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Article

The Healthy Waters science-based educational intervention programme: The potential of participatory approaches for developing and promoting students' environmental citizenship

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Keywords: environmental education; environmental citizenship; educational intervention programme; participatory methodologies; community profiling

- Schools reproduce scientific knowledge uncritically.
- Schools should provide educational opportunities for students' action, reflection, and interaction.
- Participatory approach allows students to expand their agency around climate change.
- Participatory approach promotes students' knowledge of their community's environmental problems.

Purpose: This paper explores the potential of students' participation in the HW educational intervention programme based on participatory methodologies in promoting their environmental citizenship.

Design/methodology/approach: Using a quasi-experimental design, 126 students were randomly assigned to the intervention and control groups and filled out questionnaires before and after the HW intervention to evaluate environmental citizenship dimensions.

Findings: The psychometric properties of a 16-item instrument to measure youth environmental citizenship were validated. After the HW intervention, the students' intervention group had a significant improvement in their sense of environmental efficacy.

Research limitations/implications: The cross-sectional design of this study does not allow causal inferences to be made; further research should conduct longitudinal studies.

Practical implications: Schools must promote educational experiences where students have opportunities for reflection and action in interaction in a climate of openness to dialogue and diversity with the involvement of different actors.

1 INTRODUCTION

We are currently witnessing a scenario of instability and vulnerability in multiple dimensions of society, such as the social, economic, political, and environmental. The advance of climate change is increasingly noticeable in intensified natural phenomena, the rising temperature of the planet and the level of the oceans, with the melting of the polar ice caps, the scarcity of natural resources, loss of biodiversity, and social issues, such as the increased inequalities identified as consequences of these advances (Intergovernmental Panel on Climate Change, 2022).

In Portugal, the threat of climate change is evident; the country is located in the west of the Iberian Peninsula, a region identified as a critical area for climate change, with projections indicating significant increases in temperature and reductions in precipitation (Cardoso et al., 2019; Soares et al., 2017a; Soares et al., 2022), which influence higher frequencies and intensities of drought events (Hoerling et al., 2012; Soares et al., 2022; Spinoni et al., 2017), damaging sectors such as water supply, agriculture, and forestry, among others.

In light of these concerns, there is a need to prioritise agendas and policies committed to addressing these issues at different levels and sectors of society. In the face of this moment of transformation and crisis, containment measures have been established to stabilise the worsening of the current scenario and ensure the future of the next generations. In 2010, the European Commission issued a document on the strategy for innovative, sustainable, and inclusive growth entitled Europe 2020, the objectives of which are interconnected with the roadmap drawn up by the European Union for 2050 after the Paris Agreement 2015. It refers to the relevance of society's participation in decision-making processes and exercising environmental citizenship (henceforth EC) (European Council, 2019). Environmental citizenship is recognised as an essential domain for addressing environmental problems, such as climate change (Ockwell et al., 2009; Stern, 2011); however, it appears differently in some literature and may overlap with others, depending on nature and intentionality. In the present study, EC is defined as "the pro-environmental behaviour of citizens who act and participate in society as agents of change in the public and private sphere, at different scales, through individual and collective actions to solve contemporary environmental challenges" (European Network for Environmental Citizenship, 2018).

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According to Hadjichambis et al. (2020), the intersection of environmental education and discourses in science education can contribute to corroborating and enabling the learning and exercise of EC. Within this landscape, schools have an essential role in promoting environmental citizenship. They are considered core to this task, as has been considered in recent years in the fields of environmental education, education for sustainable development, and education for global citizenship (Kindon et al., 2007; Menezes et al., 2013; Reid et al., 2008; Rios & Menezes, 2017; Simovska & Mannix-McNamara, 2015). These domains seek to raise awareness and to mobilise and promote values and skills that can contribute to changing attitudes and behaviours, aiming to provoke nonconformism and questioning in the face of current challenges, not limiting the learning to more conventional subjects and structured content (Ribeiro, Neves, & Menezes, 2014, p. 26).

In 2017, the Portuguese Environment Agency, in conjunction with the Directorate General of Education and the government members responsible for education and the environment, approved the National Strategy for Environmental Education through a resolution of the Council of Ministers. This ensures the commitment to guarantee a common, sustainable future through inclusive, visionary, and strategic citizenship, which will contribute to promoting environmental literacy in the country and developing sustainable conduct models in all dimensions of human activity. Environmental education will be an element of transversal integration of the objectives (Portuguese Environmental Agency, 2017). This approach seeks not only the dissemination of information on climate change and sustainable development but also the appropriation, participation, and accountability of civil society regarding these issues. However, this active participation of citizens depends on their capacity to problematise and act on environmental issues (Marques, Faria, & Menezes, 2018).

In the Portuguese school curriculum, environmental education and education for sustainability are presented as strands of citizenship education. This connection is intended to encourage transversality between the educational curriculum's different areas, themes, and contents. There is a focus on the development of citizenship skills based on the Competency Framework for Democratic Culture, established by the Council of Europe at the Permanent Conference of European Ministers of Education, held in Brussels in April 2016, which is defined as: “the ability to act as responsible citizens and participate fully in social and civic life” (Council of the European Union, 2018). It assumes that this measure can ensure that students know and understand the challenges they will face, the consequences of their decisions, and what they can and should refrain from doing when faced with these situations.

However, even with the elaboration of international and national policies that evoke the relevance of learning in the exercise of citizenship, and in this case, the environmental citizenship of children and young people, it is perceived that there is still an uncritical and reproductive relationship on the part of schools about scientific knowledge – reducing students’ ability to participate and exercise citizenship when confronted with real-world issues (Stevenson, 2007). In this way, it is necessary to find learning alternatives that not

only contemplate these policies but also contribute to the participation and exercise of environmental citizenship by children and young people.

Participatory methodologies emerge as a learning alternative based on these premises and the need to offer more meaningful learning, favouring participation and pro-environmental civic exercise. This type of strategy is grounded in the pedagogy centred on action and lived experiences, as emphasised by Dewey in 2018 [(1916)], incorporating components that integrate knowledge from different domains in investigating local circumstances. It follows a perspective of participation and creativity and strengthens school nuclei focused on citizenship and sustainability (Santos & Jacobi, 2019).

Participatory research methodologies construct local knowledge collaboratively with and for the community. This process involves data collection and analysis, sharing and communicating results, and constructing meanings. It promotes individual and collective reflection on the experiences encountered during the process, fostering the development of civic, scientific, and environmental competencies (Cornwall & Jewkes, 1995; Sohng, 1996).

This paper aims to discuss the potential of students' participation in educational opportunities provided by the HW educational intervention programme in developing and promoting their environmental citizenship. Given the quasi-experimental study, intervention and control groups will be compared, and differences will be looked for between them in the pretest and post-test. The results will be discussed in the light of the theoretical framework and research on participatory methodologies in education, which indicate how participatory and collaborative learning strategies can provide significant experiences and contribute to the development of relevant skills for the process of reflection and problematisation of adverse environmental situations of everyday life, in different educational contexts, as well as, foster other processes, such as mobilisation, criticism, debate and participation in decision-making processes, together with other local actors and representatives, aiming at the improvement of the territory through a process of research, planning and local action (Franco, 2005; Hadjichambi et al., 2023)

2 THE HEALTHY WATERS SCIENCE-BASED EDUCATIONAL INTERVENTION PROGRAMME

The future outlook for the climate in Portugal is alarming, with concerns over a significant increase in temperature and a noteworthy reduction in precipitation. Specifically, there is a projected maximum temperature increase of up to 7°C in the interior during the summer, coupled with an annual decrease of approximately -40% in the southern regions of the country (Cardoso et al., 2019; Soares et al., 2017a; Soares et al., 2022). The projections also indicate a substantial rise in extreme events, such as heatwaves and aridity, along with an escalation in the frequency and severity of drought events (Miralles et al., 2019; Molina et al., 2020; Soares et al., 2022; Spinoni et al., 2018; Tramblay et al., 2020; Vicente-Serrano et al., 2014), which may lead to dramatic impacts on various Portuguese

ecosystems. Based on these premises of concern about climate change and the need to preserve water resources, the Healthy Waters Environmental Education project was developed.

The Healthy Waters (henceforth, HW) educational intervention programme was created through the collaboration of Faculty X, and Faculty Y of University Z. Its main objective was to tackle two major environmental issues in a transdisciplinary way: water pollution and water conservation, which can severely compromise the population's quality of life. Education is always the strongest tool to sensitive the population to these environmental and societal challenges (Guimarães, 2020). It consists of a science-based environmental education programme to be put into practice in middle and high schools (between grades 7 and 12) located in the Porto Metropolitan Area.

This educational intervention programme was reconciled with the methodological training of the teachers from the participating classes and the training of university students with mentoring roles. The teacher training aimed to give them the autonomy to implement the WC strategy in the school where they carry out their professional activities. Thus, the training had the following objectives: to present the principles underlying participatory methodologies for co-constructing knowledge and to create spaces for discussion on different approaches to youth education for citizenship, integrating the dimension of environmental education, and identifying the integration of various actors involved in water management and efficient use. Therefore, the WC strategy course structure was distributed over four three-hour weekly sessions, totalling 12 hours, in joint, in-person sessions, covering the following contents: the WC strategy and participatory research methodologies, civic and political participation of young people in environmental issues, and methods for environmental water remediation and their implications among the different stakeholders involved.

The university students who acted as mentors in the project participated in the "Intervention Methodologies in Education" course. This course aimed to empower students to make critical and thoughtful analyses of intervention projects in different contexts and intervention methods and to provide moments for reflection on the specificities of educational interventions.

The mentors (in our case, university students) played a mediating role in collaboration with the teachers, introducing the students to the essential tools for their research and their critical analysis of the information gathered. The HW programme had three main goals: (a) to improve students' learning process in personal, civic, and academic dimensions, (b) to open the students' critical eye to environmental issues and encourage their participation in solving water-related problems identified in their respective communities, and (c) to increase and promote change in students' attitudes and dispositions related to water management and preservation. The HW educational intervention programme followed participatory research methodologies and community profile development approaches (Marques et al., 2020; Menezes & Ferreira, 2014). This strategy aims to encourage young students to learn about environmental issues relevant to the local area based on

their involvement and participation in research to identify the area's challenges and the resources available to solve environmental problems. In this type of approach, students take on the role of co-investigators with other actors from the community in actions that involve collecting data, analysing and discussing the information obtained and drawing up proposals to solve the relevant challenges; in other words, they leave the position of mere spectators and become the protagonists of their knowledge. These approaches enabled students to be placed in the role of researchers, to create their knowledge and define their course of action, while the mentors (in our case, university students) fulfilled a mediating role in collaboration with the teachers, presenting the students with the essential tools for their research and their critical analysis of the information collected. This participatory and community-based research strategy has been identified as an important avenue for tackling the identified ineffectiveness of other more formal approaches to environmental education (Roque et al., 2022; Rousell & Cutter-Mackenzie-Knowles, 2020), which aim to work “on” or “about” environmental issues in a general context rather than working “with” individuals on these issues from a local perspective, closer to their respective communities (Macaulay, 2017).

The HW educational intervention programme mentors worked with the students in their class schedule for periods of 45 minutes for three months (taking place in six sessions).

Phase One: Gathering knowledge and establishing the work path

Phase 1 involves the identification of current issues and consists of two stages. In the first stage, students are exposed to global, national, and local images, news, and videos about water-related environmental problems. This is done to familiarise them with the subject, encourage discussion on these issues, and establish connections between institutions, sectors, and actors involved in water consumption and management. The concept of interdependence among different sectors of society in water management and preservation is a crucial aspect of the project and persists throughout its development. Students are simultaneously introduced to research tools and strategies, such as surveys, interviews, and observation. Subsequently, students form groups and begin collecting information in their territories, identifying major environmental problems and potential solutions. In the second stage, young researchers share the information collected and determine the issues they want to explore and address. They then initiate a data collection process through interviews or surveys with other community members, both within and outside the school, such as teachers, political leaders, and reference professionals, seeking to understand the level of knowledge and awareness regarding the identified problems. This concludes the first phase of the community profile, focusing on identifying current issues. The activities to be carried out by the scholarship holder include:

I. Support for research and literature review guiding project activities;
II. Participation in data collection and analysis activities (interviews, questionnaires, focus groups, and document analysis);
III. Collaboration in writing scientific reports and articles and presenting work at scientific meetings;
IV. Organisation and participation in project team meetings;
V. Collaboration in other functions to support the management and execution of research and dissemination activities of the project.

Phase Two: Scientific approach to the local environmental problems

Phase 2 involves crafting proposals to address the identified problems. It is a single stage that requires more time with the students. In this stage, students were invited to visit the Laboratory associate in chemical engineering (ALiCE), Faculty of Engineering, University of Porto. The visit was crucial for students to have direct contact with researchers and technicians specialised in developing water depollution and treatment methods. It allowed students to delve into specific issues related to their respective investigations, gain insights into the progress of scientific research on water depollution and treatment methods, and recognise attitudes and behaviours that can be adopted for a conscientious and responsible consumption of this resource.

Phase Three: Time for action

Phase Four: Dissemination of results

Finally, Phase 4 is conducted through Stage 6, the sole stage of this phase, which is notable for presenting the results achieved during the investigative process. In this stage, the proposals developed by the young investigators to address the identified issues in the area are showcased. The presentation takes place in the format of a public session, as outlined in the community profile development (Hawtin & Percy-Smith, 2007; Menezes, 2010) at College X of University Z. For this event, members of the school community, political leaders, the scientific community, and other representatives from the public and private sectors involved in water management processes are invited. The session aims not only to present the results of the investigative process but also to promote social change and create connections among various societal stakeholders, to establish partnerships and commitments to address the issues presented from a perspective of shared protection, management, and care for water.

All these activities, in which the students played the dual role of civic agent and environmental researcher in their community, allowed them to understand the circumstances beyond their school walls better. They increased their environmental awareness, which helped them better comprehend how they could impact their community through their individual and collective civic action. This participatory, collaborative programme also created opportunities for students to develop other relevant skills, such as communication

skills through, for example, the presentation of their posters to the community; scientific research skills through the different investigation and data collection methods they learned and used in the sessions; and reflexive and critical thinking skills, through the different discussion moments they had to share their perception about the environmental problems and their ideas about possible solutions. One of the most relevant impacts of education programmes like that of "Healthy Waters" is their ability to modify the learning experiences from a directive knowledge transfer to an evolutive, transformative, and reflexive process, thus contributing to prompt youth emancipation in society (Menezes & Ferreira, 2014). In other words, the learning mechanisms of the project were able to mobilise the students' desire to contribute to social and environmental change, which can facilitate the creation of means for the growth of citizens willing to use knowledge critically, intervene in a socially responsible way and promote change (Giroux, 2011). As they recognise the local reality, the young individuals face injustice within power structures. It is believed that by acknowledging these situations and through their dissatisfaction with them, they were able to actively work towards promoting positive changes and transformations in their territory. The participatory approach adopted by the project facilitated the promotion of this meaning for the students. Throughout the project, students could reflect and collectively discuss environmental topics, research environmental issues, and adopt strategies to investigate the local territory, identifying problems and situations of ecological imbalance in their communities. They also sought solutions to resolve these issues in a participative and democratic manner. These experiences allowed the young individuals to learn about their position as citizens (Biesta, 2008, p. 4) and engage in civic and political participation from an agency perspective (Menezes & Ferreira, 2012, 2014).

3 METHODS

3.1 Study design and procedure

The study followed a quasi-experimental design, which allowed advancements in identifying the actual contributions of a given intervention in the experimental group (Ferraro, 2009), resorting to a comparison or control group. Thus, the methodological approach was adopted to ascertain whether there were significant changes in the perception of young students regarding environmental issues and civic participation that shape environmental citizenship after participating in the project. Both the intervention and control groups were assessed at two different time points: before the HW educational intervention program (pretest, T1) and after it (post-test, T2). The convenience sample consisted of two Portuguese public basic and secondary schools, four school classes from grade 8 and four from grade 12 in each participating school in the school year 2022–2023. Each participating school ensured the participation of two classes randomly assigned to the intervention group and two classes to the control group.

The participants' informed consent was required on the front page of the pretest and post-test questionnaire. Standardized instructions for completing were also written, as well as information on the confidential and anonymous character of the individual participation. Both surveys took approximately 20 minutes to complete.

3.2 Participants

The HW educational intervention programme was implemented in two schools in Porto, a city located in the north of Portugal. At T1, 126 students answered the pretest questionnaire: 65 students (67.7% female; M_{age} = 14.32, SD = 1.74) were assigned to the intervention group and 61 (57.4% male; M = 14.34, SD = 1.91) to the control group. At T2, 110 students responded to the post-test questionnaire: 57 students from the intervention group (retention rate = 87.7%) and 53 from the control group (retention rate = 86.9%). Little's test of missingness at random revealed a non-significant chi-squared value [$\chi^2(52) = 50.106$, $p = 0.55$], which means that missingness at post-test is not affected by the levels of environmental interest, attentiveness, efficacy, and action assessed at the pretest. Considering socioeconomic status, 67.7% of the students in the intervention group and 55.7% in the control group reported having up to 50 books at home. Regarding their schooling expectations, 51.6% of the students' intervention group and 62.3% of the control reported that they expect to conclude a bachelor's degree.

3.3 Measures

In light of previous studies (e.g., Marques et al., 2020), the current study conceived environmental citizenship as a combination of cognitive, behavioural, and emotional dimensions. The questionnaire comprised measures from existing empirical studies and will be presented below and detailed in Table 1.

Environmental interest. A four-item scale adapted from Marques et al. (2020) was used to ascertain environmental interest, considered a cognitive dimension of EC. This measure assesses the extent to which students are interested in environmental matters (e.g., I talk about environmental issues with my friends and family). Participants were asked to rate each item using a five-point scale from 1 (strongly disagree) to 5 (strongly agree).

Environmental attentiveness. A three-item scale adapted from Marques et al. (2020) was used to evaluate environmental attentiveness, integrated as a cognitive dimension of EC. This measure considers how students seek out or pay attention to environmental issues (e.g., I attentively follow the information on environmental issues circulating on the Internet). Participants were asked to rate each item using a five-point scale from 1 (strongly disagree) to 5 (strongly agree).

Environmental efficacy. A five-item scale adapted from Marques et al. (2020) was applied to evaluate environmental efficacy, considering it to be an emotional dimension of EC. It refers to their feelings about their own and others' competencies to influence and produce changes in environmental contexts (e.g., When environmental issues are being discussed, I usually have something to say). Participants were asked to rate each item using a five-point scale from 1 (strongly disagree) to 5 (strongly agree).

Environmental action. A four-item scale adapted from Lyons (2008) was used to assess environmental action and integrated into the behavioural dimension of EC. This measure seeks to collect information on students' engagement in different individual and collective actions that address environmental issues (e.g., I bought (or did not buy) products for environmental reasons). Participants were asked to rate each item using a five-point scale from 1 (strongly disagree) to 5 (strongly agree).

Control variables. The questionnaire collected sociodemographic information, including sex (1 = female), age, and socioeconomic status, which is a composite variable that results from aggregating the mean of two variables: the number of books at home and schooling expectations.

3.4 Data analysis strategy

Data was analysed using IBM SPSS Statistics 29.0 and IBM SPSS Amos 28.0. Descriptive statistics were used to examine the sociodemographic variables and scale items. A T-test was employed to assess differences in the students' age and socioeconomic status between the intervention and control groups. Fisher's exact test was used to ascertain differences in students' sex. Then, confirmatory factor analyses (CFA) were performed to test and validate the factorial structure of each EC dimension, as well as of the whole EC model, using data provided by the pretest (n = 126). The existence of outliers was investigated using Mahalanobis squared distance, and the univariate normality of the variables was assessed by analysing the absolute values of asymmetry coefficients (ISkI < 3) and uni- and multivariate kurtosis (IKuI < 10). A maximum-likelihood estimator was used to estimate model parameters, and regression imputation was performed to replace missing data. The quality of global fit was evaluated through the X^2 statistic (X^2/df < 5.0), Comparative Fit Index (CFI between 0.9 and 0.95, and root mean square error of approximation (RMSEA values between 0.5 and 0.8) (Marôco, 2014). The evaluation of construct reliability considers internal consistency reliability. The composite reliability (CR) estimation measured the internal consistency reliability. Values ≥ .70 are preferred; however, values > .40 are acceptable in exploratory research (Hulland, 1999). The assessment of construct validity includes convergent and discriminant validity. Average variance extracted (AVE) values ≥ 0.50 and CR values ≥ 0.70 suggest adequate convergent validity (Hair et al., 2006). Discriminant validity was assessed using the Fornell-Larker criterion, which means that the

square root of each average variance extracted (AVE) should be greater than its highest correlation with any other construct (Fornell & Larcker, 1981).

Further analyses will be focused on the comparison between the intervention (n = 65) and control (n = 61) groups before and after the HW educational intervention programme. Given the reported relationship between the small sample size and non-normal distribution data (Altman, 1995), Kolmogorov–Smirnov tests (n > 50) were run to examine the distribution of data in the samples of both groups. The results of Kolmogorov–Smirnov tests revealed that all of the scores in the pretest and post-test were not normally distributed (*p* values < 0.05), therefore, non-parametric tests were employed instead of *t* or other parametric tests. Specifically, the Wilcoxon signed-rank tests were run to compare the students' scores between the pretest and post-test in the four EC dimensions in each group, and the Mann-Whitney *U* tests were run to assess the results between the control and intervention groups.

4 RESULTS

The intervention and control group samples were previously detailed in this paper. T-tests and Fisher's exact test showed that significant differences were found between both groups regarding sex ($p = 0.007$) and socioeconomic status ($p = 0.046$), which means that more female participants and participants with higher socioeconomic status reported in the intervention group than in the control group.

Figure 1. CFA results for the measurement model of environmental citizenship

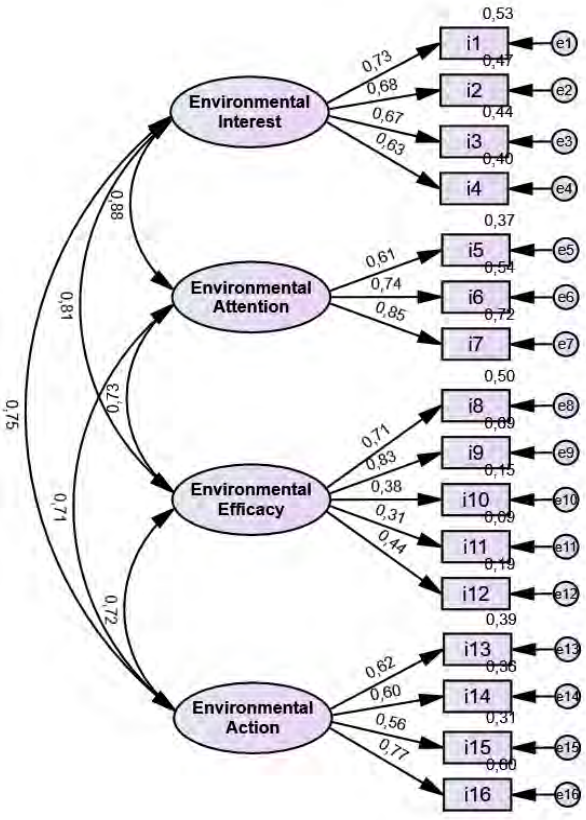

Table 1. Descriptive statistics for the 16 items of the EC instrument (n = 126).

Scales/Items	*M*	*SD*	*Sk*	*Ku*	*FW*	*r2*
Environmental interest (α = 0.76)						
i1. I talk about environmental issues with my friends and family.	2.59	1.00	0.37	-0.17	0.73	0.53
i2. I bring environmental issues into conversation with other people.	2.02	0.89	0.67	0.18	0.68	0.47
i3. I am interested in environmental issues.	3.28	1.02	-0.28	-0.17	0.67	0.44
i4. I search books and other sources for information on environmental issues on the Internet.	2.15	1.04	-0.02	-0.32	0.63	0.40
Environmental attention (α = 0.75)						
i5. I follow what is going on about environmental issues through newspapers and magazines.	2.65	1.21	0.26	-0.84	0.61	0.37
i6. I follow programmes on TV or radio that address environmental or nature issues.	2.64	1.07	0.06	-0.70	0.75	0.54
i7. I attentively follow the information about environmental issues that circulate on the Internet.	2.92	1.10	-0.02	-0.66	0.85	0.72
Environmental efficacy (α = 0.83)						
i8. I know more about environmental issues than most people my age.	2.41	0.99	0.27	-0.26	0.71	0.50
i9. When environmental issues are being discussed, I usually have something to say.	2.97	1.16	0.01	-0.73	0.83	0.69
i10. Important people in government care very little about the needs of the planet.	3.17	1.18	-0.11	-0.68	0.38	0.15
i11. People my age have little to say about what politicians do to address environmental issues.	3.22	1.22	-0.26	-0.78	0.31	0.09
i12. If young people work together, they can influence the government's decisions on environmental issues.	3.37	1,14	-0.19	-0.59	0.44	0.19
Environmental action (α = 0.78)						
i13. I participated in environmental awareness actions.	2.19	1.16	0.71	-0.32	0.57	0.39
i14. I bought (or did not buy) products for environmental reasons.	2.59	1.29	0.25	-1.14	0.55	0.36
i15. I sent news, music or videos with environmental content (e.g., on Facebook) to my contacts.	1.67	0.98	1.40	1.04	0.56	0.31

Scales/Items	*M*	*SD*	*Sk*	*Ku*	*FW*	*r2*
i16. I visited a website of an environmental organisation.	2.42	1.19	0.28	-1.07	0.86	0.60

Note: M = mean; SD = standard deviation; Sk = skewness; Ku = kurtosis; FW = factorial weight; r^2 = squared multiple correlation.

Scales/Items	*M*	*SD*	*Sk*	*Ku*	*FW*	r^2
Environmental interest (α = 0.76)						
i1. I talk about environmental issues with my friends and family.	2.59	1.00	0.37	-0.17	0.73	0.53
i2. I bring environmental issues into conversation with other people.	2.02	0.89	0.67	0.18	0.68	0.47
i3. I am interested in environmental issues.	3.28	1.02	-0.28	-0.17	0.67	0.44
i4. I search books and other sources for information on environmental issues on the Internet.	2.15	1.04	-0.02	-0.32	0.63	0.40
Environmental attention (α = 0.75)						
i5. I follow what is going on about environmental issues through newspapers and magazines.	2.65	1.21	0.26	-0.84	0.61	0.37
i6. I follow programmes on TV or radio that address environmental or nature issues.	2.64	1.07	0.06	-0.70	0.75	0.54
i7. I attentively follow the information about environmental issues that circulate on the Internet.	2.92	1.10	-0.02	-0.66	0.85	0.72
Environmental efficacy (α = 0.83)						
i8. I know more about environmental issues than most people my age.	2.41	0.99	0.27	-0.26	0.71	0.50
i9. When environmental issues are being discussed, I usually have something to say.	2.97	1.16	0.01	-0.73	0.83	0.69
i10. Important people in government care very little about the needs of the planet.	3.17	1.18	-0.11	-0.68	0.38	0.15
i11. People my age have little to say about what politicians do to address environmental issues.	3.22	1.22	-0.26	-0.78	0.31	0.09
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i14. I bought (or did not buy) products for environmental reasons.	2.59	1.29	0.25	-1.14	0.55	0.36
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i16. I visited the website of an environmental organisation.	2.42	1.19	0.28	-1.07	0.86	0.60

Table 2. The goodness-of-fit statistics for each of the univariate and multivariate models (n = 126).

Model	χ^2	*df*	χ^2/df	*CFI*	*RMSEA*	*C.I. 90%*
Environmental Interest	0.229	2	0.114^{ns}	1.000	0.000^{ns}	]0.000, 0.081[
Environmental Attention	2.138	1	0.144^{ns}	1.000	0.095^{ns}	]0.000, 0.278[
Environmental Efficacy	2.629	5	0.526^{ns}	1.000	0.000^{ns}	]0.000, 0.086[
Environmental Action	1.157	2	0.578^{ns}	1.000	0.000^{ns}	]0.000, 0.151[
Environmental Citizenship	132.747	98	1.355^{*}	0.947	0.053^{ns}	]0.027, 0.075[

Note: ns = nonsignificant (ρ ≥ 0.05) and P (rmsea <= 0.05) > 0.05; *ρ = 0.01.

Descriptive statistics for the 16 items of the environmental citizenship instrument (n = 126) are presented in Table 1. Data distributions were generally symmetrical, all items revealed acceptable absolute skewness values> 3 or kurtosis > 10 and no outliers were identified. The CFA showed a good fit for the measurement model of environmental interest, attention, efficacy, and action, as well as the four-dimensional model of EC. The goodness-of-fit statistics for each univariate and multivariate model (n = 126) are displayed in Table 2. Figure 1 summarises EC model-testing results, displaying the standardised factorial weights and individual item reliability.

Table 3. Cronbach's α, composite reliability, convergent validity, and discriminant validity of the four dimensions of EC (n = 126).

Model	*α*	CR	AVE		1.	2.	3.	4.
1. Environmental Interest	0.77	0.77	0.50		**0.71**	0.71^{**}	0.60^{**}	0.56^{**}
2. Environmental Attention	0.76	0.78	0.50		0.71^{**}	**0.71**	0.54^{**}	0.53^{**}
3. Environmental Efficacy	0.67	0.68	0.43		0.60^{**}	0.54^{**}	**0.66**	0.71^{**}
4. Environmental Action	0.72	0.73	0.50		0.56^{**}	0.53^{**}	0.47^{**}	**0.71**

Note: CR = composite reliability; AVE = average extracted variance; **ρ < 0.01.

As shown in Table 3, the results showed a relatively compact pattern among the four dimensions of EC, presenting values that range from 0.47 to 0.71. All EC dimensions are reliable and reveal convergent validity; CR and AVE values are slightly above or below the recommended cut-off levels. There is also evidence for the discriminant validity of the measures. All diagonal elements are significantly greater than the off-diagonal elements in the corresponding rows and columns. Thus, the 16-item index for measuring EC reveals satisfactory psychometric properties. Table 4 presents the means (M) and standard deviations (SD) for the four dimensions of EC in the intervention and control groups in the pretest and post-test.

Table 4. Comparison of pretest and post-test between the intervention (n = 65) and control (n = 61) groups

		Environmental Interest		Environmental Attention		Environmental Efficacy		Environmental Action	
		M	SD	M	SD	M	SD	M	SD
Intervention group	Pretest	2.46	0.82	2.66	0.99	3.06	0.82	2.18	0.93
	Post-test	2.58	0.82	2.58	0.82	3.15	0.71	2.19	0.70
Control group	Pretest	2.56	0.70	2.83	0.87	2.26	0.81	2.99	0.72
	Post-test	2.56	0.79	2.79	1.02	2.16	0.80	2.91	0.84

A Wilcoxon signed-rank test allowed us to verify if there was any significant difference between post-test and pretest scores within both groups. The test results showed that the intervention group had a statistically significant improvement in environmental efficacy (Z = -2.010, p = 0.044) but not in environmental interest (Z = -1.636, p = 0.102), attention (Z = -0.848, p = 0.396), or action (Z = -0.648, p = 0.517). The control group did not exhibit any significant change in environmental interest (Z = -0.296, p = 0.767), attention (Z = -0.108, p = 0.914), efficacy (Z = -1.1452, p = 0.254), or action (Z = -0.300, p = 0.764). There are no significant effects of the control variables (sex, age, and SES) in the change of environmental efficacy in the intervention group (p = 0.383).

Table 5. Mann-Whitney U test results

	Environmental Interest		Environmental Attention		Environmental Efficacy		Environmental Action	
	Z	*p*	*Z*	*P*	*Z*	*p*	*Z*	*p*
Pretest	-1.042	0.297	-1.102	0.270	-0.228	0.820	-0.705	0.481
Post-test	-0.040	0.968	-1.655	0.098	-1.262	0.207	-0.394	0.694

A Mann-Whitney *U* test allowed us to compare significant differences between the intervention and control groups in the pretest and post-test. As presented in Table 5, the results indicated no significant statistical differences ($p > 0.05$) between the two groups at both moments.

5 Discussion and Conclusion

This study aimed to understand whether participation in the HW educational intervention programme improved dimensions of EC, such as their knowledge, attitudes, and competencies regarding environmental water-related problems, causes, and solutions. It is crucial to evaluate the actual contribution of this type of programme since it allows us to observe whether there are changes in different cognitive, emotional, and behavioural dimensions of EC (e.g., interest, attention, efficacy, and action) after their implementation by comparing the intervention and control groups. This evaluation can also contribute to improving the design of future educational proposals to influence these dimensions in students and society regarding these specific groups of environmental issues. To this end, the present study also contributes evidence to validate the psychometric properties of a 16-item instrument developed as a four-dimensional measure of EC for young people in a Portuguese school context.

The results obtained from the pretest and post-test data analysis showed an improvement after the HW educational intervention programme in the environmental effectiveness dimension for the experimental group but not for the control group. These results show that this intervention positively influenced the participants in developing environmental efficacy. The students who participated in the HW educational intervention programme had a statistically significant improvement in their sense of environmental efficacy compared to students in the control group. This means those students feel more capable of changing the environmental conditions affecting their lives and communities. This emotional dimension has been widely discussed as a major contributor to pro-environmental behaviour (Kollmuss & Agyeman, 2002; Marques et al., 2020; Stern, 2000). Student's willingness to contribute to social change (Freire, 1970) supports the point of view that the practices inspired by critical pedagogy, as in the case of the participatory method applied, can create conditions for the development of prepared citizens capable of applying the acquired knowledge to criticise the world and also taking action to change it (Giroux, 2011). The participatory approach can play a central role in promoting environmental efficacy, as it allows students to expand their agency, enhancing their knowledge of the community's environmental problems, which resulted from their research work rather than something presented by teachers. It also allows these students to actively participate (i.e., have a voice) and build a personal and critical view on the topic (Menezes & Ferreira, 2012, 2014). This approach proved essential not only for producing students' knowledge of the issues addressed by the project but also as an instrument for drawing up educational policies, such as the construction of the learning curriculum. This is done from a perspective of co-construction with the students, acknowledging the political

nature of environmental education and its effects on curriculum design (Lopes 2013; Payne & Rodrigues 2012).

The expectation is, therefore, not only to meet the objectives outlined in international reference documents, especially those aimed at empowering and mobilising young people in education and environmental activism, but also to contribute to expanding the understanding of the curriculum, going against prescriptive perspectives. The anticipation is that the curriculum will become increasingly committed to the missions, passions, and purposes individuals articulate (Marques et al., 2018).

Based on the results, the collaborative learning strategies used in the HW programme may have contributed to the participants' individual and collective empowerment and sense of efficacy, making them feel able to be involved outside the classroom in a politicised way. These results align with many other studies employing participatory methodologies in this context (Hadjichambi et al., 2023; Marques et al., 2020). Taken together, it is possible to hypothesise that youth participation in environmental education intervention programmes based on participatory research and intervention approaches could promote their environmental citizenship, which is the main goal of the HW intervention programme. However, other important skills are also developed and promoted indirectly, such as the ability to cooperate, to do research (i.e., identify a problem, search for information, collect data and find solutions to solve it), and to communicate with others (Adamou et al., 2021; Hadjichambis & Paraskeva-Hadjichambi, 2020).

Regarding environmental attention, the findings indicate that contrary to the other dimensions under study, a slight decrease was observed after the HW intervention programme. A possible justification for this result is given in a similar study carried out by our research group – the Water Circle project, where the author states that the absence of statistical differences in the environmental attention is not a surprising result since the whole intervention period was short (i.e., around two months) (Marques et al., 2020), as is the case of the present study. This limitation is due to the number of sessions being dependent on the availability of the schools involved in the project and the time frame set by the project funding. In fact, in several works reported in the literature, the duration of these programmes is pointed out as a decisive factor in achieving positive results (Ardoin et al., 2023; Hadjichambi et al., 2023; Ruiz-Mallen et al., 2009), leading to a change, especially in the attitudes and behaviours of the participants (Chawla & Cushing, 2007).

Overall, the results allowed a deeper understanding of the contributions of the HW educational intervention programme to middle and high school participants, especially concerning increased environmental involvement and pro-activity at the individual and community levels. As a result of participating in this programme, most dimensions showed progress, reflecting the positive contribution of the HW intervention proposal that allows going beyond the school gate and creating experiences that are unusual in the curriculum that these students must follow. However, it is important to mention that this study does not allow the HW intervention impact on participants to be finely evaluated for two main reasons: (i) it does not have a longitudinal study design, and (ii) the results obtained may

be influenced by the fact that the school in which the participant students study is involved in the "*Eco-Escolas*" programme, which is based on similar pillars, such as citizenship and participation, curiosity, reflection, innovation, and responsibility (Gomes, 2019), thus creating an educational environment where environmental issues are already addressed in a structured way. This fact was already mentioned in the literature, attributing to the "*Eco-Escolas*" programme the awareness of a specific environmental issue by a group of students involved in a campaign developed by the programme and related to the topic (Marques et al., 2020). This programme has been implemented for several years in the schools that underwent interventions, providing contributions to the formation of this environmental culture in the school environment; therefore, it cannot be asserted that the Healthy Waters project was solely responsible for the results found.

Finally, schools must embrace these educational intervention programmes, where participants are provided with participation experiences which enable them to fully engage in meaningful opportunities for action, reflection, and interaction. These embrace dialogue and a diversity of perspectives and interests through the involvement of families, policymakers, and other social agents in the identification and resolution of community problems. This reinforces the idea that teaching methods that follow a participatory approach can contribute to learning active environmental citizenship. This implies creating an educational model of environmental citizenship that goes beyond individualistic and behavioural strategies and can more directly involve students in collective participation in environmental education practices (Barry, 2006; Schild, 2016).

We believe that the inclusion of these programmes in more schools at different levels of education and with an extended agenda will play an important role not only in promoting environmental education and citizenship but also in developing skills that are crucial to addressing the environmental and other challenges that arise daily in our communities and the world.

6 LIMITATIONS

The results of this study should be examined in light of some limitations. Even though self-reported measures demonstrate high validity, particularly when administrated in conditions of confidentiality as was guaranteed in the current study, participants were asked to retrospectively report how frequently they were actively engaged in a set of activities in the last months, which could potentially result in self-presentation and recall bias (Garfield et al., 2011). Another potential limitation is associated with the duration and intensity of the intervention. Our intervention was relatively brief and low intensity since it had only six one-hour sessions over three months. This limitation was also observed in several other studies (Hadjichambi et al., 2023; Marques et al., 2020), and it was denoted as an impactful factor for the quality of the effects of the education programmes studied.

Another limitation was the sample size of our study, which was small. We defined our sample size according to the availability of university students to carry out the intervention in schools within the scope of the service-learning methodology contemplated by the

HW educational intervention programme. Associated with this limitation, it is important to report that it is currently unknown how well the model and its findings will generalise beyond the specific conditions of this study, so the procedure should be replicated for different samples and contexts to examine the practical and statistical significance of the relationships between EC and other variables.

The last limitation regards the research design and its inability to determine the impact of this educational intervention since we only had two data-collection moments. To surpass this, in future studies, the programme should include a longitudinal experimental design to measure this impact, which will be relevant to evaluate this intervention in terms of its benefit on EC. It is also important to consider specific conditions of the study settings since there may already be programmes implemented in schools that can influence the analysis of the impacts of education programmes like ours.

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