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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.
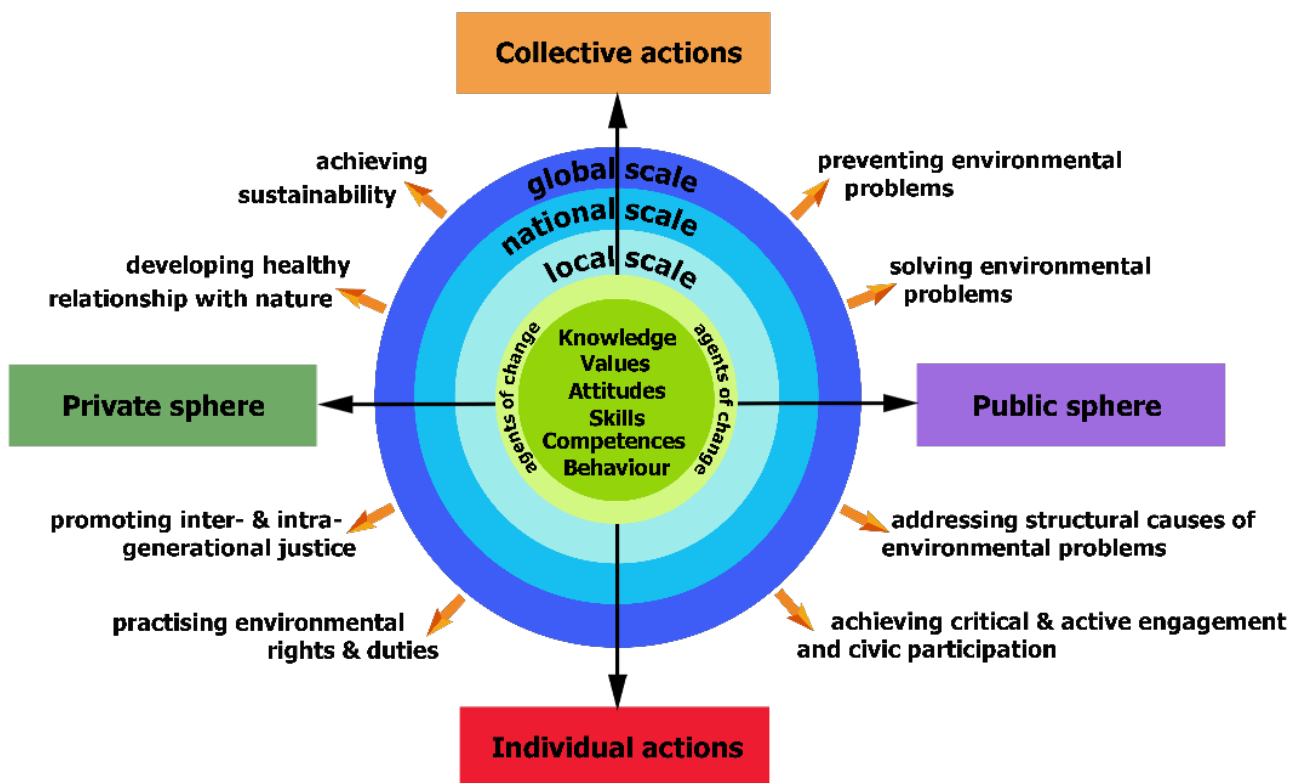
Figure 1. The EEC model [3].

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.
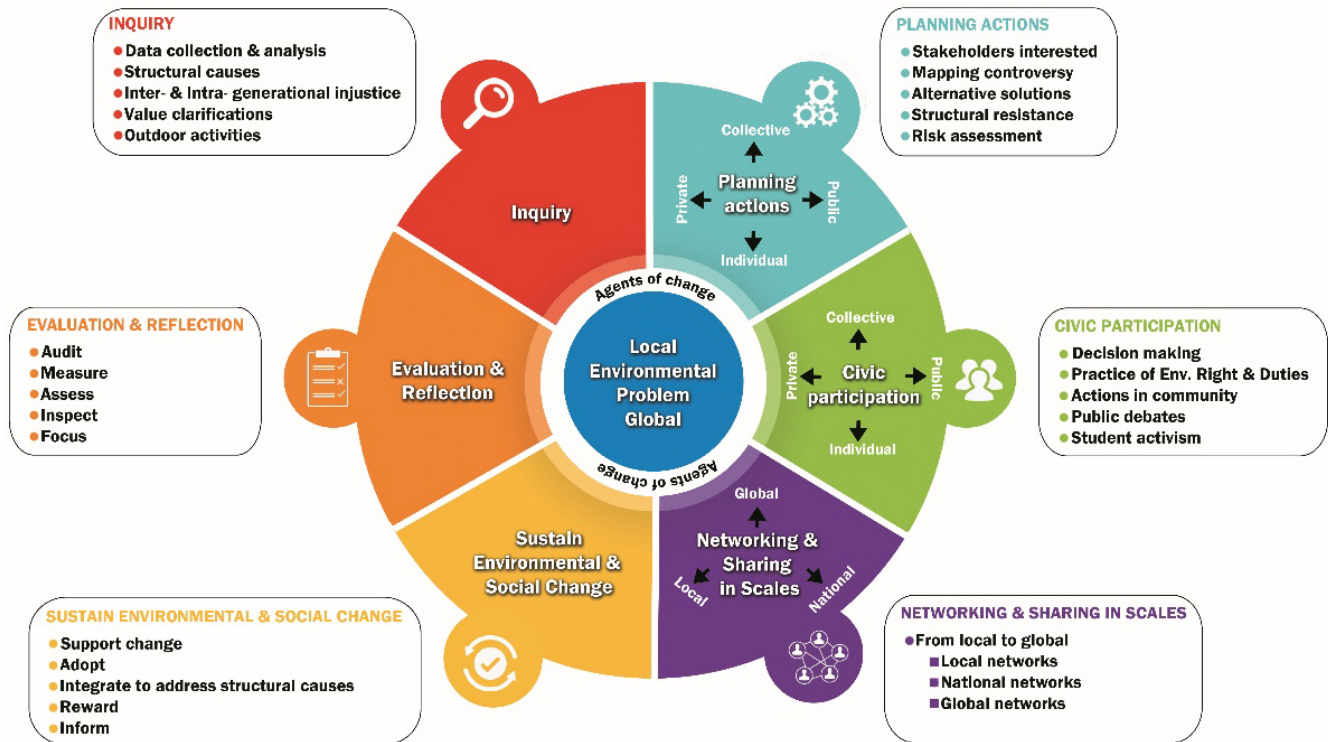

Figure 2. The Education for Environmental Citizenship (EEC) pedagogical approach [3].

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 Telešiene 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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