing up as a child in a rural versus urban surroundings was not related to environmental citizenship (r = 0.06, $p > 0.05$) nor was it related to environmental attitudes (r = 0.03, $p > 0.05$; see Table 5). The frequency of nature experiences during childhood was likewise not significantly related to EC (r = 0.14, $p > 0.05$) and EA (r = 0.10, $p > 0.05$). The positivity of nature experiences during childhood was significantly positively related to both EC and EA (EC: r = 0.17, $p < 0.05$; EA: r = 0.38, $p < 0.001$). The connection of nature in childhood was positively correlated with EC (r = 0.32, $p < 0.001$) and with EA (r = 0.29, $p < 0.001$) to a smaller degree. The interest in nature as a child was slightly more strongly correlated with EC (r = 0.43, $p < 0.001$) than with EA (r = 0.23, $p < 0.01$).

Table 5. Correlations between EC, EA, and variables related to nature experiences in childhood and youth.

	Urban vs. Rural	Frequency of Nature Experience	Positivity of Nature Experience [1]	Connection to Nature	Interest in Nature
Childhood					
EC	0.06	0.14	0.17 *	0.32 ***	0.38 ***
EA	0.03	0.10	0.38 ***	0.29 ***	0.23 **
Youth					
EC	−0.07	0.17 *	0.19 *	0.22 **	0.39 ***
EA	−0.01	0.17 *	0.29 ***	0.18 *	0.26 **

[1] scale recoded so that high values reflect positive experiences. For all bivariate correlations, $n = 140$. * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed). *** Correlation is significant at the 0.001 level (2-tailed).

Contrary to the correlations reported for childhood aspects, the frequency of nature experiences in youth was significantly positively related to both EC and EA (for both EC and EA: r = 0.17, $p < 0.05$). Apart from this, the same significant correlations regarding nature experiences during childhood were also found for youth. This means that while EC and EA are not related to the specific environment (urban/rural) in which the students grew up in, EC and EA are significantly positively related to the students' positive nature experiences, interest in nature, and sense of connectedness to nature during their childhood and youth (Table 5). nature experiences during youth and positive nature experiences during youth and childhood thus proved to be positively correlated with EC and EA. This is in line with various previous studies showing a positive correlation between early nature experiences and environmental attitudes and behaviors in adulthood [55–57].

4.4. Impact of the Intervention on Students' EC

ANOVA analyses showed that when comparing the four student groups for each of the environmental citizenship scales, no main effects were present (all $p > 0.05$), suggesting that the intervention had no effect on the different scales. However, when the four groups were compared based on the overall construct of environmental citizenship (including all items of all scales), the results indicate meaningful and significant differences, with the main effect estimates of F = 3.508 (df = 3) and $p = 0.016$. Two-by-two post-hoc analyses (Fisher's Least Significant Difference) revealed which differences occurred among which groups (see Figure 1). As could be expected (H1), no differences were found between the pre-intervention group and the pre-control group. Likewise, no differences were found between the pre-control group and the post (waiting) control group (H2) (all $p > 0.05$). As hypothesized (H3), the post (waiting) intervention group displayed significantly higher EC than the pre-intervention group (M.diff = 0.273, $p = 0.007$), and significantly higher EC as compared to the post (waiting) control group (H4) (M.diff = 0.251, $p = 0.025$). Using Cohen's d to qualify the effect size shows a medium effect (d = 0.52) for the pre–post comparison of the intervention group, and medium effect (d = 0.52) for the post-intervention control comparison.
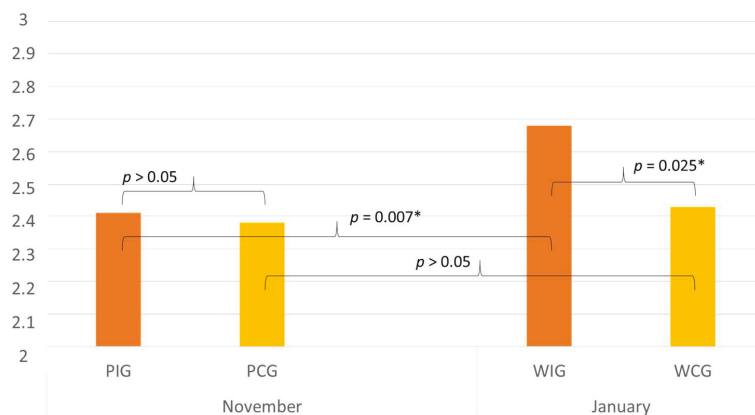
Figure 1. Mean values of EC for the four groups and significance of mean differences.

Evaluating complex interventions requires the careful consideration of the various contexts and factors that also might influence the dependent variables (i.e., EC attributes). To account for the large variation of personal contexts of the intervention course students' backgrounds, we solicited subjectively reported information via two questions "Thinking about the time you have spent in the university, in which university courses did you learn about: environmental values, issues and/or behaviors and citizenship related topics", and "In the last few months, to what extent have you learned about these topics in extra-curricular activities (not based on formal university courses): environmental values, issues and/or behaviors; citizenship related topics".

An absolute majority of the intervention course students said they learned about environmental values, issues and/or behaviors (95.6%) and learned about citizenship-related topics (84.6%) only or mainly in the course. The students from the intervention group also reported more isolated influences of the course on their learning about environmental values, issues, and/or behaviors (M = 1.51, SD = 0.66) as compared to the control group (M = 2.45, SD = 1.27; t(137) = −6.3, p = 0.000) and learning about citizenship related topics (intervention group M = 1.64, SD = 0.97, and control group M = 2.36, SD = 1.26; t(170) = −4.33, p = 0.000).

One third of the intervention group said they learned about environmental values, issues, and/or behaviors (38.5%) and learned about citizenship related topics (29.7%) to a large or moderate extent in the extra-curricular activities (external, non-university-based influences). Students from the intervention group (M = 2.3, SD = 0.98) compared to the control group participants (M = 1.99, SD = 0.85) reported lower influences of external extra-curricular activities on their learning about environmental values, issues, and/or behaviors, t(181) = 2.27, p = 0.024. Significant differences were found between the intervention and control group students' reported influences of external extra-curricular activities on their learning about citizenship-related topics.

The influence of the intended educational intervention is well isolated in terms of the university-based educational influences (other courses did not have influence, and there were no other university-related activities due to COVID-19 lockdown), but only partially isolated from external influences. The context of the global COVID-19 pandemic, and the overlapping discourses of the climate crisis and environmental degradation, might have introduced biases. These issues have been widely discussed in Lithuania during the period of the study and were related to calls for citizen action and citizen awareness, especially related to the public health crisis.

The second set of factors important for the experimental conditions is related to the actual effects of the instructional design. The intervention group students found these elements to have been important for their learning (where 3 = "Quite important" and

4 = "Very important"): activities that made students think about the relations between different real-world issues (M = 3.4, SD = 0.73), activities that asked for future thinking (M = 3.4, SD = 0.75) or for reflection on ethics and behaviors (M = 3.3, SD = 0.76), activities that require analytical thinking (M = 3.3, SD = 0.8), activities that asked to reflect on personal values (M = 3.3, SD = 0.81), multidisciplinary team of lecturers (M = 3.2, SD = 0.85), game-based activities (M = 3.2, SD = 0.87), group-work with peers (M = 3.2, SD = 0.9), design thinking activities (M = 3.0, SD = 0.83), and theory lectures (M = 3.0, SD = 0.87). One of the learning and instruction elements (LI elements of the CLIA model) was particularly important for the intervention group students. The students from the intervention group (M = 3.2, SD = 0.9) compared to the control group participants (M = 2.86, SD = 0.92) reported higher importance of group work with peers, $t(112) = 1.99$, $p = 0.049$. There were no other significant differences in terms of intervention and control group students' evaluations of the importance of various learning and instruction elements.

5. Discussion

Environmental citizenship is a crucial construct in education [52]. As we face the wicked problems that characterize the Anthropocene, it is clear that an informed and active environmental citizenship is needed. To tackle or prevent environmental issues, citizens need to act and participate as agents of change in the private and public spheres, both individually and collectively [2,58,59]. Many educational initiatives target environmental citizenship as a learning goal, and much effort is invested in formal and informal educational settings to provide students with learning experiences that foster environmental citizenship. Institutions of higher education have a crucial role to play in this aspect.

In this paper, we set out to explore the impact of a general elective course offered to incoming undergraduate students at a large technical university in Lithuania, which focuses on sustainable development, in terms of increasing the environmental citizenship among the participating students. We designed a quasi-experimental, randomized, pre-group–post-group study in which the environmental citizenship attributes of students in the experimental course (focused on sustainable development) were compared to those of students in a control course unrelated to environmental issues (focused on media philosophy). To measure the environmental citizenship attributes of students, we applied the recent instrument developed by Hadjichambis & Paraskeva-Hadjichambi [9]. Our results show a significant impact of the experimental course on the students' EC. Given that it was the first time that this new instrument was used in the context of higher education, we took several steps to assure its psychometric qualities. We will first discuss the results concerning the psychometrics of the instrument and then zoom in on and discuss the impact of the intervention. Finally, we will address limitations of the study and offer directions for present and future research in the field of education for environmental citizenship.

5.1. Validity and Reliability of the ECQ

Given the complexity of environmental citizenship, constructing knowledge, cultivating values and attitudes, and promoting active engagement in pro-environmental actions, it is difficult to assess whether and to what extent such initiatives achieve the goals they set out to reach. In 2020, Hadjichambis and Paraskeva-Hadjichambi developed a survey instrument for measuring the environmental citizenship of Cypriot students in secondary education: the environmental citizenship questionnaire or ECQ [9]. It is this instrument that we used in the current study. We introduced three innovations in the application of the ECQ: (1) we used it in another cultural context (Lithuania) than the one it was originally developed in (Cyprus); (2) we surveyed students in higher education rather than secondary education; and (3) we applied it in an intervention design rather than in a cross-sectional design. As such, our study does not only report on the impact of the educational intervention we evaluated, but it also contributes evidence for the qualities and application of the ECQ in such research.

To test the basic assumptions regarding the reliability and validity of the instrument, we assessed its internal consistency through the estimation of the Cronbach's alpha values for the entire instrument as well as for each of its nine subscales. Our results (see Table 3) show that each of the scales has excellent reliability, with all alpha values ranging between 0.830 and 0.930. The alpha value for the entire instrument is 0.929, indicating that there is also excellent internal consistency at the overarching conceptual level. It should be noted, though, that the estimation of Cronbach's alpha is influenced by the number of items in a scale, so it can be expected that a high value for the entire scale (with 76 items in total) would be reported. However, given that all subscales (ranging between three and 15 items) show high alpha values as well, it is fair to conclude that the ECQ can be used to reliably measure the environmental citizenship of higher education students in Lithuania. These results, together with those of Hadjichambis and Paraskeva-Hadjichambi [9] suggest that the instrument can be used in diverse educational contexts and with diverse ages to tap the environmental citizenship of learners in the context of educational interventions. While we found the ECQ to be reliable, in the current study we did not take an in-depth look at the validity of the instrument. Some of our results do, however, support initial claims of validity of the ECQ in this novel context. The differences we observed between male and female students (elaborated further on) point towards discriminant validity: the instrument has the potential to discern the EC among specific groups of students. The correlations found between environmental citizenship and environmental attitudes (also elaborated further on) point towards convergent validity: the theoretically related concepts correlate significantly and meaningfully. These results support the potential validity of the ECQ. Future efforts should focus on establishing the construct validity of the instrument through exploratory and confirmatory factor analyses.

5.2. Correlates of EC in Lithuanian Undergraduate Students

This study has shown that female undergraduate students display higher levels of EC compared to the male students as well as more positive environmental attitudes. This corresponds with findings of previous studies which have (relatively) consistently shown more pro-environmentalism (as reflected in positive environmental attitudes, values, and/or behaviors) among female students and adults compared to males [34–36,38,50]. The current study nevertheless adds valuable insights to previous research as it distinguished between environmental citizenship and general environmental attitudes and investigated the correlation among these. A moderate but significant correlation between the students' responses to the ECQ questionnaire and a measure of environmental attitudes developed by Hansmann and Binder [50] was observed. This points towards the potential role that attitudes play as a motivational component of EC. However, EC is a broad and encompassing concept, as reflected in the subscales of the ECQ instrument. Enacting EC does not only require pro-environmental attitudes, motivations, and value orientations, but also involves a broad range of further attributes, such as competencies and skills—including socio-political and communication skills—as well as an in depth understanding of social and environmental systems as entailed, for example, in the concept of environmental literacy [52,60,61]. Therefore, much higher correlations between environmental attitudes and EC may not be expected.

The close linkage between EC and environmental attitudes is also reflected in the similarity of their connection to third variables such as gender, and to nature experiences during childhood and youth. The current findings support and add to previous studies which have shown that a connection to nature and positive nature experiences during childhood and youth are positively related with pro-environmental values and behaviors during later life stages [33,55–57,62,63]. Both an interest in nature and a connection to nature during childhood and youth were found in this study to be positively correlated with environmental attitudes and even more strongly with the overall EC of the students. Furthermore, in line with previous studies, the positivity of nature experiences during childhood and youth was positively related to both the EC and environmental attitudes

of students [56,57,64]. On the other hand, while the frequency of contact with nature during youth was found to be significantly positively correlated with both the EC and environmental attitudes of the students, no corresponding significant relationships were found for the frequency of contact with nature during childhood. The latter results seem inconsistent with previous studies, but in the context of the other observed correlations of this study, they mainly seem to re-emphasize the importance of the positive character of nature experiences during childhood and youth for the development of young adults' EC and positive attitudes towards nature [33,56,65,66]. Furthermore, the lack of correlation between the residential settings—urban or rural—in which the participants grew up and their current EC and environmental attitudes also support that it is specifically the positive nature experiences and the sense of connection to nature that these nurture, which are meaningful for cultivating the individual's positive environmental attitudes and environmental citizenship. Children and youth growing up in urban areas may have significant nature experiences as a part of family leisure activities or other experiences such as summer camps.

In summary, the findings on self-reported nature experiences and relations to nature during childhood and youth indicate that interest in nature, connectedness to nature, and frequent (in particular, positive) experiences in nature during childhood and youth are highly important for the development of young adults' EC. According to Kellert et al. [67], "Play in nature, particularly during the critical period of middle childhood, appears to be an especially important time for developing the capacities for creativity, problem-solving, and emotional and intellectual development" (p. 83). The interest in nature comprises the cognitive motivation of children and youth to acquire the knowledge, environmental literacy, and problem-solving skills which thus form the basis from which young adults can later on further develop their EC [52,60,61,68]. For children and youth, as well as for adults, nature experiences represent a main basis for the development of environmental literacy and a close connection to nature, which can be considered integral aspects of EC [33,64]. Studies on the relationship between individuals' (of different demographic backgrounds) connectedness to nature and self-reported involvement in environmentally responsible behavior support a strong positive relationship [39], leading the authors to conclude that facilitating individuals to develop a sense of connectedness to nature should be one of the goals of EE programs and interventions as well as one of the assessments of such interventions. A recommendation stemming from this for the SD course implemented at Kaunas University of Technology is to incorporate instructional components that cultivate the students' sense of connectedness to nature.

5.3. Impact of the Educational Intervention

The findings of this study indicate a complex picture regarding the influence of the uniquely designed general elective course on the first-year students' environmental citizenship. On the one hand, the findings confirm all four of the hypotheses put forth: no differences were found between the pretest intervention and control groups (H1) nor between the posttest and pretest control group (H2); the environment citizenship of the posttest intervention group was significantly greater than that of both the pretest intervention group (H3) and the posttest control group (H4). Together, these results indicate a significant and positive impact of the sustainable development course on the students' environmental citizenship. We should recognize that the effect size was medium in term of its Cohen's d estimate, and that significant effects were found only for the construct of environmental citizenship as a whole, and not for the separate attributes that fall under the construct (EC-related knowledge, attitudes, future actions, or intentions to act as an agent of change). This does not enable us to discern the differential effects of the course on the specific components that together comprise the student' EC.

In order to differentiate between general influences on students' EC attributes that may occur during the academic experience and the influences related to the instructional methods employed in the teaching of the SD intervention, we compared the extent of

importance with which students acknowledge the various instruction methods between students participating in the intervention course and the control group. Students who participated in the SD course substantiated that it was this course that exposed them to environmental issues as well as to EC-related aspects. This indicates that the influence of the course is isolated from other university-related educational influences. Despite this, looking deeper into the various instructional methods that were implemented in the delivery of the course and that are acknowledged as meaningful for environmental education (see introduction), the (intervention) students perceived these as only moderately important (scores 3.0 > 3.5) and aside from teamwork with peers, no differences were found between the two groups of students. These findings may be related to the fact that the course was conducted during the COVID-19 pandemic, which placed severe restrictions, thus it was unable to realize the teaching–learning methods to their full potential. The significantly greater importance of teamwork with peers acknowledged by the intervention group seems to underscore the students' perception of the limitations imposed on their academic experience during social isolation; of the different pedagogies implemented, peer teamwork (conducted online in conditions of social isolation) was what made the most impression on them and was most appreciated. Although the only moderate influence acknowledged by the students may be tied to the learning conditions at the time of the study, other studies with HE students at different stages during their studies have also found that students acknowledge only modest influence of their studies to components of their environmental literacy [28,69]. Another methodological limitation is that the students' response to the questionnaire was voluntary, leading to the possibility of self-selection bias. However, the students who participated in the intervention course did not differ from students who participated in the control course in relation to various variables, which rather suggests that self-selection did not affect the two conditions asymmetrically.

Since we observed a relatively high average percentage of missingness when calculating the overall score for the students' environmental citizenship, we should look critically at our approach to calculating the overall mean EC values. To decrease respondent exclusion, we imputed missing values with average values when calculating the overall scale mean. Horton and Kleinman [70] describe that such an approach can cause bias since it artificially decreases variability in the sample. As described in the results section we report a mean of 21% imputed values. It should also be noted, though, that the bias described by Horton and Kleinman [70] would in the case of the current study not result in an increased chance of false positive results, but rather in an increased probability of a false negative result. So, the validity of the main finding of the positive effect of the sustainable development course on environmental citizenship is not threatened by the selected imputation method.

This study also enabled us to provide an overall picture of the environmental citizenship characterizing the participating students. Overall, the EC-attributes of these first-year students reflect a below moderate level of EC. While they demonstrate a pro-environmental orientation in the affective domain, reflected in their identification with social-environmental values associated with EC and environmentally supportive attitudes, they demonstrated limited intentions for involvement in environmentally supportive behaviors/actions, a limited sense of self-efficacy in relevant skills, and limited exposure to relevant knowledge. This picture is not unique to this group. Other studies exploring the environmental literacy attributes with HE students demonstrate similar findings: there is an overall below moderate level of environmental literacy, and looking at the various components, the highest levels are demonstrated in the affective domain and decrease in the cognitive and behavioral domains [28,69]. In view of the crucial role of HE in developing cadres of graduates committed to and capable of promoting sustainability, in their personal and professional lives [12,14,15] the findings indicate an ongoing challenge confronting HE.

6. Conclusions

In the context of education for sustainability, Rickenson et al. [71] emphasize the importance of connecting the influences of educational interventions and what it is about the programs that are influential in creating these impacts. This study provides a response to this direction of study, which is still largely underexplored in the context of higher education [14], by investigating the influence of a unique course developed to target the characteristics of environmental citizenship via a holistic and multidisciplinary approach and implementing various teaching methods associated with developing competences and agency in the context of sustainability [26]. A noteworthy value of this study is its implementation of the new instrument, the ECQ, developed as a tool for measuring components of environmental citizenship. While the findings indicate the psychometric quality of the instrument when used with HE students, an important direction for further study is to establish the construct validity of the instrument. A limitation of the study lies in its execution during the severe limitations necessitated during the COVID-19 pandemic. Long distance online learning did not enable us to fully and optimally implement the various instructional methodologies on which the intervention course is based. In view of the aim in connecting student outcomes and educational processes, it is important to repeat this study under an academic situation that is not grounded solely on long distance learning and with a larger cohort of students. A larger student cohort may also enable the identification of the influence of the course on the specific cognitive, affective, and behavioral variables that comprise environmental citizenship. From a methodological perspective, the recently developed ECQ provides an important contribution. In view of the paucity of instruments for measuring individual's environmental citizenship, parallel to increasing interest in educating for environmental citizenship, a direction of future work is to broaden the understanding of the relationships between the components that comprise EC and constructs and attributes (beyond those investigated in this study) that are reported in the literature in the context of environmentally responsible citizenship.

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The Importance of International Collaboration to Enhance Education for Environmental Citizenship

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Abstract: Environmental Education is essential to promote awareness and facilitate the development of environmental citizens. To contribute to the enhancement of environmental awareness, Iceland, Serbia, Bosnia and Herzegovina, and Romania have collaborated in joint educational projects which aim at building capacities on sustainable development, delivering environmental teaching lectures, and developing open educational resources. This article presents past and ongoing collaborations between the mentioned countries, assesses the status of environmental education, and highlights the benefits of international collaboration. For this purpose, information on environmental courses in representative universities from each country was collected, SWOT analyses were performed in each country, and a survey among potential students was carried out. The presented analysis reveals that international collaboration raises environmental awareness and increases the likelihood of becoming environmental citizens.

Keywords: environmental awareness; environmental citizen; environmental education; international collaboration

1. Introduction

The concept of environmental citizen has thoroughly been addressed in the literature [1–3] and redefined within the European Network for Environmental Citizenship COST action CA16229 (ENEC) [4]. The "Environmental Citizen" is defined as the citizen who has coherent and adequate knowledge, necessary skills, values, attitudes, and competencies to be able to act and participate in society as an agent of change in the private and public life, on a local, national, and global scale, through individual and collective actions in the direction of solving contemporary environmental problems, preventing the creation of new environmental problems, achieving sustainability, and developing a healthy relationship with nature. The environmental citizen practices environmental rights and duties and is capable to identify causes of environmental degradation and problems. Furthermore, the environmental citizen has the willingness and the competencies for active engagement and participation to act individually and collectively, taking into account generational justice [5]. To fulfill these requirements of an environmental citizen, education is essential, as discussed by Smederevac-Lalic et al. [6].

Citizens are formed in a long and complex process of political socialization through education, media, and popular culture [3]. The wisdom of knowledge is needed for ecolog-

ical citizenship that comes from knowing the holistic and basic aspects of environmental science. Education for Environmental Citizenship needs integrated systems of knowledge that focus on the understanding of human-environment interactions and the links between knowledge and actions for sustainability [6,7]. Knowledge is an essential element for pro-environmental behavior, and subsequently, pro-environmental behavior will consequently lead to environmental citizenship [6]. Education has been identified as a driver that can affect behavioral changes in citizens. Science education for responsible citizenship is recognized by the European Commission to be one of the main issues that could help citizens to get knowledge and participate actively, responsibly, and successfully in society [5]. Since environmental problems are complex and interdisciplinary, students have to be educated on how to approach these problems. One of the goals of environmental education is to form students that are capable of acting as informed and empowered citizens. Environmental citizenship in an educational context seems to be an imperative necessity [5].

The United Nations 17 Sustainable Development Goals (SDGs) are perhaps a more commonly known concept that is aligned with the concept of Environmental Citizen. The SDGs were adopted in 2015 by 193 member states to address global pressing social and environmental issues [8]. The SDGs aim at creating incentives for a more sustainable future for all humans on the planet. In Europe there exist various funding mechanisms to promote the implementations of SDGs, such as quality education (SDG 4), affordable and clean energy (SDG 7), sustainable cities and communities (SDG 11), partnerships for the goals (SDG 17).

A particular focus of such funding mechanisms is the collaboration between high education institutions (HEIs) from economically stronger countries with economically weaker countries in order to facilitate capacity building and knowledge transfer to less affluent counties. An illustrative example of such a knowledge transfer is the collaboration of Iceland, a country relying entirely on renewables, and the Balkan countries, which still rely primarily on fossil energy sources. Due to its location and geographical conditions, Iceland produces its entire domestic energy from geothermal and hydropower sources, while most of the Balkan states still rely on coal and other fossil fuel-based energy sources. Nevertheless, geothermal sources are abundant across the Balkans, being cheaper and cleaner, are still unexploited, due to a lack of education and general awareness. This circumstance is the reason why the collaboration between Iceland and the Balkans might be of particular importance.

In this study, we will present, analyze and highlight the importance of international collaboration between Iceland and key Balkan states, namely, Serbia, Bosnia and Herzegovina (BA), and Romania. The presented collaborations were primarily funded through EU programs such as the Financial Mechanism of the European Economic Area (EEA), CEEPUS, Erasmus+, and The European Cooperation in Science and Technology (COST Association). In the frame of these funding programs, HEIs from Iceland, Serbia, Bosnia and Herzegovina, and Romania have been and are collaborating on various educational projects: (i) joint educational lectures on sustainable management of natural resources and renewable energies, (ii) building capacities on sustainable development, and (iii) developing open educational resources (OERs) for rural citizens. As illustrative examples representative universities from each country were chosen, namely, Reykjavik University in Iceland, Brasov University and Timisoara University in Romania, the University of Banja Luka in BA, and Belgrade University in Serbia.

This study will describe the ongoing collaboration, highlight the importance to provide environmental education (EE) and education for environmental citizenship (EEC) and conclude how the collaboration enhances awareness. Indeed, EE and EEC are important for enhancing environmental awareness and for promoting the concept of environmental citizenship [4]. Environmental education provides the basic knowledge necessary for environmental awareness, can impact an entire population, and finally contributes to the likelihood of becoming environmental citizens. The concept of EEC was, in all investigated countries, new and accordingly not well embedded into the curriculum of the universities.

Nevertheless, since EE is the key driver for EEC, we focused in this paper on EE pointing out that it can lead to EEC. The study concludes by identifying international collaboration as a key driver for enhancing environmental awareness and promoting environmental citizenship.

2. Methodology

In order to assess the status of EE and EEC in Iceland, Romania, Serbia, and Bosnia we reviewed the curriculum of five key universities in each mentioned country: (i) Reykjavik University, with over 3500 students the biggest private university in Iceland, (ii) Transilvania University of Brasov (almost 20,000 students) and Politehnica University of Timișoara (14,000 students), two well-established universities in Romania, (iii) Belgrade University, with 98,000 students the biggest university in Serbia, and (iv) the University of Banja Luka, with 12,000 students one of the biggest universities in Bosnia. The universities were selected based on their reputation, their size, and their international collaboration. Data on EE and EEC courses and average student participation were collected directly from according to program managers, i.e., deans, rectors, or heads of faculties. The curriculum of each university was analyzed using a SWOT analysis conducted under the ENEC Cost Action and summarized in the SWOT Analysis on Education for Environmental Citizenship report by Hadjichambis et al. [9]. The SWOT analysis is based on questionnaires that have been designed to collect information from experts (academics, researchers, teachers, Ministry of Education officers, and NGOs) from each participating country in ENEC. Finally, a survey among students that are aware of EE and EEC was conducted in order to assess the perception of EE. In the present paper, we summarize, compare, and highlight strengths, weaknesses, opportunities, and threats regarding Education for Environmental Citizenship in each above-mentioned university.

3. Education for Environmental Citizenship

3.1. Environmental Education in Iceland

Iceland is geographically isolated in the North Atlantic and accordingly is directly dependent on international collaboration to drive innovation, information exchange, and capacity building. Being a member of the European Economic Area, the Nordic community, the Arctic Circle, and having close ties to North America, Iceland has a long history of intense exchange with both, Europe and North America. With the high potential of renewable energy sources (water resources for hydropower production [10], geothermal sources for thermal energy [11], and optimal wind conditions for wind-farms), Iceland can also export expertise and knowhow on renewable energy production as well as side products such as power-to-X [12,13], added value form residual streams and sustainable management of fish resources [14].

Although Iceland's economy has experienced turbulent times, including a financial crisis in 2008, the GDP of Iceland has been consistently ranked in the top 10 worldwide [15]. One important contribution to the productive and resilient Icelandic economy is the efficient use of natural resources [14]. Iceland spends about 3% of its GDP on scientific research and development (R&D), about 1 percentage point higher than the EU average of 2%, and has set a target of 4% to reach by 2020 [16]. Out of 72 countries that spend the most on R&D (USD 100 million or more), Iceland ranked 9th by the proportion of GDP, tied with Taiwan, Switzerland, and Germany and ahead of France, the UK, and Canada [17]. In total, 64% of Icelanders aged 25–64 have earned the equivalent of a high-school degree, which is lower than the OECD average of 73%. Among 25- to 34-year-olds, only 69% have earned the equivalent of a high-school degree, significantly lower than the OECD average of 80% [18].

Environmental education at the university level is present in all seven universities. The University of Iceland offers a master's degree in environment and natural resources, Reykjavík University has a Sustainability Institute and Forum, the University of Akureyri offers a Master program in the sustainable production of marine bio-resources, the Agricul-

tural University emphasizes environmental science and Bifröst University offers courses on sustainability and social responsibility.

This study will focus on the activities carried out by Reykjavík University (RU). RU is the largest private university in Iceland with more than 3500 students. It is chartered by the Chamber of Commerce, the Federation of Icelandic Industries, and the Confederation of Icelandic Employers. The school of technology at RU focuses on the renewable energy sector, providing domestic and foreign students hands-on training on geothermal energy, hydropower production, and sustainable engineering (Table 1). While renewable energies are the main focus, environmental educational courses, such as Environmental Impact Assessment and Sustainable Engineering provide students a holistic overview needed for sustainable development. For this purpose, theoretical concepts are being taught, examples from the main industries are discussed, and field excursions to real-life labs are being organized. These courses put the bio-economy at the center of sustainable development. Since 2019 most courses include the concept of EEC as well.

Table 1. Overview of environmental education at Reykjavik University.

University	Department	Study Program/ 2nd Level [1]	Courses Title EE Contents [2]	Enrolled Student [3]
Reykjavik University/School of Technology	Department of Engineering	Civil engineering Mechanical engineering Electrical engineering Engineering management	Environmental Impact Assessment (EE/EEC) Sustainable engineering and the environment (EE/EEC)	35
	Iceland School of Energy	MSc Sustainable Energy MSc Sustainable Energy Engineering MSc Electric Power Engineering MSc Electric Power Management Professional Development Courses	Environmental Impact Assessment (EE/EEC) Sustainable engineering and the environment (EE/EEC) ISE Summer school (EE)	35

[1] 2nd level is equivalent to master; [2] EE—Environmental Education, EEC—Education for Environmental Citizenship; [3] each course is attended on average by 35 students.

3.2. Education for Environmental Citizenship in Romania

The educational system in Romania has undergone numerous reforms in the past decades, all of them failing to overcome the barriers of conservatism implemented during the Soviet-Communism area. Thus, Education for Environmental Citizenship is a new concept for Romania. Nevertheless, ecological education and education for sustainable development have been implemented in the university curriculum as a result of Romania's accession to the European Union. Furthermore, the notion of environmental psychology has been incorporated into the educational system.

The implementation of EEC into the educational system must be done in correlation with existing educational paradigms related to environment protection. Based on the results of a study conducted in 2018 with experts in the field of education, we can say that this complex concept of EEC includes all the other types of sustainable and environmental education and should be approached from early ages, and for different educational levels. EEC is perceived to be built around the key term "environment", a more quantitative approach, this being the binder between several types of education, which needs a more qualitative analysis.

Another relevant aspect in understanding the difficulty of introducing EEC in Romania is that of the diversity of higher education institutions. In technical universities, the issue of environmental protection is only partially approached and strictly addressed from a technical point of view (e.g., what is the impact of different types of economic activities

on the environment). In response to increasing environmental concern, the Romanian higher educational system sustains the development of graduates' competencies related to environmental protection, at the undergraduate level, as set at the national level [19]:

- curricula in the field of environmental studies, such as Environmental Engineering (240 ECTS), Environmental Sciences (180 ECTS) Environmental Economics (180 ECTS) Environmental Management (180 ECTS);
- curricula in the field of different engineering studies, focusing on environmental issues, such as Energetics, Civil Engineering, Industrial Engineering, Food Industry, Agriculture;
- isolated courses introduced in the curricula of different study programs, at university decision, such as Ecology and Environmental Protection (studies in the field of Agronomy), Environmental Protection (studies in the field of Architecture), Environmental Law (studies in the field of Laws), Environmental Sociology and Environmental Anthropology (studies in the field of Social Sciences, Policy and Communication), Environmental Policies (studies in the field of Administrative, Educational Sciences, and Psychology), Environmental Management, Ecological Policy, Environmental Policy (studies in the field of Economic Sciences).

Based on autonomy, each university decides the curricula for a specified study program, in between the limits imposed by the national rules (in terms of study courses), and is responsible for the course content to develop the students' targeted competencies.

Considering two high education institutions from Romania, Transilvania University of Brasov and Politehnica University of Timisoara, the experience in environmental education, gained from more than 20 years, is summarized in Table 2.

Table 2. Overview of environmental education and environmental citizenship education at universities from Timisoara and Brasov.

University	Faculty	Study Program/ 1st or 2nd Level [1]	Courses Title EE/EEC Contents [2]	Enrolled Student
Transilvania University of Brasov	Product Design and Environment	Industrial Environmental Engineering and Protection/1st	EE curriculum	100
			Environment and Society (EEC)	25
		Engineering of Renewable Energy Systems/1st	EE curriculum	100
			Environment and Society (EEC)	25
		Sustainable Product Design and Environment Protection/2nd	EE curriculum	25
Politehnica University of Timisoara	Civil Engineering	Civil Engineering/1st	Environmental engineering (EE)	100
		Optimizing the operation of sanitary engineering systems and environmental protection/2nd	Sustainable development through projects and programs (EE)	55
		Optimization of hydro-technical systems/2nd		
	Industrial Chemistry and Environmental Protection	Inorganic Substances Engineering and Environmental Protection/1st	Environment protection (EE)	30

[1] 1st level = bachelor, 2nd level = master; [2] EE—Environmental Education, EEC—Education for Environmental Citizenship.

In the frame of the formal curriculum, as part of the umbrella concept of environmental education, the environmental engineering curricula run both at bachelor and master level, even in the field of environmental engineering studies, or in other engineering fields. The focus on education for environmental citizenship is less approached, but the course "Environment and society" delivered at the Transilvania University of Brasov provides

learning experiences to develop student's knowledge and attitudes which might contribute to their active involvement in societal environmental problems.

3.3. Education for Environmental Citizenship in Serbia

Environmental education in Serbia was included in the educational agenda in different forms for more than a century but it was never a leading subject and the whole concept of EEC is not established and understood well in Serbia [9]. The terminology of EE and ESD, SE, and CE was not differentiated, even the terms ecology and environmental protection are often confused. The Environmental Education (EE) system in Serbia is not reflected in the concept of Education for Environmental Citizenship. There are 17 universities in Serbia eight public and nine private universities. The University of Belgrade is the oldest and largest university in Serbia. It consists of 31 faculties with around 98,000 students, as well as 11 research institutes, the university library, and seven university centers. The faculties of the university are organized into four groups: social sciences and humanities, sciences and mathematics, medical sciences, and technology and engineering sciences.

Based on the results of the SWOT analysis conducted in 2018–2019 with experts in the field of education [9], the complex concept of EEC in Serbia is considered under the term "environment" and covers several types of education. Same as in the Romanian case, the diversity of faculties at the University in Serbia complicates understanding and implementation of EEC. Technical universities are covering the issue of environmental protection from a technical point of view, while natural sciences are more oriented toward sustainable use and development. Increasing environmental concern started between two conferences, Rio, 1992 and Johannesburg 2002, and it started to be of national importance and issue of cooperation of two ministries (Ministry of Education and Ministry of Environmental protection). At the time many Faculties in Serbia established new departments or study programs covering environmental issues from their scope.

Environmental education at the university level is present in all 17 universities. This study will focus on the activities carried out by the University of Belgrade (UoB). UoB is the largest university in Serbia which offers a bachelor's, master's degree, and Ph.D.'s in different environmental and natural resources perspectives. Each faculty focuses on their scope of environmental issues (Table 3).

3.4. Education for Environmental Citizenship in Bosnia

Environmental education in Bosnia has been severely suppressed by the devastating impacts of the Bosnian civil war between 1992 and 1995. After the Civil War in 1995 Bosnia and Herzegovina (BA) was established as a sovereign state with parliamentary state regulation and a decentralized political and administrative structure [20]. Two Entities (Republic of Srpska and Federation of BA) and one District (Brčko) comprise the three administrative units within BA, and are responsible for all jurisdictions over higher education. The Ministry of Scientific-Technological Development, Higher Education, and Information Society of the Republic of Srpska is the main institutional jurisdiction for higher education and the University of Banja Luka, as a public higher education institution. Considering environmental issues, BA is strongly devoted to international commitments ratifying United Nations Conventions (United Nations Convention to Combat Land Degradation; United Nations Framework Convention on Climate Change; United Nations Convention on Biological Diversity) and implementing many other International agreements and EU Directives into the existing legislative framework [21].

Table 3. Overview of environmental education and environmental citizenship education at the University of Belgrade.

University	Faculty	Study Program/ 1st or 2nd Level [1]	Courses Title EE/EEC Contents [2]	Enrolled Student
University of Belgrade	Faculty of Biology	Module Biology/1st/2nd	i.e., various environmental courses (EE)	150
		Module Ecology/1st/2nd		
		Module Professor of Ecology and Environmental Protection/2nd		
	Faculty of Forestry	Ecological engineering/1st	i.e., Environmental engineering (EE)	60
		Forestry/1st	i.e., Environmental Forestry (EE)	120
		Landscape architecture/1st	i.e., Urban ecology (EE)	60
		Ecological engineering/2nd	i.e., environmental Modules (EE)	
	Faculty of Chemistry	Environmental Chemistry/1st/2nd	i.e., various environmental chemistry courses (EE)	135
		Biochemistry/1st	i.e., Elective: Ecology (EE)	50
	Faculty of Geography	Geospatial and Environmental Science/1st/2nd	i.e., various environmental courses connected with geosciences (EE)	40
		Spatial Planning/1st	i.e., Ecological Planning (EE)	40
		Tourism/1st	Tourism and nature (EE)	70
	Faculty of Technology and Metallurgy	Environmental Engineering/1st/2nd	i.e., Environmental engineering courses and Sustainable development (EE)	60
	Faculty of Mining and Geology	Environmental Engineering/1st/2nd	i.e., Environmental engineering courses (EE)	40
	Faculty of Agriculture	Environmental protection in food production/1st	i.e., Ecology, sustainable agriculture, environmental protection courses (EE)	40
	Faculty of Physical Chemistry	Physical Chemistry/1st/2nd	i.e., Elective: Environmental Physical Chemistry	100
	Teacher Education Faculty	Educator's education/1st	Getting to know the environment	140
	Pharmaceutical Faculty	Pharmacy—Medical Biochemistry/1st	Toxicological risk assessment, environmental pollutants, elective course: Medicinal plants and the environment	72
	Faculty of Security Studies	Security Studies	Foundations of Environmental Security, elective module: Eco safety	390

[1] 1st level = bachelor, 2nd level= master; [2] EE—Environmental Education, EEC—Education for Environmental Citizenship.

The Government of the Republic of Srpska has adopted the Strategy on Development of Education for the period 2016–2021 [22], as the main document which strongly supports and encourages international cooperation between the University of Banja Luka (UBL) and other countries worldwide. UBL has already started implementing EE and EEC into some of the university courses (Table 4). Besides internationalization as the main objective, this document is important for the future integration of the Republic of Srpska (BA) into the European Union. The UBL was established in 1975, is the second-largest university in BA, with more than 15,000 students. It consists of 17 faculties, where environmental education is the part of study programs and curricula on three Faculties (Faculty of Forestry, Faculty of Agriculture, and Faculty of Science). So far, UBL has been involved in 89 Tempus projects, 17 Erasmus+ Capacity Building projects, and more than 90 Erasmus+ credit mobility projects which together with more than 200 bilateral agreements in international

academic cooperation, represents an excellent baseline for internationalization. Moreover, universities in developing countries such as BA are not visible enough due to limited capacities, particularly in post-conflict environments.

Table 4. Overview of environmental education and environmental citizenship education at the University of Banja Luka.

University	Faculty	Study Program/ 1st or 2nd Level [1]	Courses Title EE/EEC Contents [2]	Enrolled Student
University of Banja Luka	Faculty of Forestry	Forest management on sustainable basis 2nd	Environment and Society (EEC)	10
		Forestry 2nd	Environment and Society (EEC)	20
		Forestry 1st	Environment and Society (EEC)	30
	Faculty of Natural science	Ecology and Environment protection 1st	EE curriculum	12
		Biology 1st	EE curriculum	35
		Plant ecology 2nd	EE curriculum	10
	Faculty of Agriculture	Plant protection 2nd	Environment and Society (EEC)	7
		Soil and water management 2nd	Environment and Society (EEC)	6
	Mechanical faculty and Faculty of Architecture, Civil engineering and Geodesy	Energy efficiency in engineering	Environmental engineering (EE)	15

[1] 1st level = bachelor, 2nd level = master; [2] EE—Environmental Education, EEC—Education for Environmental Citizenship.

Before looking into the question of environmental citizens in BA and comparing the environmental awareness, opportunities in the educational institutions abroad, it is important to note that BA ranks in third place in 2020 Human flight and brain drain index in Europe [23], an indicator for the economic impact of human displacement and the consequences for country's development—higher index means greater emigration. BA scores 6.2 and is right behind Albania (8.2) and Moldova (7). The average for Europe from the same period was 3.5, with Sweden having the lowest index of 0.8. In 2018 the Ministry of Human Rights and Refugees of BA reported that the total number of people who live abroad but are originally from BA exceeds half of the total population recorded by BA in the 2013 census. Over 2 million people of BA have moved away [24]. An increasing number of people are trying to study abroad and those newly graduated are seeking opportunities outside of BA, in their effort to ensure advancements, professional development, social security, and stability of the state. The cost of each educated person from BA leaving the country is estimated to amount up to EUR 21,000 [25].

Young people of BA are leaving the country to expand their views and apply for master studies abroad and very few of them return to BA [25]. The losses are not only economic but often emotional, as the youth becomes a victim of the politicized educational system. While the concerns for students in BA are topped with the question of recognition of diplomas across the country from some of the institutions, UNESCO [26] warns that the current educational system in BA enhances the ethnic division of children and students.

Motivated by the concept of environmental citizenship some people of BA are enrolling in the Iceland School of Energy Master program. The program provided an ideal opportunity to enlarge the perspective while learning about environmental issues and acquiring know-how on sustainable development.

4. Frameworks for International Collaboration to Enhance Education for Environmental Citizenship

The opportunities for academic staff and students rely on international programs to provide logistical, structural, and financial support to facilitate collaborative projects as well as international student and staff exchanges. Numerous programs are offering financial support for projects (educational and/or research) and mobility, like Erasmus+, EEA Grants and Norway Grants, CEEPUS, or COST.

The European Commission has implemented the Erasmus+ Programme to support education, training, youth, and sport in Europe for the period 2014–2021 [27], to boost skills and employability, as well as to promote environmental education. The program financed both collaborative and mobility projects, for: higher education; vocational education, and training: school education (including early childhood education and care); adult education; youth and sport. For high education level mobility, Erasmus+ was based on the two key action projects:

- key action 103 (known as KA103)—for which HEIs from the program countries are eligible, including Iceland, Romania, and Serbia;
- key action 107, (known as KA107)—financing credit mobility projects between the program countries HEIs and other partner countries, all over the world, including Bosnia and Herzegovina.

The new Erasmus+ Programme (2021–2027) will provide opportunities for over 4 million Europeans to study, train, gain work experience, and volunteer abroad.

The EEA Grants and Norway Grants are grants funded by Iceland, Liechtenstein, and Norway with the aim to reduce social and economic disparities in the European Economic Area (EEA) and strengthen bilateral relations with the 15 EU countries in Central and Southern Europe [28]. The main objective of the EEA grants is the strengthening of fundamental European values such as democracy, tolerance, and the rule of law. Furthermore, and linked to the promotion of democracy and rule of law is the promotion of environmental education and sustainable development.

Central European Exchange Program for University Studies (CEEPUS) is a multilateral university exchange program in the extended Danube region based on an International Agreement. More than 15 member states have joined the current CEEPUS III agreement [29], including Bosnia and Herzegovina, Romania, and Serbia.

Apart of the educational programs, there are framework programs financing research and innovation, but all of these include educational chapters in their projects.

The European Cooperation in Science and Technology (COST) is a funding organization for research and innovation networks [30]. COST is operated according to the instrument called COST Action, which is a network dedicated to scientific collaboration, complementing national research funds. In this context, universities from Iceland and Balkan states in southeastern Europe are collaborating and joining their efforts in the COST action project for education for environmental citizenship. The European Network for Environmental Citizenship (ENEC), is one of the COST actions, in which 32 countries are participating, including 30 European Countries, Israel, and the USA [4]. The ENEC project is aiming to improve understanding and assessment of environmental citizenship and education for environmental citizenship in European societies and participating countries, being organized in four working groups:

- WG1: Environmental Citizenship through Primary Formal education;
- WG2: Environmental Citizenship through Primary Non-Formal education;
- WG3: Environmental Citizenship through Secondary Formal education;
- WG4: Environmental Citizenship through Secondary Non-Formal education.

Horizon 2020 and Horizon Europe are the eighth and ninth, framework programs (FP8 and FP9) funding research, technological development, and innovation in Europe, respectively. The programs are instruments to promote and facilitate the Innovative Union initiative. The aim is to ensure the creation of world-class European science and to facilitate

cooperation between the private and public sectors in the field of innovative work. It is also focused on the further development of the European Research Area as a single market for knowledge, research, and innovation.

Finally, various bilateral and multilateral cooperation projects financially support projects of scientific and technological cooperation between scientific research organizations based on international bilateral or multilateral agreements.

These exchange programs all aim at enhancing education for environmental citizens at all Universities involved. Most programs have a special fund focusing on Inclusiveness Target Countries, like Serbia, Romania, and Bosnia, facilitating the introduction of Environmental Citizenship and Education for Environmental Citizenship.

4.1. International Collaboration Experience of Reykjavik University

Iceland and Reykjavik University are depending on intense collaboration with Europe and North America. Being isolated in the North Atlantic, collaboration is essential for capacity building, knowledge transfer, and the development of innovation. While Iceland has extensive knowledge in hydropower and geothermal energies, sustainable fisheries, and aluminum and ferrosilicon, it also relies on incoming expertise from outside the country. Being a member of the EEA Icelandic institutions can participate in both EEA research and mobility grants and programs funded by the European Union.

In the following, we outline how international collaboration enhances education for environmental citizens at Reykjavik University (RU) and how the funding programs described in Section 3 have facilitated international collaboration. Reykjavik University welcomes every year over 150 Erasmus students and about 35 students that subscribe to a full Master's program at the Iceland School of Energy.

Reykjavik University has been actively collaborating with the Balkan states Romania, Serbia, and BA, namely Transilvania University of Brasov (Romania), Politehnica University of Timisoara (Romania), University of Belgrade (Serbia), and University of Banja Luka (Bosnia and Herzegovina). With all mentioned universities collaboration ranges from student and staff exchange, development of joint educational and research projects, to joint publications.

Especially the international exchange though the Cost Action ENEC has initiated the incorporation of EEC into the curriculum of some of the university courses (Table 1). Lecturers from Balkan countries were invited to Iceland and vice versa, both included concepts of EEC. Furthermore, through the staff exchange, teaching material was exchanged and EE, as well as EEC, was incorporated into the guest lectures (Tables 2–4).

Furthermore, the student exchange has led to the development of student projects from various parts of the world, bringing international concepts to Iceland and educating international students with Icelandic know-how. Through the incorporation of EE and EEC into university courses, environmental awareness was disseminated across the world.

4.2. International Collaboration for Environmental Citizenship of Romania

Between 2014 and 2020, Politehnica University of Timisoara (UPT), in cooperation with Institutions from Iceland, organized a series of meetings covering subjects such as environmental citizenship, sustainable land management, renewable energy, ecosystem services. Furthermore, since 2017 UPT, Reykjavik University (RU), University of Banja Luka (BA), and Institute for Multidisciplinary Research, University of Belgrade (Serbia) are cooperating within the above-mentioned COST Action CA16229 "European Network for Environmental Citizenship (ENEC)".

The meetings brought together representatives of local and regional authorities, high-school educations, SMEs, and NGOs. These meetings allowed an efficient transfer of knowledge between different actors, decision-makers at local, regional, and national levels and led to the strengthening of international relations.

At the institutional level, the exchange of staff and students had an important role in disseminating knowledge and expertise in identifying new common directions of re-

search/collaboration in terms of environmental awareness and implementing the concept of environmental citizenship in different regions, respectively. Numerous former students are currently employed in environmental sectors, indicating that the transfer of knowledge to the economic sector was successful.

Transilvania University from Brasov (UNITBV) is a prestigious institution both at a national and international level, a comprehensive university with 18 faculties, covering all fundamental domains, such as engineering sciences, exact sciences, social sciences, arts and humanities, medicine, physical education, and sports. One of the priorities of the UNITBV management is to intensely promote internationalization activities, stated in the internationalization strategy [31]. The international collaboration with other HEIs all over the world (Africa, North America, Latin America, Asia and Oceania, and Europe) is based on projects agreements (such as Erasmus, EEA, and CEEPUS) or on mutual framework agreements signed between the partners [32].

UNITBV and RU successfully applied for the project "Protecting biodiversity and the importance of ecosystem services" funded by the Fund for Bilateral Relations within the RO 02 program "Biodiversity and ecosystem services", Financial Mechanism of the European Economic Area (EEA) 2009–2014. The main objective of this project was to identify sustainable solutions to protect biodiversity, for acknowledging, understanding, and judicious using of ecosystem services through activities adapted to different age groups including adults, children, and young people through an inter-generational approach.

The partnership of UNITBV with RU and the idea of cooperation based on a project emerged after the participation of representatives from RU, Bucharest University of Economic Studies (BUES), and UNITBV at one workshop, in May 2017. Common educational training experiences and needs were identified, and thus the three teams decided to start collaboration for possible future educational projects. To prepare an educational project application, in January 2019 a Preparatory visit was organized for UNITBV and BUES groups at RU, with financial support from the European Economic Area (EEA) Financial Mechanism 2014–2021 and the Erasmus+ mobility projects. As a consequence of the discussions during the preparatory visit, in January 2020 the consortium formed by RU, UNITBV, BUES together with the Technical University Gheorghe Asachi from Iași (TUIASI) applied for a cooperation project, with the title Environmental Education—OERs for Rural Citizens (EnvEdu—OERs), as indicated in Figure 1. The project proposal was granted and started in November 2020 [33].

During the meetings that the UNITBV team had with local authorities' representatives before the project proposal, it was pointed out that the rural citizens' education related to the environment quality at the local community level is low. A list of environmental legislation, compulsory to be implemented at the local communities' level, was provided by the local authorities to the UNITBV team. This list contains legislative acts mostly related to (i) waste management in small communities; (ii) the need for active participation of the population at Environmental Impact Assessment (EIA) reports debates. Thus, the project aims to develop open educational resources (OERs) for environmental education for rural citizens and will answer to the increased need to ensure social, food, and environmental security for the rural communities, as a hotspot for designing sustainable development practices at the local level.

The project partners will manage an e-learning MOODLE platform, where OERs will be uploaded and available, organized on six modules (M):

- M1. Sustainable Communities and Social Communication (under the coordination of UNITBV);
- M2. Environment Quality (under the coordination of UNITBV);
- M3. Environmental Management, Impact and Risk Assessment (under the coordination of TUIASI);
- M4. Waste Management in Rural Communities (under the coordination of TUIASI);
- M5. Water Resources and Water Balance for Sustainable Community (under the coordination of RU);

- M6. Environmental Projects Management (under the coordination of BUES).

The project team considers that all the OERs, the meetings organized at local communities, the project website, all the communication, and dissemination envisaged activities will contribute to the environmental education citizenship in Romania and Iceland. The partners' competencies, expertise, and experience are complementary, thus ensuring a knowledge transfer among the HEIs as well to the local communities.
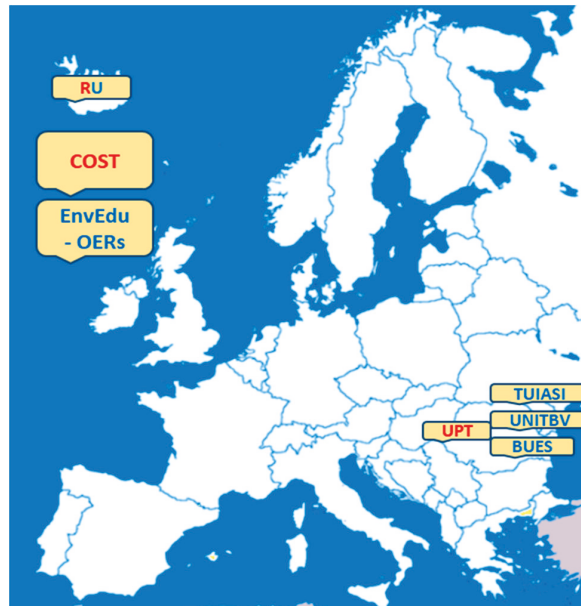
Figure 1. Ongoing international collaboration between Reykjavik University and high education institutions from Romania.

4.3. International Collaboration of Belgrade University

International collaborations aim to facilitate capacity building and foster collaboration. The University of Belgrade has maintained intense and productive collaborations with universities around the world, to affirm the policy of friendly and constructive academic ties and to promote international exchanges of teachers, students, and administration.

University of Belgrade and Reykjavik University have developed an intense student and staff exchange between the two institutions, resulting in joint research projects, joint conference proceedings, and joint research publications in the field of environmental science. During the exchange academic staff of both institutions have provided lectures to local students, promoting environmental education.

4.4. International Collaboration of Banja Luka University

The international collaboration between Banja Luka University and Reykjavik University has been postponed due to the COVID-19 pandemic that started in January 2020. However, numerous courses have been identified in the curriculum of both universities (Tables 1 and 4) that could potentially lead to a collaboration on environmental education. The two universities have successfully applied for an Erasmus+ grant and will start a teaching and research collaboration as soon as travel restrictions are lifted.

5. Key Drivers for Enhancing Environmental Education and Awareness in Balkan Countries

In the Balkan states in southeastern Europe, such as Romania, Serbia, Bosnia and Herzegovina, environmental education is not recognized as a priority, because society and economy still rely on a historically traditional form of exploitation of natural resources in an unsustainable manner. Although formal and non-formal environmental education exists, the application of knowledge in practice is based on individual efforts. Even when initiative and action exist in individuals or groups, the state, i.e., the system hampers these actions to expand their outreach, reducing their impacts and minimizing their success. This is especially true for the energy sector, where renewable energy sources could be cheaper, healthier, and environmentally friendlier than the widely used coal for heating purposes.

Formal environmental education is implemented by including environmental courses in the curriculum of schools and universities, generating a major channel of dissemination of environmental knowledge. Research and environmental initiatives endorsed formal education as a way of educating the public and students with sound environmental knowledge and achieving behavioral change [6]. In order to facilitate the incorporation of environmental courses, international collaboration plays a key role, facilitating the dissemination of environmental knowledge through projects and exchange programs by enabling the exchanges of knowledge and real-life examples.

Environmental education in BA receives more attention in the recent decade due to serious threats and ongoing climate changes that affect this region very frequently. Floods, drought, and wildfires are recognized as the main drivers of environmental degradation in BA caused by climate changes [34–37]. For example, the University of Banja Luka (UBL) implemented the Erasmus project entitled "Soil Erosion and Torrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries" focused on improving the existing education system in the forestry study program, aimed to update curricula and answer on torrential floods and soil erosion not only among students but also for practitioners who manage forests and forest land. Through this project, UBL strongly benefits from experience and knowledge exchange among project partners from developed countries in Europe promoting the importance of international collaboration for a better environment. Priority of environmental education at UBL is to update existing curricula in line with recognized threats for the environment, transfer knowledge to a wider community and to establish a better connection between science and practice. However, the post-conflict environment and limited capacities (lack of staff, equipped laboratories etc.) additionally challenge this process, but international collaboration with eminent universities worldwide has been recognized as an opportunity for the development and promotion of UBL in the future.

Academic cooperation provides the framework for ensuring a sustainable mutual transfer of knowledge thus contributing to enhancing environmental awareness as well as to the innovative strength of concepts such as environmental citizenship.

In order to find out the perception of who is responsible to provide environmental education, a survey was organized and launched to persons well aware of exchange programs, EE and EEC. Seventy-five persons of different ages and origins took part in the survey: 42 Icelanders, 23 people of BA, and 10 of other nationalities. They were asked seven questions, aiming to tackle their experience of formal education and learning about the environment. The questions are grouped as follows:

(1)   where they studied and if their formal education taught them (sufficiently) about the environment;

(2)   if they self-evaluate as sufficiently aware of the environmental concerns and about the sources of their information;

(3)   if the environmental awareness is a matter of public or private life, or how they were raised at home.

Self-evaluating their experience by responding to the statement "School taught me everything I know about the environment, participation in environmental protection

and exercise of environmental rights", 60.87% of the respondents from BA said that it is "somewhat" correct; 13.04% answered that it was not taught at all in schools and 26.09% answered that they learned all they know about the environment at school. In comparison, of all the Icelanders who took part in the survey, 59.52% stated that these concepts were not taught in school at all. Almost similar to the Icelandic situation, 50% of the participants from other countries stated that the concepts were not taught in schools.

While all the respondents consider themselves more or less well informed about the global and local environmental concerns, only one person from BA and two Icelanders of all participants in the survey identified schools as a source of information and awareness. Media, personal interest, and personal research are the main sources of information (Figure 2).
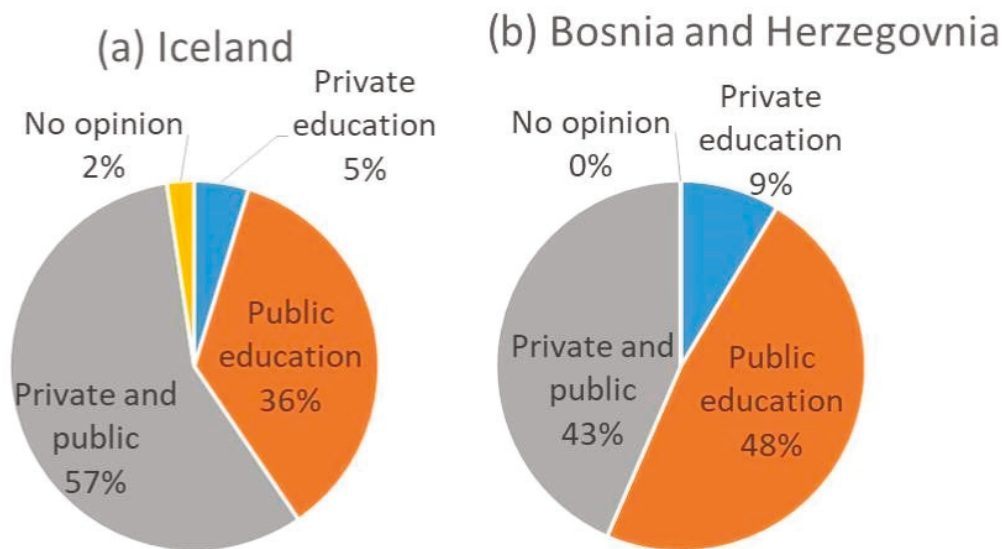
Figure 2. Perception on who is responsible to provide environmental education to children and students.

Most of the people of BA participating in the survey believe that environmental awareness is a public matter that should be addressed by the system (48%), while for Icelanders the concern is of both public and private matters (57%).

The results from the survey reveal a strong desire from students from BA for environmental education in the public education system. In comparison with Iceland, more people of BA feel that environmental education should be part of public education. While it would be interesting to further expand the study, include representation of all social and age groups, and understand what exactly is taught behind school benches and auditoriums at universities. Whether they feel free and if the complex, fragmented political system allows them to do so, seems to have a greater impact on the final decision use of that potential in BA.

6. Conclusions

This paper analyzed how international collaboration facilitates the introduction of environmental education and education for environmental citizens into the curriculum of universities in Iceland, Romania, Serbia, and Bosnia. For this purpose, data on courses including environmental education were collected from representative universities of each country. The process of integration of EE into the university curriculum was analyzed using a SWOT analysis in each country. Furthermore, the international collaboration between the representative universities from the four countries was described and analyzed. Finally,

students aware of EE and EEC were asked about their perception of EE. Based on the presented results the following conclusions can be drawn:

- EE is well incorporated into the university curriculum of all investigated universities. Nevertheless, enrollment of students is still very low, with about 3% (of the total number of students) at Reykavik University, and less than 2% in the Balkan Universities;

- EEC is in all universities a new concept and has only been incorporated into some EE courses since the start of the Cost Action ENEC. Nevertheless, all universities have been doing an effort to incorporate EEC into the curriculum;

- Numerous funding programs facilitate the collaboration between more affluent countries, such as Iceland, and economically weaker countries, as some of the Balkan countries. Most of these funding programs promote sustainable development and facilitate the promotion of environmental education;

- The international collaboration between Reykjavik University in Iceland, an affluent country (GDP per capita: USD 65,273), with the Balkan Universities (GDP per capita: USD 14,968 in Romania, USD 8748 in Serbia, USD 6728 in Bosnia) is very productive and has led to a valuable exchange of knowledge, capacity building, and joint research projects. Especially the incorporation of the concept of EEC has been facilitated through the international collaboration funded by the Cost Action ENEC;

- A key driver for international exchange is the funding opportunities for young students and researchers. Student exchange programs present a unique opportunity for ambitious students to acquire valuable know-how on sustainable development;

- The majority of the students that are aware of exchange programs, EE and EEC believe that it is at least partially the responsibility of the state to provide environmental education to children and students.

Based on these findings we conclude that funding for international collaboration on EE and EEC is of fundamental importance to promote and facilitate the implementation of the concepts of the environmental citizen into the curriculum of universities.

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Article

Knowledge Use in Education for Environmental Citizenship—Results of Four Case Studies in Europe (France, Hungary, Serbia, Turkey)

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Abstract: The aim of the paper is to contribute to the research on education for environmental citizenship in a comparative perspective. The central concept of education is the complex issue of knowledge. In the present paper, different knowledge forms, knowledge use, and types of knowledge production in environmental education are analysed for two EU countries, France and Hungary, together with two candidate countries, Serbia and Turkey. We review the most important theories and publications, the research questions and the methods considered to be examples for our present work. The second part of the paper presents the case studies according to the theoretical priorities. Evidence-based papers on cases in different European countries illustrating and discussing the evaluation of the types of knowledge used in environmental education and sustainability projects, as well as analysing the power-related components of knowledge use are reviewed. In the final part, case studies are compared and conclusions are drawn.

Keywords: education; environmental citizenship; knowledge; power relations; cross-country comparison

1. Introduction

The use of knowledge is a central issue in environmental discourse, highlighting whose knowledge determines the direction of environmental practices in education, policy decisions, local development, and the economy. The functioning of power is perhaps most clearly understood through the assertion of the types of knowledge that permeates all relevant components of environmental citizenship, from the formation of environmental education and attitudes to the details of resource allocation and practical activities. The detection and management of environmental hazards has always triggered the activities of groups of different actors who have had unequal access to the production, use, and validation of the necessary knowledge. Indigenous, tacit knowledge is mostly subordinated to environmental doctrines worked out and accepted in organizations. The mobilization capacity of NGOs and state or international bureaucratic institutions require a different kind of knowledge capital. Hadjichambis et al. [1] highlighted that key concepts and practices can affect a wide variety of scientific, advocacy, economic, and political arenas, just as green political thinking can be saturated with conflicting moral values [2]. The practice-oriented

nature of intervention, prevention, and mobilization focuses on something other than the ethically determined values of autonomous provision and locality [3].

Environmental education and education for environmental citizenship, as defined by Hadjichambis et al. [1] are a particularly special field for the symbolic and practical clashes of competing ideas, interests, and organizations. Smederevac-Lalic et al. [4] explain that formal, informal, and non-formal education are mediators of other types of knowledge and that the perceptions and interests of participants in the three organizational forms also express different intentions and aspirations.

The aim of this paper is to show, with four cases of environmental education (French, Hungarian, Serbian, and Turkish), what forms of organizations are created in practice for the production and transfer of knowledge related to Environment Citizenship. The source of growing complexity is what kind of aspirations and ideas are the main drivers of formal and informal education, which is the focus of our work together with the neglected subject of power relations. The structure of the paper is as follows. Following the introductory part, the second includes a review of the most important concepts and publications, and the third includes the research questions and methods. In the fourth part, we describe the cases of environmental education, divided into four subchapters. The discussion chapter summarizes the evidence for comparing the four cases, and finally conclusions are drawn.

2. Theoretical Background

A summarizing study [4] clearly points out that environmental education is successful if it can combine the use of a wide variety of types of knowledge in specific organizational forms that "*assist in the application of environmental ethics in every human activity*" [4] (p. 80). Environmental knowledge is naturally interdisciplinary, and its utilization is beneficial if it incorporates the benefits of several types of knowledge.

Scientific knowledge is mainly explicit, well documented, institutionalized and sequential [5,6]. While scientific knowledge presents embracing theories and concepts, based on proven and excepted scholarly methods supported by a systematic collection of information from different localities and situations, local knowledge is specific, based on experiences and sometimes irregular observations. Scientific knowledge can be used locally if it is adjusted to the local environment and refined based on local experiences; thus local and scientific knowledge supplement each other. Local knowledge is most useful if it is combined with other knowledge forms, although it can be valuable in itself, such as, for example, when managing socio-ecological systems [7,8].

As mentioned above, local knowledge is informal, simultaneous, often tacit, and based on experiences [5,6]. Local knowledge sometimes overlaps with traditional knowledge, although the dynamics of succession of these types is different [9]. In addition, the terms traditional ecological knowledge, indigenous knowledge or science, folk knowledge, farmers' knowledge, fishers' knowledge, and tacit knowledge shall be classified as local knowledge.

A third knowledge form defined in previous research on knowledge used in local development is managerial knowledge. Its emergence is linked to the project class phenomenon [10,11]. Managerial knowledge refers to financial and administrative knowledge, e.g., project writing and management skills [5]. According to the literature, managerial knowledge is explicit, specialised and learned in educational institutions. However, it can also be informal, experiential, and person-bound [5]. Although it has site-specific elements, it is always rooted in wider institutional and economic environment. It plays an important role in the projectified society [11,12]; thus it became one of the most important forms of knowledge, and it is necessary to analyse it more deeply.

Citizen science has gained popularity, as it offers to close or at least tighten the gap between science and society [13]. It has various forms, from engaging individuals or communities to the whole process of knowledge production to using them as data sources. The analysis of education for environmental citizenship initiatives can be interesting from this point of view, because these could be built on local knowledge per se and also show

the force of inclusion. Thus, it builds on an existing knowledge and provides a real world example of how a democratic process can evolve; this way power relations are also an important part of the analysis.

Knowledge use encompasses the bottom-up and participatory approach [4], which, according to research experience, can be safely supplemented with top-down knowledge transfers. None of the ways of using knowledge takes place in a social vacuum; in practice, individual and institutional interests, as well as the operational rationality of projects and bureaus, mean that the moral commitments of the participants all affect environmental knowledge, modifying, strengthening, or even weakening its effectiveness.

Among the possible dimensions of research on knowledge use in environmental citizenship, the issue of power certainly has an important function. As the study of Levinson et al. [14] explains, the nature and intervention of political power can primarily influence the use of knowledge between human beings and the environment. As an example, the libertarian [15] and communitarian [16] orderly societies are mentioned, whose dominant ideological perspectives (referring to Dobson's [17] division of environmentalism versus ecologism) clearly determine the content of environmental citizenship. Political power can have strong control over the school system, which has a prominent role to play, but also over the definition of themes and values of out-of-school knowledge transfer, the formalization of education, and access to the necessary resources. The work of Levinson et al. [15] underscores the role of key players and, based on Johnson and Morris [18], describes the ideal types of environment citizen as the personally responsible, participative, and socially responsible ideal types, not forgetting that not only individuals but also institutions, and above all the state, can also be key players. Csurgó et al. [19] recommend a *joint analysis of the use of knowledge types and power (project) networks for a more accurate interpretation, a method we will use in our paper.*

3. Research Questions and Methods

In our paper, we seek to reveal the different knowledge forms appearing in environmental education by comparing France, representing Western Europe, and an old member state of the EU; Hungary, representing Central Eastern Europe, and a new member state of the EU; Serbia, an Eastern European country, and Turkey, both candidate countries of EU membership. According to the reviewed literature the differences in knowledge use and forms of knowledge production in environmental education also mirror the characteristic power relations of environmental education. We analysed the different forms of environmental education to grasp its diversity: the French case focuses on the knowledge used in environmental education in formal higher education, the Hungarian case focuses on non-formal elementary education, the Serbian case analyses the knowledge use in formal elementary education, while the Turkish case again is focused on formal higher education.

By bringing together the four cases, we aim to answer the following questions:

1. What is the role of environmental education and education for environmental citizenship in the analysed cases?
2. What are the main forms of knowledge represented and used in environmental education?
3. How are power relations represented in education for environmental citizenship?
4. How do power relations influence environmental education?

To answer the above questions we used mainly secondary analysis of existing statistical data, the review of case studies, grey literature, and other existing documents of the institutions where the case studies were conducted. For each country, we prepared a first version of the analysis using the above described methods to reveal knowledge use and power relations, and we prepared a case-study based on additional semi structured interviews with experts and activists from the field. The activists were mostly teachers or members of civic associations but were sometimes officials [20,21].

4. Methodology

Our analysis is based on published literature about EE, semi-structured interviews with experts in the field of education, and the results of a common questionnaire conducted for a SWOT Analysis on Education for Environmental Citizenship [1]. We used a common framework for the secondary analysis of the case studies in each country to understand knowledge use and power relations in EE. We chose for each country the best examples of the case studies to demonstrate the contextualised implementation of the environmental education in practice. The country-specific methodological descriptions are as follows:

The analyses curricular diachronic evolution in the last two decades of French higher education, with a particular focus on the bachelor's degree in environmental planning as offered through 17 different B.A. programmes throughout France; the curriculum of the programmes was analysed using a context analysis. The study started in 2004 [22,23] and was extended in 2021; it is connected to the partnership between territories and education, and in some way to actors and citizenship. Power relations through EE are analysed, taking into account the introduction of ESD at university. Analysis shows that changes in EE have occurred in terms of the movement of degrees towards sustainable development over the last two decades, thus changing access to environmental citizenship. The issue is a much deeper curriculum change, which modifies power relations and knowledge use in environmental citizenship education.

The Hungarian case study is based on document analysis (policy documents, planning documents), on available data, and on six semi-structured interviews conducted with teachers responsible for school gardens (3 interviews), with civic organizers of the School Garden movement (2 interviews), and an additional interview with a representative of the state administration. The interviews were transcribed. The interviews were supplemented by transect walking, as a triangulation method. We analysed the interviews using a semi-open coded method to explore the power relations and knowledge forms influencing the development of school gardens.

The Serbian case study is based on analyses of the semi-structured interviews conducted with teachers engaged in the compulsory education system as well a teacher who is the founder of an NGO and who works additionally with children with special interests in environmental problems. Semi-structured interviews were conducted to investigate particular questions about environmental education, knowledge use, and knowledge production in compulsory education of the current country and to give examples of case studies that can contribute to the better understanding of the interaction of knowledge and environmental citizenship behaviour.

The Turkish case study is based on a methodology used by Oral et al. [22]. A questionnaire was prepared to collect the responses of the foreign students from African countries and native Turkish students, who took the "*Fundamentals of Sustainable Development*" course from the Faculty of Economics and Administrative Sciences; they were asked what they knew about sustainability. The survey asked about the environmental knowledge, thoughts, and behaviours of the international and Turkish students. A study by Uzun and Sağlam [23] cites a questionnaire with 37 questions. The convenience sample method, which is further aided by the Google survey form, was used to identify 50 international and 50 Turkish students, for total at 100 students, at random. Students accessed the forms online for two weeks. For data analysis and interpretation, we used the SPSS 17.

5. Results—Country Case Studies

5.1. The Hierarchical Power of Project Knowledge over Bottom-Up Managerial Initiatives in France

The French story of environmental education clearly reflects the consequences of project proliferation, the extent of which is indicated by the emergence of the concept of "projectified society" [24,25]. The ongoing conceptual, moral, and financial opposition between experts and key citizens ended with the dominance of the project's practical needs. According to Kovách and Kučerova, project class theory [11], with the emergence of the new social class, involves the substantial changes associated with knowledge use. The

practice-oriented project class has a specific approach to using, reflecting on, and producing knowledge. The main goal of the project class is materialistic, and flexibility in managerial and other skills provide vitality for achieving this goal. Kovách and Kučerova concept of the rivalry of two cognitive groups—the project class and the scientists—to define directions of development and control over resources, which may provoke the realignment of knowledge use and the production of knowledge, can be extended to the conflict between project class and key citizen on the basis of the French case. In a hierarchical power network, the benefits of local initiatives weaken and scientific knowledge loses its guiding role.

5.1.1. Context of Case Study

In the present paper, we analyse the changes of the role of different types of knowledge in the curriculum of French universities. We focus on the following knowledge types: (i) environmental systems knowledge, (ii) action-related knowledge, and (iii) effectiveness knowledge and its different meanings in the last two decades [4]. The goal of the study is to understand the co-production and power relation between new knowledge by experts and key citizens as central to the idea of a participatory approach towards developing Environmental Citizenship. This analysis is linked to the fact that, in France, environmental citizenship education terminology in not used currently, and EE has gone through various evolutionary stages [26]. Our hypothesis is that these stages are related to knowledge-use changes in environmental citizenship. The first stage is the integration of environmental issues in the educational process, linked to the social movement in France, which focuses on nature and nature conservation. The evolution of the terminology from education related to Education for Sustainable Development is the second stage. It is connected with the international movements for institutional ESD's global expansion, starting with the Bruntlandt report [27] and the decade of ESD (2004–2014) and culminating in the 2030 UNESCO report concerning the 17 SD goals [26]. A third stage involves the shift to Anthropocene education and/or transition education. As an earlier paper presents, the concept of sustainable development is accepted by the different actors in university education and becomes part of the curriculum [28], but that changes the power relations in EE.

5.1.2. Presentation of the Case: Based on Facts

The case analyses the curricular diachronic evolution of the last two decades of French higher education. The sample is made up of the curriculum of 17 different bachelor degree programs in environmental planning, distributed throughout France. The method is based on the word occurrence and content analysis collected for 2004 B.A programs, then for 2014 [29,30], and ultimately, 2021. Then, we focus on curriculum changes and their meanings.

Our analysis shows that the presence of ESD brought profound changes at universities in France; thus, we seek to reveal whether this change applied only to curriculum or also to citizenship knowledge use. To do so, we link these elements to the above-described knowledge forms as well as to numbers of interactions between the diplomas and the surrounded territories, especially the personalized territory-based education project, to analyse the citizenship competencies. Implementation of SD in higher curriculum comes with local agendas, with communities engaging in them through different approaches. They generate partnerships between universities and local actors through their roles as financers. Then, the educational contents are therefore formalized, in part, around these projects. Thus, we can say that the local translation of public policies of SD will be based on local associations that respond to tenders, and the studies to be performed will be helped by the student body. Both are legitimized by the presumed expertise of faculty members and their institutional presence in the project. In return, the local association (which possesses the application experience of SD approaches) inserts the students in a concrete sustainable development project, valued as a social integration of the university.

We noticed that educational content is turning slowly from environmental to sustainable development studies [31]. Knowledge forms are evolving into hybrid forms [32]. Contents are more oriented toward local partnership entering the curriculum, which can be considered as the evolution of environmental citizenship education.

There was a strong decrease of environmental systems knowledge [33] in the last two decades; this period also showed an increase of action-related knowledge and effectiveness knowledge, which could prove that they are not linked. As noted by Smederevac-Lalic et al. (2020) [4], (p. 73.) "*Education should encompass two types of literacy—ecological literacy and civic literacy*". ESD curriculum evolution puts forward a principle of partnership with local territories and the associated sphere [34,35]. This stipulates the idea of educational co-construction and thus curriculum hybridisation. This means that the collaboration between the different actors is involved in the curriculum process of developing guidelines and training content. But it is also strongly framed by imposed international standards. This raises a number of ethical issues related to the educational institution [36] and the legitimacy of the teachings. The authors also formulate the idea of a utilitarian and dominant partnership [37]. We consider this is in some way contrary to the idea of reflective citizenship.

Thus, territorial actions, the autonomy of universities, and project-based teaching push in a multi-stakeholder dynamic and lead to a hybrid curriculum [32]. In this way, ESD is also considered as environmental citizenship education but is frequently linked to controversial issues [38,39]. Two dominant features emerge about the perception of civic engagement and scientific local knowledge appearance and use in the initiative.

The relative absence of scientific knowledge from the educational project was presented in the scientific literature [29]. The reason for this is that these curricula have a behavioural (focused on best practices) and developmentalist (the economic value of knowledge, for instance for tourist interests) focus. We formulate that this could cause changes in learners' relationships to knowledge and promote change in societal logic, but this is still attenuated in France, considered as environmental reflexive citizenship. From an epistemological viewpoint, the aim of most ESD actors in territories is to construct an intermediate reference framework. This could legitimize the choice of teaching and learning contents. Then, the knowledge chosen as a priority is that which seems useful in terms of justifying the social normalization process associated with sustainable development as a political project. The selected knowledge becomes valuable according to its degree of immediate operationality: it mostly underpins practice, which has several consequences. The first one is a form of rejection of more theoretical knowledge. The second one is the lack of knowledge problematization, which goes against the civic educational approaches that aim at promoting deliberative or critical thinking [29] even though they are often formulated in relation to sustainable development. Most of the time, knowledge is, instead, presented as self-evident (common future for instance) and is therefore not discussed. The risk is what is finally excluded is the scientific debate about the uncertain nature of the scientific knowledge that could serve as a reference, leading to relativism. Reduced to its most basic expression, scientific knowledge serves as an alibi, and any confrontation between scientific paradigms is systematically avoided.

However, this epistemic void is filled by the emergence of content, generally new teachings or presentations of good practices, mostly related to project management. What is considered by few as best practices and included in projects becomes a non-discussed admitted societal practice. Then, life is increasingly conceived in terms of project management—a series of responses to project tenders—with a concomitant emphasis on competitive values and performance. However, this happens to the exclusion of other forms of societal organization. This way of teaching establishes new forms of societal management and new powers of governance. These are both supported by lessons in law and in communication, again without the principles being discussed. From this point of view, the new governance theories have a performative nature (in the sense meant by Callon) [40]; that is to say, they contribute to the creation of the social reality that they purport to explain.

The negation of the distance between the knowledge to be taught (generally recognized as necessary in that it ensures a degree of objectivity) and social practices is, then, a common posture in ESD. This is evidenced by the lesson plans based on examples of eco-efficiency initiatives or social practices such as ways of organizing waste sorting, composting, carpooling, etc. [28,30,41]. By placing emphasis on technical aspects without any critical distance, education could become a technique for the operationalization of procedures. As one of the results, the ability to problematize sustainable development issues, though central to the making of autonomous citizens [38,39], is low, which causes a risk of a normative drift. Teaching becomes training in ethics, which focuses on the 'politically correct' to the detriment of scientific knowledge. The normative drift continues to the point of resulting in the interpenetration of vocational logics and of the private sphere [29]. Schematically speaking, convincing individuals of the need to recycle waste at home is easier than tackling the issue through a reflection on production and on long-term waste management. This negation of the distance between social practices and knowledge crystallizes the debate around a project of normalization that is supposed to be collectively accepted [28], as is evidenced by the adoption (without any serious debate, and strongly oriented towards "best practices") of "green plans" by universities. Indeed, SD conveys an image of collective responsibility in a common world, and anything that refers to it then appears as unquestionably necessary for the construction of a safeguard project meant to avoid the destruction of the planet's ecological balance. This normative stance leads teachers to adopt a relativist approach. In other words, they place more emphasis on socially valued behaviour (waste sorting, for example) than on the scientific knowledge their students would need in order to truly understand the phenomena.

5.2. School Garden Program in Hungary: Practice and Ideology in Multipolar Power Network

Scientific and managerial knowledge plays a central role in school garden programs, which are both a site of knowledge production and a site to strengthen environmentally friendly attitudes; thus, they contribute to both science education and environmental education [42]. In the long term, their contribution to food self-provisioning and food sovereignty can play a role also in strengthening environmental citizenship. In addition to the involved teachers, different decision-makers appeared around the school garden program, but the different interests could be harmonized in a multipolar power network that has no central individual or institutional actor with a decisive role. The ministry subsidies the program, and the presidential foundation provides a loose framework that schools and teachers fill with great freedom in content. It is thus an effective system, although its growth is limited and is likely to include schools where the social capital of school children is higher than average; this may be a source of unequal distribution of access to future environmental education [43].

5.2.1. The Hungarian Context

In the following part of the paper, we present the status and role of school gardens in the Hungarian Kindergartens and elementary schools. As we will show, the activity in the school gardens is an optional activity both for the schools and for the pupils, and consequently is very loosely built into the school curriculum, although there is a state programme to promote such initiatives. In the SWOT [1], we argued that both education for environmental citizenship and environmental education (EE) have a highly unfavourable status in Hungary. The closest subjects to EE and citizenship studies are not among the most important subjects in Hungarian primary (and secondary) education. This represents an additional problem; the subjects linked to the activity of school gardens are also less important (for example environmental education was removed from the curriculum of elementary schools as a result of the latest modifications).

5.2.2. A Special Field for EE: The School Gardens Program in Hungary

According to a recent report on the school gardens in Hungary, there were at least 1118 gardens; this means that at least in every fifth Kindergarten or elementary school, there is a school garden. Some are more than 70 years old, but most were founded in the last decade [43]. In the first third of the 20th century, school gardens were a more important part of the school curriculum; however, during the eighties and nineties, their popularity stagnated (https://www.iskolakertekert.hu/index.php/hu/tudastar/orszagos-felmeres; accessed on 29 September 2021). Despite this, the initiative never disappeared, and in the last two decades started to blossom again; each year, several new gardens were established. In the last three years, thanks to a school garden programme, school gardens gained special attention [44]. The programme was initiated in Hungary by the Ministry of Agriculture together with the National Agricultural Chamber, the Foundation for School Gardens, and a local organization of the Caritas Hungary, a catholic aid organization. Since its initiation, 167 school gardens have been established and more than 20,000 students have been involved. The program developed gradually: in 2018, 50 schools, in 2019, 17 schools, and in 2020, 100 schools and Kindergartens gained subsidies; the latter was the first year when proposals from Kindergartens were welcome. As we will see later, there are slight differences among the approaches to the role of school gardens in the curriculum and in the school life between the different actors: the Ministry, Caritas, the Foundation, and the schools. Not all school gardens were able to gain subsidies. Nowadays, the initiative benefits from the strong and clear support of the Agricultural Ministry and from a Foundation, which was established by the president of Hungary.

Only by analysing the introductory and promotional materials of the programme does it become clear that the different actors have different goals related to the programme. The overall aim of the initiative is summarised in the following quotation:

"School gardens teach about openness, patience, responsibility, self-care, raise the attention on healthy food, on jobs related to agriculture and environment. By working in the school gardens, pupils learn the proper and conscious use of the environment, gain basic experiences about sciences and have opportunity to try and practice the materials of the lessons." (homepage)

The above quotation collects most of the motivations behind school gardens. The stakeholders linked to the government, like the Minister of Agriculture, the spokespeople of the government, and the leader of the foundation (a former politician) emphasize that school gardens can increase the environmental consciousness of children, that sustainability issues can be linked to everyday practices, and:

"The president of the Republic of Hungary funded the Blue Planet Foundation to support all local initiatives to show that one can work for sustainability not only theoretically in the schoolbooks and in political speeches but in our everyday life." (politician)

The teachers' aspirations are slightly different, as the quotations below show:

"It is not compulsory for the children, they can work in the gardens for a year or for four years; we would like to show children that it is a joy" (teacher); "We hear from the colleagues that children are really happy to be outside, they even pick the weeds, and are motivated to go outside, to meet the living environment, and also the teachers are happy to see the pupils in another situation" (organizer of school garden programmes). The teachers interpret the school gardens as a pedagogical tool but also as a method to educate in a broader sense, not only in the sciences, but also attitudes and ethics.

The Caritas has a slightly different approach. They organize different workshops, mostly about practical knowledge on gardening, which are linked to other school activities and to other types of gardening; thus, this supports food self-provisioning of the parents. The main aim of the organization is to build communities around the school, to strengthen schooling, and also to encourage food self-provisioning among poor families.

5.2.3. Case Study Analysis

School gardens are mainly organized by one or two enthusiastic teachers in each school, but they must have alliances in the school to engage colleagues and children in the activities. They mainly build on their scientific knowledge, but as the Ministry initiated the programmes and subsidies, managerial knowledge also became important. In addition, as the activity is not compulsory, they also show practical examples, and thus go beyond education. This latter can be important for education for environmental citizenship: through the examples, children learn about responsibility towards the environment, learn about food, etc. School gardens could serve as practical sites of education for environmental citizenship and could be the basis of science classes by showing how the knowledge learned during SE classes could be turned into real experiences. Despite this unique opportunity, as EE and Education for Environmental Citizenship are almost invisible, and SE teachers are often not the same as EE (and Education for Environmental Citizenship) teachers, the link between the subjects remains invisible to the students.

5.3. Context of EE in Serbia: The Examples of Eco Musketeers in Serbia and Eco School Alliance—The Equality Networks

5.3.1. The Serbian Context

Environmental education and the formation of ways of thinking start in youth, and therefore, the function of educators is significant at all levels (preschool, elementary, secondary, and higher education) in order for the generations to fully participate in preventing and solving the problems of the human environment. EE in Serbia operates within the institutional framework of the education system, but on a voluntary basis, in a network of coordinated actors. Because training is strongly related to the basics of the subjects taught in schools, scientific knowledge is of paramount importance. As schools initiate EE training at the individual discretion of principals, and the participation of educators is also an individual decision, local knowledge can be of particular importance. Within the institutional framework of schools, but also using the benefits of civic self-organization, examples of effective, goal-oriented EE that is attractive to students due to its uniqueness can be created. The cooperation of actors with equal network capital is also particularly suitable for accommodating extracurricular volunteers, as exemplified by the extensive volunteer activity. The challenges are how to maintain the flexibility and openness of current cooperation after a project and how to establish closer links with international organizations.

Environmental Education (EE) started in Serbia at the beginning of the 20th century, as the pupil's oath from 1914 indicates:

"I swear that I will not destroy the trees or treat badly the flowers; I promise that I will not sully the floor in the school and in the house or on the road; I give my word that I will not spoil the fences and apply malfunction to buildings; I will never throw papers or whatever kind of trash on the street; I'll always be courteous: I will defend someone else's property how I would like to defend mine; I promise to be an honest and straight citizen."

Since that period, environmental education has been integrated into different curricula and has existed in different types of education, but unfortunately, due to turbulent political and economic circumstances, it was never given priority. Between the two conferences of Rio in 1992 and Johannesburg in 2002, it started to be of national importance and an issue of cooperation of two ministries (Ministry of Education, Science and Technological Development and Ministry of Environmental Protection). However, under the unstable political situation in Serbia, environmental issues never gained important role. Now, EE education is in the shadows, like in the most transitional societies [1]. The problems are faulty technology, enormous construction of different facilities in protected areas for the sake of economic interest, despite consequences for nature and natural resources, traffic, fossil fuels and air pollution, the arms race, military actions, and other effects that distort the natural balance and cause damage to nature.

Education for Environmental Citizenship is not considered by the experts as applicable for a major impact on environmental responsibility. It requires interdisciplinary collaborations to fill knowledge gaps. Environmental values affect education, society, ecological and environmental movements, technological development, and traditions. To ensure the creation of ecological value systems of the young generation, family and the collective contributions are crucial.

Despite the fact that environment and ecology are separate subjects that are not present in compulsory education, ecological contents have been studied from the preschool stage. To what extent environmental content will be presented in the obligatory and optional activities depends on the interests and tendencies of the students, educators, and educational system as a whole. In Serbia, major weaknesses are the lack of understanding of the consequences of their own environmental and social actions and the lack of possibilities to create a participative and motivating learning environment.

In primary school education, environmental content is intertwined through many subjects. The main objective is to create the foundations of environmental issues and to develop awareness about the environment. Besides obligatory education content, there are elective subjects in elementary school education. The subject "Nature and Society" is intended to develop the ability for responsible living by teaching about oneself and about one's own natural and social environment. Ecological content in higher elementary education grades is represented in subjects on natural sciences. Geography covers environmental content extensively. In higher education, the field of environmental education is represented at many universities, which have specialized departments for education in ecology and environmental protection [45].

Active environmental citizenship is a proscribed part of the topic "life in the ecosystem", included from Grade 5 to 8 in the primary school curriculum. Pupils are instructed and recommended to participate in activities such as making bird feeders, participate with the local community in animal feeding actions in the area, etc. New curriculum for biology is developed to have topics that are upgraded to be more complex in each subsequent grade. For example, cells should be covered in ecology, genetics, and evolution. The support of school principals is necessary at all education levels (e.g., for biochemistry, biomathematics, and biophysics).

The biology curriculum is defined by the Law on primary education and the program on primary education established by the Ministry of Education, Science and Technological Development of the Republic of Serbia and the Institute for the Improvement of Education of the Republic of Serbia. The program changes every 4 to 10 years. Teachers who would like to be part of the core group for preparation of the new curriculum apply to do so, and the Ministry selects members of the board according to their references. At present, there are six different publishers for the subject of biology for the Grade 4 in primary school, which has not proven a good solution. Each school is allowed to choose a book from a publisher for their pupils to use. The program that should be covered is the same, but in many cases the learning material is slightly different. Subjects in the curriculum are connected in an interdisciplinary way. The idea is to have interdisciplinary overlaps and to respect interdisciplinary competences. One of the 11 interdisciplinary competences is the attitude towards the environment (water, air, and land). Thematic planning and project activities in teaching are the main ideas. One project was, for example, setting up a hotel for insects. The subject of geography contributes in terms of which parts of the world bees and insects live. The subject of technical education involves building houses for insects. Mathematics calculates how much cost is involved in building houses for insects, the budget needed, and space that is optimal. Biology educates students on how the disappearance of bees will lead to the dire consequences. Serbian language deals with the literature (books, poems, and stories) on the issue. Languages translate the project aims to languages learned in the particular school. Music teaches the pupils about songs about the insects. Hotels that were made in the school were donated to different interested stakeholders. Each school has its own development plan according to the curriculum.

The school should have different activities related to the environment. However, most the teachers demonstrate minimum engagement in these activities and give few practical activities, which does not motivate children to think and act ecologically in everyday life (Smederevac-Lalić, personal communication, 2021).

5.3.2. The Case Study

There are some solid examples of environmental education. "Eco musketeers" was initiated by an NGO funded by an especially motivated teacher who works additionally with children with special interests for environmental problems. Beside activities, they compete in global environmental competitions: "EU school for living planet", "Stars of science", etc. Unfortunately, this kind of education and effort has no reward from the state system in Serbia; even though pupils have success in the competition, there are no special awards in terms of further education or enrolment in high school. However, these positive examples continue in practice and in life, because these children will turn to activities that are the application of what they learned in their youth. For example, the students of a teacher who was motivated to do practical work and extracurricular activities are now successful in various fields where knowledge and skills are practically applied to solve environmental issues: on student has a master's degree in sustainable wind use, one opened a recycling yard, one works as a vegetarian chef, and one is an expert in bio programs in cybernetics (Smederevac-Lalić, personal communication 2021).

Another example of formal education in Serbia in the special field of EE is the Eco School alliance. This is a worldwide program in which 56,000 schools are involved. In Serbia, 130 schools have an eco-school label and have fulfilled the requirements (eco patrols, code, flags, program, etc.). Once a year is project day, and all teachers have to work on the proscribed environmental topic that day, such as climate change issues, for example.

5.4. The Environmental Education in the Closed, Hierarchical Network of Turkish Higher Education

EE may appear as an optional subject on offer in higher education in Turkey. A significant part of those interested are foreign students. In a university system organized in a bureaucratic fashion, EE is closely linked to disciplinary departments that are only able to respond to challenges with difficulty. In a closed system of higher education interwoven with power networks and interests, EE is subordinated to disciplinary scientific knowledge, resulting in a loss of openness and topicality. The lower interest of Turkish university students is also likely to be a consequence of this.

5.4.1. Context of EE in Turkey

Environmental Education (EE) is not a subject that is commonly taught to students in Turkish higher education institutions. In primary and secondary education institutions, rather than universities, EE is often offered to students at a basic level [46–48].

Regardless of its obscurity, several universities offer this subject as a course. At Istanbul Aydin University (IAU), for example, university elective courses such as Environmental Education and Fundamentals of Sustainable Development are available to students. With 35,999 students enrolled in 2018–2019, including about 6000 foreign students, IAU is one of Turkey's 73 Foundation Universities [23]. In addition, Turkey has 84 private universities and 109 public universities [49].

5.4.2. The Case of Turkish Tertiary Education

Several Turkish universities have fundamentals of sustainable development and environmental education courses in their EE programs for undergraduate students. These courses do not take an interdisciplinary approach and do not address current environmental issues like nature-based solutions (NBS) and responses to environmental problems as well as circularity perspectives. Only the Fundamentals of Sustainable Development course at IAU covers these topics in the course syllabus [50].

The Environmental Education course is offered as an elective university course for the students. Students from the Faculty of Engineering take this course as an elective course. The course's European Credit Transfer System (ECTS) credit is 3.00, and courses are carried out in a face-to-face training model. English is the teaching medium of the course, and the course aims to increase students' level of knowledge of environmental issues. Current environmental science literature was followed in an interdisciplinary manner to prepare the course syllabus [50].

The Fundamentals of Sustainable Development course is also offered as an elective course. The ECTS of the course is 3.00, and it is an in-person course. English is the teaching medium of the course, and the course aims to teach sustainability perception. For this reason, the current environmental science literature was followed under an interdisciplinary structure while preparing the course syllabus. For instance, nature-based solutions and circularity assessments of environmental problems are two of the course topics in the course syllabus [50].

The majority of students enrolled in these courses at IAU are international students. For example, the Fundamentals of Sustainable Development course is offered as an elective to 10 departments in the Faculty of Economic and Administrative Sciences. International students account for more than half of the students enrolled in these departments' courses. The Environmental Education course is also given to the students of the Faculty of Engineering. Students enrolled in all English departments of this faculty take this course as an elective.

The most recent literature, particularly on environmental sciences, was used to prepare the curricula for these courses. Furthermore, the literature published for projects such as H2020-funded research networks COST CA 17133 "Implementing nature-based solutions for creating a resourceful circular city" and CA 16229 European Network for Environmental Citizenship (ENEC), for the respective topics of nature-based solutions and circularity, was used. Moreover, the overall curriculum of these courses is related to an interdisciplinary perspective and a method of evaluation related to other subjects. As for the relation to the knowledge of the students and instructors, students were more involved as they observe current issues in the course curriculum rather than classic and familiar environmental problems. As a result, environmental concerns have become more prominent in people's minds. The method used in this case study is inspired by Oral et al. [50], who studied environmental education as well as citizenship understanding and action among university engineering students. IAU students who took these classes were asked to complete an online survey, and the results were compared to those for students from another university. Similarly, several questions were posed to IAU students enrolled in the Environmental Education and Fundamentals of Sustainable Development course online, and their responses were carefully analysed by basic statistics. Since this is an elective course, various faculty members teaching it in different semesters had to do extra study on some of the topics discussed in the program.

A survey conducted among the participants of a course at the Faculty of Engineering on Environmental Education found that the knowledge of the students significantly grew by the end of the semester on circularity and nature-based solutions. It was observed that 29 of 30 students gave the correct answers to questions about NBSs and sustainability. These students will act as forerunners, as examples of environmentally conscious members of their communities. Thanks to their education, they are able to act responsibly and find solutions to the local environmental problems within their own community.

Stakeholders other than students are also involved in the courses. For example, in a factory that his family owned and ran, a student enrolled in the Fundamentals of Sustainable Development course chose to use the waste management and circular economy techniques taught in class. As a result, the student was able to use the production facilities to integrate the important aspects of the topic that he learned during the lecture.

6. Discussion

The Hungarian case shows on the one hand how a traditional school practice, the school gardens, gains a new role after being accepted and supported by a government initiative and also how it fails to become integrated into formal education and create a link between the different subjects and everyday life. It also fails to link the otherwise emphasized issue of food sovereignty to environmental education; thus, it cannot be a stepping stone for education on environmental citizenship. As we showed, school gardens are not part of formal education, and the initiatives are mainly based on the enthusiasm of the teachers leading the gardens; it also does not help the integration of science education, environmental education, or education for environmental citizenship.

As we presented above, in Serbia, environmental education and education for environmental citizenship is poorly integrated into formal education, similar to the Hungarian case. Real activism is the result of rare individuals: teachers, pupils, parents, or sometimes even ordinary citizens who complain about local environmental problems. The activities in formal education mostly depend on a school director's affinity to allow and motivate teachers to enrich and broaden the curriculum with action-related environmental behaviour and activities. Despite the fact that EE is present in a modest way in the curriculum from the youngest ages, throughout the whole education system, knowledge and concrete actions usually come from individuals and/or the non-governmental sector, citizens' associations that bring together activists, and people who are aware of environmental problems.

The Turkish case showed that although environmental education and education for environmental citizenship are also not included in the main stream issues of the curriculum of higher education, they are still present and are taught by different departments. The lack of systematic curriculum also leads to a certain neglect of the issue.

The French case shows that ESD causes important value conflicts that lead to different points of view concerning citizenship and civic engagement. In some way, the role of knowledge sharing and community learning could have virtue, but this is considered in France by some researchers as a controversial issue [30]. Given the context, they consider that associative competencies and projects from local territories engage local ESD in two very specific dominant forms in France, which could be very normative. This could be contested in higher education, as can be seen in the different curricula and researchers' positions in education for sustainable development [28]. The first and most widespread is eco-responsibility (e.g., sorting waste, energy conservation, and car sharing), a result of normative citizen learning. The second is the formalized project area; this can be seen as a utilitarian response to sustainable development. It is based on different forms of technical training: spatial planning, tourism, management, community development, agriculture in ESD, etc. Thus, if there is more citizenship education in curriculum design, there is also more uncertainty concerning the quality of citizenship education (loss of environmental systems knowledge) and problems of relativism of the knowledge taught.

Table 1 allows for a comparison of individual cases, showing how complex values, actors, and interests influence the use of knowledge in environmental citizenship. The table also depicts the diversity of institutional forms, knowledge types, the role of power in the different initiatives, and the different variations in citizenship types. As Table 1 shows, both local and scientific knowledge are important in the French, Hungarian, and Serbian cases, while only scientific knowledge is relevant in the Turkish case. Managerial knowledge seems to be important only in the Hungarian case.

In terms of organizational form, while the French and Turkish case studies present similarities, there is no similarity among the other two countries. NGOs, on the other hand, form the common points of the French and Serbian cases. A closer examination of the other criteria in the Table reveals that the case studies of the four countries have little in common. Key actors and individual and/or institutional interests can be given as examples of this. Analysing the type of citizenship, we found that the French and Hungarian cases show a participative, while the Serbian and Turkish cases a personally responsible, citizenship model.

Further quantitative research would be necessary to gain generalizable results on the role of the different factors influencing the use of the different knowledge forms and the effects of power relations in education for environmental citizenship.

Table 1. Dimensions of knowledge use and power in environmental citizenship.

Context	French	Hungarian	Serbian	Turkish
Type of knowledge	hybrid: scientific and local knowledge vs. managerial knowledge	local knowledge, scientific knowledge, managerial knowledge	scientific knowledge, local knowledge	scientific knowledge
Organisational form	higher education (technic of operationalizing) temporary project organisation, NGO	Kindergarten and primary schools	environmental education in schools foundations, NGO	higher education
Key actors	universities partnership with local actors; managerial project class	teachers & civic organizations, ministry (as providers of financial support)	principals, educators, activists, volunteers	teachers and scientists, university and state administration
Basic values	ethical, sustainability issues—effectiveness issues	ethical, sustainability, volunteering— environmental consciousness	ecological, ethical, sustainability, environmentalism	ecological, scientific, organization, institutionalization, controllability
Individual and/or institutional interest	social normalisation—project effectivity	pedagogical, environmental enlightenment	environmental consciousness and responsibility networking, fund raising, institutionalisation, sustainable development	educational, institutional/ bureaucratic
Power network	top-down, controlling, political project	ancillary partnership	cooperating and inclusion	top-down
Type of citizenship	participative	participative and socially responsible	personally responsible and participative	personally responsible

(Source: own compilation).

7. Conclusions

The presented case studies from the four different countries helped us to better understand the knowledge use in environmental education and in education for environmental citizenship. Among the drivers of environmental education, bottom-up NGOs or committed individuals play a particularly advanced role. In most cases, they are initiators and pioneers who are able to activate several types of knowledge, such as environmental systems knowledge, action-related knowledge, managerial knowledge, effectiveness knowledge, and above all, scientific knowledge. Compared to formal education, environmental education can apply hybrid types of knowledge, even if it is realized within the school system. The knowledge of activation, involvement, and persuasion is clearly a strength and advantage that is not present in other forms of education. An evolutionary approach is the key to the success of educational practices, nourished by scientific knowledge and always oriented toward rapidly changing practice.

In the activities of temporary organizations, or in the practices of school courses considered as additional subjects, the transfer of knowledge that accepts complexity and variability as a goal can necessarily conflict with the knowledge monopoly arising from the interests of bureaucratic organizations (e.g., school systems, project management). The novelty of our joint study of knowledge use and power relations highlights that, from an organizational point of view, without coordinating the activities of temporary organizations,

volunteers, and bureaucratic organizations in new ways, the extension of the essence of environment citizenship can be damaged. Case studies from four countries show that the bureaucratic governmental, EU, educational, and project organizations mostly override and limit the benefits of bottom-up initiatives, the complex, flexible use of knowledge, and mobilization capacity. The message of our work is that achieving environmental citizenship cannot be without coherence between the bottom-up and bureaucratic organizations.

This paper collected experiences from European and inclusiveness target countries in the context of education for environmental citizenship at different levels, from preschool to tertiary education. The common conclusion from all of the countries involved in the survey is the need for environmental citizenship education, despite the differences in environmental perceptions or political and economic contexts. Education for environmental citizenship is promoted at different multidisciplinary educational levels and depends on social development. The collaboration between countries through international projects has a significant impact in promoting environmental citizenship and sustainable development at all levels.

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Article

Promoting Environmental Citizenship in Education: The Potential of the Sustainability Consciousness Questionnaire to Measure Impact of Interventions

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Abstract: Policy documents across the globe call for citizen engagement to fight climate change emergencies and build more sustainable societies. They also recognize the key role of formal and non-formal education in preparing citizens to address those challenges. However, there is a need to identify appropriate instruments to evaluate the impact of educational interventions on people's knowledge, attitudes, and behaviors, which are essential components of the action competence required to become environmental citizens and agents of change. The aim of this paper is to investigate the potential of the Sustainability Consciousness Questionnaire (SCQ) to evaluate different educational interventions aimed at increasing environmental citizenship. It presents three sub-studies from Spain, Belgium, and Sweden using the SCQ with varying contexts, duration, and target groups yet sharing common pedagogical features in the interventions. Pre-intervention scores indicate a common pattern of high sustainability knowingness, moderate sustainability attitudes, and lower sustainability behaviors in the three dimensions (environmental, social and economic) of sustainability consciousness, and a positive impact on sustainability behavior after the intervention. These findings are especially significant when compared to previous studies. We therefore conclude that the SCQ is useful for detecting the effects of learning interventions of varying designs and contexts that address environmental citizenship. The results are discussed in terms of key pedagogical features of the educational interventions, and the appropriateness and sensitivity of the instrument in detecting changes in the intended direction. It concludes with implications for research and practice and suggestions for future lines of work.

Keywords: environmental citizenship; Education for Environmental Citizenship; educational impact; Sustainability Consciousness Questionnaire; educational intervention

1. Introduction

Current societal and environmental challenges can only be faced by aligning personal values and behaviors with political aims and measures through a process of cooperation. This will help maximize our capacity as human beings to achieve sustainable development goals through societal transformation [1].

Education plays a key role in preparing environmental citizens able to develop their full potential to actively participate in the generation and implementation of creative

and sustainable solutions. However, what kind of education equips individuals with the knowledge, values, dispositions, and skills necessary to become environmental citizens? According to Hadjichambi & Paraskeva [2], the answer to that question is Education for Environmental Citizenship (EEC). EEC emphasizes active and contextualized learning linked to investigating and providing solutions to local environmental problems. This encompasses a wide range of processes such as inquiry, planning, acting, evaluating, and reflecting on results as well as expanding the impact of actions through networking and dissemination.

However, before scaling up educational interventions, it is necessary to evaluate their impact and provide rich contextual information that extends our knowledge and understanding of how to develop teaching approaches with the capacity to foster environmental citizenship. Addressing this need, we evaluate three educational interventions in formal and non-formal contexts that share a common goal: to promote environmental citizens. In particular, we focus on cases taking place in different national contexts (Belgium, Spain, and Sweden) that engage various age-groups.

The impact of each educational intervention was evaluated using the Sustainability Consciousness Questionnaire [3]. This instrument measures the impact of interventions on participants' knowledge, attitudes, and behaviors, enhancing their ability to become environmental citizens. In particular, we addressed the following research questions:

1. What is the impact of three different educational interventions aimed at promoting environmental citizens by increasing sustainability knowledge, attitudes, and behaviors?
2. What potential does the SCQ have to detect the impact of educational interventions in diverse contexts?

The analysis of participants' responses before and after different educational interventions provided us with useful empirical research evidence highlighting the potential of the SCQ to extend our knowledge of how best to evaluate and educate environmental citizens across different types of interventions, cultural contexts, educational contexts, and ages.

2. Theoretical Background

2.1. Environmental Citizenship

The term environmental citizenship began to draw international attention in the early 1990s and has recently generated increasing interest due to the climate crisis. Over the last few decades, different authors have tried to address general concerns about environmental issues by enriching traditional views of citizenship with new values and tenets.

Bell [4] approaches this concept from a liberal view of citizenship where freedom and pluralism go hand-in-hand with the preservation of human-rights, some of which have implications for the environment and its management. He groups rights into three categories: substantive rights, such as access to natural goods (clean water, clean air . . .), procedural rights (the right to participate in democratic processes relating to environmental issues), and personal rights, such as people's right to make green choices in the way they live their lives. However, it is important to note that, from a liberal perspective, the exercise of these rights is always a matter of choice, which raises several concerns.

For instance, other authors claim that leaving environmental issues to the choices of individuals may undermine our capacity as human beings to tackle current environmental, social, and economic challenges. Conversely, addressing these challenges from a republican environmental citizenship perspective would mean intervening to create norms essential for the survival of the political community and the protection of the public good. In this line of thought, John Barry offers one of the most influential works. He argues that the characteristics typically associated with classical republicanism (virtue, duty, obligation and public service) are best suited to the promotion of citizens aligned with environmental and social justice values [5]. The conception of citizenship proposed by Barry aims to repair not only environmental problems but also their roots and causes, pursuing structural as well

as lifestyle changes and seeking a balance between the extremes of excessive consumption and poverty.

However, the concept of republican citizenship remains strongly attached to the notion of the state and political boundaries, whilst environmental issues such as ozone depletion or climate change transcend national borders and demand transnational solutions and cooperation. The latter calls for a different citizenship model aligned with a cosmopolitan view and global citizens that think beyond national borders, exhibiting a greater sense of interconnection and interdependence [5].

Cao [6] discusses different attempts to accommodate environmental issues within mainstream theories of citizenship in a thought-provoking way, encouraging critics to scrutinize and analyze the concept of ecological citizenship, one of the main points of reference in the debate on environmental citizenship. Cao highlights the lack of attention paid to gender matters, its anthropocentric (human-centric) nature; and its potential for authoritarian politics. In addition, Cao [6] discusses a set of alternative and emerging theories that consider aspects of environmental citizenship often neglected by mainstream approaches. The most significant of these assert that gender matters, promote the incorporation of nature into citizenship, and argue the need to place democracy and pluralism at the heart of all conceptions of environmental citizenship. This sets the stage for the development of the environmental citizenship concept by the European Network of Environmental Citizenship, which is discussed later in this paper.

The increasing political interest in environmental citizenship is evident in the European Green Deal, which highlights the key role of citizens in addressing climate change and emphasizes the need to engage pupils, parents, professionals from different fields and the wider community in the changes needed for a successful transition to a green economy and a more sustainable and smarter planet. These transformations entail changes in personal behaviors to reduce carbon and environmental footprints, but also individuals' participation in collective actions to fight climate action and actively contribute to environmental protection [7]. Newell et al. [8] discuss the crucial role of behavior change in implementing the 1.5 °C target-consistent pathway set by the Intergovernmental Panel on Climate Change and highlight the importance of dealing with scale challenges in space and time to ensure individual and collective actions have a significant impact. An important question to address is what kinds of transformations are needed to impact people's individual and collective behaviors.

A strong emphasis is placed on promoting environmental awareness through formal and non-formal education. Pupils and students have the potential to become ambassadors for climate action and environmental protection by sharing their knowledge, experience, and engagement with their families, local communities, and with public and private decision makers. Combining educational interventions with other forms of civic engagement could lead to a more sustainable lifestyle and a healthier relationship with the environment; one that involves caring for biodiversity protection and stimulating the search for nature-based solutions to support climate resilience and sustainable ways of consumption and management [9].

However, to achieve these ambitious objectives through educational interventions, we must go far beyond the unproblematic transmission of knowledge or the promotion of certain sustainable behaviors within social norms and regulations. We need to consider ways of affecting individual and social fundamental values attached to personal and cultural identity [10]. These include the personal and social values that shape the philosophy of life and the means and procedures to ensure sustainable development, economic prosperity, and social justice, both internationally and intergenerationally.

This view aligns with the conceptualization of environmental citizenship provided by the European Network of Environmental Citizenship [11]. This holds that an environmental citizen exhibits the will and competences (understood as the efficient integration of knowledge, values, dispositions, and skills) to actively participate in resolving and preventing sustainability problems, enabling healthy relations with the environment and

ensuring intra and inter-generational justice [12]. In relation to the competences necessary to take an active role in sustainable development, action competence is defined as possessing the relevant knowledge, willingness, and self-efficacy needed to contribute to solving controversial problems [13–15].

Action competences that enable people to become agents of change in relation to sustainability issues are central ideas in the conceptualization of environmental citizenship. Sarid and Goldman [16] developed a theoretical framework to educate people on environmental citizenship based on Schwartz's theory of fundamental values [17]. They constructed a three-level framework of environmental citizenship (EC) (individual-level, community-level, and socially transformative-level), depending on the level of change agency exhibited by individuals. These authors emphasize change agency as a core element of environmental citizenship and argue that individuals' capacity to act as agents of change to solve structural causes of environmental problems depends on their openness to change and their distinct motivational values, ranging from self-enhancement to self-transcendent. Self-enhancement is a motivational value related to the opportunity to achieve personal goals and development, while self-transcendence reflects the motivation to act beyond self-interest for the common good [16]. Against this background, we conclude that environmental citizenship aims for action competence; the question that then emerges is how to achieve such action competence, and it is here that education comes to the fore, an aspect addressed in the following section.

2.2. Education for Environmental Citizenship

In view of the ambitious educational objectives linked to the generation of environmental citizens, it is essential to design educational interventions that bring about the intended learning outcomes. To address this need, Hadjichambis and Paraskeva-Hadjichambis [2] proposed a pedagogical approach to Education for Environmental Citizenship that emphasizes the role of active and contextualized learning linked to the investigation and resolution of local environmental problems or global ones with relevant local implications. The EEC approach considers the key characteristics of an environmental citizen as the starting or central point, and the outputs or potential outcomes of acting as an environmental citizen as the destination point.

The characteristics of an environmental citizen can be defined in terms of the *knowledge, skills, values, and dispositions* exhibited. These constitute the *competences* and *behaviors* necessary to act in an informed and successful way while addressing environmental issues. These elements are the core or central components of the personal development of an environmental citizen and are aligned with the cognitive and affective resources supporting action competence for sustainability [13]. Therefore, education for Environmental Citizenship should provide citizens with the action competences necessary to take an active role in the transformations required to build a more sustainable society, as well as the environmental and sustainability-oriented knowledge, attitudes, and values required to motivate them to take on responsibility for action [18].

The elements identified as destination points or outcomes of acting as an environmental citizen are termed outputs by Hadjichambis and Paraskeva-Hadjichambi [2]. The EEC outputs align with the definition of environmental citizenship and are presented in a non-hierarchical order as follows:

- Solving current environmental problems.
- Preventing new environmental problems.
- Achieving sustainability.
- Developing healthy relationships with nature.
- Practicing environmental rights and duties.
- Identifying structural causes of environmental problems.
- Achieving critical and active engagement and civic participation.
- Promoting inter- and intra-generational justice.

Based on these outputs, an environmental citizen should, according to the framework, support healthy relationships with nature, sustainability, and social justice beyond their close circle of relationships and think of the human being as a whole, thereby caring about the prosperity of future generations. To attain these goals, an environmental citizen should be able to critically reflect on the structural causes of sustainability issues and actively engage in the resolution and prevention of problems, exercising their rights and duties. These outputs of the framework may be the result of a wide range of actions undertaken at an individual or collective level, in the private or public sphere, and with a local, national, or global impact. Therefore, in addition to the central elements of personal development and the intended outputs, the pedagogical approach of EEC entails different dimensions (individual or collective), spheres (private and public), and levels (local, national and global).

As seen from the definition of the central elements of personal development and the intended outputs, the pedagogical approach to education for environmental citizenship aims to guide peoples' behavior in a more sustainable direction with a focus on developing citizens' action competence. To accomplish that aim, the pedagogical approach needs to engage with the personal characteristics of each learner in meaningful and authentic contexts. However, what are the key processes conducive to the intended learning outcomes and outputs? Hadjichambis and Paraskeva-Hadjichambi [2] propose a pedagogical approach that consists of the following stages: inquiry, planning actions, civic participation, networking and sharing in scales, sustaining environmental and social change, and evaluation and reflection. In the following, we briefly comment on each of these stages: In the *inquiry stage*, individuals raise questions about local issues with global implications and collect evidence that will allow them to better understand the environmental problems at stake and their structural causes. This will empower them to make informed decisions as to what can be done. The information collected and the understanding developed in the inquiry stage may be used to plan informed and effective *actions*. These actions could extend the impact on the solutions developed and contribute to the prevention of new sustainability problems by promoting *civic participation*, using dissemination and *networking* processes for scaling up. An important emphasis is placed on *sustaining* environmental and social *change* in the intended directions and on promoting *evaluation and reflection* as a means of ensuring an increased understanding of the key issues and continuous improvement.

Hadjichambis and Paraskeva-Hadjichambi [2] drew attention to the fact that the different processes or stages are not applied in a linear fashion, but can be started at any point and follow any sequence in order to better adapt to the environmental issue being addressed and the needs and interests of the agents involved. Moreover, it may be the case that not all stages are covered in a particular educational intervention; instead, just some may be addressed, depending on the nature and context of the intervention. These stages are enshrined in different pedagogical approaches widely recognized in the specialized literature, which are part of what has been described as the *pedagogical landscape* of education for environmental citizenship. This landscape includes approaches such as problem-based learning, socio-scientific inquiry-based learning, placed-based learning, community service learning, action-competence learning, and the pedagogy of eco-justice.

Previous works have discussed these and other pedagogical approaches striving to understand what kinds of processes are conducive to the learning outcomes necessary to generate environmental citizens. According to Činčera et al. [19], effective interventions are *constructive*, *collaborative*, *critical* and *reflective*, providing useful opportunities to develop *ownership* and *responsibility* for environmental issues, along with a sense of *empowerment* as citizens who can actively contribute to improving the world around them. The pedagogical approach to education for environmental citizenship proposed by Hadjichambis and Paraskeva-Hadjichambi [2] exhibits all of these characteristics. However, it is vital to develop a better understanding of the various ways in which this pedagogical approach might be enacted, as well as their impact on environmental citizenship.

Moreover, the enactment of environmental citizenship is dependent on various aspects of how a school is organized and functions [20]. Aspects of the specificity of curricula, the way the local school is organized, and the predominant assessment and teaching traditions bring important challenges to implementing education for environmental citizenship in formal settings [21]. In addition, the curriculum, school organization, and traditions of teaching and assessment differ substantially in different countries, across school levels, and in formal versus informal education [21]. Therefore, the way EEC is implemented and orchestrated will need to be adapted to the local context, and as a consequence its impact might differ between these contexts. It is thus important to conduct studies in various cultural and organizational contexts where the initiatives and interventions that enact EEC are investigated, which is the aim of this study. Moreover, evaluation instruments like the SCQ might respond differently to these various contexts, hence it is important to investigate the potential of instruments to detect intervention effects in different contexts.

2.3. Measuring Outcomes of Environmental Citizenship Education

To investigate the educational outcomes or effects of pedagogical initiatives in line with EEC, instruments are needed to measure the intended learning goals of such initiatives. However, because the holistic perspective of the environmental citizenship model covers multiple aspects and dimensions, it is challenging to find one single instrument that can evaluate aspects of the EEC model. A holistic instrument covering several psychometric constructs, topic domains (the environment, society, and economy), dimensions (individual and collective), and spheres (private and public) is therefore desired. In the work within the Europen Network for Environmental Citizenship (ENEC), questionnaire instruments with such a capacity were inventoried and suggested, and the one identified as possessing the measurement requirements was the Sustainability Consciousness Questionnaire, also known as the SCQ [22]. Therefore, in this study the SCQ was used as an evaluative instrument in a pre–post study to investigate the effects of various interventions.

The SCQ-instrument measures the concept of Sustainability Consciousness [3]. Human consciousness is exemplified by all things we can observe or experience [23], thus SC refers to human experience or the awareness of sustainability phenomena [3]. The SCQ is an instrument that operationalizes SC into a research tool and also provides the possibility to measure knowingness (recognition of the importance of sustainability), attitudes (the attitudes towards sustainability), and self-reported behavior (the willingness to act towards a sustainable future) in relation to the three pillars model of sustainable development dimensions (environment, economy and society), as presented in Figure 1. The instrument was originally developed and fully validated in Sweden in an educational context [3], but it has also been successfully used and validated in countries such as Spain [24], Pakistan [25], and Taiwan [26].

As indicated in Figure 1, the SCQ includes items covering the three dimensions of sustainability; environment, economy, and society. Each item also reflects either knowledge, attitudes, or behavior, which corresponds to the inner circle of the environmental citizenship model. Sustainability Consciousness explicitly refers to the following goals of Environmental Citizenship: achieving sustainability, preventing environmental problems, solving environmental problems, addressing structural causes of environmental degradation, promoting intra- and inter-generational justice, achieving critical and active engagement, and civic participation. The SCQ primarily investigates individual actions in the private sphere, but some items also relate to the public sphere. Given the holistic and broad coverage the SCQ-instrument provides, it is useful to empirically investigate its potential to discern the effects of educational interventions aimed at developing environmental citizenship in diverse cultural and educational contexts. The SCQ-instrument exists in a long version (SCQ-L) comprising 49 items and a short version (SCQ-S) comprising 27 items. In the studies presented herein, the short version was used.
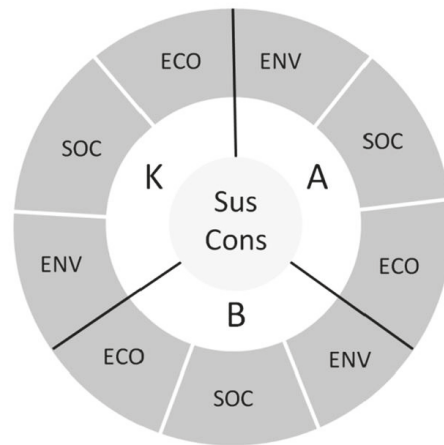
Figure 1. Conceptual representation of Sustainability Consciousness. K = knowingness; A = attitudes; B = behaviors; ECO = economic; SOC = social; ENV = environmental; Sus Cons = Sustainability Consciousness (taken from [3]).

3. Materials and Methods

In line with the background, aim, and research questions, this section first describes the contexts and interventions of the three cases in Spain, Belgium, and Sweden (see also Table 1). Secondly, we describe the common survey used to evaluate the educational impact of each of the initiatives: the sustainability consciousness questionnaire (SCQ). Finally, we describe the common analytical approach employed for the investigations in each of the three cases.

Table 1. Descriptions of the three interventions.

	Spain	Belgium	Sweden
Sample	*n* = 68	*n* = 104	*n* = 495
Male	34%	50%	62%
Female	66%	48%	35%
Undisclosed	0%	2%	3%
Age	25–70 years	12–14 years	17–18 years
Education type	Non-formal	Formal	Formal
Education level	Adult education	Lower Secondary education	Upper secondary education
Intervention length	1 day	1 semester	1 school year

3.1. The Spanish Case

3.1.1. Context and Sample

The Spanish case focuses on the evaluation of a 1-day sustainability workshop offered to adults voluntarily participating in a regional program aimed at raising sustainability consciousness in rural areas with less than 100,000 inhabitants through non-formal education intervention. The study comprises a convenience sample of 68 participants, distributed among three different rural areas (23 males and 45 females), with ages ranging from 25 to 70 years and with different levels of education (primary, secondary, and higher education).

3.1.2. Intervention

The intervention consisted of a 3 h interactive workshop conducted by the facilitator. The main focus was on eliciting participants' preconceptions, raising awareness of current sustainability issues through the use of multimedia and interactive games, and promoting reflection and discussion on structural causes and how current environmental problems

could be prevented or solved through individual and collective actions. In the following section, we provide a more detailed description of the intervention.

Pre-Intervention

The questionnaire on sustainability consciousness was distributed before the informal educational intervention. The short version of the questionnaire developed by Gericke et al. [3] was used for the pre-test and post-test to collect data on outcomes of the environmental and sustainability education intervention. This not only served to measure the change induced in the participants by the educational intervention but also served as the starting point for their learning experience. After completing the questionnaire, participants were invited to take part in a discussion to elicit their initial ideas about sustainability. The debate in which they engaged connected with the inquiring, evaluation, and reflection processes included in the EEC pedagogical model. During the session, different activities were performed and orchestrated by the facilitator using a PowerPoint presentation.

Videos and debate: The session started with the video: 'La historia que tú estás formando' (the history you make) (https://www.youtube.com/watch?v=ovvKUho-cHc (accessed on 13 October 2021)), 2.45′ video by the UN. Participants were then asked to answer two questions: the first of these was "What do we understand by sustainable development?" Each participant wrote the answer on post-it notes and was then asked to read it aloud, stimulating the debate. The second question asked was, "What do you think the Sustainable Development Goals are?" This was followed by a few minutes of discussion in which personal answers to the questions were shared. A second video, "Los Objetivos del Desarrollo Sostenible; qué son y cómo alcanzarlos" (https://www.youtube.com/watch?v=MCKH5xk8X-g (accessed on 13 October 2021)), 6′ by UNESCO, was then presented to introduce the Sustainable Development Goals (SDGs).

Games: The game "Take all today or all take always" by McKeown et al. [27] was designed to help participants learn how to manage natural resources in a sustainable way without compromising future generations and, consequently, consider the effect on the environment. Games based on simulations of real situations made the participants realize to what extent their own decisions and actions have an effect at local, regional and global scales. This connects with the planning and acting processes within the EEC pedagogical model. The facilitator explained the three different dimensions in the sustainable development concept (social, environmental, and economic) and started to play the second game "The three dimensions of sustainable development". Each group of 4 people had a list of the 17 SDGs and were asked to assign at least one dimension to each SDG. Finally, the facilitator introduced the 5R conceptual framework on waste management (reuse, reduce, repair, rethink, and recycle). To boost the debate, participants were asked the following question: "What ideas can you provide for materials recycling?" The third game, Recapacicla, focused on the different types of waste, their correct classification, and the time taken for each to disappear in the environment in order to focus on the environmental dimension of sustainability.

Introduction of new concepts: Ecological rucksack: The concept of ecological backpack [28,29] was explained. The participants were asked to give their opinion on secondhand buying, generating a debate. The role of NGOs and volunteering associations was also explained to connect with the social aspect of sustainability. SDG 1, poverty eradication, was presented and participants discussed the economic and social dimensions of sustainability, which made it easier to identify the structural causes of environmental problems and align the intervention activities with the EEC outputs.

Post-Intervention

Finally, participants were asked once again to complete the questionnaire on sustainability consciousness in order to determine whether there had been any variations in their level of sustainable consciousness, and whether such variations were statistically significant. The workshop was designed to engage participants in the exploration of con-

temporary issues related to the impact of human activities on the planet. It also aimed to promote discussion and reflection on structural causes and how particular issues might be solved or prevented, which calls for personal responsibility and engagement and the undertaking of individual and collective actions.

3.2. The Belgian Case

3.2.1. Context and Sample

The Belgian case includes data from a single secondary school that participated in a large-scale research and development project known as VALIES (VALorization of integrated and action-oriented Education for Sustainable Development, see, e.g., [30], which aimed to build teachers' competences to implement education for sustainable development. The school is located in a suburban area in Flanders, the Dutch-speaking community in the north of Belgium. Through their participation in the VALIES project, the teachers implemented a school-wide intervention throughout the year (see Section 3.2.2). Given the specific focus of the research aspect of the project, only students in grades 7 and 8 were surveyed: in total, 104 students aged 12–14, all from four general education class groups, participated in the survey. A total of 50% of the participants self-identified as girls, 48% as boys, and 2% chose not to disclose their gender. However, students from grades 9–12 also participated in the project at school (albeit located at a different campus), without participating in the survey. All student data were collected online and on two separate occasions: before (September 2019) and after the intervention (June 2020). Drop out was minimal, with just one student missing in the second phase of data collection. An important point to highlight is the schools' motivation to take part in the VALIES project, which was two-fold. Internally, the school was motivated to work on a shared school-wide project focusing on the development of students' sustainability literacy as well as building a feeling of community and collective efficacy within the school. Externally, the school aimed to respond to the new curriculum in Flanders, which came into action in September 2019 and in which sustainability and citizenship competences are now at the core of the objectives for formal education [31].

3.2.2. Intervention

Within the VALIES project, teacher teams from approximately 60 schools participated in a teacher professional development program that focused on designing and implementing education for sustainable development. For the current study, we focus on the student results of a single school. Below, we briefly sketch (a) the teacher professional development program, and (b) the intervention developed and implemented by the teachers in their own school.

The Teacher Professional Development Course

Between September 2019 and June 2020, selected teachers ('core teams') from each school took part in four joint training days, each with a specific focus, to acquaint them with the principles and practices of education for sustainable development. In between training sessions, VALIES staff members visited schools multiple times to provide tailored support, focusing on Education for Sustainable Development (ESD), group dynamics, and identifying and overcoming barriers. Following an intake interview in September 2019 to clarify the schools' motivations to participate and to identify goals and expectations, an initial kick-off was organized in October 2019. Here, the focus was on familiarizing students with the ESD principles of holism, pluralism and action-orientation, which form the core of the VALIES pedagogy [31]. An inspiring example of an ESD practice at school was then discussed in small mixed groups to illustrate these principles in a concrete situation. In November 2019, core teams were again gathered for a training day with a focus on the diversity of possible approaches toward integrating the SDG into teaching practices. One primary aim of this training session was to open up the concept of sustainability to cover the full range of interconnected sustainable development goals. Core teams were also supported in designing action plans to implement ESD in their own practice. Between

the second and third training session, the teams experimented with these implementations. Experiences with and reflections on these experimentations formed the core of the third training session in February 2020. Here, teams were further inspired to expand their projects, incorporate educational evaluation, and explain to each other how the key principles of holism; pluralism and action-orientation, are present within their projects and or plans. After this session, the school teams scaled up to full implementation. Plans were made for a fourth session in June 2020, but this was replaced by an online intervention session in February 2021 due to the COVID-19 outbreak. Several schools dropped out of the project due to the pandemic, reduced their ESD projects or postponed them to the next academic year. The school focused on in the current study is one that continued with full implementation even though it had to switch to online teaching between April and June 2020.

The School Project

All the students (grades 7–12, across different campuses) participated in this whole-school project, which was designed by the teachers to facilitate action taking by students. The students in grades 7 and 8, of whom we include SCQ data in this study, focused thematically on climate change. They followed several steps in their educational process that aligned with the EEC pedagogical model [2]. First, in small groups of about five students they explored a specific issue related to climate change in Belgium from diverse sustainability perspectives. Examples of these issues are depleting ground water levels, increased viticulture opportunities, and climate refugees. The students researched these issues from two approaches: (1) understanding the underlying scientific processes (natural science) and (2) stakeholders' perspectives (social science). Students surveyed their families and inhabitants around the school on opinions relating to their specific climate change issue. In the next phase they analyzed data and, through the pedagogical tool of 'student expert groups', informed each other about these issues. Students were then supported in acting within their own action radius. This included active and guided exploration of their own possibilities, visualizing and communicating different possibilities, mapping their potential impact, and selecting and bringing into practice specific actions. For some students, these were individual actions in their own lives (e.g., reducing meat consumption), for others they were collective action (e.g., developing a climate awareness video). These steps align with the EEC pedagogical model with one step missing: mapping the impact of their own actions. Although as researchers we studied the impact of the intervention on the students' SCQ, the students did not map the net environmental and social impact of their own actions. This is partially due to COVID-19, which shifted priorities in the school.

3.3. The Swedish Case
3.3.1. Context and Sample

The Swedish case includes an investigation of the development of environmental and sustainability education in an upper secondary school. After the compulsory school level in Sweden (grade nine), almost all students continue to an upper secondary (grade 10–12) school program according to their specific interests, which is either a vocational or a theoretical program. The school representing the Swedish context offers two theoretical programs; the students therefore attended either the science program or the technology program. The upper secondary school is located in a municipality with almost 100,000 habitants. In total, 495 students in grades 11 and 12 (between 17 and 18 years old) participated in a pre-test in early September 2018. About eight months later, in April 2019, 438 of the students in these two grades (now aged between 18–19 years old) participated in the post-test. Of these, 35% were girls, 62% were boys and 3% did not want to acknowledge themselves as either boy or girl.

3.3.2. Intervention

In this environmental and sustainability education intervention, all the teachers in the upper secondary school attended a teacher professional development program on environmental and sustainability education. The idea behind the professional development program was to support the teachers in developing an EEC approach to teaching and learning (see [2,32]). In addition, the program was designed to result in the development of important environmental and sustainability education outcomes and competences at the student level (see, [33]). The investigations in this Swedish context therefore focused on investigating the effect of an intervention in terms of students' sustainability consciousness.

The Teacher Professional Development Course

All the teachers in this upper secondary school participated in the teacher professional development program, which included four full day or half day seminars, the first in August 2017 and the last in November 2018. In these seminars, lectures, and workshops, discussions took place that were related to environmental and sustainability education. The first three seminars aimed to develop teachers' knowledge and self-efficacy regarding environmental and sustainability teaching and learning. The fourth seminar focused more directly on transforming the teaching at their school to be more cross-disciplinary and to adopt a more action oriented, participatory, and democratic EEC approach to teaching [2]. A summary of the seminar occasions for the teachers is presented as follows.

- August 2017. A full day seminar focusing on what environmental and sustainability education is. Components of the EEC approach were introduced.
- November 2017. A half day seminar including a workshop on what an EEC approach to teaching could look like for the teachers.
- June 2018. A half day seminar on examples of how to arrange cross disciplinary teaching at the upper secondary school level. The day included both a lecture by a researcher/teacher with experience of cross disciplinary teaching at the upper secondary level and work team discussions.
- November 2018. A final full day seminar focusing on hands-on activities for work teams on how to transform environmental and sustainability teaching and learning into an EEC approach at the school.

The teachers also worked in their teams at the school in between the seminars and engaged in regular meetings on a weekly basis. In these sessions, the teaching of students and the development of environmental citizenship and competences for sustainability were discussed along with other practical and urgent issues that were part of teachers' teamwork. Once each semester, two researchers met the school leaders to plan and discuss how to conduct the development program with the teachers and the intervention with the students. Moreover, to support the work teams, two teachers worked 20% each as facilitators to support the environmental and sustainability education development process. The facilitators regularly met two researchers and facilitators from other schools in the municipality to discuss and support each other in the development of sustainability teaching and learning at their schools (two-hour meetings three to four times each semester).

Research suggests it is important to include the student level when investigating the effects of a teacher professional development program such as the one described above (e.g., [33,34]). In this context we therefore investigated the outcomes at the student level by collecting student data in a pre-test and a post-test during a period where students took part in the planned environmental and sustainability teaching and learning intervention. The pre-test was assigned some time into the teacher professional development program, as the teachers spent a great deal of time incorporating input from the three first seminars and related work team discussions into their teaching and intervention with the students. The pre-test therefore took place at the beginning of September 2018, before the final "hands-on" seminar. The post-test was administered approximately one school year later in late April 2019, a sufficient period of time after the final seminar for teachers to ensure they had time to implement their plans into environmental and sustainability teaching and learning at

their school. The short version of the sustainability consciousness questionnaire [3] was used to collect pre- and post-data on the outcomes of the environmental and sustainability education intervention at the student level.

The School Project

In connection to the seminars described previously, the Swedish teachers started to involve the students in sustainability interventions through their teaching and through extracurricular activities. The facilitators at the school gathered volunteer students from each class (approximately 20 students) to work as *sustainability ambassadors* at the school. In line with the EEC approach, the intention was to involve students in decision-making and action taking at their school by including the environmental, economic, and social perspectives of sustainability. The student school ambassadors met every second week with the goal of improving sustainability at the school. They worked on minor issues such as actions to reduce disposable materials and waste products in the cafeteria, but also with larger projects. One example of such a larger project was the congress on circular economy arranged by the students at the school. At this congress, different local companies and municipality representatives were invited to explain how they practice circular economy. In connection with the congress, and for students to practice circular economy themselves, they arranged an exchange of secondhand clothing at the school. Students could bring clothes that they did not use anymore, or were tired of, and exchange these with others for free instead of buying new clothes.

Additionally, in line with the EEC approach, the teachers initiated international sustainability collaborations with two other schools in two African countries, enabling the students to exchange their local sustainability experiences in a global context. This project involved teachers from different school subjects, which meant cross-disciplinary work and the possibility for students to interconnect different subjects through teaching and learning. At the time of the post-test, this international sustainability collaboration was awarded and the school became one of three *Life Schools* in the world (see https://life.se/projects/life-schools/ (accessed on 15 August 2021). To become a Life School, the entire school had to be permeated by sustainability work and sustainability action-taking. The teaching and learning at the school also had to deal with issues connected to the 17 global sustainability goals. The award means that the school can continue the development of the EEC approach locally and exchange experiences with others globally.

3.4. Instrumentation

The short version of the Sustainability Consciousness Questionnaire (SCQ-S) was administered before and after the intervention. The SCQ-S consists of 27 items evaluated using a 5-point Likert scale (totally disagree to totally agree with a neutral option in the middle). Items represent the environmental, social, and economic components of sustainable development within three dimensions: sustainability knowingness, sustainability attitudes, and sustainability behaviors. The sustainability knowingness, attitude, and behavior items reflect (i) what people acknowledge as necessary features of sustainability (e.g., the environmental item: Reducing water consumption is necessary for sustainable development), (ii) feelings about sustainability and what people think about sustainability issues (e.g., the social item: I think that we who are living now should make sure that people in the future enjoy the same quality of life as we do today), and (iii) the self-reported behavior of people in relation to these issues (e.g., the economic item: I avoid buying goods from companies with a bad reputation for looking after their employees and the environment). The theoretical foundation and empirical validation of the instrument are described in Gericke et al. [3].

In the Swedish context, we administered the original Swedish version of the SCQ-S that was used with the participants in the original validation of the instrument (see Gericke et al., 2019). The internal consistency of the scale was well within the required parameters for a scale with good reliability (Cronbach's alpha was 0.842 for the scale as a whole).

The instrument was translated into Spanish with minimum modifications to adapt to the sample and the cultural context of the Spanish participants, while checking that the internal consistency of the scale remained high after translation (Cronbach's α = 0.786). A similar approach was employed in Belgium, resulting in an acceptable level of internal consistency (α = 0.853).

3.5. Analyses

We estimated the reliability of the SCQ for each of the three contexts by calculating a Cronbach's alpha value for the construct of sustainability consciousness, as well as for the three subconstructs: sustainability knowingness, attitudes, and behavior. We used a value of 0.65 as a cut-off for indicating good scale reliability [35]. After establishing reliability, we calculated a mean value for each subscale within each context and for the entire construct. Missing values were replaced with the respondents' mean values for the respective item. As we were not comparing the SCQ of respondents across the interventions, but rather the scales' potential to detect changes over time, we limited comparisons to a (M)ANOVA test for each separate intervention. Therefore, multivariate estimations of mean differences were made across time for sustainability consciousness, knowingness, attitudes, and behavior in Spain, Belgium and Sweden. In line with convention, we accepted statistical significance at a level of $p < 0.05$. Furthermore, to quantify the effect size of differences, we calculated a Cohen's d for each comparison, with values below 0.20 indicating limited effects, values between 0.2 and 0.5 small effects, values between 0.5 and 0.8 medium effects, and values above 0.8 large effects [36].

4. Results

This section is divided into two main sub-sections in accordance with the research question. We first describe the results concerning the impact of the three different educational interventions on promoting environmental citizenship in terms of participants' sustainability knowingness, attitudes and behaviors. We then present the results regarding the potential of the SCQ to detect the impact of educational interventions in diverse contexts.

4.1. The Impact of the Interventions

Table 2 presents the results of the impact analyses for each of the interventions and for each of the (sub)constructs. For the Spanish intervention, the results indicate large effects both for the overall construct of sustainability consciousness and for each of the subconstructs, suggesting a full and balanced impact. For the Belgian intervention, the results indicate a large effect on participants' sustainability attitudes, a small effect on their behavior, and no effect on their knowingness. Overall, the Belgian respondents exhibited a large increase in sustainability consciousness. For the Swedish intervention, the effect was concentrated in the behavioral dimension and should be labelled as limited. Figure 2 summarizes these results and reveals a pattern that is similar in each country, with knowingness and attitudes displaying relatively high mean values and behavior exhibiting lower values. The results also highlight the consistent impact of all three interventions on the behavioral dimension of the SCQ. As discussed later in Section 5.2, we did not make statistical comparisons between the countries, but rather were interested in the impact of the interventions in each country as well as the patterns identified within that impact.

Table 2. Descriptive statistics and differences between pre- and post-test values for the entire scale (Sustainability consciousness) and subscales (Sustainability knowingness, -attitudes, -behavior) in each country.

Country	Construct	M ± SD (Pre)	M ± SD (Post)	M.diff	p	d
Spain	Sustainability consciousness	4.27 ± 0.92	4.59 ± 0.67	0.32	<0.001 *	0.935
	knowingness	4.47 ± 0.70	4.72 ± 0.48	0.25	<0.001 *	0.615
	attitudes	4.41 ± 0.91	4.64 ± 0.72	0.23	0.001 *	0.653
	behavior	3.92 ± 1.02	4.42 ± 0.73	0.50	<0.001 *	1.100
Belgium	Sustainability consciousness	4.13 ± 0.36	4.36 ± 0.39	0.23	0.001 *	0.613
	knowingness	4.34 ± 0.41	4.41 ± 0.45	0.07	0.211	0.155
	attitudes	4.20 ± 0.41	4.46 ± 0.42	0.26	0.001 *	0.626
	behavior	3.97 ± 0.54	4.14 ± 0.52	0.17	0.027 *	0.321
Sweden	Sustainability consciousness	4.07 ± 0.49	4.11 ± 0.52	0.04	0.332	0.063
	knowingness	4.42 ± 0.56	4.42 ± 0.62	0.00	0.984	−0.01
	attitudes	4.40 ± 0.54	4.36 ± 0.62	−0.004	0.303	−0.07
	behavior	3.44 ± 0.66	3.56 ± 0.67	0.12	0.008 *	0.174

* indicates significant differences at *p* < 0.05.
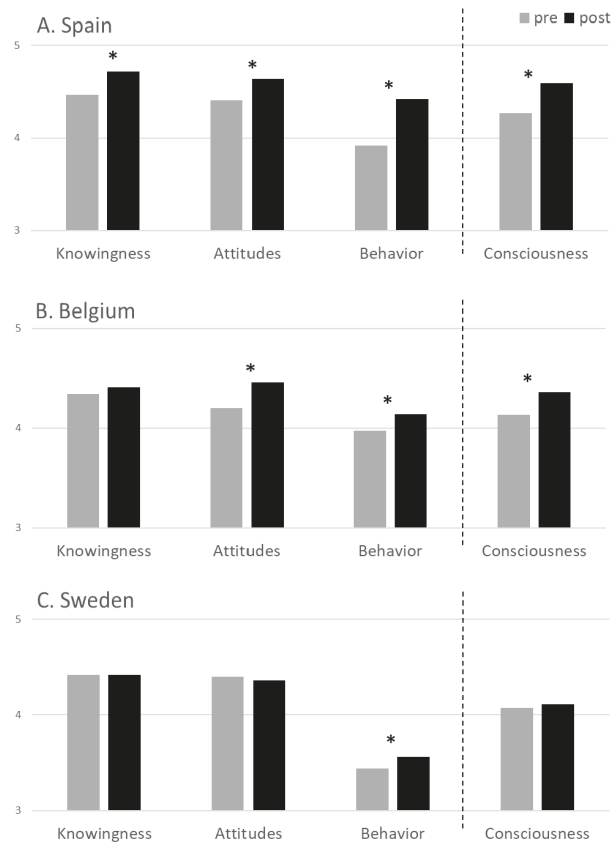
Figure 2. Impacts of the interventions on participants' sustainability consciousness (all items), knowingness (K-items), attitudes (A-items), and behavior (B-items) in each of the three countries: (**A**). Spain, (**B**). Belgium, (**C**). Sweden. * indicates significant differences.

4.2. Psychometric Quality of the SCQ

Table 3 presents the Cronbach's alpha values for the entire instrument as well as for each of the sub-constructs in each country The results indicate that the SCQ functions as a reliable instrument to measure the sustainability consciousness, knowingness, attitudes, and behaviors of respondents. All values surpass the 0.65 cut-off value. It should be noted, however, that for sustainability behavior the Cronbach's alpha value is only just above 0.65. Nevertheless, these results suggest it is meaningful to calculate mean scale scores for each of the (sub)constructs. Based on the mean values and standard deviations, the effect sizes in terms of Cohen's d in different contexts indicate that the instrument has the potential to detect small to large effects of the pre- and post-test (see Table 3). In Spain, the effect sizes were medium to large, in Belgium small to medium, and in Sweden they were small. Hence, the results suggest that the SCQ has the potential to detect the full spectrum of effects of interventions applied in different contexts.

Table 3. Cronbach's alpha values for the entire scale and subscale in each country.

Scale (Items)	Spain	Belgium	Sweden
Sustainability consciousness (27)	0.786	0.853	0.842
Sustainability knowingness (9)	0.756	0.772	0.789
Sustainability attitudes (9)	0.692	0.685	0.737
Sustainability behavior (9)	0.652	0.748	0.704

5. Discussion

EEC plays a key role in preparing environmental citizens with the ability to take action on sustainability issues [2]. It is important to develop educational initiatives in line with those incentives, and to evaluate the effects on students in order to fine tune the pedagogical approaches.

In this paper we set out to explore the potential of one specific measurement instrument to evaluate the outcomes of educational interventions that aim to build environmental citizenship in learners: the Sustainability Consciousness Questionnaire (SCQ). Previous research using this instrument has been performed mainly within single cultural contexts e.g., [24–26,37,38] and been cross-sectional by design. In the current paper we brought together data from three interventions from three different countries, each applying a pre-post design, and focused on a common learning outcome (environmental citizenship). We aimed to (1) describe the impact of the three different educational interventions in terms of sustainability knowingness, attitudes, and behaviors, and (2) explore the potential of the SCQ to detect the impact of educational interventions in diverse contexts.

5.1. The Impact of the Educational Interventions

While the three interventions differed significantly in relation to their length, target group, educational context, and level of education, there were important similarities in their pedagogical approach. The key elements present in the pedagogy of each of the interventions were as follows:

- Contextualization in authentic issues and real-life problems that help trigger participants' motivation and engagement.
- Opportunities for active learning through a wide range of activities (posing questions, designing investigations, collecting information, discussing and presenting results . . .).
- Value-driven actions aimed at achieving environmental protection, social and intergenerational justice, and the common good.
- An emphasis on decision-making and taking action after evaluating the available evidence and considering different perspectives and alternative arguments.
- Critical reflection on how things are and how they should be, identifying weak and strong points and areas for improvement.

In the studies conducted in Spain and Belgium, effects were found at both the first level of constructs, sustainability consciousness, and at the second level; sustainability knowingness, sustainability attitudes, and sustainability behavior. In Spain, all second level constructs demonstrated effects, while in the Swedish case effects were only found for sustainability behavior. Notably, effects for the sub-construct of sustainability behavior were evident in all three interventions; in their own context and with their own pedagogical approaches, these impacted positively on the sustainability behavior of the participants.

The reliability scores were close to or well over 0.7, as recommended in the literature. The somewhat lower results for some of the sub-constructs in the Spanish sub-sample could be explained by the rather low number of respondents (*n* = 68).

Given that (1) within EEC, the overarching goal of education is to influence and change the way citizens act, i.e., their action competence for sustainability [13], and (2) the intervention focused on diverse participants (ages ranging from 10 to 75 years), the ability of the instrument to recognize self-reported sustainability behavior is of great importance as an outcome variable for EEC. The current study thus empirically demonstrates that the SCQ is a valuable and appropriate tool to measure this central aspect of EEC, as previously theoretically advocated by Gericke et al. [22].

The results revealed high scores in the attitude and knowledge domains before the intervention, indicating that participants exhibit relatively high awareness of sustainability across its three dimensions (environmental, social and economic). The higher deviations in the Spanish case are consistent with the heterogeneity of this group, with a wider age range and mixed educational background (34% primary education; 29% secondary education; 37% higher education). The lower scores obtained in the behavioral dimension in the pre-test in all three study cases highlights the difficulty of developing behavioral changes in citizenship that could be effective in environmental protection or conservation [39]. Although behavioral science has made substantial gains in understanding how to encourage prosocial behavior, pinpointing the importance of social norms, risk communication, emotion, and choice architecture [40], a multi-scale approach is needed to effect behavioral changes [41].

The use of a pre-post questionnaire strategy provides evidence for the net value of the behavioral component after the intervention. This strengthens the proficiency of the specific pedagogical approaches used in the current cases that represent the EEC approach. For instance, place-based education offers students authentic opportunities to participate in effecting positive change within their local communities, impelling them to be agents of change [2]. During each of the three interventions, several steps of the EEC pedagogical approach were included: *Inquiry, planning actions, civic participation and evaluation,* and *reflection*. Additionally, the use of site-specific material and data made the message relevant and meaningful to the participants and engaged them in authentic environmental socio-scientific issues.

5.2. The Potential of the SCQ to Detect the Impact of Educational Interventions Aiming to Promote Environmental Citizenship

In three different cases in three different contexts, the SCQ-instrument demonstrated good potential to detect the learning outcomes of educational initiatives that align with EEC. An important finding of this study is that the SCQ instrument is a useful tool for pre-post design measurements of such learning outcomes. To the best of our knowledge, the instrument has not previously been used in such a study design. Moreover, our current study also shows that the SCQ can fruitfully be used in longitudinal studies in different countries (Belgium, Spain and Sweden) with different groups of respondents (different educational backgrounds, ages from 13 to 70 years) and using different lengths (one day, one semester, one year) and types of intervention (directly addressing the respondents, or addressing teachers in TPD that, in turn, teach students that are tested). The SCQ is clearly a versatile instrument that can be employed in many different types of sustainability and environmental citizenship interventions, as well as evaluations of these interventions,

using a pre-post design. None of the three studies used a retention post-test, which would be useful for future studies using the SCQ to include.

Regarding the SCQ's coverage of the EEC framework, we argue that SCQ primarily investigates individual actions in the private sphere, but some items also relate to the public sphere. However, aspects of citizenship connected to the EEC model that relate to practicing environmental rights and duties are not covered by the SCQ. If these are of interest in EEC interventions, the SCQ should be complemented with other instruments, suggestions for which can be found in [22] or in [42]. Moreover, if certain aspects of the EEC model are of specific interest, it might be necessary to go down to the item level of the SCQ and conduct an analysis, for example *solving current environmental problems* relates to item A 18, A 5, B 2 and K 9 ([3], p. 41). If so, it might be better to use the long version (SCQ-L) of the questionnaire rather than the short version (SCQ-S). The SCQ-L contains 49 items and is wider in its coverage of topics relating to environmental citizenship. Furthermore, it allows measurement of a third layer of sub-constructs as it can be applied to separately measure, using nine subscales, the knowingness, attitudes, and behaviors of people relating to the environmental, social, and economic dimensions of sustainability.

Several methodological considerations arise here. Firstly, we should investigate the possibility of ceiling effects [43] when using a Likert-scale such as the SCQ. Such effects appear when participants generally respond positively to the items in a scale, leaving little room for (a) a nuance or discrimination of responses at the higher end of the scale, and (b) growth over time as respondents in a longitudinal design tend to give high answers on the first measurement occasion. Neither scenario seems to be in place in the current study as SCQ scores in each of the three cases exhibit meaningful standard deviation in the pre-test and increase towards the post-test. These results suggest there is no ceiling effect for the SCQ in these cases

We should also highlight that in our analysis we could have chosen to make comparisons between the three different contexts, but purposefully avoided statistical cross-cultural comparisons due to the different groups in the three cases. However, such comparisons have been made elsewhere using the SCQ, for example between Sweden and Taiwan [26], and it is also possible to do this with the SCQ-instrument. Such comparisons would need to employ advanced statistical techniques based on cross-cultural comparability. Specifically, to meaningfully compare factors across distinct groups (such as countries), each item must be interpreted by respondents in the same way and function within the scale in the same way in each group [44]. Without establishing such invariance, cross-country comparisons are less robust. The next study on the horizon for the validation of the SCQ, and its potential to meaningfully compare the outcomes of education for environmental citizenship, is one that addresses the measurement invariance of the scale across specific cultural groups.

5.3. Action Competence and the SCQ

Even though invariance cannot be established, we can already explore several similarities that arise from our current analyses. If we look across the three contexts at the pre-intervention scores, there is a clear, recurring pattern of high sustainability knowingness, moderate sustainability attitudes, and lower sustainability behaviors (see Figure 2). This pattern elicits several lines of thought that are valuable to reflect upon. Within the competence approach to teaching and learning environmental citizenship, a balanced profile of knowingness, attitudes, and behaviors comes into focus as an outcome: learners need all three elements of the competence in order to meaningfully act on environmental issues. Each of the interventions we described and studied managed to increase (self-reported) sustainability behavior among their participants. The magnitude of the effect was different in each country (see Table 2) but, given that we did not perform measurement invariance testing, we cannot compare the outcomes across contexts. Nevertheless, the effect is significant within each context. This finding is intriguing because, in a review study, Ardoin and colleagues [45] conclude that this kind of effect typically exerts very

limited influence on the behavioral outcomes (e.g., [46,47]). Moreover, even though there is an effect on cognitive outcomes, such as knowledge, this correlates to a very low degree with behavioral outcomes (e.g., [48]). In this study, however, we identified the strongest effects in the behavioral rather than the cognitive domain (knowingness). This indicates two things. Firstly, the interventions appear to achieve EEC's aim of developing students' action competence, which is a prerequisite for sustainability behavior. Secondly, the SCQ seems to have a good ability to capture the action dimension of student outcomes in the interventions. This is supported by results from a previous study where the SCQ significantly correlated with an instrument measuring self-perceived action competence for sustainability (SPACS-Q; [38]). Both are extremely positive results. Further studies are therefore required to explore these aspects further.

6. Conclusions

In conclusion, our results indicate that the SCQ is sensitive enough to register significant learning outcomes as a result of learners participating in EEC interventions, measuring their impact in pre- and post-test longitudinal study designs. Moreover, the results provide evidence for the impact of participation in short-term educational interventions as well as those using longer interventions. Additionally, we have demonstrated that the SCQ is useful in both formal and non-formal education scenarios. However, because the EEC framework is complex and covers multiple aspects of citizenship, it might need to be complemented with other instruments when evaluating educational interventions, depending on what specific aspects of EEC need to be evaluated.

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Article

Socio-Scientific Inquiry-Based Learning as a Means toward Environmental Citizenship

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Abstract: This paper draws on the meta-theory of Critical Realism providing a theoretical basis for the pedagogical approach of Socio-Scientific Inquiry-Based Learning (SSIBL) in supporting Education for Environmental Citizenship (EEC). We argue that while there are different configurations of EEC, inducting citizens in decision-making needs satisfies the following criteria: (a) relevant transdisciplinary knowledge, (b) a values orientation toward both the complexity of, and the necessity for, a sustainable world and (c) a confidence for, and commitment to, socio-political action at individual and collective levels. In order to provide a rich perspective about how SSIBL has been operationalized in various national contexts through specific teacher professional development, we present four cases purposefully selected as exemplars from different European countries (the Netherlands, Spain, the UK and Cyprus). The four cases provide powerful scenarios to discuss different ways in which the SSIBL approach can be implemented in teacher education to meet the criteria identified and, thus, promote informed and responsible action in relation to socio-environmental issues. The whole picture shows a consistent theoretical foundation and interesting opportunities for teacher education, as a relevant strategy to prepare teachers in taking risks and integrating SSIBL within school curricula to foster environmental citizenship.

Keywords: socio-scientific inquiry-based learning (SSIBL); education for environmental citizenship; teacher education; critical realism; transdisciplinarity

1. Introduction

In a recent interview, Bill Gates opined that the coronavirus pandemic was a mere episode compared with the existential threat to the planet posed by environmental degradation [1]. Life on Earth has become one of the BBC's flagship programs, and its presenter, Sir David Attenborough, is a global campaigner for environmental protection. At the other end of the age scale, teenager Greta Thunberg has stirred people of all age groups to take a position on excess consumerism. Pressure groups such as Extinction Rebellion have gathered popularity from many sections of the population. Likewise, more than 94% of a sample of 27,881 EU citizens reported, in face-to-face interviews, that the environment is personally relevant to them [2]. 'Sustainability' and 'Environment' have now become key terms in socio-political action.

Environmental Education has gradually been incorporated into school curricula with distinct philosophical approaches, some focusing on the importance of fundamental change

in practice (Education for Sustainability, EfS), some on the three pillars of 'economy', 'society' and 'environment' (Education for Sustainable Development, ESD) and some that align Environmental Education more closely to science education [3]. Whichever educational approach is adopted, they draw on common knowledge and skills: a depth of scientific (including environmental) knowledge and an understanding of citizenship action personally, socially and globally [4]. This type of Education for Environmental Citizenship (EEC) has, therefore, become a central aspect of debate in recent times, for instance through the ongoing European Network of Environmental Citizenship [5,6], which raises the need for further theorization of EEC from an epistemological perspective.

Socio-Scientific Inquiry-Based Learning (SSIBL) has been placed within the pedagogical landscape of EEC by the European Network for Environmental Citizenship [6] We intend to provide a theoretical foundation to this pedagogical approach and to discuss various learning scenarios developed in collaboration with teachers, to illustrate how SSIBL has been operationalized in four different countries through teacher education. The learning scenarios co-designed with teachers in the four different countries will be discussed on the basis of the underlying values, the relevant transdisciplinary knowledge mobilized and their potential to support responsible and informed socio-political action.

Therefore, the main objectives of the present work are as follows:

1. To provide an epistemological foundation for the SSIBL model, as a powerful pedagogical approach to support education for environmental citizenship;
2. To illustrate how the SSIBL pedagogy has been operationalized in four different countries through teacher education;
3. To provide concrete co-designed learning scenarios to apply relevant transdisciplinary knowledge and a value-based orientation to develop a commitment to environmental socio-political action at personal and communal levels.

2. Theoretical Background

One of the problems facing both science and environmental educators today is the diverse approaches to epistemology. There are two distinct educational discourses (and many intermediate ones). One argues that non-specialists have misconceptions about the causes of environmental phenomena and that any action taken presupposes authoritative scientific causal explanations, for example, about atmospheric effects, e.g., [7–10]. For any action to be effective, actors must understand the scientific explanations behind these effects. Another discourse maintains that scientific and environmental knowledge is derived and contextualized as a result of action; participants learn as they go along and the 'knowledge-in-practice' they accrue is often used to answer specific questions, in other words knowing-in-action [11,12]. These poles of research traditions reflect Simonneaux's [13] hot and cold extremities of educational priorities. At the cold end is mastery of 'sedimented' knowledge in the promotion of technoscience; issues are drawn on to illustrate or reinforce central scientific concepts. At the hot end, students understand the need to recontextualize destabilized knowledge in dealing with controversial issues.

This spectrum is characterized in three teaching traditions in environmental and sustainability education [14,15]. The fact-based tradition, consistent with the cold end of the spectrum, relates most closely to the emphasis on scientific knowledge as a precursor to solving problems. Scientific concepts are taught, and it is assumed they can be applied to a particular issue. The environmental problems are mainly seen as ecological and detached from a social context. This essentialist approach focuses on disciplinary knowledge compared with the progressivism of the development of the individual [16].

The second, normative tradition recognizes that human wellbeing is inseparable from the sustainability of the planet, derived from a shared sense of the common good and that authoritative scientific knowledge can provide a guide to the best way of living. Problem-solving of this nature takes experience and attitudes into account; teaching strategies might entail groups with different experiences using their knowledge to help solve a

problem. With its reliance on the authority of science it has connections to essentialism with progressive approaches.

The third teaching tradition, the pluralistic tradition, is reconstructionist in that it recognizes that social justice is intricately bound with problems of sustainability, that science alone cannot provide solutions, but that a transdisciplinary approach is called upon to draw on science, humanities, the arts as well as human experience in order to address moral and political problems relating to the environment through democratic participation and action [17]. It is this third teaching tradition that the Socio-Scientific Inquiry-Based Learning (SSIBL) pedagogical approach adheres to [18,19].

2.1. Socio-Scientific Inquiry-Based Learning (SSIBL)

SSIBL [18,19] conforms broadly to a pluralistic approach in that it is inquiry-driven and identifies problems that need solving, drawing on transdisciplinary methods in seeking solutions to a variety of common problems associated with the uncertainties of a post-normal world [20], i.e., one such as in the present COVID-19 pandemic where facts are uncertain; values are in dispute, such as the push or resistance to the global distribution of vaccines; stakes are high in literal terms of life and death; and decisions are urgent, for example the need to trial vaccines before standard regulatory periods. Figure 1 demonstrates the approach behind SSIBL [19]. SSIBL was formulated through an EU project, 'Promoting Attainment of Responsible Research and Innovation in Science Education' (PARRISE), to bring to the fore transnational ideas, best instructional practices and resources relating to learning about responsible innovation [21]. SSIBL links the following three pedagogical approaches: (a) Inquiry-Based Science Education (IBSE), which takes inquiry as its starting point where knowledge can both be used and constructed; (b) Socio-Scientific Issues (SSI) in which inquiry takes place through examining social issues with a strong scientific content such as sustainability; and (c) Citizenship Education (CE), which focuses on participatory learning and inquiry, with objectives consistent with democratic practices. These ideas can be encompassed through inquiries that are directed towards sustainable, socially desirable and ethically acceptable outcomes [22].
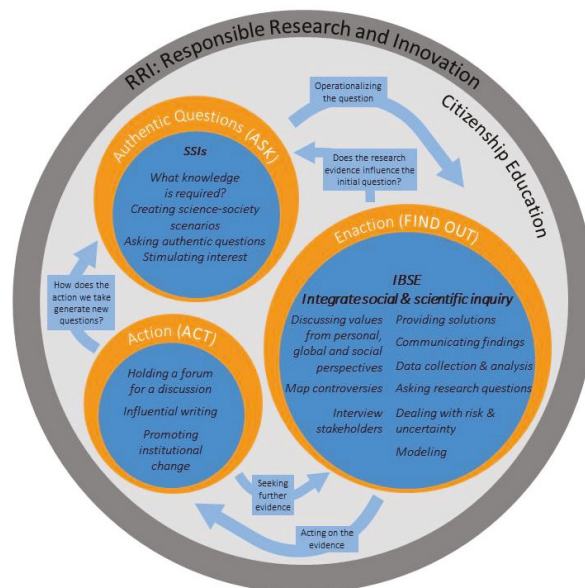

Figure 1. Socio-Scientific Inquiry-Based Learning. Figure based on [19] (p.15–16), adapted by Knippels and van Harskamp.

The three pedagogical approaches and their interconnections illustrated in Figure 1 have been organized into three instructional phases formulating a practice-based model that can be used by educators across age phases and with teachers. These instructional phases consist of the following:

(a) ASK, which focuses on posing *authentic questions* framed within particular SSI-based perspectives that can be investigated by students;

(b) FIND OUT, which focuses on students *enacting or carrying out* different types of socially responsible inquiries (structured, guided, open) [23] in order to collect evidence and unveil different perspectives to answer their questions; and finally,

(c) ACT, which focuses on how active citizenship is enacted by students, who consider the outcomes of their investigations and devise appropriate forms of *action* (e.g., campaigning for climate action, writing to their local authorities) that can empower them to contribute responsibly within their communities, at local, national or global levels [18,19].

In the following sections, we discuss how the theoretical framework of critical realism [24] can provide the underlying epistemology for the SSIBL pedagogy within a pluralist teaching tradition [25], which emphasizes transdisciplinarity, action and a values-oriented educational approach. This aims to address what we consider to be the shortcomings of the fact-based and normative teaching traditions, previously identified in environmental and sustainability education [14–17]. Our focus on transdisciplinary inquiry, action and values orientation through SSIBL promotes the idea of human emancipation in the context of sustainability and fosters environmental citizenship.

By emancipation, we draw on the praxis of actors making sense of their communal lives and acting in ways that are consistent with their values, reason and experience [26]. For the sake of illustration, it is possible to exemplify how emancipation might be achieved. One approach might be for a student to learn from a more experienced and wiser other, for example a teacher, and to act accordingly based on advice. Another way might be a 'pragmatist' perspective [27], which is to make an efficacious decision based on deciding rationally what are one's own best interests. The problem with the pragmatist perspective is that actions might be based on false beliefs. A third position, and one that is consistent with a critical realist approach, is that action takes place within a framework of meanings: social discourse elaborates a social reality that offers itself open to critique; hence, an understanding of social science and the dialectic of reasons would underpin SSIBL.

2.2. Critical Realism as a Background Epistemology to SSIBL

Critical Realism exposes the epistemic fallacy: what we know is not the same as what is. It recognizes the difference between a real world, a realist ontology and our knowledge of it. Hence, it differs from empiricism where data correlations conflate reality with knowledge, and also from interpretivism because it recognizes a reality beyond subjectivity [28]. In science domains, an important aspect of a critical realist (CR) approach [24,25] is that explanations are mediated by the real world we live in, a world that is an open system in scientific terms.

At some stage of their school lives, pupils are taught about the Law of Falling Bodies often accompanied by an apocryphal account of Galileo at the top of the Leaning Tower of Pisa dropping two objects of very different masses at the same time and demonstrating that they hit the ground simultaneously. However, everyday experience suggests this is not the case. Drop a lead weight and a feather at the same time and the lead weight will always reach the ground first. It seems that everyday experience contradicts the validity of a scientific law. This difference can be explained by the fact that the law only holds true in an airless medium, a vacuum, and that air currents impede the fall of the feather. The distinction drawn here is between what within CR would be considered as the closed world of Covering Laws and the open systems of the real world we inhabit and experience. The Law of Falling Bodies holds true in closed systems, i.e., in a vacuum, but needs to be amended in open systems, the world we experience.

One way to take account of the lived experienced world is to draw on the fact that objects have causal powers or tendencies [29]. Using a causal powers explanation [30], we can state that the Earth has a tendency to draw objects toward it such that they accelerate toward its center regardless of mass. Objects have a tendency to fall toward the center of the Earth. Air currents have a tendency to resist the fall of objects. If we see these objects—the Earth, falling objects, air currents—as having causal powers or tendencies, then we can explain the observed behavior in the world of experience in terms of interactions. We do not need to start with a vacuum and demonstrate ideal closed conditions; we can start with the real lived world.

To take another example, metallic zinc has the 'power' or potential to reduce solvated hydrogen ions in an acid into hydrogen molecules in the form of hydrogen gas.

$$Zn(s) + 2H^+(aq) = Zn^{++}(aq) + H_2(g)$$
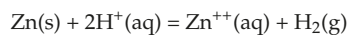
The term 'power' is used because this potential is only activated when the zinc is immersed in the acid. Similarly, the acid has the potential to strip electrons off zinc when they react together. The reaction is explained by hidden mechanisms, in this case, electrode potentials that contribute to redox reactions. The redox chemical reaction—the event—takes place when these powers or tendencies are actuated. Therefore, one aspect of a CR pedagogy in science is to start from events or issues that pupils experience—problems that need solving, and thus, require taking action—rather than abstract concepts.

Values, Transdisciplinarity and Emergence

A central concern of CR is the concept of 'emergence'; that understanding a particular phenomenon goes beyond explaining its constituent parts. An example is water, H_2O, a liquid at room temperature. Water is comprised of two elements (hydrogen and oxygen), both of which are flammable gases at room temperature. The compound liquid water is chemically different from its constituent elements; we can deduce this a posteriori.

A more complex example is consciousness. Consciousness implies a sentient mind. A necessary condition of consciousness is physico-chemical and biological: a sentient mind relies on a functioning nervous system, itself dependent on the supply of nutrients, in other words a balanced and varied diet. However, consciousness reflects a psychological state of mind, a social awareness of others and an understanding of historical and cultural context. A pre-requirement of consciousness is physico-chemical mechanisms, but it can only be more completely understood through psychological, social and political contexts. Any conditions that might prevent that level of reflection and awareness, for example, sustenance, leisure, social contacts and education, impede human autonomy and emancipation. Consequently, a consideration of SSIBL based on the metatheory of CR also necessitates the inclusion of values, social justice and transdisciplinarity as important dimensions of understanding emergent issues and events.

Further, events such as the maintenance of multispecies habitation of a pond, the flourishing of a forest, the visit of a robin to a garden feeding spot can be explained by a variety of mechanisms at different disciplinary levels. Only by incorporating these levels into an overarching explanation can the event be understood. Concepts from different fields of study need to be brought together to make sense of experience or an event meaning that transdisciplinarity is a necessary dimension of a CR pedagogy, and a key principle of the SSIBL pedagogy.

Within SSIBL, events or issues rather than concepts form the basis of study. Consider a typical SSIBL activity, such as pupils inquiring into heat loss in their school and wastage of fuel. Such an inquiry might involve measuring where the heat loss takes place, how it can be reduced through an understanding of heat transfer, what materials might be needed to do this, how resources might be harnessed to enable this to take place, persuading relevant authorities that action needs to be taken. Importantly, reflection on values also becomes part of the learning process (e.g., considering reducing the consumption of fossil fuels).

2.3. SSIBL as a Pedagogical Means toward Environmental Citizenship

According to Hadjichambis and Reis [4], environmental citizens become agents of change through individual and collective actions aimed at creating a more sustainable and just world, exercising their rights and duties as responsible citizens in the public and private spheres. Environmental citizenship is considered a prerequisite to sustainability [31], as it can enable young people to take action and develop pro-environmental behaviors. At the same time, EC is a complex, multifaceted and multidimensional concept, that requires engagement and action at local, national and global levels, individually and collectively, privately and publicly [5].

All three instructional phases of the SSIBL pedagogical approach (ASK, FIND OUT, ACT) require students to equip themselves with the knowledge, dispositions and skills they need to act as environmental citizens. When students engage in the exploration of contemporaneous environmental issues or dilemmas through the SSIBL approach, they apply experimental or social inquiry processes utilizing transdisciplinary knowledge to develop an in-depth view and to collect research evidence. They identify multiple perspectives and interest groups while combining scientific knowledge with social, environmental and ethical considerations and they use democratic processes and open deliberation to make informed decisions and take action. Organizing such transdisciplinary inquiries is clearly a pedagogic challenge [32,33]; it requires whole school support, requisite teacher training and a willingness of both teachers and pupils to work on a transdisciplinary basis amongst others. In the following sections, we use four exemplars to illustrate how the SSIBL approach can be implemented to emphasize transdisciplinarity, action and a values-oriented educational approach as a means toward environmental citizenship.

3. Implementation of SSIBL in Different National Contexts

Four cases have been purposefully selected from different European countries (the Netherlands, Spain, the UK and Cyprus) that participated in the PARRISE project and utilized SSIBL within teacher professional development (TPD) courses with pre-service or in-service teachers at the elementary (Cyprus) and secondary (the Netherlands, the UK, Spain) education levels. Each case provides insights on the multiple ways in which SSIBL has been implemented in order to address socio-environmental issues placing emphasis on the diversity with which a novel pedagogical approach can be adapted in different educational contexts [34]. The cases presented illustrate the affordances of SSIBL as a means toward environmental citizenship in each context, through a focus on informed and responsible action-taking in relation to environmental and sustainability issues, the ways in which a values orientation to recognizing the complexity of sustainability issues is considered by teachers and how transdisciplinarity has been used.

3.1. SSIBL in The Netherlands

In the Netherlands, the secondary science curriculum pays explicit attention to reasoning on socio-scientific dilemmas. Students of chemistry, biology and physics need to be able to distinguish between scientific facts, normative-societal considerations and personal opinions when evaluating SSIs. Among the SSI contexts included in the curriculum, many relate to sustainability, such as human influence on the Earth system, energy preservation and sustainable production processes. The chemistry curriculum, which was revised in 2016, goes further. It builds upon the principle of 'green chemistry' (Groene Chemie), which includes such skills as recognizing realized, possible and desirable changes in industry and chemical processes [35] (p. 6).

Despite this explicit presence of SSI and sustainability-related contexts in the curriculum, many Dutch science teachers experience difficulties in incorporating them into their daily practice [36]. Dealing with personal values and beliefs and ethical aspects of science, is challenging for many teachers, and other parts of the curriculum are experienced as needing more time or being more important for national exams. Teachers indicate lack of time as one of the main difficulties.

To support science teachers in addressing sustainability issues in their daily practice, SSIBL was implemented in pre-service teacher training across 11 cohorts (n = 86) at Utrecht University over the last five years. For these training sessions, SSIBL was operationalized in the following seven stages: (i) introduction to the dilemma, (ii) initial opinion-forming, (iii) creating a need-to-know, (iv) inquiry into scientific, social and personal aspects of the dilemma, (v) dialogue, (vi) decision making and (vii) reflection [36]. At each stage, examples showing how to introduce SSIBL in classroom practice were discussed and pre-service teachers (PST) could practice specific stages in small-group tasks. The SSIBL training consisted of two 1.5-hour face-to-face sessions and a take-home (group) assignment to design an SSIBL lesson, within the context of a 20-week pre-service training course.

Lesson design plans made by the student teachers were collected (n = 39), 19 of which were based on sustainability-related SSIs by the PSTs' own free choice. Additionally, the PSTs completed a questionnaire with five evaluative, open-ended questions on the SSIBL approach. These were analyzed for common themes in their perceived possibilities of SSIBL as well as their expected struggles with the approach. The 19 lesson designs were analyzed based on the occurrence of the ASK, FIND OUT and ACT instructional phases, and how the PSTs addressed these phases in their teaching and learning activities.

3.1.1. Findings

Overall, the teacher training sessions supported the PSTs in designing SSIBL-based lessons, although certain aspects seem underexposed. The analysis of the 19 lesson designs showed that the ASK phase was mainly initiated by media of some form to raise students' questions, including watching video footage (four designs), reading articles about the SSI (four designs) and dialogue about statements regarding specific SSIs (two designs). In the FIND OUT phase, inquiry was more readily applied on social aspects (10 designs, e.g., mapping stakeholders' positions, interviewing parents), and scientific aspects (nine designs, e.g., literature research or other types of sources-based research), with personal inquiry being the least common (five designs, e.g., students articulating their personal values and beliefs in a dialogue). Common interpretations of the ACT phase included constructing a poster (five designs), writing an article or essay (five designs), forming an opinion on a dilemma (three designs) and giving advice, by means of letters to stakeholders (two designs). Four designs lacked a clear ACT phase, and half of the designs were explicitly linked to the national curriculum.

To illustrate what these lesson plans look like, we will discuss one design in more detail. In this design, consisting of four lessons, the PST selected an environmental issue from the students' community (local issue). This issue involved a chemical company that dumped their waste into a local river, thereby introducing the potential carcinogen C8 into the environment. In doing so, the company stayed within boundaries set by the government, yet inhabitants of the area did not trust the guidelines. They feared the potential carcinogen was responsible for the inexplicable illnesses from which some of the factory workers suffered.

The main goal of the PST's design was to foster students' informed opinion-forming about this issue. The first lesson focused on the ASK phase. Students watched a documentary about the C8 issue, while individually answering opinion-forming questions, such as 'Do you think the boundaries set by the government are fair?' and 'Do you think residents have a reason to worry?'. Afterwards, students discussed their views in small groups. They had to list stakeholders of the issue as homework. The second lesson made them discuss the views of these stakeholders and consider with which stakeholders they identified most strongly by physically positioning themselves on a line in the classroom. Their position on the line represented with which stakeholder they identified most (controversy line activity). With this activity, content-related and normative student questions were raised. As a next step in the design, the PST raised the question 'What do we need to know before we can form a well-informed opinion about this issue?'.

The FIND OUT phase started after the first lesson, with a homework assignment. Students had to seek information on the potential toxicology of C8. To facilitate this, the teacher provided some pointers. In the third lesson, they performed a scientific inquiry by performing a titration experiment on a water sample of the polluted river. Students titrated several samples, each representing different areas of the river, both upstream and downstream of the factory. In this way, they identified the absence or presence of (different) C8 concentrations in the river water.

During the final lesson, the ACT phase started with students discussing the issue based on statements reflecting different sides of the dilemma (e.g., banning C8 from industry, the financial value of human lives, conflict of interest when companies determine the toxicity of their own processes and governments basing policy on scientific research as opposed to the gut feelings of stakeholders). As a homework assignment, students had to write an argument to substantiate their point of view. Finally, students reflected on the lesson series and their own personal growth in understanding the issue by answering a set of reflective questions. The connection of the lesson plan to the seven educational stages through which SSIBL was operationalized is depicted in Table 1.

Table 1. Representation of the seven educational stages in the lesson module on C8 in river water.

SSIBL Phase	Educational Stages	Activity in the Lesson Plan
ASK	(i) Introduction of the dilemma	Documentary on the SSI
	(ii) Initial opinion-forming	Answering questions individually during the documentary, with subsequent discussion
	(iii) Creating a need-to-know	Making students experience the different perspectives of stakeholders, raising normative and content-related questions
FIND OUT	(iv) Inquiry into scientific, social and personal aspects of the dilemma	Listing stakeholders and discussing their views (social inquiry), seeking information on the potential toxicology of C8 and carrying out the titration experiment of river water sample (scientific inquiry), exploring their own position during the controversy line activity (personal inquiry)
	(v) Dialogue	Discussion about the dilemma, based on different statements (personal inquiry)
ACT	(vi) Decision making	Looking back on first opinion and on previous activities by answering reflective questionsWriting an argument to substantiate their point of view
	(vii) Reflection	Reflective questions about students' learning process and progress

3.1.2. Reflective Points

This SSIBL design of four lessons shows the transdisciplinary nature of SSIBL-lessons, which involve scientific, social and personal inquiry. Students view a real life, local issue through the eyes of different stakeholders. They perform different kinds of inquiry, for instance, relating to scientific processes and normative considerations about the issue. The exploration of values, from both the students themselves and the different stakeholders involved in the selected issue, is central to this design. This way, they experience how SSIBL can be used to make sense of actual, real life issues in their own community.

Based on the analysis of 19 of these lesson designs, we found that the SSIBL guidelines were helpful in structuring SSIBL-based lessons, implementing a diverse range of environmental issues that were linked to the regular curriculum. However, most lesson designs included scientific and social inquiry activities, underexposing personal inquiry.

The open-ended questionnaire showed that PSTs felt SSIBL was of added value, e.g., "SSIBL is very appealing to me. It makes students think about social, moral and complex issues to which there is usually no unequivocal answer. It teaches them to look at issues in a more nuanced way' [PST-18]. PSTs indicated that SSIBL could show how science

at school relates to the real world, e.g., 'SSIBL is important because it connects topics with 'the real world'. This answers the 'why should I learn this' question. I like connecting school topics with contexts (teaching doesn't stop outside the classroom)" [PST-4]. Moreover, they indicated that it makes science more interesting to students and stimulates critical thinking, but they perceived it would take much time to effectively implement it into their teaching, e.g., 'The downside is, it takes time; the curriculum is already overloaded' [PST-9].

The educational sequence used in these teacher training sessions will help science teacher educators and teachers to enact SSIBL, thereby fostering students' opinion-forming and decision-making skills in complex environmental issues.

3.2. SSIBL in Spain

The main aim of the Spanish case is to describe how the SSIBL approach has been introduced in teacher initial education in Spain at both primary and secondary school levels, and to illustrate how it might be used to design classroom activities that empower students to act on contemporary socio-scientific issues as responsible environmental citizens.

The SSIBL approach was first introduced in Spain in 2015 at both primary and secondary school levels. The preliminary work focused on finding connections between SSIBL and the Spanish educational curriculum [37]. Curriculum mapping was considered essential to show teachers how SSIBL might assist students in achieving the intended learning outcomes. Connections between SSIBL and the Spanish curriculum have been identified both in terms of key competences and transdisciplinary learning outcomes such as critical thinking or problem-solving skills, and in relation to content knowledge associated with different school subjects (math, science, citizenship education), as illustrated in the example shown in Table 2.

Table 2. The Spanish case: masks, sustainability issues and COVID-19.

SSIBL Phase	Lesson Element	Specifications
ASK	Overarching question	Which type of masks would you choose to wear and why, to protect yourself and others from COVID-19?
	Guiding questions	What do you need to know about masks and COVID-19 in order to make a good decision? Which different aspects might influence decision making (health and safety, economic, environmental, social, etc.)? How does SARS-CoV-2 infect people? How do masks protect people from infection? Concerning sustainability issues: What is the mask made of? Where do the raw materials come from? How, where and under what conditions are they produced? How long are the transport routes to bring raw materials and final products? How often is the product used and how is it disposed of?
FIND OUT	Social research	Making a survey to know about mask preferences and health and environmental awareness among the local population. Researching about the life cycle of a particular product (different types of masks). Collecting key information from reliable information sources.
	Experimental research	Analysis of masks' permeability to coloured liquids sprayed from various distances. Observations of pathogens' infections depending on distances: The situation might be modelled checking infection over time among pieces of fruits located at different distances from mouldy oranges.

Table 2. *Cont.*

SSIBL Phase	Lesson Element	Specifications
	Content knowledge	Maths: Making estimation and calculations (costs, life cycles, usage, etc.); length units applicable at small scales Biology: Health and virus (size, infection, reproduction cycle, activation, etc.) Physics and chemistry: materials' properties, dissolutions.
	Transdisciplinary	Maths, Biology, Physics and Chemistry Social research and experimental research
ACT	Attitudes and values	Developing a sense of responsibility and care about common health and safety. Awareness of the environmental impact of daily products. Developing criticality towards the reliability of information sources.
	Competences	Designing experiments to test ideas Analysing data from different sources, including media and freely available articles and reports. Identifying different aspects influencing decision making (environmental, economic, socio-cultural, health and safety issues) Making informed decisions based on evidence and social and environmental responsibility.
	Action-taking	Distribution of leaflets to their community with key information for making informed decisions about COVID-19 and masks.

After the curriculum mapping task, a model for SSIBL teacher education was developed through different cycles of implementation, evaluation and improvement. The model was based on the specialized literature about effective teacher professional development [38] and has at its core the three instructional steps of the SSIBL approach: ASK, FIND OUT, ACT. The outer circles in Figure 2 represent the different phases of the Spanish Teacher Professional Development (TPD). The SSIBL model represented by the inner cycle was a referent point in any of the six TPD phases represented by the outer cycles, thus supporting teachers to acquire, experience and implement the SSIBL model: Spanish PSTs were introduced to contemporary issues using news and the media, they were immersed in socio-scientific inquiry about them in order to experience the SSIBL approach as learners, they reflected on the educational potential of the process as future practitioners, were invited to co-design new SSIBL activities and discuss them with other colleagues to build a community of learning and practice [39].
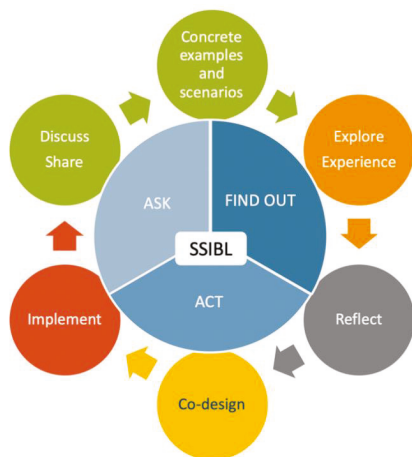

Figure 2. Teacher Professional Development for SSIBL in Spain.

Special attention was paid to the process of co-design. PSTs were provided with explicit criteria to design high quality SSIBL activities, well aligned with the SSIBL framework (Figure 1). Quality criteria referred to making good use of media to bring authenticity into the science classroom through the selection of contemporary socio-scientific issues unravelling the complexity of the issue through controversy mapping [40], identifying links with the Spanish curriculum, defining consistent learning outcomes and assessment processes, formulating questions for learning, scaffolding and encouraging students' inquiry and action-taking. Quality criteria were discussed with PSTs in advance and were later used for self-evaluation and peer evaluation [41,42].

To illustrate how the SSIBL approach might be used to educate scientifically literate students and responsible environmental citizens, we present in more detail an exemplar SSIBL design developed by Spanish secondary school PSTs. The starting activity designed by PSTs provides students with news about COVID-19 and asks them which type of face masks they would choose and why, to protect themselves and others from COVID-19.

To respond to the emergent issue and the initial questions posed, students are asked to inquire about the SARS-CoV-2 virus and how masks protect people from infection. Besides health issues, choosing a particular mask has a wide range of social, economic and environmental implications. To evaluate environmental implications, students should find out, for any type of mask, where the raw materials come from, under what conditions they are produced, how long the transport routes take to bring the raw materials and final products, how often they are used and how they are disposed of.

The SSIBL approach provides opportunities for conducting both social and experimental science research. Inquiry activities resembling social research are (a) making a survey to learn about a local population's mask preferences, as well as a local population's health and environmental awareness; (b) researching about the life cycle of different types of masks; and (c) collecting key information from reliable information sources (those supported by scientific evidence and widely recognized institutions). Inquiry activities resembling experimental research are (d) the analysis of masks' permeability to coloured liquids sprayed from various distances and (e) the observation of how contact and distance influence pathogens' infections, by checking, over time, how pieces of fruit located at different distances from mouldy oranges might become infected. Table 2 includes the key elements of the SSIBL lesson plan about masks for protection against COVID-19.

Reflective Points

In the following, we discuss how the SSIBL lesson design developed in the Spanish context by secondary PSTs is aligned with the epistemology proposed in this article and exhibits the key features of the SSIBL pedagogy, as an interesting approach to education for environmental citizenship.

To address the emergent issue about masks and COVID-19 protection using an SSIBL approach, students should ASK key questions, FIND OUT about them to collect substantial evidence and take consequent ACTIONS based on their findings. The whole process is addressed from a pluralistic perspective aligned with the metatheory of CR and, therefore, students are encouraged to explore the implications of wearing different types of COVID masks from the perspective of individual and public health, the economy and the environment, using a wide variety of sources and methods. Therefore, to make an informed decision, they should combine both social and experimental research and make meaningful use of relevant knowledge from different disciplines while inquiring about virus infection and a material's properties, or while applying mathematics to estimate economic costs and the life cycle of the masks' components. Assessing the life cycle of a particular product is a challenging but inspiring task, where it is necessary to consider a wide range of different aspects, such as where and how the raw materials are obtained, the manufacturing process requirements (water, heating, electricity, ventilation), where they are produced and transported and how long the path is between the origin and the destination of the products. Finally, it is important to consider whether the products can

be reused, for how long or if they can be recycled. The environmental implications of choosing one product over another should be evaluated, not only in terms of resources and energy consumption, but also in terms of the impact of the processes involved (pollution, greenhouses emissions, altering ecosystems, etc.).

Finally, the lesson design encourages students to take informed actions in relation to mask wearing, developing environmental awareness and individual and collective responsibility for both health and sustainability issues, thus exhibiting a values orientation and a commitment to both individual and collective action. Action at the individual level mainly concerns the private sphere where students can make informed choices to reduce the environmental impact of their own actions related to choosing and wearing a particular mask and to exercising their duties and responsibilities as citizens, when creating safe and fair living conditions, protecting themselves and others. The social level is addressed when students engage in collective actions such as distributing information leaflets to disseminate their research results or campaigning to raise public awareness of the different implications of particular behaviours, in this case, taking the social responsibility of wearing a mask for COVID-19 protection and caring about the health, economic and environmental implications of choosing one mask over another.

The above considerations illustrate how the SSIBL approach may be enacted in a particular context (the Spanish context), to empower teachers to develop values-orientated educational interventions, where students can go through both social and experimental inquiry about relevant emergent issues to construct and use transdisciplinary knowledge, while developing a commitment for informed and responsible action.

3.3. SSIBL in England

As part of the PARRISE project, an SSIBL-focused TPD for PSTs was embedded in a secondary science initial teacher education program in the south of England. Across three years, 103 PSTs took part in SSIBL-based activities engaging them in scenarios as learners (e.g., 'Would you vote against drugs testing on animals?'), as designers and teachers (planning and implementing SSIBL-based lessons) and as reflective practitioners (reflecting on using the SSIBL framework, and on their students' learning during that process). A case study of one male PST in his early 20s, Ryan (a pseudonym), who showed a keen interest in the SSIBL approach at the start of the academic year, is presented to illustrate how SSIBL can function as a pedagogical means to environmental citizenship. Data collected from Ryan include his lesson plans, and classroom materials (e.g., PPT presentations and student worksheets) from teaching 12–16 year olds, an SSIBL lesson observation (Energy Sources, Table 3) and a reflective discussion about the lesson observed. This data set is analysed to illustrate the ways in which transdisciplinary inquiry, action and the value and necessity of sustainability were addressed in Ryan's design and implementation of SSIBL lessons.

Table 3. Levels of representation of the ACT phase in each of the three sustainability-focused topics taught by Ryan.

Levels within the ACT Phase	Evidence from Lesson Materials
L1—Raising Awareness of issue: Students create a presentation summarizing their findings	Science in Society—Energy Sources topic Learning Objectives: To collect evidence about a specific case study (of an energy source, e.g., fossil fuels) To create an action plan for this case study To create a presentation outlining what you have found (Source: PPT slides)
L2—Intention to Act: Students make presentations of their findings to other groups and students suggest a course of action they would take personally and justify it	In the second lesson, students will be expected to summarize what action they would take and why (Source: lesson plan) What I think should be done (and why). (Source: student handout)

Table 3. *Cont.*

Levels within the ACT Phase	Evidence from Lesson Materials
L2—Intention to Act: At the end, take a vote in class on what the council should do about the energy plant	[Students] will take a vote as well (Source: student handout)
L2—Intention to Act: Students suggest and justify the course of action they would take personally	Science in Society—Recycling topic Your final task for this lesson is to summarize what you have learned! Before you can leave, you'll need to tell me: - What YOU would do about the plastic bags - Why you would do it (Source: PPT slides) What I think Sustown should do about plastic bags: I think that the best thing for Sustown to do is: … … … … … … … … … … … … … … … . I think this because … … … … … … … … . . . (Source: Student handout)
L2-Intention to Act: Students suggest and justify the course of action they would take personally, with emphasis on social wellbeing	Science in Society—'Digging for Trouble' topic Your task is to research the case study you have been given and decide what needs to be done to fix any problems in the area. Include: - What is being mined and what is it used for? - Who benefits from the mine? - Who is harmed by it? - What would you do to keep everyone happy? Why? (Source: PPT slides)

3.3.1. Findings

Ryan designed and implemented three sustainability-focused SSIBL lesson topics (two lessons per topic), with three different year groups. For each of the three topics, Ryan designed and taught two lessons following a similar approach across topics. The first lesson of each topic focused on Ryan presenting the topic, key questions and socio-scientific context to the students (ASK). The 'Energy Sources' topic was contextualized for the students at a personal and local level, by using the example of an energy power plant in their own town, with implications directly affecting them. The 'Recycling' topic had both a local and global context as it was based on an imaginary scenario of the students and residents of a town working together to decide whether they should ban plastic bags from their shops [43]. The students had to consider what they would do at a personal and local level as residents of this imaginary town ('what would YOU do', Table 3), but they were also dealing with a global issue, as the ways in which plastics are sourced and disposed are both socio-environmental issues. Finally, the socio-scientific context for the 'Digging for Trouble' topic was at a global level based on mining in different countries (e.g., Brazil, China) but also asked the students to consider what they would do on a hypothetical level.

Transdisciplinary knowledge within socio-environmental issues was included in Ryan's lesson designs as illustrated through the keywords chosen, which were used when introducing the socio-scientific context of each lesson. For instance, in the 'Digging for Trouble' lessons, the keywords were 'Environment, Social Issues, Cultural Issues, Finance'. Evidence from the students' presentations during these lessons indicates that the student groups were able to incorporate environmental knowledge (e.g., pollution of the Amazon) as well as other types of knowledge, such as political (e.g., role of governments), social (influence on people) and financial (economic impact on people's livelihoods). In the Energy Sources lessons, the keywords given were 'Environment, Financial issues, Social issues', again emphasizing the environmental dimension of the issue discussed as well as its socio-scientific context, and the presence of controversy, creating the conditions for the emergence of issues that were the starting points for the students' socially responsible transdisciplinary inquiries. The scientific knowledge required was focused on the types of energy sources that exist (e.g., fossil fuels, biomass, solar power), which the students had previously

learned about. The FIND OUT instructional phase was based on structured inquiry [23] requiring the students to work in groups to collect evidence through the sources provided (printed material, online sources), to analyse this evidence and answer the key questions given to them. The Recycling topic similarly required and included a consideration of scientific knowledge ('environmental aspects associated with using polymers', lesson plan) and when considering the benefits and challenges of recycling (e.g., 'melting plastics needs heat. Supplying heat may use up fossil fuels and produce greenhouse gases'; student handout) as well as financial (impact on local shops and shoppers) and social implications.

ACT was framed in Ryan's lessons around informed decision making. During the second lesson of each topic, the students were asked to create a group presentation outlining the results of their investigations, suggest actions they could take to address their findings and justify their decision. Ryan's approach to the ACT instructional phase was analysed using a three-level framework emerging from previous analyses of SSIBL lesson designs [44,45] (Figure 3).

Figure 3. Continuum of levels of representation of the ACT instructional phase in SSIBL based on Amos and Christodoulou [44] (p. 64).

The three levels of ACT are placed on a continuum from raising the students' awareness and knowledge of an SSI (Level 1), to creating the intention to act by providing the students with opportunities to consider what actions they would take at a hypothetical level (Level two) and modelling those in class (e.g., taking a vote on an issue), and finally, enabling and supporting the students both to consider actions they would take and most importantly, enact change as a result of their learning (Level three). Table 3 summarizes the three levels of representation of the ACT phase in Ryan's lessons.

The approach to informed decision making and taking action that Ryan used when enacting SSIBL was represented at the level of 'intended action' in all three topics. Ryan was able to move beyond simply raising awareness of these socio-environmental issues but at the same time, he did not explicitly enact action within his planning and teaching. For instance, in the Energy Sources topic, Ryan initially asked the students to summarize their findings in the form of a short presentation; he then focused on the students' intention to act by asking them to consider what they would do and why, before also allowing the students to participate in voting for which energy sources they thought should be used by their local council. Level three of the action continuum could be represented by the students writing to their local council to share the results of this voting and to make their views heard.

3.3.2. Reflective Points

Ryan's SSIBL lesson designs and implementations were consistent with SSIBL's focus on socially responsible transdisciplinary inquiries, whereby the students were asked to investigate a question to enact change [18,19,21,22]. The sustainability-focused lessons analyzed illustrate how the various levels of civic engagement for environmental citizenship (local, global scales) [5] can be addressed in different ways within and beyond classroom settings. Education for environmental citizenship using the SSIBL framework can challenge the distinction that is often made between these levels, as such issues can emerge as objects of investigation at multiple levels and scales. For instance, contextualizing and presenting to the students the Recycling lessons at both public (local, global) and personal levels made the dimension of personal action more evident in the students' learning, and at the same time allowed them to consider this socio-environmental issue in relation to society at

large; this approach to contextualizing socio-environmental issues provides affordances for developing the students' environmental citizenship.

Further, Ryan's SSIBL lessons illustrate how citizenship and action-taking can be conceptualized in educational settings through a focus on decision making. Ryan's inclusion of the opportunity to vote at the end of the lesson on what action to take about the socio-environmental issue in hand, offered the students opportunities to engage in learning that had elements of democratic participation (i.e., taking a vote on an issue). This, in turn, created affordances for the students to engage in environmental citizenship learning as part of their science lessons, and made the presence of citizenship dimensions stronger (e.g., person action, taking a vote) in the students' learning. At the same time, the third level of ACT was not present in Ryan's lessons, indicating that enacting action within classroom settings can be a challenging area, which requires continuous engagement and explicit consideration by teachers as they learn to enact SSIBL.

3.4. SSIBL in Cyprus

In Cyprus, several co-design groups were created, each consisting of in-service science teachers and a university researcher who facilitated each co-design group. Over the course of the two iterations of the TPD, 67 Biology, Chemistry and Elementary School science teachers collaborated in 12 co-design teams, to produce SSIBL curricula that adopted the ASK, FIND OUT, ACT approach, and were built around (a) socio-scientific controversies with local impact, (b) student inquiry and (c) active citizenship decision making.

The TPD's co-design approach situated professional learning in actual practice, established teachers as intellectual partners in design and, thus, augmented the sustainability of an innovation such as the PARRISE SSIBL approach [46]. Each co-design group met both face-to-face and online for a total of 39 (TPD1) and 43.5 contact hours (TPD2). Each group developed and enacted an SSIBL learning module, several of which had a sustainability focus, such as

- Endangered species (lower secondary biology education and elementary science group one);
- Biodiesel or petroleum diesel (lower secondary chemistry education);
- Disinfecting drinking water (upper secondary chemistry education);
- Which shopping bag should you use (elementary science group one).

In this article, we draw from one of the 12 co-design groups; this co-design team included five in-service elementary school science teachers, who taught second, third and fourth grade at four different schools. The teachers, with the support of a university researcher, met regularly and co-designed an SSIBL module that was subsequently implemented with 73 students. The SSIBL module was designed for five 80-minute lessons, and the activities centered around the ASK, FIND OUT, ACT dimensions. The driving question for the students was formulated as "Plastic, biodegradable, or fabric bags? Which one would you choose to carry your groceries?" This was an authentic question at the time of the co-design, as the law banning the use of free plastic bags was not instituted in Cyprus until two years after the conclusion of the co-design unit.

In the FIND OUT phase, the students engaged in different inquiry activities designed to help them understand which of the different types of materials would be more environmentally sustainable. The jigsaw approach [47] was adopted: jigsaw is a collaborative pedagogical approach in which the students work in small expert groups to investigate complementary but different aspects of a problem. In our case, each expert group took on the role of a stakeholder group. Following their investigation, the expert groups break up and form synthesis groups, each one comprised of one representative from each expert group. The synthesis groups discuss and, through dialogue and evidence from the sources they studied, reach a decision on the driving question, which they then propose to the plenary. Through these activities, the students were expected to understand that terminating the use of plastic bags does not automatically lead to resolving the impact on

the environment, as it increases the use of other raw materials, something that may also impact the environment.

After their work in the expert and synthesis groups, the students participated in plenary discussions that connected the classroom activity with their local context. The students decided to take action; the following are some of the actions realized by the 73 students with the support of their teachers:

- Creation of a survey on the use of plastic bags, which was administered to peers, teachers and parents and was used during the students' decision making;
- Creating informational leaflets and sharing them with their peers, their parents and from door to door in their neighborhood;
- Creating fabric bags from reusable materials and explaining their advantages;
- Participating in a TV show;
- Participating in awareness campaigns, including video conferences, with students in other schools;
- Proposing mitigation measures to the Mayor, the Environment Commissioner, the Minister of Education and Culture and to Parliament.

Table 4 illustrates the key points of the SSIBL module.

Table 4. The SSIBL dimensions of the elementary science co-design on which bag one should choose to carry groceries.

SSIBL Phase	Main Activities
ASK	The learning activity begins with the following event, presented to the students via an animation their teachers prepared: A family is at a supermarket cashier, who presents them with the following three alternatives to carry their groceries: Plastic, biodegradable, or fabric bags? The students' mission is to find out which is the most environmentally sustainable and appropriate choice to carry their groceries.
FIND OUT	The students work in groups following the collaborative inquiry—jigsaw puzzle approach. Each group adopts the perspective of one of the following main stakeholder groups: plastic bag factory owners, consumers and environmental organizations. The students interpret various information sources, collected by their teachers and themselves (i.e., from comics, videos, articles, interviews, posters), which represent the differing viewpoints of the main stakeholders to prepare an evidence-based answer to the driving question.
ACT	Following the work of the expert and synthesis groups (of the jigsaw puzzle approach), the students collectively decided to take several actions to raise their community's awareness about the use of plastic bags and the informed decision to use alternative solutions.

Data from classroom implementations were collected in the form of videotaped lessons, students' constructed artifacts, researcher field notes and teacher reflections and were analyzed qualitatively. After the classroom implementations, the co-design team, consisting of the in-service teachers and the researcher, met to discuss the effectiveness of the SSIBL materials; during these meetings they constructed a SWOT (Strength–Weaknesses–Opportunities–Threats) analysis of the learning module and then proceeded with suggestions for the refinement of the activities in the learning module, based on the teachers' reflections.

3.4.1. Findings

A main question of interest is whether the implementation of the SSIBL approach fostered students' environmental citizenship. Even though the implementation presented challenges, especially due to the teachers' own lack of familiarity with methods such as the jigsaw approach [47], but also due to students needing time to understand how to engage in this new approach, the teachers documented benefits from the implementation

of the SSIBL unit, such as an increase in students' participation and active engagement with the learning activities, increased competencies for communication, collaboration and argumentation, self-confidence, scientific, environmental and social literacy, and improved learning outcomes. When the co-design teachers were asked by an independent evaluator to compare the learning that occurred during the SSIBL unit implementation, as compared with other non-SSIBL implementations, they overwhelmingly reported positive outcomes as well. The following excerpt represents the teachers' impressions of how their students approached SSIBL and what they had learned:

> " . . . the only thing I can say is that many times we can ask our students something and they do not remember anything or remember very fragmented information. In contrast, through this program the children learned a lot of things, and they kept them in their memory, because they learned them on their own, we did not teach them. They found out on their own, they discussed them on their own, they supported them on their own, they communicated them to others on their own, so when this knowledge became their experience, they learned it better . . . this is definitely something they will not forget, as we see unfortunately happening with the lessons we do in our other subjects."

Teacher, 4th grade, Elementary Education Co-Design Group 1.

3.4.2. Reflective Points

The SSIBL module on the most environmentally appropriate choice of grocery shopping bags required the students to acquire transdisciplinary knowledge, in that it focused on a social issue that required knowledge about environmental impact and an understanding of the complexity of multiple stakeholders' interests to make an informed decision on which bag is best to use. The students began their quest with an emergent real-life problem they needed to solve; with the support of the jigsaw puzzle pedagogical strategy, they then explored the topic in depth and in breadth, with age-appropriate activities. To be able to decide, the students needed to understand the advantages and disadvantages of each type of bag, based on personal criteria but also based on criteria shared by the stakeholder groups.

The SSIBL materials and learning activities encouraged respectful dialogue and exchange of ideas between students, supported the development of personal and group-based evidence-based answers, promoted argumentation and debate and created an environment for collective citizenship actions. As evidenced from the teacher reports, classroom observations and the analysis of students' actions and artifacts, the SSIBL pedagogical framework had an impact on students' interest, motivation to engage with environmental citizenship ideas; most importantly, it also led to the discussion of actions the students wished to take to inform others in their community of what it means to act responsibly regarding their everyday choice of grocery bags. As their teachers reported, many of the citizenship actions that were undertaken by the students go far beyond what these students would usually propose in non-SSIBL units. These actions imply an understanding that moves beyond the conceptual and the cognitive, extending to the consideration of personal choices and the development of values and attitudes connected to the controversial socio-scientific topic under investigation.

4. Discussion

The SSIBL approach, as underpinned by Critical Realist metatheory, is transdisciplinary in addressing sustainability issues, as has been illustrated in the four cases presented. Starting with PSTs learning to enact SSIBL is promising because they can bring fresh ideas into a school setting, which are restricted by a subject-based curriculum, the importance of examinations and time, and, as the Dutch case demonstrates in particular, these are real constraints for teachers. Nonetheless, these limitations can be overcome by forethought in carefully linking subject concepts to the inquiry so that they aid the solution to problems rather than become learning objectives in themselves. The potential

link of SSIBL activities to different subjects and content knowledge is clearly signaled in the Spanish case (see Table 2). As several of the cases presented show, such an approach has the potential to enhance the learning of subject matter but also fosters motivation to engage in and act upon the ideas. The Spanish case illustrates how a current problem arising in everyday life brings the need for inquiry and empirical evidence to make informed and socially responsible decisions. In the example shown, the transmission of disease and the effectiveness of masks in a pandemic can be gauged by testing the permeability of different types of face masks, inquiring about the life cycle of different products or studying the spread of mold from fruit. Using the SSIBL approach to investigate and act on issues of sustainability can enhance the learning of core concepts. However, importantly, this learning has durability because students realize the value effect of their learning. A transdisciplinary approach towards inquiry, with social justice inquiry at its core, is not, therefore, a diversion but a means of developing and consolidating learning.

Current conceptualizations of EEC and its pedagogical implementation as reported by Hadjichambis and Paraskeva-Hadjichambi [6] focus on using inquiry as one of six stages that teachers and students work through, with the other stages being planning actions; critical and active engagement and civic participation; networking and sharing at the local, national and/or global scale; sustainable environmental and social change; and evaluation and reflection. Any of these stages can be the entry point for initiating learning within this EEC framework [6]. However, the SSIBL approach within a pluralistic teaching tradition starts with emergent events that are problematized as socio-scientific, controversial issues that require solutions; thus, it establishes the need for finding a solution through decision making and action as an inherent dimension of SSIBL, and consequently, as the means toward environmental citizenship. Rather than having a pedagogical approach for EEC that can start from any of the stages mentioned above, the starting point should be identifying events and issues that require a solution and this should be framed within an inquiry-based learning approach, rather than considering an inquiry as one part of the learning process. A core aspect of SSIBL is that it expands the conceptualization of inquiry as a scientific process and considers it as a socially responsible inquiry; that is, an inquiry presupposes skills and attitudes that are a prerequisite to social justice such as personal responsibility, ethical sensitivity and openness and honesty in dialogue. These skills are also core to the promotion of EEC [4], and further support the use of SSIBL as a means toward environmental citizenship, since focusing only on promoting subject knowledge within EEC can be a counter-productive practice in supporting young people develop pro-environmental behaviors [48].

Achieving sustainability and environmental citizenship requires a pedagogy that can transcend the physical and educational structures, and limits, of schooling since individuals should be able, and willing, to act in both the private and public sphere, which require an outward engagement from schools into their communities. At the same time, we need to consider what is achievable within those school boundaries that can establish a basis for considering how actions, values and behavior can be addressed within and outside of school. Using SSIBL as theory based on a CR position and having it as a starting point issues or events to initiate a need for learning, can support students and teachers in problematizing knowledge, addressing these issues and supporting the development of environmental citizenship in young people.

Perhaps, the most difficult aspect of SSIBL is what counts as action. A simplistic view of action can negate learning in favor of the need to change. In the UK case study, the teacher focused on action by focusing on justified decision making; this brings to light the problem that change always involves some kind of trade off and democratic participation is making decisions in full awareness of what is at stake. The UK case also shows how action can be enacted at different levels within classroom settings, which can provide affordances for engaging students with this SSIBL dimension, as also shown by the Cyprus case. At the same time, embedding and enacting taking action within classroom settings can be a challenge for teachers.

A note of caution is how the personal, local, national and global are interlinked; the importance of critical EEC is apprehending the interrelationship between global, national and local aspects of sustainability, a point that needs emphasis in EEC [49]. As encountered in the Dutch study, engagement with the global context of sustainability can overshadow more personal aspects but if the personal and the local or global contexts are presented concurrently through a focus on personal decision making, as enacted in the UK case study, these different dimensions can become part of EEC.

5. Conclusions

We have drawn on postulates of Critical Realism to underpin the epistemology of SSIBL and its appropriateness as a pedagogical tool in promoting sustainability and a means toward environmental citizenship. Its requirements might seem problematic in terms of school curricula but the illustrated cases of SSIBL indicate real opportunities for promoting EEC within traditional school curricula and PSTs prepared to take risks. We recognize that schools are organized into different disciplines of knowledge, and subjects, which are often compartmentalized. Biology and Social Science teachers, for example, have different curricula, different expectations and different aims. Most schools are not organized for an SSIBL-based curriculum as they are often organized for fact-based approaches. Further, EC is not a well-defined concept in the current literature, and teachers are less aware of its multiple dimensions [31]. As research in EEC continues to develop, the role of teachers needs to take a central position within this, in order to address the multidimensional nature of EC within educational practices. To do so, it requires teacher education environments that allow PSTs and novice teachers to engage with the conceptual and pedagogical dimensions argued for here, such as ways in which transdisciplinary knowledge is used to address socio-environmental issues, and the ability and willingness to consider social sciences knowledge and values.

The illustrative cases presented in this article also emphasize the importance of teachers experiencing SSIBL as learners, which is an important aspect of encouraging democratic deliberation and of politically responding to diverse views [50] and should be a key component of teacher professional development for EEC. We have illustrated how SSIBL can be used in a tiered manner as teachers learn to engage with it and use it as part of their practices. As a first step, it might be best to start at a simple level where an activity is highly scaffolded by the teacher and might be carried out in one day or in one lesson. Teachers can provide students with the overarching questions to investigate, as in the four cases presented, rather than expect students to devise their own investigation questions. They can then work with their students to progressively support them in developing skills in asking authentic questions and considering ways of investigating them, taking into account societal, scientific and environmental dimensions and implications of the issues explored. A more sophisticated activity might involve teachers from different disciplines collaboratively working together across the curriculum and designing SSIBL activities so that their students can engage in socially responsible inquiries in an interdisciplinary manner [33,51]. In either case, having as a starting point issues or events to initiate a need for learning, and addressing the three criteria of (a) transdisciplinary knowledge, (b) a values orientation toward both the complexity of, and the necessity for, a sustainable world and (c) a confidence for, and commitment to, socio-political action at individual and collective levels can support students and teachers in problematizing knowledge, addressing socio-environmental issues and supporting the development of environmental citizenship in young people.

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Environmental Citizen Science Initiatives as a Springboard towards the Education for Environmental Citizenship: A Systematic Literature Review of Empirical Research

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Abstract: Environmental Citizen Science (CS) initiatives have been recognized over time as a promising way to engage citizens in the investigation and management of various socio-ecological issues. In this context, it has been often hypothesized that these CS initiatives may also contribute to the education and subsequent transformation of citizens into environmentally aware and active citizens. However, the potential of CS to serve as a springboard for supporting Education for Environmental Citizenship (EEC) has not been explored yet. A systematic review was conducted, seeking to examine how citizens' participation in environmental CS initiatives contributes to the EEC, as a venue through which citizens can undertake actions in different scales (local, national, global) to achieve environmental citizenship. A content analysis procedure was implemented on thirty-one empirical studies ($n = 31$) retrieved from a systematic review of the literature covering the timespan of the last two decades (2000–2020), according to the PRISMA methodology. The findings indicated that the majority of the reviewed environmental CS initiatives primarily enhanced citizens' skills and knowledge over the competences of attitudes, values, and behaviors. In addition, it was found that CS initiatives empowered primarily citizens' personal and responsible environmental actions, which were situated in the private sphere and at the local scale. The derived environmental outcomes were mainly related to the solution and prevention of environmental problems. Finally, correlational statistical analysis indicated that there were strong correlations between the Environmental Citizenship (EC) competences, actions and EEC outcomes and unveiled a set of keystone components; namely, components of crucial significance in the field of EC. We reflect on these findings, and we discuss directions for future research.

Keywords: Education for Environmental Citizenship (EEC); EC actions; EC competences; EEC outcomes; environmental citizen science (CS) initiatives; systematic literature review

1. Introduction

The world is facing an unprecedented global environmental crisis, as environmental problems have been exacerbated in recent decades. Climate change and the consequent degradation of ecosystems, biodiversity loss, as well as the depletion and degradation of natural resources, are among the most prevalent socio-ecological challenges our planet is dealing with [1]. Inevitably, human well-being does not remain unaffected by this drastic pace of change, as nature and humans are closely connected, thus urgent actions are required to be taken. In view of the growing pressure on nature, scientists have often argued towards the involvement of citizens in environmental Citizen Science (CS) initiatives, as a way to contribute to environmental management and ecological conservation.

The term "Citizen Science" was first coined in the mid-1990s by Irwin (1995) [2]. It refers to the involvement of citizens, hereafter citizens, in the scientific process [3,4], with the aim of examining scientific questions and addressing issues of common concern [5]

in the fields of science, policy, and society [6]. Over the past decade, CS has gained prominence as a tool for science and public engagement, and especially in ecological and environmental science [7,8]. CS benefits both science and the environment, as it serves as an effective key tool in environmental research [9,10], and as a key component in monitoring progress towards addressing various socio-ecological issues [8,11]. The development of environmental CS initiatives constitutes a valuable contribution to the scientific realm, as it provides an understanding of ecological processes towards conservation planning and environmental management [7,12]. These could be attributed to the CS affordances on collecting large datasets with environmental data due to the input of citizens; these datasets are then deployed to understand and address various socio-ecological challenges.

Although CS is well documented for its benefits to science and the scientific community [13,14], more broadly, it can also be valuable to society, as it can facilitate knowledge generation, empower individuals and communities, stimulate action-taking, and enhance civic participation in commons and in decision-making processes [8,15]. This process of developing an ever-increasing awareness can be also seen as an effective form of education that supports environmental and social awareness efforts [8]. Put simply, environmental CS initiatives are assumed to have the potential to strengthen social ties with science and nature as well as to raise global environmental awareness based on the notion of environmental rights and responsibilities, by providing a promising venue which can support Education for Environmental Citizenship (EEC) [16]. In this way, environmental CS initiatives may act as a springboard towards EEC which empowers citizens to act as "agents of change", who are actively involved in civic engagement and participation to tackle current and future socio-ecological problems and challenges [17].

However, despite the assumed benefits of participation in environmental CS, it is important to note that not all environmental CS initiatives are intended to promote environmental citizenship, as many of them are deliberately designed to address merely scientific questions [16]. More specifically, environmental CS initiatives often adopt a more science-oriented rather than a citizen-centered approach [18]. Despite the fact, the extent to which CS initiatives achieve to promote environmental citizenship remains unexplored. In this paper, we focus on CS initiatives which have an environmental management and ecological conservation focus, with the ultimate goal to investigate whether and how environmental CS initiatives contribute to Education for Environmental Citizenship (EEC). Put simply, as part this review, we sought to investigate the impact of the reviewed CS initiatives on citizens' environmental citizenship, to define the potential relations of the EC components identified in the CS initiatives as well as to find out the more salient EC components.

2. Theoretical Framework

Environmental Citizenship (EC) is a multifaceted concept, which deals with pro-environmental behavior and citizens' attitudes towards environmental conservation and social change. Tsybulsky (2020) strongly argues that EC is manifested in terms of pro-environmental behavior with a positive change on citizens' attitudes towards the environment [19]. In this line, environmental citizens could be actively involved with the commons while integrating pro-environmental actions to tackle current and emerging socio-ecological problems.

A recent work undertaken by the European Network for Environmental Citizenship (https://enec-cost.eu/, accessed on 30 August 2020) (ENEC 2018) comprehensively conceptualizes EC as follows:

> "Environmental Citizenship is defined as the responsible pro-environmental behavior of citizens who act and participate in society as agents of change in the private and public sphere on a local, national and global scale, through individual and collective actions in the direction of solving contemporary environmental problems, preventing the creation of new environmental problems, achieving sustainability and developing a healthy relationship with nature. 'Environmental Citizenship' includes the practise of environmental rights and duties, as well as

the identification of the underlying structural causes of environmental degrada-
tion and environmental problems and the development of the willingness and
the competences for critical and active engagement and civic participation to
address those structural causes and to act individually and collectively within
democratic means, taking into account inter- and intra-generational justice."

This conceptualization of EC has been widely used in the literature since 2018 [16,18,20,21].

Grounded in this definition, the ultimate goal of Education for Environmental Citi-
zenship (EEC) is to equip citizens with a coherent corpus of competences that will enable
them to act pro-environmentally, as "agents of change", as well as to help them understand
the urgency of current socio-ecological issues and realize the necessity to actively partic-
ipate in the civic and social arena. Towards this direction, Hadjichambis and Paraskeva-
Hadjichambi (2020), in their recent work undertaken within ENEC, proposed the EEC
model that paves the way to promote EC in an integrated educational approach [17]. In
this model, the scholars summarized the structural elements of EEC as follows: (a) the
competences that shape citizen's personal development, (b) the potential actions an en-
vironmental citizen may undertake (in different dimensions, spheres, scales), and (c) the
main intended environmental outcomes that could contribute to environmental and social
change. An overview of the model is illustrated in Figure 1.

Figure 1. The EEC Model [17].

What follows in the next subsections is a brief overview of the structural components
comprising the EEC model.

2.1. The EC Competences

The EC competences (presented within the green cycle of Figure 1) constitute the
adequate body of components that shape citizen's personal environmental citizenship,
including "knowledge", "attitudes", "skills", "values", and "behaviors". Additionally, the
EC competences cumulatively describe the ability of a citizen to act in a responsible way and
actively participate in the civic and social arena based on a comprehensive understanding
of the social, economic, scientific, cultural, and political concepts and structures, thus
becoming an "agent of change".

2.2. The EC Actions

Citizens' potential actions within the context of environmental citizenship are situated
at different dimensions (individual or collective), spheres (private or public), and scales (lo-
cal, national, and global). More specifically, actions situated in the "individual" dimension,
are those referring to personal actions, such as recycling and composting, whereas actions
placed at the "collective" dimension are participatory actions, such as community actions to
tackle pollution or the development of possible restoration actions of an ecosystem. Actions

can also take place at various spheres, thus affecting the relations between individuals and societies (private) or the relations in societies (public). Finally, actions of environmental citizenship can be contextualized at various scales (local, national, global) according to their impact and scalability [17].

2.3. The EEC Outcomes

When citizens are equipped with the EC competences, they are then expected to undertake actions (of different dimensions, spheres, and scales) towards environmental citizenship to achieve specific environmental outcomes, which can promote environmental and social change. According to the EEC model, the main environmental outcomes are the following: (a) solution of current environmental problems, (b) prevention of the creation of new environmental problems, (c) addressing the structural causes of environmental problems, (d) development of a healthy relationship with nature, (e) practice of environmental rights and duties, (f) achievement of critical and active engagement and civic participation, (g) promotion of inter/intra-generational justice, and (h) achievement of sustainability.

3. Rationale

The participation of citizens in environmental CS initiatives is assumed to increase their knowledge on environmental issues and to reinforce their pro-environmental attitudes, which sequentially intensifies their pro-environmental behaviors towards environmental management and ecological conservation [22]. According to a recent study by Jørgensen and Jørgensen (2020), environmentally oriented CS may contribute to EEC, as it provides benefits beyond science and scientific knowledge gain [18]. Although several studies have documented how environmental competences foster pro-environmental behavior [23–25], to the best of our knowledge, there is lack of studies investigating how environmental CS initiatives may contribute to the development of EC competences, actions, and EEC outcomes. In this paper, we have conducted a systematic literature review to shed light on this issue, by exploring empirical research published during the last two decades (2000–2020). Overall, we sought to examine how participation in environmental CS initiatives may serve as a springboard to educate citizens to become environmental citizens, able to act as "agents of change".

4. Research Questions (RQs)

The main objective of our review study was to investigate whether participation in environmental CS initiatives could promote Education for Environmental Citizenship (EEC), as this was presented in Section 2. This objective was formulated in three research questions (RQs), as follows:

- RQ1: Whether participation in environmental CS initiatives contributes to the development of citizens' EC competences, actions, and EEC outcomes;
- RQ2: What are the main correlations among the EC competences, actions, and EEC outcomes in the reviewed environmental CS initiatives?
- RQ3: Which are the more salient components from the EC competences, actions, and EEC outcomes in the reviewed environmental CS initiatives?

5. Methodology

5.1. Data Collection

The studies analyzed in this literature review covered empirical research published in peer-reviewed academic journals, in the English language, during the timespan of the last twenty years, from 2000 to 2020. The retrieval of the reviewed studies followed the PRISMA standards for systematic literature reviews (http://prisma-statement.org/, accessed on 2 September 2020) and was based on a multi-step procedure comprised of three sequential stages, as follows: (a) Identification, (b) Screening, and (c) Eligibility (Figure 2).
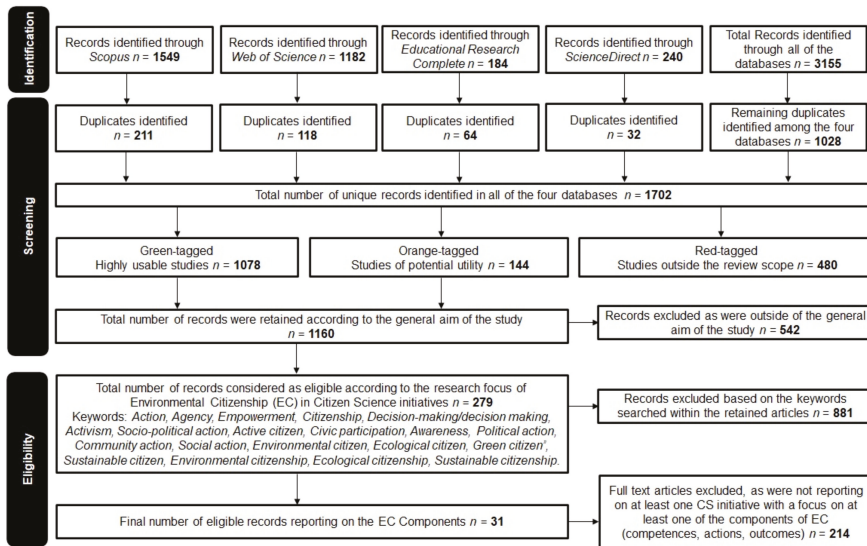
Figure 2. Flow diagram of the systematic literature review selection process.

The identification step included the survey of the published literature using four (4) electronic databases, as follows: Scopus, Web of Science, Education Research Complete (via EBSCO), and ScienceDirect. Within each database, the terms "Citizen science", "Open science", "Public science", "Participatory science", "Civic science", and "Community science", were combined with the terms "Environment", "Nature", and "Ecology", e.g., "Citizen Science" AND "Environment", "Open Science" and "Nature", thus leading to 18 combinations. The retrieved studies have been checked within the title, abstract and keywords, to ensure that they would be mostly restricted in the context of environmental CS initiatives. Therefore, a total number of 3155 studies were obtained as of September 2020.

The screening step over the latter studies included the removal of duplicates within and among the four databases, leading to a total of 1702 peer-reviewed studies. This step also included the color-tagging of the 1702 studies as green, orange, or red, according to their alignment with the research scope of this review study; namely, the study should report on the design, implementation, and/or management of at least one environmental CS initiative. More specifically, the green-tagging was used for highly usable studies, in contrast to the red-tagging which referred to studies outside the scope of this review. Studies of potential utility were marked with the orange-tagging, as it was not straightforwardly obvious whether they were aligned or not with the research scope of this study. In this case, the full text versions of these studies were examined to ensure that they were reporting on the design, implementation, and/or management of an environmental CS initiative. The screening step resulted in 1160 green-tagged publications.

As part of the eligibility step the 1160 retained publications were further evaluated according to their research focus on Environmental Citizenship (EC) and Education for Environmental Citizenship (EEC). In this case, an initial filtering was performed by examining the retained articles' title, abstract, and keywords for any mention of the following terms: "Action", "Agency", "Empowerment", "Citizenship", "Decision-making", "Activism", "Socio-political action", "Active citizen", "Civic participation", "Awareness", "Political action", "Community action", "Social action", "Environmental citizen", "Ecological citizen", "Green citizen", "Sustainable citizen", "Environmental citizenship", "Ecological citizenship", and "Sustainable citizenship".

This iterative search process resulted in 279 peer-reviewed journal articles that were categorized according to their research methods into: (i) empirical papers, reporting on the implementation of at least one environmental CS initiative, (ii) review papers, and (iii) theoretical papers, which were not providing any empirical data. This categorization led to 65 relevant empirical articles which were thoroughly examined according to two main inclusion criteria, as follows: (a) a study should evaluate and report on the impact of the environmental CS initiative on any of the EC competences, actions, or EEC outcomes at the article's results, discussion, and/or conclusions and, in order to do so, (b) a study should adopt various evaluations techniques (e.g., interviews, surveys and questionnaires, etc.). The implementation of this criteria ultimately resulted to 31 empirical studies, which composed our data corpus and were further analyzed for the purposes of this review study. All the reviewed studies are marked with an asterisk at the references.

5.2. Data Analysis

5.2.1. Coding Scheme

For the purposes of our study, we initially developed a comprehensive typology which served as the coding scheme for capturing the main EC components (competences, actions, and outcomes), as these were reported in the reviewed environmental CS initiatives. In order to do so, we adopted a multi-step process (see Figure 3).

Step A
EEC model

The Education for Environmental Citizenship model (EEC model), conceptualized by ENEC, was used as the basis for the creation of our Typology

Step B
Deconstruction of the EEC model

Deconstruction of the EEC model to its constitutional elements of:
- Competences
- Actions
- Environmental Outcomes

Step D
Validation step

A complementary approach to fully cover EC aspects avoiding any overlaps between them

Step C
Literature review on the EEC components

A three-step procedure used to identify the linkage between public participation in CS initiatives and Environmental Citizenship:
1) Review of the literature
2) Categorization based on EEC model components
3) Focus on Competences of the EEC model

Step E
Identified categories for EC competences

EC competences identification was based on the competences of:
1) Knowledge
2) Skills
3) Attitudes
4) Values
5) Behaviors

Step F
Typology on EC

Comprehensive Typology capturing EC in CS initiatives consisting:
1) 3 Parts
2) 7 Categories
3) 48 Sub-Categories

Figure 3. Steps followed for the development of the EEC typology.

More specifically, the EEC model was used as the basis on which our typology was developed (Figure 3, Step A). Further exploitation of the EEC model led to its analysis into its constitutional components of: (a) EC competences, (b) EC actions, and (c) EEC outcomes (Figure 3, Step B). The possible links between EEC and environmental CS initiatives were explored by: (a) reviewing the literature on the components of the EEC model, (b) forming categories that are more closely aligned with the principles of EC, and (c) deepening into the component of EEC competences (Figure 3, Step C). During the development of the typology, a complementary approach (validation step) was adopted, to fully cover all

aspects of the EC competences in a non-overlapping way (Figure 3, Step D). In particular, special emphasis was given on the EC competences representing the competences of knowledge, attitudes, skills, values, and behaviors within the core of Environmental Citizenship expressions, as shown in Table 1 (Figure 3, Step E). Overall, this process led to a typology (Figure 3, Step F) consisting of 7 categories, which are further divided into 48 sub-categories (Table 1), along with their original source.

Table 1. Typology of Environmental Citizenship (EC).

EC Components	Sources
EC Competences: Knowledge (EC-C-K)	
Environmental Systems Knowledge (ESK)	[26]
Action-Related Knowledge (ARK)	[26]
Self-Effectiveness Knowledge (SEK)	[26]
Political Systems Knowledge (PSK)	[27]
Transformative Action Knowledge (TAK)	[27]
EC Competences: Skills (EC-C-S)	
Collaboration and Social Interaction Skills (CSIS)	[17,28]
Critical Thinking Skills (CTS)	[17,28]
Problem-Solving Skills (PSS)	[17,28]
Communication Skills (CS)	[17,28]
Systems Thinking Skills (STS)	[17]
Evidence-Based Thinking Skills (EBTS)	[17]
Decision-Making Skills (DMS)	[17]
Argumentation Skill (AS)	[28]
Constructive Participation Skills (CPS)	[28]
Interacting with Media Skills (IMS)	[28]
Critical Understanding of Media Skills (CUMS)	[28]
EC Competences: Attitudes (EC-C-A)	
Willingness to Act in Society as Agents of Change (WASAC)	[17]
Willingness to Eliminate New Environmental Problems (WENEP)	[17]
Willingness for Collective Environmental Actions (WCEA)	[17]
Willingness for Networking to Solve Environmental Problems (WNSEP)	[17]
Respect for Environmental Rights (RER)	[28]
Willingness for Democratic Decision-Making (WDDM)	[28]
Willingness for Intercultural Communication for the Environment (WICE)	[28]
Willingness to Take Responsibility for the Environment (WTRE)	[28]
Willingness for Environmental and Social Justice (WESJ)	[28]
EC Competences: Values (EC-C-V)	
Biospheric Values (BV)	[29]
EC Components	**Sources**
Altruistic Values (AV)	[29]
Egoistic Values (EV)	[29]
Hedonic Values (HV)	[29]

Table 1. *Cont.*

EC Competences: Behaviors (EC-C-B)	
Activism Behaviors (AB)	[30]
Non-Activist Behaviors (NAB)	[30]
Private Sphere Behaviors (PSB)	[30]
Other Behaviors (OB)	[30]
EC Actions (EC-A)	
Collective Actions (CA)	[17]
Individual Actions (IA)	[17]
Private Sphere Actions (PrSA)	[17]
Public Sphere Actions (PuSA)	[17]
Local Scale Actions (LSA)	[17]
National Scale Actions (NSA)	[17]
Global Scale Actions (GSA)	[17]
EEC Outcomes (EEC-O)	
Development of Healthy Relationship with Nature (HRN)	[17]
Prevention of New Environmental Problems (PNEP)	[17]
Solution of Environmental Problems (SEP)	[17]
Achievement of Sustainability (AS)	[17]
Achievement of Critical and Active Engagement and Civic Participation (CAE)	[17]
Promotion of Inter/Intra-Generational Justice (IGJ)	[17]
Practice of Environmental Rights and Duties (ERD)	[17]
Addressing Structural Causes of Environmental Problems (SCEP)	[17]

5.2.2. Content Analysis

The three (3) EC components (EC competences, EC actions, EEC outcomes) in the reviewed environmental CS initiatives (*n* = 31) were examined with qualitative content analysis coding; namely, each one of the environmental CS initiatives comprised the unit of our analysis. In each one of the reviewed CS initiatives, we were coding the presence/impact (1) or the absence/no impact (0) of the CS initiative on the EC competences, actions, and EEC outcomes according to our coding scheme (see Section 2.1). An indicative excerpt for each one of the coding sub-categories is presented in Supplementary Materials, Table S1. The reviewed articles on content analysis are presented in Supplementary Materials, S2.

Inter-Reliability Process

To ensure that all the coded data had been interpreted correctly, a validation process of three stages was implemented. In the first stage, the third co-author was assigned to peer review the work of the initial coding, by thoroughly reading each coded article, reviewing the metadata in each sub-category, and proposing amendments that better capture the content of the EC. Inter-coder reliability for the coded variables was approximately 85%. The second validation stage was applied in cases where no mutual consensus on coding was observed between the first two co-authors. In this case, the fourth co-author was assigned to peer review the related sub-categories and make suggestions for the final decision. It is noteworthy mentioning that the final coding of the response variables was validated only in the case of mutual consent among the three co-authors. The final stage of the validation process was performed to increase the coding validity, where a fourth peer-review process was elaborated by all co-authors for the complete examination and finalization of the coding scheme.

5.2.3. Descriptive Analysis

Initially, to investigate our first research question (environmental CS initiatives' contribution to the development of citizens scientists' EC competences, actions, and outcomes) we deployed a descriptive analysis to identify the extent to which the constitutional elements of EC (competences, actions, outcomes), were promoted in the reviewed environmental CS initiatives. More specifically, we coded and calculated the frequency of the EC components according to the EC typology, as well as the percentage they covered in the reviewed environmental CS initiatives. For instance, the EC sub-category of Environmental Systems Knowledge (ESK) was found in 19 of the 31 reviewed environmental CS initiatives; therefore, ESK was reported in 61.3% of the reviewed environmental CS initiatives.

5.2.4. Bivariate Correlations

To investigate our second research question (main correlations between the EC competences, actions, and outcomes in the reviewed environmental CS initiatives) we deployed a bivariate correlations analysis using the Statistical Package for the Social Sciences (SPSS V.24.0). More specifically, all computations were performed to identify the possible linkages between EC competences, actions, and outcomes as promoted in the context of the reviewed environmental CS initiatives, using the Spearman's Rank-Order correlation analysis. Spearman's rank correlation was selected as a non-parametric statistical analysis to examine the strength of association between two variables. The significance level was set at $p < 0.05$ to define the minimum acceptable level of significance, while the strength of correlation was based on the range of the r coefficient, with 0.00–0.19 indicating a very weak correlation, 0.20–0.39 a weak correlation, 0.40–0.59 a moderate correlation, 0.60–0.79 a strong correlation, and 0.80–1.0 a very strong correlation [31].

5.2.5. K-Means Cluster Analysis

To investigate our third research question (the most salient components from the EC competences, actions, and outcomes in the reviewed environmental CS initiatives) we focused on the connections between the EC components, as these emerged in the context of the bivariate correlations (see Section 5.2.4). At a first step we calculated the number of connections (moderate and strong correlations) of each EC component with the rest of the other components, and we then created a frequency table indicating how many connections were identified for each of the 48 EC components. At a second step we deployed a K-means cluster analysis to classify the components in two homogenous groups, taking into account the number of their connections with the rest of the EC components [32]. Put simply, K-means cluster analysis uses Euclidean distance to classify data in a number of pre-defined groups through multiple iterations; this process continues until cluster means do not shift more than a given cut-off value or the iteration limit is reached. In this way, we aimed at setting a cut-off point to classify the EC components into: (a) "Keystone Components" (KCs), namely components with the greatest number of connections, and (b) "Peripheral Components" (PCs), namely components with a lower number of connections with the rest of the ECC components.

6. Results

What follows is the presentation of the findings derived from the data analysis. The findings are presented according to the research questions guiding this study.

6.1. RQ1: Whether Participation in Environmental CS Initiatives Contributes to the Development of Citizens' EC Competences, Actions and Outcomes

To address RQ1, as already mentioned, a qualitative content analysis was conducted as an inductive approach to capture the EC competences, actions, and outcomes, which were promoted due to the participation of citizens in environmental CS initiatives. In the following sub-sections, we present the main findings derived regarding the three EC components: (a) competences, (b) actions, and (c) outcomes.

6.1.1. Overview of EC Competences

Our results revealed that environmental CS initiatives provided a fertile context for the EC to take place which, in turn, had a positive impact on the participating citizens' competences. Overall, as presented in Table 2, the reviewed environmental CS initiatives mainly contributed to the enhancement of the citizens' Knowledge (*n* = 25 CS initiatives, 80.5%), and Skills (*n* = 27 CS initiatives, 87.1%), and to a lesser degree to the enhancement of Attitudes (*n* = 19 CS initiatives, 61.3%), Values (*n* = 11 CS initiatives, 35.5%), and Behaviors (*n* = 8 CS initiatives, 25.8%).

Table 2. Absolute number and percentage of CS initiatives reporting on the development of the EC competences.

EC Competences	N	%
Knowledge (EC-C-K)	***n* = 25**	**80.5%**
Environmental Systems Knowledge (ESK)	*n* = 19	61.3%
Action-Related Knowledge (ARK)	*n* = 11	35.5%
Self-Effectiveness Knowledge (SEK)	*n* = 11	35.5%
Political Systems Knowledge (PSK)	*n* = 2	6.5%
Transformative Action Knowledge (TAK)	*n* = 1	3.2%
Skills (EC-C-S)	***n* = 27**	**87.1%**
Collaboration and Social Interaction Skills (CSIS)	*n* = 16	51.6%
Evidence-Based Thinking Skills (EBTS)	*n* = 16	51.6%
Interacting with Media Skills (IMS)	*n* = 13	41.9%
Critical Understanding of Media Skills (CUMS)	*n* = 7	22.6%
Critical Thinking Skills (CTS)	*n* = 7	22.6%
Problem-Solving Skills (PSS)	*n* = 7	22.6%
Communication Skills (CS)	*n* = 6	19.4%
Constructive Participation Skills (CPS)	*n* = 5	16.1%
Systems Thinking Skills (STS)	*n* = 4	12.9%
Decision-Making Skills (DMS)	*n* = 1	3.2%
Argumentation Skill (AS)	*n* = 1	3.2%
Attitudes (EC-C-A)	***n* = 19**	**61.3%**
Willingness for Collective Environmental Actions (WCEA)	*n* = 14	45.2%
Willingness to Act in Society as Agents of Change (WASAC)	*n* = 10	32.3%
Willingness to Eliminate New Environmental Problems (WENEP)	*n* = 8	25.8%
Willingness for Networking to Solve Environmental Problems (WNSEP)	*n* = 4	12.9%
Willingness for Democratic Decision-Making (WDDM)	*n* = 2	6.5%
Willingness for Intercultural Communication for the Environment (WICE)	*n* = 1	3.2%
Willingness for Environmental and Social Justice (WESJ)	*n* = 1	3.2%
Willingness to Take Responsibility for the Environment (WTRE)	*n* = 0	0%
Respect for Environmental Rights (RER)	*n* = 0	0%
Values (EC-C-V)	***n* = 11**	**35.5%**
Biospheric Values (BV)	*n* = 16	51.6%

Table 2. *Cont.*

EC Competences	N	%
Egoistic Values (EV)	*n* = 5	16.1%
Hedonic Values (HV)	*n* = 5	16.1%
Altruistic Values (AV)	*n* = 3	9.7%
Behaviors (EC-C-B)	***n* = 8**	**25.8%**
Private Sphere Behaviors (PSB)	*n* = 6	19.4%
Activism Behaviors (AB)	*n* = 2	6.5%
Non-Activist Behaviors (NAB)	*n* = 1	3.2%
Other Behaviors (OB)	*n* = 1	3.2%

More specifically, according to our findings a main goal of environmental CS initiatives was to equip citizens with the necessary skills and knowledge to be able to collect reliable datasets, thus giving less attention in fostering the pro-environmental values, attitudes, or behaviors of the participating citizens. Put simply, given that the environmental CS initiatives' focus is usually placed on data collection and environmental monitoring processes, in their majority, the reviewed environmental CS initiatives were designed to engage citizens in scientific research, thus promoting the development of substantial skills and knowledge.

EC Competences: Knowledge

As presented in Table 2, we have found that the reviewed environmental CS projects promoted various types of knowledge. More specifically, our findings revealed that the majority of the reviewed CS initiatives reported on the enhancement of Environmental Systems Knowledge (ESK) (*n* = 19 CS initiatives, 61.3%), followed by Self-Effectiveness Knowledge (SEK) (*n* = 11 CS initiatives, 35.5%), and Action-Related Knowledge (ARK) (*n* = 11 CS initiatives, 35.5%). These results show the potential that such initiatives have to enhance citizens' knowledge on how the natural states of ecosystems operate and the interrelated processes within them, the benefit (effectiveness) of environmentally responsible actions, as well as on what actions can be taken in order to address an environmental problem. On the other hand, Political Systems Knowledge (PSK) (*n* = 2 CS initiatives, 6.5%), and Transformative Action Knowledge (TAK) (*n* = 1 CS initiative, 3.2%) were found to be among the less prevalent types of knowledge that are promoted in environmental CS projects.

EC Competences: Skills

As shown in Table 2, the more promoted EC skills referred to Collaboration and Social Interaction Skills (CSIS), namely to the ability of individuals to effectively engage with and co-work with others in common or public interest, in relation to environmental issues (*n* = 16 CS initiatives, 51.6%); to Evidence-Based Thinking Skills (EBTS) (*n* = 16 CS initiatives, 51.6%); as well as to interacting with media skills (IMS) (*n* = 13 CS initiatives, 41.9%). On the other hand, our findings indicated that the reviewed environmental CS initiatives gave less attention to the development of citizens' Problem-Solving Skills (PSS) (*n* = 7 CS initiatives, 22.6%); Critical Understanding of Media Skills (CUMS) in the frame of preventing and solving environmental problems (*n* = 7 CS initiatives, 22.6%); Critical Thinking Skills (*n* = 7 CS initiatives, 22.6%); Communication Skills (CS) (*n* = 6 CS initiatives, 19.4%); Constructive Participation Skills (CPS) in community activities (*n* = 5 CS initiatives, 16.1%); Systems Thinking Skills (STS) (*n* = 4 CS initiatives, 12.9%); Decision-Making Skills (DMS) (*n* = 1 CS initiative, 3.2%); and Argumentation Skills (AS) (*n* = 1 CS initiative, 3.2%).

EC Competences: Attitudes

Considering the development of the EC attitudes, as shown in Table 2, most of the reviewed environmental CS initiatives had an impact on the Willingness for Collective Environmental Actions (WCEA) in addition to individual actions for the protection of the environment (*n* = 14 CS initiatives, 45.2%), Willingness to Act in Society as Agent of Change (WASAC) (*n* = 10 CS initiatives, 32.3%), Willingness to Eliminate New Environmental Problems (WENEP) (*n* = 8 CS initiatives, 25.8%) or willingness for networking to solve environmental problems (WNSEP) at the local, national and global scale (*n* = 4 CS initiatives, 12.9%). These results show that environmental CS initiatives have the potential to promote or reinforce pro-environmental attitudes through strengthening the interrelationships among the social networks, and thus contributing to attitudinal and behavioral change of individuals. Attitudes, such as Willingness for Democratic Decision-Making (WDDM) (*n* = 2 CS initiatives, 6.5%), Willingness for Intercultural Communication for the Environment (WICE) (*n* = 1 CS initiative, 3.2%), as well as Willingness for Environmental and Social Justice (WESJ) (*n* = 1 CS initiative, 3.2%), were also found to be cultivated in participants, though in a very limited degree. Finally, our content analysis showed that the EC attitudes of Respect for Environmental Rights (RER) and Willingness to Take Responsibility for the Environment (WTRE) were not promoted at all in the reviewed CS initiatives.

EC Competences: Values

According to our results, as far as it concerns the EC values (see Table 2), we found that participation in environmental CS initiatives mostly contributed to the development of Biospheric Values (BV) (*n* = 16 CS initiatives, 51.6%). We also identified an equal distribution of CS initiatives reporting on Hedonic Values (HV) and Egoistic Values (EV) (*n* = 5 CS initiatives each, 16.1%). Finally, Altruistic Values (AV) were only promoted in a limited number of CS initiatives (*n* = 3 CS initiatives, 9.7%). Overall, our findings revealed that participation in environmental CS initiatives strongly promotes Biospheric Values (BV), which underly environmental preservation and restoration actions, and favors behavioral changes in the general public.

EC Competences: Behaviors

In line with the previous results, under the EC Behaviors, we have identified that participation in environmental CS initiatives seems to have a positive impact on the behavioral profile of individuals. More specifically, as shown in Table 2, some of the reviewed CS initiatives reported a positive effect regarding the Private Sphere Behaviors (PSB) (*n* = 6 CS initiatives, 19.4%), while a lower number of CS initiatives also reported on the promotion of Activism Behaviors (AB) (*n* = 2 CS initiatives, 6.5%), Non-Activist Behaviors (NAB) (*n* = 1 CS initiative, 3.2%), and Other Behaviors (OB), namely behaviors indicating an indirect influence of individuals to their organizations (*n* = 1 CS initiative, 3.2%).

6.1.2. EC Actions

Our review highlights that the participation in environmental CS initiatives has a positive impact that extends beyond citizens' competences. More specifically, we have found that participation in environmental CS initiatives empowers citizens' EC actions, according to the three axes of the EEC model: (a) Dimensions: Individual/Collective actions; (b) Spheres: Private/Public actions; (c) Scales: Local/National/Global actions (Figure 4).
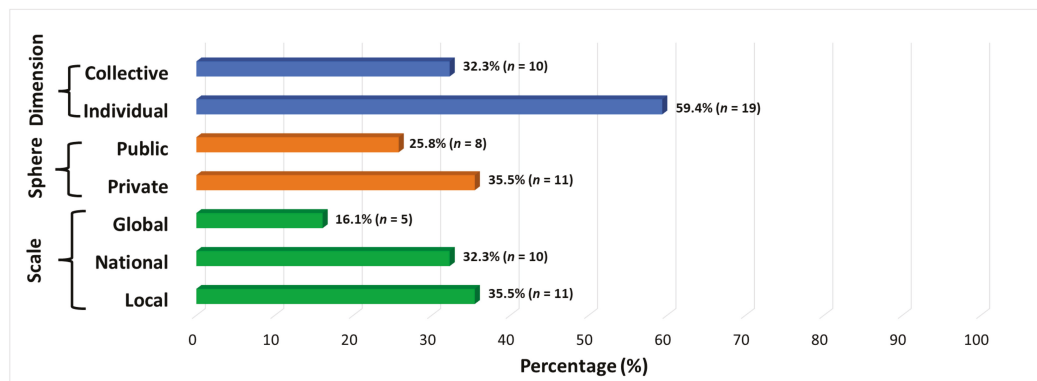
Figure 4. Absolute number and percentage of environmental CS Initiatives reporting on the promotion of EC actions per dimension, sphere, and scale.

More precisely, we have found that the majority of the reviewed environmental CS initiatives were related with the empowerment of citizen's Individual Actions (IA) (*n* = 19 CS initiatives, 59.4%) rather than Collective Actions (CA) (n = 10 CS initiatives, 32.3%), as well as with the empowerment of Private Sphere Actions (PrSA) (*n* = 11 CS initiatives, 35.5%) rather than the Public Sphere Actions (PuSA) (*n* = 8 CS initiatives, 25.8%). We have also found that most of the environmental CS initiatives were related to the empowerment of citizen's Local Scale Actions (LSA) (*n* = 11 CS initiatives, 35.5%) and National Scale Actions (NSA) (*n* = 10 CS initiatives, 32.3%), rather than to the Global Scale Actions (GSA) (*n* = 5 CS initiatives, 16.1%).

6.1.3. EEC Outcomes

An overview of the EEC outcomes, as identified in the reviewed environmental CS initiatives, is presented in Table 3.

Table 3. Absolute number and percentage of environmental CS initiatives reporting on the achievement of EEC Outcomes.

EEC Outcomes	N	%
Development of Healthy Relationship with Nature (HRN)	*n* = 15	48.4%
Prevention of New Environmental Problems (PNEP)	*n* = 14	45.2%
Solution of Environmental Problems (SEP)	*n* = 13	41.9%
Achievement of Sustainability (AS)	*n* = 6	19.4%
Achievement of Critical and Active Engagement and Civic Participation (CAE)	*n* = 1	3.2%
Promote Inter/Intra-Generational Justice (IGJ)	*n* = 1	3.2%
Practice Environmental Rights and Duties (ERD)	*n* = 0	0%
Address Structural Causes of Environmental Problems (SCEP)	*n* = 0	0%

Based on our findings, the most frequently reported EEC outcome (see Table 3) was the Development of Healthy Relationship with Nature (HRN) (*n* = 15 CS initiatives, 48.4%); this one, most of the time, was discussed as a need to connect with nature. The second most reported EEC outcome was the Prevention of New Environmental Problems (PNEP) (*n* = 14 CS initiatives, 45.2%), while the third one was the Solution of Environmental Problems (SEP) (*n* = 13 CS initiatives, 41.9%). More specifically, a variety of environmental CS initiatives seemed to contribute to the ecosystem stewardship by employing appropriate strategies

for better-informed management and control techniques. A lesser emphasis was captured on the promotion of outcomes, such as the Achievement of Sustainability (AS) (*n* = 6 CS initiatives, 19.4%), and only a very small proportion of the reviewed CS initiatives, was found to result in outcomes such as the Achievement of Critical and Active Engagement and Civic Participation (CAE) (*n* = 1 CS initiative, 3.2%) as well as the Promotion of Inter/Intra-Generational Justice (IGJ) (*n* = 1 CS initiative, 3.2%).

6.2. RQ2: What Are the Main Correlations, among the EC Competences, Actions, and EEC Outcomes in the Reviewed Environmental CS Initiatives?

According to our second research question we aimed at exploring and further understanding if and how: (a) the EC competences are inter-related, (b) the EC competences are correlated to EC actions and EEC outcomes, and (c) the EC actions are correlated to the EEC outcomes. In the next sub-sections, we present our findings according to the aforementioned bivariate correlations.

6.2.1. Correlations between the EC Competences

At our first step we aimed to identify and report all possible strong and moderate correlations among the EC competences: knowledge, skills, attitudes, values, and behaviors. An overview of these correlations is presented in Figure 5 and is further discussed in the following sub-sections.
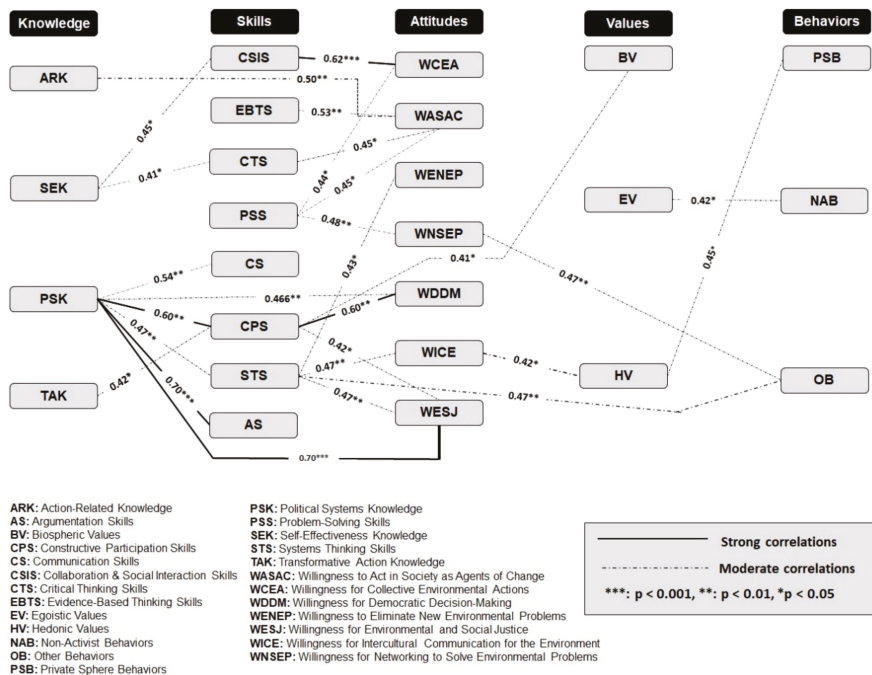
Figure 5. Correlations between the EC competences (knowledge, skills, attitudes, values, behaviors).

Correlations between EC Knowledge and Skills

Statistical analysis led to several moderate and strong positive correlations between EC knowledge and skills. In more details, strong positive correlations were observed between Political Systems Knowledge (PSK) with Argumentation Skills (AS) (r = 0.70, *p* < 0.001) and Constructive Participation Skills (CPS) (r = 0.60, *p* < 0.001). In addition, moderate positive correlations were observed between Political Systems Knowledge (PSK)

with Communication Skills (C) (r = 0.54, *p* < 0.01) as well as with Systems Thinking Skills (STS) (r = 0.47, *p* < 0.01). In addition, moderate positive correlations were also identified between Transformative Action Knowledge (TAK) and Constructive Participation Skills (CPS) (r = 0.42, *p* < 0.05), as well as between Self-Effectiveness Knowledge (SEK) with Collaboration and Social Interaction Skills (CSIS) (r = 0.45, *p* < 0.05), and Self-Effectiveness Knowledge (SEK) with Critical Thinking Skills (CTS) (r = 0.41, *p* < 0.05).

Correlations between EC Knowledge and Attitudes

The examined correlations between EC knowledge and attitudes showed a strong positive correlation between Political Systems Knowledge (PSK) with Willingness for Environmental and Social Justice (WESJ) (r = 0.70, *p* < 0.001). In addition, a moderate positive correlation was found between Action-Related Knowledge (ARK) and Willingness to Act in Society as Agents of Change (WASAC) (r = 0.50, *p* < 0.01), as well as between Political Systems Knowledge (PSK) and Willingness for Democratic Decision-Making (WDDM) (r = 0.47, *p* < 0.01).

Correlations between EC Skills and Attitudes

The examined relations between EC skills and attitudes revealed a strong positive correlation between Collaboration and Social Interaction Skills (CSIS) and the Willingness for Collective Environmental Actions (WCEA) (r = 0.62, *p* < 0.001), as well as between Constructive Participation Skills (CPS) and Willingness for Democratic Decision-Making (WDDM) (r = 0.60, *p* < 0.001). In addition, we found a moderate positive correlation between Problem-Solving Skills (PSS) with: (a) Willingness for Networking to Solve Environmental Problems (WNSEP) (r = 0.48, *p* < 0.01), (b) Willingness to Act in Society as Agents of Change (WASAC) (r = 0.45, *p* < 0.05), and (c) Willingness for Collective Environmental Actions (WCEA) (r = 0.44, *p* < 0.05). Furthermore, we observed a moderate positive correlation between Systems Thinking Skills (STS) and Willingness for Intercultural Communication for the Environment (WICE) (r = 0.47, *p* < 0.01), Willingness for Environmental and Social Justice (WESJ) (r = 0.47, *p* < 0.01) and Willingness to Eliminate New Environmental Problems (WENEP) (r = 0.43, *p* < 0.05), as well as between Evidence-Based Thinking Skills (EBTS) and Willingness to Act in Society as Agents of Change (WAS) (r = 0.53, *p* < 0.01). Finally, Critical Thinking Skills (CTS) were found to be positively and moderately related to the Willingness to Act in Society as Agents of Change (WASAC) (r = 0.45, *p* < 0.05), and lastly, Constructive Participation Skills (CPS) with Willingness for Environmental and Social Justice (WESJ) (r = 0.42, *p* < 0.05).

Correlations between EC Skills and Values

According to the retrieved results on Spearman's correlations, we have identified only one correlation between EC skills and values. In particular, we have found a moderate positive correlation between Constructive Participation Skills (CPS) and Biospheric Values (BV) (r = 0.41, *p* < 0.05).

Correlations between EC Values and Attitudes

According to the retrieved results on Spearman's correlations, we have identified only one correlation between EC values and attitudes. In particular, we have found a moderate positive correlation between Hedonic Values (HV) and Willingness for Intercultural Communication for the Environment (WICE) (r = 0.42, *p* < 0.05).

Interrelations between EC Values and Behaviors

Two moderate positive correlations were identified between EC values and behaviors. More specifically, we have found a positive moderate correlation between Hedonic Values (HV) and Private Sphere Behaviors (PSB) (r = 0.45, *p* < 0.05), as well as between Egoistic Values (EV) and Non-Activist Behaviors (NAB) (r = 0.42, *p* < 0.05).

Correlations between EC Attitudes and Behaviors

According to the retrieved results on Spearman's correlations, we have identified only one correlation between EC attitudes and behaviors. More specifically, a moderate positive correlation was found to link Willingness for Networking to Solve Environmental Problems (WNSEP) and Other Behaviors (OB), indicating the indirect influence of individuals to their organizations and its consequent effects on the environment (r = 0.47, *p* < 0.01).

Correlations between EC Skills and Behaviors

According to the retrieved results on Spearman's correlations, we have identified only one correlation between EC skills and behaviors. In particular, Systems Thinking Skills (STS) were captured to be linked with a moderate positive correlation with Other Behaviors (OB), indicating the indirect influence of individuals to their organizations and its consequent effects on the environment (r = 0.47, *p* < 0.01).

6.2.2. Correlations between the EC Competences and Actions

At our second step we aimed to reveal all possible strong and moderate correlations among the EC competences and the EC actions. An overview of these correlations is presented in Figure 6 and is further discussed in the following sub-sections.

Figure 6. Correlations between the EC competences and actions.

Correlations between EC Knowledge and Actions

Several statistically significant correlations were found between EC knowledge and actions. In particular, Self-Effectiveness Knowledge (SEK) was positively related to Individual Actions (IA) (r = 0.45, *p* < 0.05). Political Systems Knowledge (PSK) as well as Action-Related Knowledge (ARK) were found to be positively related to Public Sphere Actions (PuSA) (r = 0.49, *p* < 0.01, and r = 0.41, *p* < 0.05, respectively). Thus, participation in CS initiatives can help citizens use the knowledge gained from their experiences and apply it to local environmental issues the society is dealing with.

Correlations between EC Skills and Actions

Statistical analysis led to several moderate and strong positive correlations between EC skills and actions. More specific, Collaboration and Social Interaction Skills (CSIS) were found to be strongly related to Local Scale Actions (LSA) (r = 0.72, *p* < 0.001) and moderately

related to Collective Actions (CA) (r = 0.42, *p* < 0.05). In addition, Critical Thinking Skills (CTS) were identified to be associated with Private Sphere Actions (PrSA) (r = 0.41, *p* < 0.05), while Problem-Solving Skills (PSS) with Local Scale Actions (LSA) (r = 0.41, *p* < 0.05). Communication Skills (CS) were found to be positively related to Collective Actions (CA) (r = 0.53, *p* < 0.01), as well as to Local Scale Actions (LSA) (r = 0.49, *p* < 0.01). This could be attributed to the fact that the majority of the retrieved studies reported on CS initiatives which were place-based focused, thus targeting local environmental problems.

Correlations between EC Attitudes and Actions

The examined relations between EC attitudes and actions revealed that Willingness for Collective Environmental Actions (WCEA) was found to be moderately associated to Local Scale Actions (LSA) (r = 0.55, *p* < 0.01). In addition, Willingness to Act in Society as Agents of Change (WASAC0 was found to be positively correlated to Public Sphere Actions (PuSA) (r = 0.45, *p* < 0.01), Collective Actions (CA) (r = 0.40, *p* < 0.05) and Local Scale Actions (LSA) (r = 0.50, *p* < 0.01). Finally, a moderate correlation was also observed between Willingness for Intercultural Communication for the Environment (WICE) and Global Scale Actions (GSA) (r = 0.42, *p* < 0.05).

Correlations between EC Values and Actions

According to the retrieved results on Spearman's correlations, we have identified only one correlation between EC values and actions. More specifically, Hedonic Values (HV) were found to be linked with moderate positive correlation with National Scale Actions (NSA) (r = 0.45, *p* < 0.05).

Correlations between EC Behaviors and Actions

Two moderate positive correlations were identified between EC behaviors and actions. More precisely, Private Sphere Behaviors (PSB) were found to be correlated with National Scale Actions (NAS) (r = 0.54, *p* < 0.01), whereas Other Behaviors (OB), indicating the indirect influence of individuals to the organizations they belong to and the consequent effects on the environment, were found to be linked with a moderate positive relation to Global Scale Actions (GSA) (r = 0.42, *p* < 0.05).

6.2.3. Correlations between the EC Competences and EEC Outcomes

At our third step we aimed to reveal all possible strong and moderate correlations among the EC competences with the EEC outcomes. An overview of these correlations is presented in Figure 7 and further discussed in the following sub-sections.
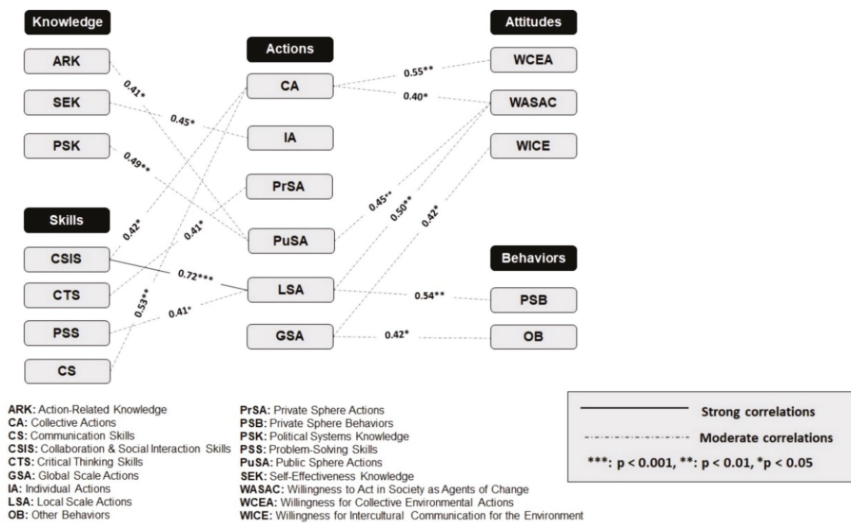
Correlations between EC Knowledge and EEC Outcomes

According to the retrieved results on Spearman's rank correlations, Political Systems Knowledge (PSK) was found to be strongly associated with the Promotion of Inter/Intra-Generational Justice (IGJ) (r = 0.70, *p* < 0.001). Furthermore, Action-Related Knowledge (ARK) was captured to be moderately related with the Prevention of New Environmental Problems (PNEP) (r = 0.41, *p* < 0.05), and the Solution of Environmental Problems (SEP) (r = 0.46, *p* < 0.01).
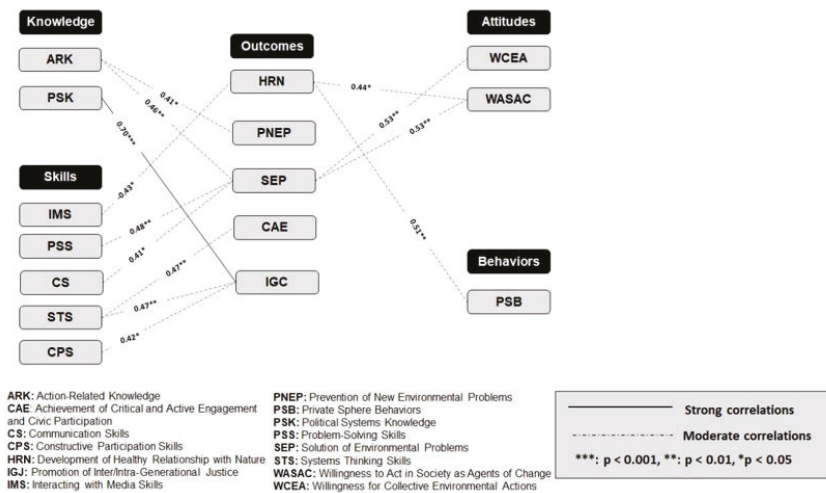
Figure 7. Correlations between the EC competences and EEC outcomes.

Correlations between EC Skills and Outcomes

According to the retrieved results on Spearman's rank correlations, it was found that both Problem-Solving Skills (PSS) and Communication Skills (CS) were positively linked to the Solution of Environmental Problems (SEP) with moderate correlations (r = 0.48, *p* < 0.01 and r = 0.41, *p* < 0.05, respectively). In addition, Systems Thinking Skills (STS) were identified to be moderately related to the Achievement of Critical and Active Engagement and Civic Participation (CAE) (r = 0.47, *p* < 0.01), and the Promotion of Inter/Intra-Generational Justice (IGJ) (r = 0.47, *p* < 0.01); the latter was also found to be associated with Constructive Participation Skills (CPS) (r = 0.42, *p* < 0.05). Worth noting is also the negative correlation observed between Interacting with Media Skills (IMS) and the Development of Healthy Relationship with Nature (HRN) (r = −0.43, *p* < 0.05). This finding though is not surprising given that use of media and digital interfaces is often accused of disconnecting people from nature.

Correlations between EC Attitudes and EEC Outcomes

Statistically significant moderate correlations were identified between the Willingness to Act in Society as Agents of Change (WASAC) with the Solution of Environmental Problems (SEP) (r = 0.53, *p* < 0.01), as well as with the Development of Healthy Relationship with Nature (HRN) (r = 0.44, *p* < 0.05). Moreover, Willingness for Collective Environmental Actions (WCEA) was shown to be moderately associated to the Solution of Environmental Problems (SEP) (r = 0.53, *p* < 0.01).

Correlations between EC Behaviors and EEC Outcomes

One moderate positive correlation was observed between citizens' EC behaviors and environmental outcomes. In particular, Private Sphere Behaviors (PSB) were found to be positively related with the Development of a Healthy Relationship with Nature (HRN) (r = 0.51, *p* < 0.01).

6.2.4. Interrelations between EC Actions and EEC Outcomes

At our fourth and final step we aimed to reveal all possible strong and moderate correlations among the EC actions and EEC outcomes. An overview of these correlations is presented in Figure 8.
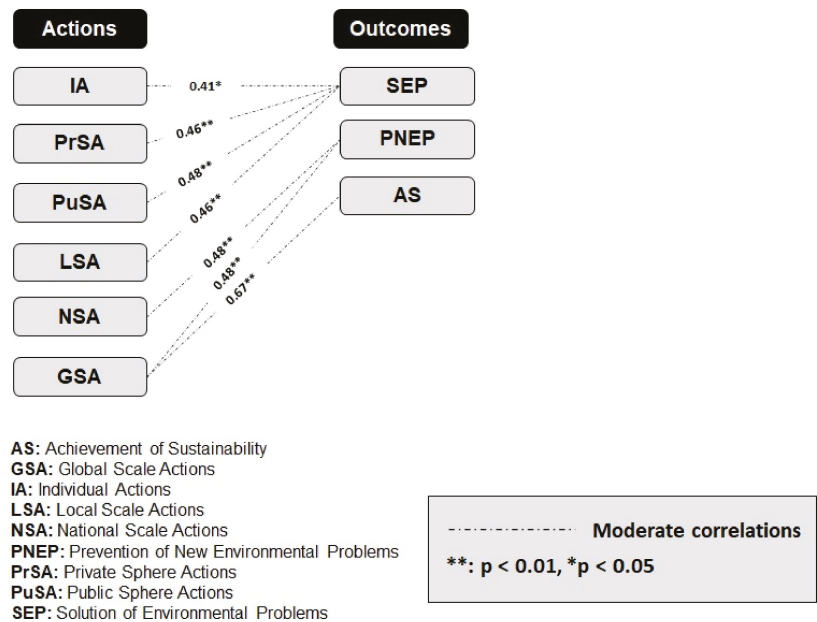
Figure 8. Correlations between the EC actions and EEC outcomes.

According to our findings, the Solution of Environmental Problems (SEP) was found to be moderately related to Individual Actions (IA) (r = 0.41, $p < 0.05$), Private Sphere Actions (PrSA) (r = 0.46, $p < 0.01$), Public Sphere Actions (PuSA) (r = 0.48, $p < 0.01$), as well as to Local Scale Actions (LSA) (r = 0.46, $p < 0.01$). In addition, National Scale Actions (NSA) were found to be positively related to the Prevention of New Environmental Problems (PNEP) (r = 0.48, $p < 0.01$). Finally, Global Scale Actions (GSA) were found to be positively related to the Achievement of Sustainability (AS) (r = 0.67, $p < 0.01$) and, to a lesser extent, to the Prevention of New Environmental Problems (PNEP) (r = 0.48, $p < 0.01$).

6.3. RQ3: Which Are the More Salient Components from the EC Competences, Actions, and EEC Outcomes?

As part of RQ3, we conducted a k-means cluster analysis to identify the most salient components (from the EC competences, EC actions, and EEC outcomes), taking into account their connections to the rest of the components, as these ones emerged in the context of the previously presented bivariate correlations (see Section 6.2). The k-means cluster analysis categorized the EC components in two homogenous groups (clusters): the Keystone Components group (KCs, n = 7 EC components) which indicated a higher number of connections ($\bar{x}$ = 7, SD = 1.73), and the Peripheral Components group (PCs, n = 41 Components), which indicated a lower number of connections ($\bar{x}$ = 1.71, SD = 1.35) with the other EC components. This difference between the number of connections between the two groups was also statistically significant (t (48) = −9.23, $p < 0.001$).

More specifically, as presented in Figure 9, we have identified seven KCs, as follows: Willingness to Act in Society as Agents of Change (WASAC) (n = 9 connections), Solution of Environmental Problems (SEP) (n = 9 connections), Political Systems Knowledge (PSK) (n = 8 connections), System Thinking Skills (STS) (n = 7 connections), Constructive Participation Skills (CPS) (n = 6 connections), Problem-Solving Skills (PSS) (n = 5 connections), and Local Scale Actions (LAS) (n = 5 connections).
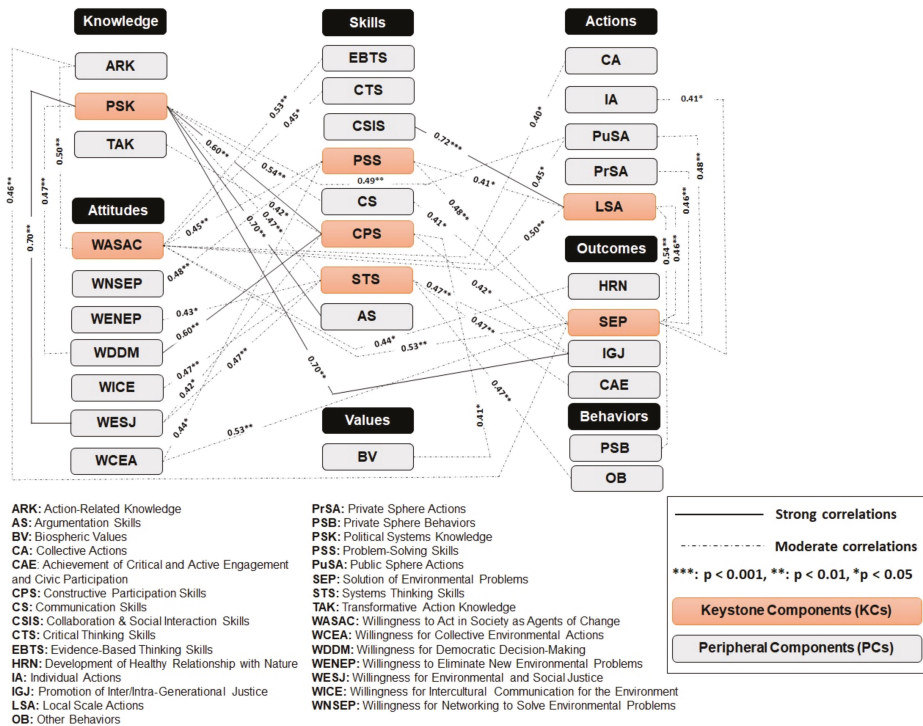
Figure 9. Correlations between the keystone components with the other EC components.

The first keystone component was Willingness to Act in Society as Agents of Change (WASAC), which was positively linked with a moderate correlation to Action-Related Knowledge (ARK) (r = 0.50, $p < 0.01$), Evidence-Based Thinking Skills (EBTS) (r = 0.53, $p < 0.01$), Critical Thinking Skills (CTS) (r = 0.45, $p < 0.05$), Problem-Solving Skills (PSS) (r = 0.50, $p < 0.01$), Collective Actions (CA) (r = 0.40, $p < 0.05$), Public Sphere Actions (PuSA) (r = 0.45, $p < 0.05$), Local Scale Actions (LSA) (r = 0.50, $p < 0.01$), Development of a Healthy Relationship with Nature (HRN) (r = 0.44, $p < 0.05$), and Solution of Environmental Problems (SEP) (r = 0.53, $p < 0.01$).

The second keystone component was the Solution of Environmental Problems (SEP), which was positively linked with a moderate correlation to Action-Related Knowledge (ARK) (r = 0.46, $p < 0.01$), Problem-Solving Skills (PSS) (r = 0.48, $p < 0.01$), Communication Skills (CS) (r = 0.41, $p < 0.05$), Willingness for Collective Environmental Actions (WCEA) (r = 0.53, $p < 0.01$), Willingness to Act in Society as Agents of Change (WASAC) (r = 0.53, $p < 0.01$), Individual Actions (IA) (r = 0.41, $p < 0.05$), Private Sphere Actions (PrSA) (r = 0.46, $p < 0.05$), Public Sphere Actions (PuSA) (r = 0.48, $p < 0.01$), and Local Scale Actions (LSA) (r = 0.46, $p < 0.01$).

The third keystone component was Political Systems Knowledge (PSK), which was positively linked with a moderate correlation to Communication Skills (CS) (r = 054, $p < 0.01$), System Thinking Skills (STS) (r = 0.47, $p < 0.01$), Willingness for Democratic Decision-Making (WDDM) (r = 0.47, $p < 0.01$), and Public Sphere Actions (PuSA) (r = 0.49, $p < 0.01$). In addition, Political Systems Knowledge (PSK) was positively linked with a strong correlation with Constructive Participation Skills (CPS) (r = 0.60, $p < 0.01$), Argumentation Skills (AS) (r = 0.70, $p < 0.01$), Willingness for Environmental and Social Justice (WESJ) (r = 0.70, $p < 0.01$), and the Promotion of Inter/Intra-Generational Justice (IGJ) (r = 0.70, $p < 0.01$).

The fourth keystone component was Systems Thinking Skills (STS), which was positively linked with a moderate correlation to Political Systems Knowledge (PSK) (r = 0.47, *p* < 0.01), Willingness for Environmental and Social Justice (WESJ) (r = 0.47, *p* < 0.01), Willingness for Intercultural Communication for the Environment (WICE) (r = 0.47, *p* < 0.01), Willingness to Eliminate New Environmental Problems (WENEP) (r = 0.43, *p* < 0.05), Other Behaviors (OB) (r = 0.47, *p* < 0.01), Achievement of Critical and Active Engagement and Civic Participation (CAE) (r = 0.47, *p* < 0.01), and Promotion of Inter/Intra-Generational Justice (IGJ) (r = 0.47, *p* < 0.01).

The fifth keystone component was Constructive Participation Skills (CPS), which was positively linked with a moderate correlation to Transformative Action Knowledge (TAK) (r = 0.42, *p* < 0.05), Biospheric Values (BV) (r = 0.41, *p* < 0.05), Willingness for Environmental and Social Justice (WESJ) (r = 0.42, *p* < 0.05), Promotion of Inter/Intra-Generational Justice (IGJ) (r = 0.42, *p* < 0.01), and Willingness for Democratic Decision-Making (WDDM) (r = 0.47, *p* < 0.01). Constructive Participation Skills (CPS), were also positively linked with a strong correlation to Political Systems Knowledge (PSK) (r = 0.60, *p* < 0.01).

The sixth keystone component was the Problem-Solving Skills (PSS) which was positively linked with a moderate correlation to Willingness for Collective Environmental Actions (WCEA) (r = 0.44, *p* < 0.05), Willingness to Act in Society as Agents of Change (WASAC) (r = 0.45, *p* < 0.01), Willingness for Networking to Solve Environmental Problems (WNSEP) (r = 0.48, *p* < 0.01), Local Scale Actions (LSA) (r = 0.41, *p* < 0.05), and Solution of Environmental Problems (SEP) (r = 0.48, *p* < 0.01).

Finally, the last keystone component was the Local Scale Actions (LSA) which was positively linked with a moderate correlation with Problem-Solving Skills (PSS) (r = 0.41, *p* < 0.05), Private Sphere Behaviors (PSB) (r = 0.54, *p* < 0.01), Solution of Environmental Problems (SEP) (r = 0.46, *p* < 0.01), and Willingness to Act in Society as Agents of Change (WASAC) (r = 0.50, *p* < 0.01). In addition, the Local Scale Actions (LSA) component was positively linked with a strong correlation with Collaboration and Social Interaction Skills (CSIS) (r = 0.72, *p* < 0.001).

7. Discussion

7.1. Contribution to Citizens' EC Competences, EC Actions and EEC Outcomes

According to our findings, the reviewed environmental CS initiatives contributed a great extent to the promotion of EC competences; however, we have also found that the reviewed environmental CS initiatives did not have an equal contribution to all the EC competences. We have found, for instance, that citizens' participation in the environmental CS initiatives had a mainly positive impact on their EC knowledge and skills. More specifically, our findings provide empirical substantiation on prior claims regarding CS initiatives' potential to promote scientific and ecological literacy, especially Environmental Systems Knowledge (ESK), which can deepen environmental connectedness [33–37]. Likewise, our findings are in agreement with prior research supporting that environmental CS initiatives contribute to the development of various inquiry-based and scientific skills, e.g., Evidence-Based Thinking Skills (EBTS), Problem-Solving Skills (PSS), Collaboration and Social Interaction Skills (CSIS), and Communication Skills (CS) [38,39]. However, we have also found that the reviewed environmental CS initiatives had a limited impact on other types of knowledge, such as Political Systems Knowledge (PSK) and Transformative Action Knowledge (TAK), as well as on skills such as Decision-Making Skills (DMS) and Argumentation Skills (AS), despite the significance of those in EC.

In addition, we have found that citizens' participation in environmental CS initiatives supported the enhancement of Biospheric Values (BV) to a significant degree. Likewise, our findings indicated that the reviewed CS initiatives had a positive impact on citizens' attitudes related to Willingness to Act in Society as Agents of Change (WASAC), Willingness for Collective Environmental Actions (WCEA), or Willingness to Eliminate New Environmental Problems (WENEP). However, attitudes related to Willingness for Environmental and Social Justice (WESJ), or Respect for Environmental Rights (RER) were addressed

to a very limited degree or were not addressed at all. It should be noted, however, that the absence of these latter attitudes in the reviewed CS initiatives may be crucial for the development of environmentally responsible and active citizens, given that the degree of inclusiveness, the depth of democracy and participation, the issues of equality as well as the issues of intra- and inter-generational justice are of particular importance for the promotion of environmental citizenship, and for this reason are also situated into the core of EEC [17].

At the same time, it should be mentioned that, aligned with the prior research, our study confirms that the contribution of environmental CS initiatives to the enhancement of values, attitudes and pro-environmental behaviors was much more limited in comparison to their impact on citizens' environmental-related knowledge and skills [40]. Of course, this finding is not surprising, considering that, in most of the cases, citizens' participation in environmental CS initiatives seems to be relatively brief, while in addition to this, citizens' engagement is usually narrowed down to data collection processes [16]. This could provide a plausible explanation for the limited contribution of the reviewed CS initiatives to the enhancement of citizens' attitudes, values, and behaviors, which are deeply rooted in personality and need more time investment and concerted effort to be modified. Despite this fact, early enough, Dobson (2007) has supported that changing attitudes and values are crucial to cultivating environmental citizenship [41], whilst active involvement with environmental projects, such as environmental CS initiatives, should be deployed as an ideal venue to do so.

On a different note, our results have also shown that the EC actions supported by the reviewed environmental CS initiatives were mainly situated in the individual rather than in the collective dimension, as well as in the private rather than the public sphere. At the same time, we have identified that the EC actions, which were included in the reviewed environmental CS initiatives, were mostly situated at the local and national rather than at the global scale. This finding can be attributed to the dominant nature of environmental CS initiatives, given that in most of the cases, CS initiatives aim at establishing a local community connection, adopting a place-based approach, and as such, they prioritize local civic actions [16]. However, the multi-scalar environmental citizenship, as identified in the reviewed CS initiatives, should not be perceived as a drawback given that many environmental problems and their effects exist at global scales that require, at least initially, national or local community responsibility [18,42].

Finally, based on our results it seems that the contribution of environmental CS initiatives to the promotion of EC outcomes was much more limited in comparison to the promotion of EC actions and competences. In addition, we have found that the most reported environmental outcomes were the Solution of Environmental Problems (SEP), the Prevention of New Environmental Problems (PNEP), as well as the Development of a Healthy Relationship with the Nature (HRN). This latter finding is aligned with prior research, which supports how citizens involved in environmental management and conservation, biodiversity monitoring, and other nature-based activities included in environmental CS initiatives, tend to have a higher connectedness to nature than the average citizen [43,44]. However, our analysis has shown that environmental outcomes, such as the Promotion of Inter/Intra-Generational Justice (IGJ) or the Practice of Environmental Rights and Duties (ERD), were totally neglected. This reveals a significant gap, considering that EC involves an internal motivation of justice; what Hayward (2012) calls "embedded ecological justice" [45] (p.104).

7.2. Correlations among the EC Competences, EC Actions, and EEC Outcomes in Environmental CS Initiatives

As part of our review study, we have found a large number of strong and moderate correlations between the EC competences, EC actions, and EEC outcomes, in the context of the reviewed environmental CS initiatives. However, due to space limitations, in this section we will focus on and discuss only the strongest correlations, also taking into account their significance.

To begin with, we have found strong correlations of Political Systems Knowledge (PSK) with Willingness for Environmental and Social Justice (WESJ), as well as with the Promotion of Inter/Intra-Generational Justice (IGJ). Knowledge has often been argued to play a crucial role in influencing pro-environmental behavior [46,47]. Following this reasoning, knowledge has been also assumed to play an essential role in promoting environmental citizenship; however, what remains unclear is what type of knowledge can contribute to the growth of environmental citizenship [48]. Socio-environmental justice as well as inter- and intra-generational justice are considered among the core components of Environmental Citizenship [17]. According to our findings, it seems that Political Systems Knowledge (PSK), as the knowledge about where authority lies, is related to issues of socio-environmental justice. This is not surprising as PSK can equip citizens with the knowledge needed to lobby authorities to achieve tangible environmental results and combat forms of inter- and intra-generational justice regarding current and prospect socio-environmental inequalities.

Secondly, we have found strong correlations of Political Systems Knowledge (PSK) with Argumentation Skills (AS) and Constructive Participation Skills (CPS). In addition, we have found that Constructive Participation Skills (CPS) were strongly correlated with Willingness for Democratic Decision-Making (WDDM). These correlations highlight the "civic" side of environmental citizenship, given that the successful participation of citizens in society as agents of change depends on the development of a person's knowledge and skills for a critical, active, and democratic engagement in preventing and solving environmental problems [49]. Put simply, to resolve environmental problems, citizens need to acquire skills and competencies, such as argumentation and decision-making skills, critical thinking, scientific or evidence-based thinking, and constructive participation skills [50,51]. Besides, the critical praxis of environmental citizenship implies elements of critical pedagogy [52] and "a capacity to critically examine and assess the complexities, patterns and politics that promulgate local and global environmental problems" [17] (p. 246).

Finally, we have found strong correlations of Collaboration and Social Interaction Skills (CSIS) with Willingness for Collective Environmental Actions (WCEA) and Local Scale Actions (LSA). These correlations emphasize the "social" and the "collective" nature of environmental citizenship given that, as posed by Hadjichambis and Reis (2020), environmental citizenship has collective action as an integral component, apart from personal actions in a private and public sphere [53]. Following this reasoning, Hadjichambis and Paraskeva-Hadjichambi have also argued that Education for Environmental Citizenship (EEC) "advocates a need to move beyond a central focus on individual attitudinal and Behavioral changes towards collectively building a better understanding of environmental learning processes aimed at socio-ecological change" [17] (p. 249). While this dimension of environmental citizenship has been often neglected in the context of environmental education, environmental CS initiatives could provide a fertile ground for this dimension to flourish, especially if they include more collaborative activities requiring a collective input from the participating citizens.

7.3. The Most Salient Components from the EC Competences, EC Actions, and EEC Outcomes

As part of this review study, we also aimed at unveiling the most salient components, from the EC competences, EC actions, and EEC outcomes. To do so, we focused on the number of connections between the EC components as these emerged in our bivariate correlation analysis, and we then conducted a k-means cluster analysis. In this way, the EC components were classified in two clusters, as follows: Keystone Components (KCs) with the greatest number of connections, and Peripheral Components (PCs) with a lower number of connections, with the rest of the EC components.

The first KC was Willingness to Act in Society as Agents of Change (WASAC), which was positively linked to nine of the EC components. This finding fits well with the core of EEC which integrates citizens' roles as agents of change, given that its ultimate goal is to transform citizens into catalysts for achieving sustainability in their local environment and beyond [17]. Environmental citizenship lies its ability to provide citizens the opportunity

to participate in effecting positive change within their local communities, thereby allowing citizens to experience a higher "sense of their own agency and collective capacity" [54] (p. 192).

The second KC was Political Systems Knowledge (PSK) which was positively linked to seven of the EC components. This finding is crucial as it highlights the political dimensions of environmental citizenship and their importance. More specifically, as argued by Levinson et al. (2020), within a sustainable society people should be perceived as citizens with a political role, and as such "they need to understand those political structures which can be transformed through actions open to them for living in a sustainable environment" [55] (p. 25). Put simply, according to Hadjichambis and Reis 2020, individual citizens should be equipped with the knowledge needed in order be able to contribute to current environmental crisis through public pressures for political action (e.g., signing petitions, writing to politicians and newspapers) [53].

The third KC was Systems Thinking Skills (STS), which was positively linked to six of the EC components. This finding is not surprising given that in their milestone work on environmental citizenship, Berkowitz et al. (2005) have placed much emphasis on the understanding of key socio-ecological systems using sound ecological thinking, while also realizing the nature of ecological science and the role of humans within ecological systems and their interdependence with other organisms [51]. According to Paraskeva-Hadjichambi et al. (2020), "comprehending interdependence means understanding relationships—a shift in perception from focus on objects to focus on relationships and patterns in these relationships" [17] (p. 216). This type of perception is characteristic of systems thinking and plays a crucial role in achieving sustainability and education for sustainability [56].

The fourth KC was Constructive Participation Skills (CPS), which was positively linked to six of the EC components. Indeed, from a socioecological perspective, Regula Kyburz-Graber (2013) has claimed that educational approaches intended at involving citizens in environmental issues should be, among others, constructive by allowing people to participate in the construction of meaning and solutions [57]. In addition, Jackson et al. (2005) have argued that where values, risks and benefits are discussed between experts and stakeholders (e.g., at early stages of development of an innovative technology), all parties should be able to take part constructively [58]. Likewise, when it comes to environmental citizenship, citizens should be able to participate constructively in the public domain.

The fifth KC was Local Scale Actions (LAS), which was positively linked to five of the EC components. This finding is not surprising given that EC is mainly encouraged in the context of community- and place-based projects [20,59]. Likewise, environmental CS initiatives mainly adopt place-based approaches at a great degree aiming at the solution of local environmental issues [16]. However, CS initiatives should be also expanded in addressing socio-ecological challenges at national and global scales.

Last, the final two KCs were the Problem-Solving Skills (PSS) and Solution of Environmental Problems (SEP), which were positively linked to the rest of the EC components with a total of five and nine connections, respectively. Undoubtedly, for an environmental citizen, being able to address and contribute to the solution of current socio-ecological problems is vital. From an educational perspective, several researchers have argued for the importance of engaging both teachers and their students with a problem-solving process to address and find solutions to authentic environmental problems [60,61]. Put simply, as argued by Parra et al. (2020), Education for Environmental Citizenship "should therefore provide knowledge, skills and competences for real-world problem-solving processes in contexts of polycentric governance reaching from local to larger scale levels" [62] (p. 157).

Overall, the aforementioned KCs had a crucial role in structuring the maps (see Figures 5–8) presenting the main correlations among the EC components, as they were correlated to a significant number of these components (i.e., EC competences, EC actions and EEC outcomes). Just like the keystone species, which contribute to defining an entire ecosystem and without them, the ecosystem would be dramatically different or cease to

exist altogether, the KCs that emerged in this study presented a similar value in structuring and holding together the "EC ecosystem".

8. Conclusions

Despite the prevailing scientific goals of CS to generate quality data [63], there is an increasing interest in understanding the impact of CS initiatives on participants themselves as well as on society [33,64]. Aligned with this direction, the present study has unveiled that environmental CS initiatives can contribute to Education for Environmental Citizenship (EEC), as a venue through which citizens can be active within their communities and beyond to achieve environmental sustainability.

Building on Irwin's call (1995) for linking science, citizens, and sustainability, our synthesis of existing research provided empirical substantiation on how citizens' participation in environmental CS initiatives can generate scientific knowledge about the environment, actively shape their own practices, and produce environmental action. More specifically, we have found that the reviewed CS initiatives have empowered citizens' personal and responsible environmental actions, which were mainly situated in the private sphere and at the local scale.

However, our findings have also indicated that the majority of the reviewed environmental CS initiatives primarily enhanced citizens' skills and knowledge over the competences of attitudes, values, and behaviors, as well as over actions and EEC outcomes. At the same time, our correlation analysis has brought to light a set of keystone components for EC; unfortunately, except for Solution of Environmental Problems (SEP) and Local Scale Actions (LAS), the rest of the keystone components, such as Willingness to Act in Society as Agents of Change (WASAC), Political Systems Knowledge (PSK), System Thinking Skills (STS), Constructive Participation Skills (CPS), and Problem-Solving Skills (PSS), were not supported to a great extent by the current forms of environmental CS initiatives. These findings may guide the future design of environmental CS initiatives, as according to Jørgensen and Jørgensen (2020), involvement in environmental CS activities can cultivate environmental citizenship, if CS initiatives are intentionally designed to do so [18].

9. Limitations

Even though the findings of this review study may help flesh out a more comprehensive picture regarding the relation of environmental CS initiatives with Education for Environmental Citizenship (EEC), this work has also some limitations. To start with, the use of search engines for retrieving scientific articles by filtering the available literature with specific keywords has risks and should be treated carefully to draw valid conclusions [65]. More specifically, our approach resulted in the review of academic articles in the English language within the last two decades (2000–2020), without covering other languages. However, the filtering of studies according to time of publication and English language might lead to chronological and geographic exclusion of other relevant work in the field [66]. At the same time, the fact that our review included only 31 empirical studies could be perceived as another limitation.

10. Future Directions

Despite the aforementioned limitations, in our review study we have proceeded on a thorough statistical analysis of the available empirical data, and our findings can guide future research in the field of environmental CS initiatives in various ways. Profoundly, environmental CS initiatives should integrate the EC competences, EC actions and EEC outcomes of the EEC model at a much greater degree; in this way, the "citizen" dimension in "citizen" science initiatives will be empowered and promoted, as needed. More specifically, future environmental CS initiatives should provide more emphasis on the development of the EC competences and in particular of attitudes, values, and behaviors. For instance, attitudes related to Willingness for Environmental and Social Justice (WESJ) or Respect for Environmental Rights (RER) should be addressed, taking into account that they are of

crucial significance in the context of EC. Secondly, even though the reviewed environmental CS initiatives seem to promote mostly the EC competences of knowledge and skills, we have found that several EC skills and knowledge were neglected. In this context, future environmental CS initiatives should pay more attention to the promotion of other types of knowledge, such as Political Systems Knowledge (PSK) and Transformative Action Knowledge (TAK) as well as on other skills, such as Decision-Making Skills (DMS) and Argumentation Skills (AS). Thirdly, our findings urge the need for expanding the nature and type of CS initiatives to also include EC actions, such as collective and public actions, as these can deepen even more the notion of environmental citizenship. Fourthly, while we have found that the majority of environmental CS initiatives adopted a place-based approach and were narrowed down to the promotion of local scale actions; future CS initiatives should be expanded towards the promotion of EC actions situated at the national and global scales. Finally, according to our findings, when it comes to the EEC outcomes, it seems that future environmental CS initiatives should place more emphasis on inter/intra-generational justice as well as on the empowerment of practicing environmental rights and duties. Overall, as argued by Stuhmcke et al. (2012) environmental CS initiatives should be designed in a way that expands citizens' participation from mere data collection activities in the process of decision-making regarding crucial socio-environmental issues, as well as in the following action-taking oriented towards environmental and social change [67]. When this occurs, then more fertile ground will be available for environmental citizenship to flourish in the context of environmental CS initiatives.

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Article

Evaluating a Novel Learning Intervention Grounded in the Education for Environmental Citizenship Pedagogical Approach: A Case Study from Cyprus

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Abstract: In times of environmental crisis, Education for Environmental Citizenship (EEC) is argued to be of great significance in the development of secondary education students' pro-environmentalism as environmental citizens. However, given that EEC is still emerging, there is a lack of empirical foundation on how environmental citizenship can be approached in a pedagogically sound way; as a result, empirical documented interventions in secondary education are also limited. This paper presents a case study from Cyprus, which evaluates the impact of a novel learning intervention grounded in the EEC pedagogical approach, taking into consideration the potential effect of students' gender as well as of their past/present EC actions. The participants were fifty students ($n = 50$) in secondary biology education who attended the learning intervention; the students comprised 29 girls (58%) and 21 boys (42%), from two intact classrooms. Data were collected with the Environmental Citizenship Questionnaire (ECQ), which was administered before (pre-) and after (post-) the learning intervention, and were analyzed using a combination of non-parametric statistical analyses (Wilcoxon signed-rank test, Mann–Whitney U test, Spearman's Correlation and cluster analysis). Our findings indicated that there was a statistically significant increase in the students' EC learning gains, both EC competences and EC future actions, by the end of the intervention. However, our findings also indicated that the impact of the learning intervention was related significantly to the students' gender as well as to their past/present EC actions, as these were reported by the students prior the intervention. Overall, our findings provide empirical substantiation of the contribution of the EEC pedagogical approach to the development of secondary students' EC. At the same time, our study also pointed out the critical roles of gender and past/present EC actions in students' learning gains.

Keywords: Education for Environmental Citizenship (EEC); EEC pedagogical approach; Environmental Citizenship Questionnaire (ECQ); learning intervention; gender; past/present EC actions

1. Introduction

Environmental citizenship (EC) reframes the relationship between humans and nature. It emphasizes that everyone should make responsible decisions about complex socio-ecological issues and take action, individually as well as collectively, to minimize their ecological impact on the Earth, thus contributing to environmental conservation [1,2]. Environmental citizenship has gained considerable traction in current times, due to the ever-increasing environmental crisis, which requires well-prepared environmental citizens who are able to undertake action to achieve sustainability [3]. Environmental citizenship has, therefore, started to emerge as a crucial construct in education; secondary education students comprise a crucial target group, due to their anticipated role as prospective citizens.

Secondary education in formal and informal contexts plays a crucial role in developing environmentally literate students who are capable of working toward the mitigation and

resolution of current and future environmental problems [3,4]. However, despite the rich theoretical discourse on EC, Education for Environmental Citizenship (EEC) is a relatively novel field of study that has not penetrated the core of our educational systems thus far [3,5,6]. According to van Harskamp et al. [2], the increased focus on EC in the context of environmental policy does not necessarily imply that an increase in EC-related interventions is taking place in classrooms. Likewise, according to Schild [7], limited attention has been devoted to the implementation of EC in the field of environmental education.

This situation can be attributed to various factors. In a recent review effort, Georgiou et al. [8] found, for instance, that teachers manifest a limited and narrow understanding of EC, and, as such, it is challenging for them to integrate the concept into their instruction. This situation deteriorates due to the under-represented role of EC in national curricula, as well as in subject syllabi [2,4]; indeed, previous research has indicated that curriculum is one of the greatest barriers to teaching about sustainability and complex socio-ecological issues [9,10]. Finally, another issue of importance is the lack of educational resources, learning materials and best practices to support the teaching of EC in secondary education [3].

Taking into account the aforementioned challenges, it is not surprising that there is a lack of empirical studies addressing educational interventions for cultivating sustainability and EC in secondary education [11,12]. Pedagogical interventions thus far are limited to the level of tertiary education [6,13–16], investigating the effect of university courses on higher education students' EC. Most of these studies have provided empirical evidence that university students' understanding and conceptualization of EC is quite limited. Similarly, Mohd Meerah et al. [1], who designed a study to investigate how the concept of EC is reflected in primary and secondary school student's knowledge, attitudes, skills, lifestyles and daily activities, found that the students' EC was low to moderate. In addition, they also identified that there was much room for students' knowledge, skills and attitudes to improve in order to achieve the desired EC level.

This paper presents a case study from Cyprus that evaluates a novel learning intervention grounded in the EEC pedagogical approach and seeks to promote 10th graders' EC, while taking into consideration the potential effect of students' gender and their past/present EC actions. In fact, to our knowledge, this study is the first attempt to implement and evaluate a learning intervention underpinned by the EEC pedagogical approach, as this was proposed by Hadjichambis and Hadjichambi [3]. To accomplish this, we used the recently validated Environmental Citizenship Questionnaire (ECQ) of Hadjichambis and Hadjichambi [17] as a holistic EC measurement in the context of secondary education.

2. Theoretical Background

2.1. Defining the Education of Environmental Citizenship

Environmental citizenship (EC) has gained significant ground over the last decade, with the researchers expressing various views about how EC should be defined and what it truly entails [18,19]. According to Dobson [20], an environmental citizen is tasked "to live sustainably so that others may live well" (p. 282). He also supports the idea that EC is both intra- and inter-generational because the actions undertaken here and now may also have an impact somewhere else and in the future; therefore, environmental citizens are aware that their own decisions and actions will also have public implications. EC entails aspects of all three citizens' profiles, which according to Westheimer and Kahne [21] are summarized as follows: (i) the profile of the personally responsible citizen who is characterized by responsibility, compliance with the law and honesty; (ii) the profile of the participatory citizen who is actively involved in existing systems and undertakes leadership actions; and (iii) the profile of the social-justice oriented citizen who challenges, questions and transforms existing systems.

Considering the numerous environmental issues that the world is battling today, such as water contamination, air pollution, global warming and decreasing energy supplies [22], it is unsurprising that EC has also penetrated the field of K-12 education as a crucial construct [3,23]. As the argument goes, to tackle existing environmental problems and prevent

new ones, students, as prospective citizens, should be equipped with the competences needed to act as "agents of change" in the private and public spheres, both individually and collectively [3].

The importance of education for EC is acknowledged at the European and international policy-making level. The Council of Europe has developed, for instance, the Reference Framework of Competences for Democratic Culture, in which the importance of knowledge and critical understanding of the environment and sustainability in citizenship education is stressed [24]. Likewise, EC is considered one of the most important goals to be achieved both in the objectives of the EU's economic growth strategy for 2050 and the Sustainable Development Goals for 2030. However, despite this focus on EC in educational policy, EC has been neglected from prior research in the arena of environmental education.

EC has only recently started to gain traction, due to the ever-increasing environmental crisis we are witnessing. During the last two years, researchers have collaborated at the European and international level as part of the European Network for Environmental Citizenship (ENEC) [22], trying to produce a coherent definition for "Education for Environmental Citizenship". The ENEC conceptualization has been widely used in the literature since 2018, due to its holisticness, inclusiveness and comprehensiveness [8,25–29], and it is also adopted in this study. More specifically, according to ENEC:

> *"Education for Environmental Citizenship is defined as the type of education that cultivates a coherent and adequate body of knowledge as well as the necessary skills, values, attitudes and competences that an Environmental Citizen should be equipped with in order to be able to act and participate in society as an agent of change in the private and public sphere on a local, national and global scale, through individual and collective actions in the direction of solving contemporary environmental problems, preventing the creation of new environmental problems, in achieving sustainability as well as developing a healthy relationship with nature. Education for Environmental Citizenship is important to empower citizens to practise their environmental rights and duties, as well as to identify the underlying structural causes of environmental degradation and environmental problems, develop the willingness and the competences for critical and active engagement and civic participation to address those structural causes and act individually and collectively within democratic means, taking into account the inter- and intra-generational justice".*

According to this definition, the main goal of Education for Environmental Citizenship (EEC) is to provide young students with a set of core competences that will allow them to understand the urgency of current socio-ecological issues and act pro-environmentally as "agents of change". Towards this direction, Hadjichambis and Paraskeva-Hadjichambi [3] proposed the EEC model, which paves the way to promote EC in an integrated educational approach. In this model, they summarize the structural elements of EEC as follows: (a) the competences (knowledge, attitudes, skills, values and behaviors) that shape students' personal development and allow them to act in a responsible way and actively participate in the civic and social arena, thus becoming "agents of change"; (b) the potential actions an environmental citizen may undertake in different spheres (private or public), dimensions (individual or collective) and scales (local, national and global); and (c) the main intended environmental outcomes that could contribute to environmental and social transformation. Finally, the main desirable environmental outcomes are related to solving existing environmental problems, preventing new ones, addressing their structural causes, developing a healthy relationship with nature, practicing environmental duties and rights, achieving active and critical engagement/civic participation, promoting inter-/intra-generational justice and achieving sustainability. An overview of the model is illustrated in Figure 1.

Figure 1. The EEC model [3].

Moving a step forward, Hadjichambis and Paraskeva-Hadjichambi [3] have also developed a pedagogical approach for the promotion of EEC, comprising of six stages (Figure 2), as follows: (a) Inquiry; (b) Planning actions; (c) Civic Participation and Critical Active Engagement; (d) Networking and Sharing in Scales, € Sustain Environmental and Social Change and (f) Education and Reflection (Figure 2). These stages are not always meant to be followed in a linear sequence; instead, a starting point can be any one of the six stages, according to the case. In addition, considering the nature of environmental problem, which is investigated, the learning context (e.g., formal or non-formal) and the educational level (e.g., primary or secondary), the necessary changes and can be made.

Overall, EEC, as was defined by ENEC [22], has a lot to contribute to the education of the future environmental citizens. The suggested pedagogical approach of Hadjichambis and Paraskeva-Hadjichambi [3] is an integrated and comprehensive tool that includes a sequence of stages and steps designed to promote EEC.

2.2. The Evaluation of EEC Learning Interventions

Empirical studies for the evaluation of EEC learning interventions in secondary education are lacking in the literature, as are empirically validated tools for the evaluation of secondary education students' environmental citizenship [17]. In fact, prior explorations of EC have been mostly based on the deployment of qualitative approaches [2,13,14,30–32] or partial questionnaire items addressing adults' (i.e., teachers and higher education students) environmental citizenship [33–36].

It is only recently that Hadjichambis and Hadjichambi [17] presented a comprehensive, holistic and validated metric for evaluating the environmental citizenship of secondary education students: the Environmental Citizenship Questionnaire (ECQ). According to Telešiene et al. [6], this questionnaire addresses "competencies associated with EC in the cognitive (knowledge, conceptions and skills) and affective (attitudes, values) dimensions and engagement in actions associated with EC in both private and public spheres currently and with a future-oriented perspective (likeliness of involvement in the future)" (p. 2).

In addition, Telešiene et al. [6] deployed the ECQ questionnaire to evaluate the impact of a university course on higher education students' EC, while also providing empirical support for the reliability and validity of the instrument in measuring higher education students' EC.

Figure 2. The Education for Environmental Citizenship (EEC) pedagogical approach [3].

However, the ECQ has not yet been deployed for its original purpose, namely for the evaluation of secondary education students' EC or the evaluation of EEC learning interventions in the context of secondary education. In addition, in view of the novelty of this questionnaire, little is known about the potential relations underpinning its dimensions. For instance, how might past/current students' EC actions correlate to students' EC competences and EC future actions, and what is their potential effect on the impact of a given EEC learning intervention? Might the ECQ capture any differences in boys' and girls' EC, thereby indicating a potential gender effect on the impact of an EEC learning intervention? These research questions remain to be explored.

3. Research Questions and Hypotheses

The main goal of this case study is to evaluate the impact of a learning intervention on 10th grade biology students (15–16 years old) based on the EEC pedagogical approach, taking into consideration the potential effect of students' gender as well as of their past/present EC actions. More specifically, we put forward three distinct research questions accompanied by three research hypotheses as follows:

Hypothesis (H1). *Is there evidence of students' EC learning gains after the completion of the proposed learning intervention underpinned by the EEC pedagogical approach?*

Our first research hypothesis (H1) was that the learning intervention would have a statistically significant impact on students' learning (i.e., EC competences and EC future actions) when considering the nature, as well as the characteristics, of the EEC pedagogical approach. In particular, the EEC pedagogical approach was designed with the EEC model at its core, and, as such, it is fully aligned with the competences, environmental actions and

outcomes that the EEC model strives to accomplish [3]. To achieve this, the EEC pedagogy approach is a multi-stage approach that expands in time and space, providing students the opportunity to become involved with both individual and collective environmental actions, in the public and private spheres, starting with the local dimension and expanding to the global one. In this context, in contrast to short-term environmental interventions, which are often considered ineffective and lack impact on students' environmental attitudes and behavior [37,38], the EEC pedagogical approach provides the opportunity for long-term educational interventions with the potential to more deeply impact students' EC and pro-environmentalism.

Hypothesis (H2). *Is the impact of the learning intervention affected by students' gender?*

Our second research hypothesis (H2) was that girls would outperform boys by the end of the intervention in terms of their EC learning gains. This hypothesis was motivated by the findings of prior empirical studies in the field of environmental education. More specifically, prior research has shown a gender difference in pro-environmentalism (i.e., positive environmental attitudes, values and/or behaviors) with girls outperforming boys in primary and secondary education [39–42], and, later on in adulthood, with females outperforming males [43–45].

Hypothesis (H3). *How do students' past/present EC actions correlate with and affect the students' learning gains?*

Our third and final research hypothesis (H3) was that students' past/present EC actions would be positively correlated with their EC learning gains by the end of the intervention. This hypothesis was grounded in prior research, which has consistently supported that prior experiences in nature, as well as actions within and for the environment, play a central role in students' connection with nature and the development of their pro-environmentalism [46–48].

4. Methods

4.1. Sample

The sample of the study was a total of fifty (*n* = 50) biology students in 10th grade (15–16 years old), comprised of 29 girls (58%) and 21 boys (42%), derived from two (2) intact classrooms at an urban high school in Cyprus. Aligned with the national educational practices, the students were of mixed academic ability. Each classroom comprised of students with low-average to high-average cognitive abilities, and there were also some highly gifted students. Before the intervention, consent forms were collected from the students' parents to ensure consensus regarding the students' participation in the learning intervention, as well as in the data collection process.

4.2. Learning Intervention

The "Environmental Citizens in Action" learning intervention (based on the EEC pedagogical approach) was implemented as a project and embedded in biology lessons for a duration of four months. The learning intervention started with a local environmental problem. The environmental problem was related to the establishment of a casino resort nearby a protected wetland that supports a lot of endangered species. As part of the learning intervention, the students were given the opportunity to participate in several activities related to the six stages of the EEC pedagogical approach: (a) Inquiry; (b) Planning Actions; (c) Civic Participation and Critical Active Engagement; (d) Networking and Sharing in Scales; (e) Sustain Environmental and Social Change and (f) Education and Reflection (Table 1). In all the stages, the students worked collaboratively in small groups of four or five students, while several of the activities took place in real-world contexts; the EEC

learning intervention, therefore, removed the walls separating schools from science and the society (Figure 3a,b).

(**a**)

(**b**)

Figure 3. Data collection activities in the classroom (**a**) and field-based data collection (**b**).

Overall, the proposed intervention, which evolves according to the six aforementioned stages, is aligned with the position of Iversen and Jonsdottir [11], who suggested that dealing with complex socio-ecological issues "in real-world settings through out-of-school activities set in the students' local district is important for practicing environmental citizenship" (p. 411).

Table 1. Description of the learning activities per EEC pedagogical stage.

EEC Pedagogical Stages	Description of the Learning Activities
	The students
Inquiry	visited the site and participated in field-based data-collection activities.
Planning actions	captured the stakeholders' perspectives in relation to the environmental problem (e.g., developers, environmentalists, students, politicians, the government, the community). mapped the socio-environmental controversy.
Civic participation	weighted the alternatives derived from the previous stage and made an evidence-based decision. participated in campaigns to inform their local community regarding their suggestions.
Networking and Sharing in Scales	developed local networks in which they involved other classmates, teachers, experts on the topic and members of the community to disseminate their work in scales (e.g., via participating in local conferences).
Sustain Environmental and Social Change	sustained the impact of their previous civic actions by leveraging the affordances of social media and participating in a local radio broadcast.
Evaluation and Reflection	collaborated with their teachers, developed various evaluation tools and assessed the success of their approach.

4.3. Instrumentation and Data Collection

The 10th graders' environmental citizenship were investigated with the "Environmental Citizenship Questionnaire" (ECQ), which was developed and validated for secondary school students by Hadjichambis and Paraskeva-Hadjichambi [17]. Initially, the questionnaire captures the students' gender, which served as an independent variable in our study. In addition, the questionnaire includes seventy-six close-ended items, which are evaluated on Likert-type scales from 1—low to 4—high, with the exception of six items that are reversed.

These 76 items are classified in nine variables and three main dimensions (areas) as follows: (a) past/present EC actions; (b) EC competences and (c) future EC actions. More specifically, past/present EC actions were measured only prior the learning intervention and served as the second independent variable in our study. Alternatively, EC competences, and future EC actions were measured both before and after the learning intervention and served as the dependent variables.

Table 2 presents Cronbach's alpha coefficients for each variable and dimension, while also providing an exemplar item for each of them. Cronbach's alpha coefficients indicate whether there is high internal consistency in the items comprising the variables/dimensions in given questionnaire, with the recommendable criterion set from the value of 0.70 and above [49,50]. As can be seen, the overall Cronbach's alpha value for the ECQ is equal to 0.944 while Cronbach's alpha values range from 0.702 to 0.925. These values indicate that there is high internal consistency in the items comprising the variables and dimensions of the ECQ.

4.4. Data Analysis

Initially, we employed the Kolmogorov–Smirnov test for normality to assess the distribution of the data under analysis. Considering that the data collected were not following a normal distribution, as well as the relatively small size of our sample, nonparametric tests were employed to analyze the data, with the significance level set at $p < 0.05$. In addition, we used Hattie's [51] proposed benchmarks for the effect size magnitude as follows: small $d = 0.20$, medium $d = 0.40$, large $d = 0.60$ and above.

Table 2. Dimensions, variables, number of items, exemplar items and Cronbach's alpha values of the ECQ.

Dimensions (Areas)	Variables and Exemplar Items	Number of Items	Cronbach's Alpha	
Past and Present EC Actions	Past and Present EC Actions (e.g., Have you ever been involved in activities of an environmental organization or club group outside school?)	6	0.702	0.702
EC Competences	EC Knowledge (e.g., At school, to what extent have you learned about environmental topics?)	11	0.893	0.925
	EC Conceptions (e.g., In your opinion, how important is participation in activities that benefit the environment for being a good citizen?)	12	0.836	
	EC Skills (e.g., How well do you think you would do, now as a student, in speaking in front of your class about an environmental issue?)	6	0.755	
	EC Attitudes (e.g., To what extent do you agree that everyone should be given the opportunity to acquire the knowledge, values and skills that are necessary to live sustainably?)	8	0.733	
	EC Values (e.g., How important for you personally is it to protect the environment?)	15	0.734	
EC Future Actions	EC Future actions inside school (e.g., If you were given the chance, how likely is it that you would join a group of students campaigning for an environmental issue you agree with?)	4	0.779	0.896
	EC Future actions outside school (e.g., As a citizen would you organise an online group to take a stance on a controversial environmental issue?)	11	0.839	
	Agents of change (e.g., How likely is it that you would actively participate in decision making as well as engage in action taking?)	3	0.747	
Overall EC	Cronbach's Alpha	76	0.944	

4.4.1. RQ1: Impact of the Learning Intervention

To address RQ1, the pre-test and the post-test scores were initially calculated per student and descriptive statistics were employed for their analysis. Then, a Wilcoxon signed-rank test was used to evaluate the impact of the learning intervention on students' EC competences (i.e., knowledge, conceptions, skills, attitudes, values) and EC future actions (i.e., future actions inside school, future actions outside school, agents of change).

4.4.2. RQ2: Gender Effect

To address RQ2, a Wilcoxon signed-rank test was conducted to evaluate potential learning gains from pre- to post-testing, separately for the girls and boys. Subsequently, we calculated the normalized learning gains for all the students (PostTest-PreTest/Max.Score-PreTest). Finally, we conducted a Mann–Whitney U test to investigate statistically significant differences between the boys' and girls' EC learning gains.

4.4.3. RQ3: Past/Present EC Actions

To address RQ3 (the effect of past/present EC actions) a Spearman's rank correlation was initially used to investigate possible significant correlations between students' prior EC experiences and their post-learning intervention EC competences and intentions to undertake future EC actions. The significance level was set at $p < 0.05$, while the strength of the correlations was based on the range of the ρ coefficient with 0.80–1.0 signifying a very strong correlation, 0.60–0.79 signifying a strong correlation, 0.40–0.59 signifying a moderate correlation, 0.20–0.39 signifying a weak correlation and 0.00–0.19 signifying a very weak correlation [52]. In addition, we employed a k-means clustering analysis

as a particular statistical approach for identifying homogeneous groups grounded in the similarities and/or differences of the subjects [53]. The k-means clustering analysis was conducted, setting the students' past/present EC actions as an attribute. The k-means classification analysis resulted in two clusters; the first cluster included students ($n = 16$) who were more engaged with past/present EC actions, thereby named "Highly Active Environmental Citizens" (HAECs), whereas the second cluster included students ($n = 34$) who were less engaged with past/present EC actions, thereby named "Lowly Active Environmental Citizens" (LAECs). Finally, the students' learning gains regarding the EC competences and EC future actions were compared between the two clusters by employing a Mann–Whitney U test.

5. Findings

5.1. Impact of the Learning Intervention

The comparison of students' performance, prior to and after the EEC learning intervention, using the Wilcoxon test statistical analysis, revealed that the students improved their performance from pre-testing to post-testing. As presented at Table 3, the results showed statistically significant improvement in the students' EC competences overall ($z = -6.04$, $p < 0.001$) with a large effect size (d = 0.85), and, more specifically, in the students' knowledge ($z = -6.03$, $p < 0.001$, d = 0.85), conceptions ($z = -4.80$, $p < 0.001$, d = 0.68), skills ($z = -4.71$, $p < 0\ 001$, d = 0.67), attitudes ($z = -3.61$, $p < 0.001$, d = 0.51) and values ($z = -3.34$, $p < 0.01$, d = 0.47).

Table 3. Comparison of pre- and post-test students' EC competences.

	PRE-Test		POST-Test		Z	Effect Size
	Mean	SD	Mean	SD		
ECcompetences	**3.12**	**0.23**	**3.45**	**0.25**	**−6.04 *****	**0.85**
EC knowledge	2.71	0.51	3.46	0.36	−6.03 ***	0.85
EC conceptions	3.18	0.39	3.53	0.33	−4.80 ***	0.68
EC skills	3.15	0.44	3.49	0.43	−4.71 ***	0.67
EC attitudes	3.30	0.22	3.47	0.25	−3.61 ***	0.51
EC values	3.27	0.26	3.38	0.25	−3.34 **	0.47

Note: ** $p < 0.01$. *** $p < 0.001$.

From a deeper look at the results, we have found that, in the pre-test, most of the students were scarcely involved in EC activities undertaken by environmental organizations or groups outside school, and, at school, were not given many opportunities to become familiar with ways of preventing or solving environmental problems, practicing environmental rights and duties or actively participating in society. Furthermore, inside schools, students had only learned to a small extent how to act and create networks at a national (country) level, as well as at a global level. Those parameters were considerably improved in the post-test, as revealed by the statistical analysis. In addition, after their involvement in the learning intervention, students were statistically proven to develop many EC skills, such as discussing a newspaper article about environmental conflicts, arguing about controversial environmental issues and speaking in front of their class about environmental topics.

Likewise, as presented in Table 4, the results showed statistically significant improvement in the students' EC future actions overall ($z = -5.06$, $p < 0.001$) with a large effect size ($r = 0.72$), and, more specifically, in the students' future actions inside school ($z = -3.98$, $p < 0.001$, d = 0.56), future actions outside school ($z = -4.92$, $p < 0.001$, d = 0.70) and as agents of change ($z = -4.00$, $p < 0.001$, d = 0.57). It is worth noticing that, after the learning intervention, the students' intention to act in the future as "agents of change" increased considerably. More specifically, we found a significant improvement in the students' intention to talk to others about environmental issues, to contribute to online discussion forums about environmental issues and in their willingness to take part in peaceful marches.

Table 4. Comparison of pre- and post-test students' EC future actions.

	PRE-Test		POST-Test		Z	Effect Size
	Mean	**SD**	**Mean**	**SD**		
ECfuture actions	**2.97**	**0.42**	**3.28**	**0.50**	**−5.06 *****	**0.72**
Future actions inside school	3.16	0.59	3.47	0.57	−3.98 ***	0.56
Future actions outside school	2.79	0.42	3.11	0.54	−4.92 ***	0.70
Agents of change	3.38	0.49	3.66	0.54	−4.00 ***	0.57

Note: *** $p < 0.001$.

5.2. Gender Effect

The comparison of the girls' performance, before and after the EEC learning intervention, using the Wilcoxon test statistical analysis, indicated that the girls improved their performance from pre-testing to post-testing. As presented in Table 5, the results showed statistically significant improvement in the girls' EC competences overall ($z = −4.67$, $p < 0.001$) with a large effect size ($d = 0.87$), and, more specifically, in the girls' knowledge ($z = −4.63$, $p < 0.001$, $d = 0.86$), conceptions ($z = −3.77$, $p < 0.001$, $d = 0.70$), skills ($z = −3.62$, $p < 0.001$, $d = 0.67$), attitudes ($z = −3.32$, $p < 0.01$, $d = 0.62$) and values ($z = −2.95$, $p < 0.01$, $d = 0.55$). In addition, as presented in Table 5, the results showed statistically significant improvement in the girls' EC future actions overall ($z = −4.51$, $p < 0.001$) with a large effect size ($d = 0.84$), and, more specifically, in the girls' future actions inside school ($z = −3.08$, $p < 0.01$, $d = 0.57$), future actions outside school ($z = −4.55$, $p < 0.001$, $d = 0.84$) and in the girls' as "agents of change" ($z = −3.90$, $p < 0.001$, $d = 0.72$).

Table 5. Comparison of girls' pre- and post-test EC competences and EC future actions.

	PRE-Test		POST-Test		Z	Effect Size
	Mean	**SD**	**Mean**	**SD**		
ECcompetences	**3.23**	**0.16**	**3.56**	**0.17**	**−4.67 *****	**0.87**
EC knowledge	2.90	0.51	3.58	0.33	−4.63 ***	0.86
EC conceptions	3.35	0.34	3.66	0.20	−3.77 ***	0.70
EC skills	3.31	0.43	3.76	0.24	−3.62 ***	0.67
EC attitudes	3.35	0.22	3.54	0.15	−3.32 **	0.62
EC values	3.32	0.15	3.46	0.23	−2.95 **	0.55
ECfuture actions	**3.17**	**0.29**	**3.59**	**0.18**	**−4.51 *****	**0.84**
Future actions inside school	3.46	0.39	3.79	0.27	−3.08 **	0.57
Future actions outside school	2.94	0.34	3.42	0.26	−4.55 ***	0.84
Agents of change	3.62	0.36	3.97	0.10	−3.90 ***	0.72

Note: ** $p < 0.01$. *** $p < 0.001$.

Likewise, the comparison of the boys' performance, before and after the EEC learning intervention, using the Wilcoxon test statistical analysis, indicated that the boys also improved their performance from pre-testing to post-testing. As presented in Table 6, the results showed statistically significant improvement in the boys' EC competences overall ($z = −3.91$, $p < 0.001$) with a large effect size ($d = 0.85$), and, more specifically, in the boys' knowledge ($z = −3.88$, $p < 0.001$, $d = 0.85$), conceptions ($z = −3.11$, $p < 0.01$, $d = 0.68$) and skills ($z = −3.06$, $p < 0.01$, $d = 0.67$). However, no statistically significant differences were found in the boys' attitudes ($z = −1.80$, $p > 0.05$, $d = 0.39$) and values ($z = −1.65$, $p > 0.05$, $d = 0.36$). Alternatively, as presented in Table 6, the results showed statistically significant improvement in the boys' EC future actions overall ($z = −2.16$, $p < 0.05$) with a medium effect size ($d = 0.47$), and, more specifically, in the boys' future actions inside school ($z = −2.43$, $p < 0.05$, $d = 0.53$). However, no statistically significant differences were found in the boys' future actions outside school ($z = −1.48$, $p > 0.05$, $d = 0.32$) or in the boys as "agents of change" ($z = −1.73$, $p > 0.05$, $d = 0.38$).

Table 6. Comparison of boys' pre- and post-test EC competences and EC future actions.

	PRE-Test		POST-Test		Z	Effect Size
	Mean	**SD**	**Mean**	**SD**		
ECcompetences	**2.69**	**0.21**	**3.28**	**0.25**	**−3.91 *****	**0.85**
EC knowledge	2.45	0.39	3.28	0.34	−3.88 ***	0.85
EC conceptions	2.94	0.33	3.36	0.39	−3.11 **	0.68
EC skills	2.91	0.35	3.12	0.35	−3.06 **	0.67
EC attitudes	3.24	0.22	3.37	0.32	−1.80	0.39
EC values	3.20	0.35	3.27	0.24	−1.65	0.36
ECfuture actions	**2.69**	**0.43**	**2.85**	**0.49**	**−2.16 ***	**0.47**
Future actions inside school	2.75	0.58	3.02	0.60	−2.43 *	0.53
Future actions outside school	2.57	0.44	2.68	0.53	−1.48	0.32
Agents of change	3.05	0.46	3.23	0.62	−1.73	0.38

Note: * $p < 0.05$, ** $p < 0.01$. *** $p < 0.001$.

Taking into account the findings presented above regarding the girls' and boys' performance before and after the learning intervention, it is unsurprising that a Mann–Whitney U test indicated statistically significant differences between the EC learning gains of boys and girls (Table 7). Results showed that the girls outperformed the boys regarding their learning gains in EC future actions overall ($z = –3.96$, $p < 0.001$), and, more specifically, in future actions inside school ($z = –2.80$, $p < 0.01$), future actions outside school ($z = –4.19$, $p < 0.001$) and as "agents of change" ($z = –2.49$, $p < 0.05$). In addition, results showed that the girls outperformed the boys regarding their learning gains in EC skills ($z = –2.53$, $p < 0.05$).

Table 7. Comparison of the EC learning gains between boys and girls.

	Learning Gains [Boys]		Learning Gains [Girls]		Z
	Mean	**SD**	**Mean**	**SD**	
ECcompetences	**0.32**	**0.19**	**0.42**	**0.24**	**−1.29**
EC knowledge	0.51	0.28	0.61	0.26	−0.77
EC conceptions	0.34	0.39	0.33	0.63	−0.61
EC skills	0.18	0.20	0.53	0.52	−2.53 *
EC attitudes	0.14	0.41	0.23	0.32	−0.71
EC values	0.01	0.26	0.19	0.36	−1.78
ECfuture actions	**0.14**	**0.25**	**0.47**	**0.25**	**−3.96 *****
Future actions inside school	0.19	0.36	0.53	0.54	−2.80 **
Future actions outside school	0.10	0.21	0.43	0.21	−4.19 ***
Agents of change	0.23	0.51	0.61	0.47	−2.49 *

Note: * $p < 0.05$, ** $p < 0.01$. *** $p < 0.001$.

5.3. Effect of Past/Present EC actions

To examine the potential bivariate correlations between the students' past/present EC actions, as these were reported before the learning intervention, with the students' learning gains, we deployed a Spearman's rank correlation test.

Our findings indicated several statistically significant correlations between the students' learning gains and their past/present EC actions (Table 8). In particular, the students' past/present EC actions were related with a moderate positive correlation to EC future actions in general ($\rho = 0.51$, $p < 0.001$), to future actions outside school ($\rho = 0.56$, $p < 0.001$), to future actions inside school ($\rho = 0.40$, $p < 0.01$) and to EC skills ($\rho = 0.47$, $p < 0.01$). In addition, the students' past/present EC actions were related with a weak positive correlation to EC knowledge ($\rho = 0.32$, $p < 0.05$), EC attitudes ($\rho = 0.36$, $p < 0.05$) and "agents of change" ($\rho = 0.33$, $p < 0.05$). No statistically significant correlations were found between the students' past/present EC actions and EC competences, EC conceptions or EC values.

Table 8. Spearman's rank correlations between past/prior actions and students' EC learning gains.

Learning Gains (LG)	Prior EC Experiences
EC competences	**0.24**
EC knowledge	0.32 *
EC conceptions	0.18
EC skills	0.47 **
EC attitudes	0.36 *
EC values	−0.02
EC future actions	**0.51 ***
Future actions inside school	0.40 **
Future actions outside school	0.56 ***
Agents of change	0.33 *

Note: * $p < 0.05$, ** $p < 0.01$. *** $p < 0.001$.

Furthermore, a cluster analysis classified the students into two distinct and homogeneous groups. The first group included students ($n = 16$) who were more engaged with past/present EC actions, thereby named "Highly Active Environmental Citizens" (HAECs), whereas the second group included students ($n = 34$) who were less engaged with past/present EC actions, thereby named "Lowly Active Environmental Citizens" (LAECs). The comparison of students' EC learning gains between the first and second group indicated that there were statistically significant differences between the two groups (Table 9).

Table 9. Comparison of the EC learning gains between LAECs and HAECs.

	Learning Gains [HAECs]		Learning Gains [LAECs]		Z
	Mean	**SD**	**Mean**	**SD**	
ECcompetences	**0.50**	**0.22**	**0.32**	**0.20**	**−2.40 ***
EC knowledge	0.69	0.26	0.51	0.26	−2.64 **
EC conceptions	0.56	0.43	0.23	0.56	−2.35 *
EC skills	0.64	0.31	0.26	0.46	−2.94 **
EC attitudes	0.34	0.39	0.13	0.33	−2.24 *
EC values	0.16	0.44	0.10	0.26	−0.34
ECfuture actions	**0.52**	**0.17**	**0.24**	**0.30**	**−2.98 ***
Future actions inside school	0.58	0.43	0.30	0.51	−1.84
Future actions outside school	0.48	0.15	0.20	0.28	−3.29 **
Agents of change	0.69	0.44	0.34	0.52	−2.22 *

Note: * $p < 0.05$, ** $p < 0.01$.

In particular, the students classified as HAECs outperformed their counterparts, who were classified as LAECs, in terms of EC competences ($z = -2.40$, $p < 0.05$), knowledge ($z = -2.64$, $p < 0.01$), conceptions ($z = -2.35$, $p < 0.05$), skills ($z = -2.94$, $p < 0.01$), attitudes ($z = -2.24$, $p < 0.01$), EC future actions ($z = -2.98$, $p < 0.01$), future actions outside school ($z = -3.29$, $p < 0.01$) and "agents of change" ($z = -2.22$, $p < 0.05$).

6. Discussion

6.1. Impact of the Learning Intervention

The findings of our study indicate the statistically significant and positive impact of the "Environmental Citizens in Action" learning intervention on the participating high-school students' EC. What is of critical importance, though, is the large effect size, which goes beyond the statistical impact and signifies that the impact of the learning intervention is meaningful and may have practical implications for researchers, teachers and students who adopt educational interventions underpinned by the EEC pedagogical approach [54].

Importantly, we should also emphasize that statistically significant effects were found not only for the overarching constructs, but also for all the separate attributes which fall

under the overarching constructs of the EC competences (i.e., knowledge, conceptions, skills, attitudes, values) and EC future actions (i.e., future actions inside school, future actions outside school, agents of change). In addition, these statistically significant effects were not marginal ones, as in all cases their statistical significance level was defined as $p < 0.001$, except for the EC values, which were defined as $p < 0.01$. The latter finding is not surprising considering that, according to the literature, environmental values are deeply rooted in the personality and, as such, are rather constant and difficult to change [55–57]. Nonetheless, we should reiterate that our learning intervention had a statistically significant impact both holistically, as well as on all the attributes of the students' EC.

Overall, our findings confirm our first research hypothesis and provide empirical substantiation for the EEC pedagogical approach, as suggested by Hadjichambis and Hadjichambi [3]. Put simply, our findings suggest that if an EEC learning intervention is structured according to the six stages of the EEC pedagogical approach [(a) Inquiry; (b) Planning Actions; (c) Civic Participation and Critical Active Engagement; (d) Networking and Sharing in Scales; (e) Sustain Environmental and Social Change and (f) Education and Reflection], this may have a positive impact on students' EC. As mentioned before, each stage includes several steps; these steps can support the successful implementation of each stage. Although it is not required to adopt all the steps in each stage, it is significant to include steps deriving from all six stages, as each stage addresses different aspects and dimensions of EC. The high impact on the effect size of our learning intervention reveals that the combination of activities at the various stages is essential for integration of the complex and challenging nature of EC.

6.2. Gender Effect

Despite the promising findings presented in the previous section, the picture differs when zooming in and discussing the impact of the "Environmental Citizens in Action" learning intervention separately for the participating boys and girls. More specifically, focusing on girls, we found that the learning intervention had a statistically significant and high impact on the effect size both for the overarching constructs, but also for all the separate attributes which fall under the overarching constructs of EC competences (i.e., knowledge, conceptions, skills, attitudes, values) and EC actions (i.e., future actions inside school, future actions outside school, agents of change). Alternatively, focusing on boys, we also found a statistically significant and high impact on the effect size of the learning intervention on the boys' EC competences, as well as on the attributes of knowledge, conceptions and skills, which fall under the EC competences. However, we did not find a statistically significant impact on the attributes of attitudes and values for the boys. In addition, our findings revealed a statistically significant but low impact on the effect size of the learning intervention on the boys' EC future actions in general, as well as on the attribute of future actions inside school. However, we did not find a statistically significant impact on the attributes of future actions inside school and agents of change for the boys. In line with the aforementioned findings, girls outperformed boys in their learning gains regarding EC skills, as well as regarding EC future actions and all of the attributes falling under the EC future actions (i.e., future actions in school, future actions outside school and agents of change); these differences were statistically significant.

Overall, our findings provide empirical substantiation for our research hypothesis that girls would outperform boys by the end of the intervention in terms of their EC learning gains. In particular, our findings are in agreement with prior literature, which has provided empirical substantiation that, across age, females outperform males in terms of their pro-environmentalism (i.e., positive environmental attitudes, values and/or behaviors) [58–60]. One plausible explanation for the gender difference is that boys are characterized by lower emotional empathy compared to girls [43]. More specifically, it is argued that girls are socialized to become more altruistic and compassionate to others [61]; in this context, it is not surprising that girls demonstrate a more empathetic disposition towards nature [62,63]. As a consequence, girls are assumed to hold, in most cases, higher environmental attitudes

than boys, as well as to have stronger feelings about environmental issues [60,64]. However, our study goes a step further; rather than pro-environmentalism in general, it is specifically focused on EC and reinforces the findings of recent studies in this emerging field, which have also found that females report more EC than males [6,33].

6.3. Effect of Past/Present EC Actions

Beyond the gender effect, as discussed in the previous section, our findings also indicated that that past/current EC actions had a significant effect on the students' EC learning gains. More specifically, we found that the students' learning gains were, in most cases, positively correlated with their past/current EC actions, as these were reported prior to the learning intervention. These findings were also supported by a cluster analysis that classified the participating students according to their past/current EC actions into Lowly Active Environmental Citizens (LAECs) and Highly Active Environmental Citizens (HAECs); HAECs outperformed LAECs in their EC learning gains in all aspects, and this difference was statistically significant, except for EC values and future actions inside school. As such, these findings also provide empirical support for our research hypothesis that the students' past/present EC actions would be positively correlated with their EC learning gains by the end of the intervention

These findings are also well aligned with prior research supporting the assertion that previous experience in nature is positively related with pro-environmental attitudes and behaviors [65]. More specifically, previous studies found a positive association between first-hand experiences with nature and pro-environmentalism [66–68], while, in contrast, dissociation from nature was found to be related to hindering support for environmental causes [69,70]. In addition, an increasing corpus of studies has provided empirical substantiation for the claim that participation in environmental and nature-based Citizen Science (CS) projects may contribute to the transformation of citizens into environmentally responsible and active citizens [26,29,71]. In its essence, participation in environmental-related activities implies that people contribute to the environmental management process, and, in turn, this also affects and shapes their own lives. Overall, our findings are aligned with those of Karatekin et al. [35], who found that teachers' participation in environmental activities positively predicted their EC. Likewise, our study supports the postulation that students' prior EC actions also defined the degree of the EC learning gains made by the end of the "Environmental Citizens in Action" learning intervention.

7. Conclusions and Implications

The findings of this case study provide empirical documentation that the proposed learning intervention, which was structured around the EEC pedagogical approach, can contribute to the development of secondary education students' EC. However, this study does not come without limitations.

Firstly, despite the fact that this study investigated whether gender and past/present EC actions can affect the impact of the learning intervention on students' EC, several other factors may also define the impact of such learning interventions and deserve further exploration (e.g., sociocultural factors, prior environmental knowledge). Secondly, the sample of our study was relatively small (i.e., fifty biology students in 10th grade, derived from two intact classrooms). Therefore, the findings of this study should be treated with caution, considering the statistical power of the study. Future studies could replicate this research with bigger samples. Thirdly, this study relied on a self-reported, subjective, quantitative measure, which may be considered a limitation. Future studies could combine the ECQ with more qualitative data collection approaches (e.g., interviews, reflective diaries), as well as with more objective data collection approaches, such as observations and audio-recordings of students' verbal interactions. Fourthly, the present study evaluated a specific learning intervention addressed specifically to 10th graders. Future studies should deploy other learning interventions addressed toward students of different ages to examine the consistency of our findings in other contexts. Finally, while the EEC pedagogical

approach is comprised of six sequential stages, the research design adopted in this study allowed for an evaluation of the pedagogy as whole unit. Future studies could adopt a different research design to isolate the learning effects of each pedagogical stage on the EC competences and EC future actions.

Despite the aforementioned limitations, it should be noted that this case study is the first one to present the implementation of a learning intervention grounded in the novel EEC pedagogical approach. It is also the first study to evaluate the impact of a learning intervention on secondary students' EC, following up on the previous study of Telešienė et al. [6], who evaluated the impact of a learning intervention on higher education students' EC with the newly validated Environmental Citizenship Questionnaire (ECQ). Both studies support the appropriateness of the ECQ for the evaluation learning interventions, which aim to promote students' EC in high schools and, later on, in universities.

Overall, our findings provide empirical documentation for the contribution of the EEC pedagogical approach, as a multi-stage and holistic approach, to the development of secondary students' EC. At the same time, our study has pointed out the critical role of gender and past/present EC actions in students' EC learning gains. More precisely, our findings suggest that future studies should examine the reasons underlying such gender differences. In addition, another implication relates to the development of learning interventions that consider students' prior EC actions and, thus, provide more learning opportunities (e.g., additional/more targeted educational activities) to reinforce the EC of students with limited prior EC experiences. In this way, if the factors associated with students' EC are considered, future learning interventions in the field could increase their learning effectiveness even more.

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