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Educational Gardens and Climate Change Education: An Analysis of Spanish Preservice Teachers' Perceptions

Diego Corrochano [1,*], Enzo Ferrari [1], María Antonia López-Luengo [2] and Vanessa Ortega-Quevedo [2]

1 Department of Mathematics Education and Science Education, Universidad de Salamanca, 37008 Salamanca, Spain; enzoferrari@usal.es
2 Department of Sciences Education, Social Sciences Education and Mathematics Education, Universidad de Valladolid, 47002 Valladolid, Spain; mariaantonia.lopez@uva.es (M.A.L.-L.); vanessa.ortega@uva.es (V.O.-Q.)
* Correspondence: dcf@usal.es

Abstract: Educational gardens are powerful outdoor learning environments to address the subject of climate change and foster climate action. Using an online questionnaire, this study examines the influence of the main sociodemographic and academic factors, and the role of connectedness to nature, on the perception of educational gardens as contexts of climate change education (CCE) among Spanish preservice teachers (PSTs). The sample consisted of 889 PSTs enrolled in 9 university campuses of Spain. The statistical analyses performed evidenced that women are more likely to use educational gardens than men and that there is a progressive decrease in the positive perception of PSTs about the usefulness of gardens for CCE as the educational level at which they are being trained increases. Statistics also revealed that the variable connectedness to nature and the rating of the importance of educational gardens in CCE are not significantly related. Nevertheless, the Mann–Whitney U test indicated that PSTs who scored higher on connection to nature wished to broaden their knowledge of sustainable agriculture and, thus, connectedness to nature could be considered a predictor of environmental attitudes, each influencing the other. Based on these findings, recommendations for PSTs' training in the CCE context are provided.

Keywords: school garden; climate literacy; outdoor education; connectedness to nature; gender; teacher education

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1. Introduction

Currently, climate change (CC) and its linkage to global change, is one of the most important challenges that our world is facing. Such is the seriousness of the problem that in a recent study conducted in 50 countries and involving more than half of the world's population, 64% of the participants considered that CC remains a global emergency despite the COVID-19 health crisis [1]. There is widespread consensus among the scientific community that there is a causal relationship between human activities and CC [2], with a convincing body of evidence that CC is the result of a combination of an increase in greenhouse emissions and land-use changes [3]. The negative effects of global warming on natural and human systems make it necessary to mobilize society in general, and every individual in particular, to create a coherent and coordinated response to solve the problem. Societies are faced with the urgency of transforming the energy model and their citizens' way of life. To this end, there is a pressing need to educate people in an effective manner, so that they can act and make decisions, both in the present and in the future, in an educated and informed way. In such a challenge, the major role of preparing skillful, competent, and motivated teachers with all the fundamental pedagogical and content knowledge is undeniable.

The remainder of the introduction section develops as follows: first, the concept of climate change education (CCE) is described, followed by a review of studies focusing on educational gardens and their benefits; second, the matter of gardens and connectedness to nature is approached; subsequently, the importance of teacher training in CCE is analyzed; finally, the more specific aims and research questions of the study are presented.

1.1. Gardens and Climate Change Education

Climate change education is addressed in the context of education for sustainable development [4]. Specifically, it is aligned with Goal 13 (Climate Action) of the 2030 Agenda and the Sustainable Development Goals [5], Target 3 "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning". CCE must provide students with a set of transversal skills and abilities that enrich their cognitive and affective domains [4]. Moreover, it must be an interdisciplinary task that encompasses scientific, socio-economic aspects, and possible solutions [6], and it must educate for climate and for change [7]. CCE aims to develop individuals' capacities for climate literacy, which can be defined as the ability to understand, comprehend, and analyze climate concepts in depth, understanding people's influence on climate and climate's influence on them and society, so as to develop attitudes of respect towards the environment and people [8]. From this perspective, schools should encourage participation, information management, and free and conscious decision making [9]. These skills are part of what is known as critical thinking, another of the key competences for the 21st century [10], which again links to the 2030 Agenda (Goal 4, Quality Education). Specifically, CCE and the development of critical thinking are related to Targets 4.6 and 4.7 since the development of scientific literacy and critical thinking skills must be considered to achieve a literate population. These, in turn, include the theoretical knowledge, skills, and attitudes necessary to promote sustainable development.

The construct of CC competence was recently introduced with the purpose of creating a framework to develop understanding, awareness, and abilities related to CC through education [11]. It is composed of three dimensions: knowledge, skills, and attitudes. Knowledge is founded on evidence-based science and current scientific consensus, and should serve to understand what CC is, its causes, and its consequences [11]. The skills dimension connects the capacities that a student should acquire to learn what can be done to face CC. Nevertheless, it should be noted that a person being aware of a problem and knowing what can be done to avoid it does not necessarily imply that this person will take action and apply such knowledge (i.e., people may know what recycling is (knowledge) and may know how to recycle (skill), but that does not necessarily mean that they will do it). Therefore, competence is incomplete without the attitudinal dimension, whose objective is to raise awareness and mobilize society to address this important challenge, and to enable citizens to freely exercise their knowledge and skills. In this context, educational gardens have proved a suitable strategy in the frame of the current European educational model based on teaching and learning by competences, because they are capable of mobilizing the cognitive, procedural, attitudinal, and relational dimensions of learning [12].

The COVID-19 crisis has brought to light the need for green cities and schools. The results of the project carried out in France, Germany, Poland, the UK, and the USA [13] show that during the COVID-19 pandemic, urban gardens and farms adapted to become more resilient and address the challenges and opportunities that arose. Lessons should be learned for long-term planning to enable urban and school agriculture to respond to future public health, economic or other crises, as was the case in the past. All over the world, community gardens are being developed as living green welfare infrastructures in response to CC and global change, the loss of biodiversity, and the loss of the sense of community resulting from rapid industrialization and urbanization [14–16]. According to Zinia and McShane [14], green adaptations make communities more resilient to pressure from demographic change and CC, which makes them increasingly relevant in industrialized countries.

Educational gardens can be defined as any context in which to implement garden-based learning approaches, which, in turn, can be defined as instructional strategies that use gardens as a context for integrated learning through active and real-world experiences [17].

Thus, educational gardens encompass several types of green spaces, mostly in outdoor settings, such as community gardens, allotment gardens, school gardens, university gardens or any other type of space where vegetables or fruit can be grown. In recent years, these spaces are experiencing a resurgence and an increase in popularity; one of the possible reasons for this being the current environmental crisis that is driving them to go "from leisure to necessity" [18]. Although community and allotment gardens are not formal educational spaces, they can provide opportunities for environmental education and for Education for Sustainable Development (ESD) that lead to a more sustainable society since they are spaces where people could both explore and learn, and share and experience natural processes, for example, how vegetables grow [19]. The literature includes studies that show their educational value, sometimes as service-learning projects/community service projects in higher education [20] or as intergenerational learning opportunities [21]. In addition to promoting the development of the aforementioned SDGs related to CCE, gardens also contribute to the achievement of many other goals. They can undoubtedly be seen as a connecting link for Goal 2 (Zero hunger, target 2.4 ensure sustainable food production systems and implement resilient agricultural practices), Goal 3 (Good health and Well-being, target 3.4 promote mental health and well-being), 11 (Sustainable cities and communities, target 11.7 green and public spaces, in particular for women and children, older persons and persons with disabilities), Goal 12 (Responsible consumption and production, target 12.2 achieve the sustainable management and efficient use of natural resources) and Goal 15 (Live on land, target 15.9 integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts).

For several decades now, school gardens have become established as interdisciplinary tools to engage students in experiential, real-world, problem-based, and outdoor learning for health, science, environmental education, and many other disciplines. Studies have shown that gardens promote healthy nutritional habits by encouraging children to eat more vegetables [22–25], provide the health benefits of outdoor environments, such as well-being, and physical and mental health [26], and engage students in food production and consumption models [27]. Regarding emotional associations, their benefits to mental health are related to the fact that they are places where emotion can flow (they involve teamwork, physical work, controlling frustration, wondering about life processes, etc.). Gardens are also useful tools for the teaching of science across educational stages since they are used as natural laboratories that arouse students' interest and motivation towards learning [12,28] and promote inquiry-based methods [29]. In fact, previous research has shown an overall positive impact on direct academic outcomes with the highest positive impact on science followed by math and language arts [30]. Ruiz-Gallardo et al. [31] also demonstrated that garden-based learning programs could influence personal behavior and lead to a substantial decrease in dropout rates. In addition, their results showed that this approach creates a better classroom atmosphere, with a significant reduction in disruptive behavior throughout the experience. School gardens must also be a mirror of traditional allotment gardens, where nature and culture are inextricably linked, thereby everybody benefits from including diverse backgrounds and perspectives in field experiences that include human-influenced ecosystems as well as more conventional natural habitats [32].

Educational gardens also seem ideal settings to integrate the global perspective of environmental education and CCE into local action. In this regard, according to Stevenson et al. [6], CCE "cannot be confined to traditional structures and formal curriculum spaces of education but needs to draw on new informal and hybrid (e.g., school/community) spaces offering alternative possibilities for learning and action. Such spaces that provide opportunities for students to engage in inquiry/project-based and action-oriented learning include community and school gardens that allow for learning about alternative paths of food production and security, as well as creating community" (p. 70). As examples, during instruction, teachers should work on and reinforce the ideas that growing plants favors carbon sink enlargement, that a healthy soil also contributes to carbon sequestration, or that compost activities and eating local food products are a way to reduce "food miles" and carbon footprints.

Nevertheless, while there are several examples in the literature dealing with environmental education and gardens, just a few focus specifically on CC. Trott [33] documented a collaborative, multisite participatory action research project in collaboration with 10-to 12-year-old children to act on CC in Northern Colorado (USA). Her findings showed that children who participated in the garden program perceive themselves as competent and effective change agents in their families and communities because of their engagement with CC. Thus, it can be concluded that gardens favor positive environmental attitudes and climate action. A study conducted in Spain with PSTs, found that a garden-based learning program had a positive impact on students' cognitive domain regarding certain CC-related topics [34]. Finally, in a study conducted in Germany, Sellmann and Bogner [35] demonstrated that a one-day intervention involving CC in a botanical garden was an effective learning experience that led to short- and long-term cognitive achievements in the area of CC. Hence, they concluded that botanical gardens provide a unique opportunity to educate about the complexity of climate change and its consequences for ecosystems and plants in concrete terms.

1.2. Gardens and Connectedness to Nature

The increase in indoor activities, the use of video games, and online relationships, which are more pronounced among young people and children, are causing a worrying lack of connectedness to nature [36,37]. This detachment is a matter of concern, given the evidence of health and well-being benefits that human interaction with nature provides and its contribution to addressing sustainability challenges, particularly the need to embed them within ecological limits and become aware of them, and, most importantly, changes in behaviors. Some researchers have shown that connectedness to nature is associated with satisfactory early experiences, especially those linked to adventure and pleasure, such as leisure time in the wild nature [37,38] or fieldwork [32]. It is therefore necessary to offer opportunities to enjoy nature or naturalized spaces such as school gardens, even though domesticated nature experiences have a weaker effect on connectedness to nature [38]. Furthermore, promoting connectedness to nature should be made one of the goals of environmental education programs [38,39]. However, as Ives et al. [40] point out, a connection to nature must be drawn together through a transdisciplinary methodological approach and go beyond individual, local, Western scales to help guide the transformation of societies towards sustainability. Connectedness to nature is a material, experiential, cognitive, emotional, and philosophical association, and this demonstrates the importance of using multidimensional strategies to promote conservation behaviors, as we think educational gardens are [41].

Although there are quantitative studies that have questioned whether environmental behaviors consistently improved with gardening [24], it is widely assumed that experiences in outdoor settings can be significant in developing environmental sensitivity, knowledge, affective connection to nature, pro-environmental attitudes, and protective actions, and can thus contribute to the current sustainability education agenda [42,43]. Moreover, many studies have shown that using gardening made the achievement of environmental awareness relatively high, both in formal [34,44] and non-formal educational contexts [45]. Direct contact with nature cultivates bonds with it [46,47], which means, as stated by [48], that by offering experiences in nature, environmental education interventions in outdoor learning settings may not only affect knowledge and environmental attitudes but could also influence an individual's degree of connectedness to nature. Schultz [49] first defined connectedness to nature as "the extent to which an individual includes nature within his/her cognitive representation of self" (p. 67). This construct was formulated on the basis that, according to the extent to which the construction of the self includes nature, it could determine both the type of environmental awareness and behaviors of a person. In fact, previous research has demonstrated the relationship between nature connectedness and pro-environmental behaviors [47], and the positive results derived from the latter, such as happiness and well-being [49]. In addition to these findings, Pérez-López et al. [34]

also demonstrated that educational gardens could promote sustainability by increasing participants' connection to nature. Sellmann and Bogner [48] pointed out that connectedness to nature only increased directly after a one-day intervention in a botanical garden, but not in a long-term perspective. In line with this argument, [50] suggested that contact with nature can act as a way to communicate the urgency of CC to young people. Wang et al. [51] suggested that individuals with a higher degree of connectedness to nature are more concerned about the natural environment, more aware of the dangers of CC, and believe more strongly that CC is a reality. In other words, since CC acceptance has been found to be deeply determined by an individual's environmental values, to effectively face CC and increase awareness of it requires a reconnection between people and nature. As stated by Galway et al. [52], connectedness to nature has a direct positive association with individual-level climate action.

Therefore, this theoretical framework can lead to the assumption that a relationship, similar to a chain reaction, could exist between the use of educational gardens and a connection to nature, allowing the possibility to improve CCE and promote climate action.

1.3. Gardens and Preservice Teacher Education

Different research studies [53–57] have emphasized the role of teacher training in environmental issues as a fundamental pillar for new generations of teachers to acquire competences in CC and in sustainability, and to be able to implement it in their teaching work. However, there are studies that have highlighted deficiencies in socio-environmental issues or competences in sustainability in preservice teachers' (PSTs) training [58–60], as well as in that of in-service teachers [61,62]. Therefore, there is a clear need to intervene in initial and in-service teacher training so that teachers may feel able and comfortable to bring environmental education programs and ESD into the classroom that mostly focus on personally relevant and meaningful information; hence, using a variety of engaging, active, and student-centered teaching methods acquires special relevance in CCE and ESD [63].

On the other hand, a successful educational garden experience could be defined not only as one that fulfills its pedagogical objectives in the medium and long term but also as one that can be maintained over time, adapting to the different needs and changes that may occur. School garden continuity or failure, that is, school garden success, mostly depends on teachers and principals as major variables [24]. Inadequate teacher training has been identified as one of the factors that contribute to weak environmental education efforts and poor environmental literacy [64]. In this regard, a study conducted in Slovenia in a real school context demonstrated that improving science teachers' capacity to effectively lead school garden experiences is critical to developing the educational goals of such experiences [65]. Therefore, it is important to address the lack of essential pedagogical and content knowledge training of PSTs in this specific topic to achieve successful gardening experiences in their future teaching.

1.4. Purpose and Research Questions

Within this framework, this research extends the existing literature on the use of educational gardens in CCE and explores the possible relationship between their use and connectedness to nature. More specifically, considering that knowledge about teaching-related perceptions is essential for promoting effective teacher training [66], an evaluation of PSTs' perceptions of educational gardens as suitable learning environments for CCE is provided, examining their willingness to learn about sustainable agriculture and analyzing how sociodemographic factors, including gender, and their connectedness to nature, determine their use. Finally, since the results obtained can reflect their teaching performance in the future, some recommendations on preparing preservice teachers are suggested.

Specifically, the study was guided by the following research questions:

(1) Do PSTs think that educational gardens are good learning environments for CCE? If so, what sociodemographic and academic factors does this depend on?
(2) Does connectedness to nature influence the use of educational gardens in CCE?

(3) Do PSTs want to learn more about sustainable agriculture during their teacher education studies?

2. Materials and methods

2.1. Design of the Study

The study is based on a cross-sectional analytical design conducted to evaluate the perception of PSTs of the use of educational gardens in CCE, using a non-probabilistic convenience sampling procedure. Data collection was performed through an online questionnaire that was administered during the months of September and October (at the beginning of the first semester) of the 2021/2022 academic year. The link to the questionnaire was provided to the students at the beginning or end of their university classes. Data collection took place outside of any specific educational intervention and did not take into account any possible interventions that students could have previously experienced in educational gardens. In that sense, it should be noted that the university campuses of Ávila, Zamora, Ciudad Real and Soria have educational gardens and some students of the education degrees could have carried out practical work in these environments prior to the completion of the questionnaire. All the PSTs who participated in this study did so voluntarily and provided their consent.

2.2. Participants

The study population is made up of university students who were studying higher education teacher programs: Early Childhood Education Degree, Primary Education Teacher Degree, Double Degree in Early Childhood Education and Primary School Education Teacher and Secondary Education Teacher Master's Degrees, Table 1 shows the number of participants at 4 Spanish universities (Universities of Castilla la Mancha, Salamanca, Valencia, and Valladolid) and 9 different campuses and cities (Albacete, Ávila, Zamora, Salamanca, Segovia, Valladolid, Ciudad Real, Valencia, and Soria), located in three autonomous communities of Spain (Castilla y León, Castilla la Mancha, and Valencia), covering a large area of the Spanish state. A convenient and non-probabilistic sample of 889 students was obtained. Their ages ranged from 18 to 47 (mean = 21.32, SD = 3.5) and the majority were women (72.3%), which reflects the reality of the Spanish teacher population (it is common for the Spanish non-university teacher population to be mostly female; more specifically, in the Spanish education system, 66.9% of teachers are women, a number that significantly increases to 97.6% in Early Childhood Education [67]). In total, 59.6% of the sample were studying for a degree in Primary Education, 18.4% were enrolled in the Double Degree in Early Childhood Education and Primary School Education, 14.2% were studying for a degree in Early Childhood Education, 7.3% were enrolled in Secondary Teacher Education Masters (major in science and technology), and, finally, 0.4% were studying other educational programs.

Table 1. Demographics of the sample.

Type of PST\Gender	Male		Female		Total	
	f	%	f	%	f	%
Early Childhood	7	5.6	119	94.4	126	100
Primary	187	35.3	343	64.7	530	100
Double degree	24	14.7	139	85.3	163	100
Secondary	27	41.5	38	58.5	65	100
Other	2	40	3	60	5	100

2.3. Instrument

The data used in this research were collected via an online survey as part of a larger study that measured the three dimensions of the Climate Change Competence. The survey had two parts. The first gathered simple sociodemographic information and academic aspects of the participants (age, gender, place of birth, university teacher education studies, course, university, and center of study), and the second, which was composed of three questions, explored PSTs' perception of their connectedness to nature, gardening, and CCE, and their interest in learning more about sustainable agriculture.

Connectedness to nature was measured using Schultz's Inclusion of Nature in Self (INS) seven-point Likert scale [49]. In this scale, participants are asked to select the image that best describes their relationship with nature from a series of seven Venn diagrams, which use pairs of circles with varying degrees of overlap, each circle pair containing the words "Self" or "Nature". Circles with no overlap (value = 1) indicate less interconnectedness, whereas complete overlap represents a closer relationship between the self and nature (value = 7).

Secondly, to understand students' willingness to use gardens, the participants were asked to rank, from highest to lowest, the resources and tools they considered most appropriate for teaching CC. A list of 7 common resources used in CCE and sciences and social sciences education in Spain was provided [63,68–70]. These are listed as follows: hands-on experiments, audio-visual and digital resources, games, gardens, models, textbooks, and media.

The third question asked about PSTs' interest in learning more about certain topics related to CC during their teacher education studies. We provided to the students a list where they could mark more than one of the following topics: energy and CC, nutrition, health and CC, sustainable agriculture and CC, biodiversity and CC, responsible consumption and CC, physical and chemical principles of CC, mitigation and adaptation of CC, and didactics of CC.

2.4. Data Analysis

The aim of the study was achieved using a four-step data analysis procedure. The first step involved the exploratory analysis of the data (median, mean and standard deviation, normality). In the second step, a Friedmann ANOVA test was carried out to establish the differences in the order of educational resources (experiments, textbooks, audio-visual and digital tools, media, educational gardens, games, and models) in CCE. In addition, the effect size for the Friedman ANOVA, called Kendall's W (coefficient of concordance), which determines the effect of the agreement on individuals, was calculated. Kendall uses Cohen's interpretation, whose values 0.1 and 0.29, 0.3 and 0.49 and above 0.5 are considered small, medium, and large effect sizes, respectively. In the third step, a chi-square test was applied to determine associations between categorical variables such as gender, PSTs type, and CC-related topics required to expand knowledge associated with the importance of gardens as an educational resource. The gamma value was calculated to establish the effect size for the chi-square test. This value is interpreted as the percentage of prediction that one variable has on another, and it also provides information on strength and direction. According to Healey [71], the strength of the relationship between the two variables is defined by values between 0.00 and 0.30 (weak), 0.31 and 0.60 (moderate), and above 0.60 (strong). However, when one of the categorical variables (such as PST) involves more than four categories, it is necessary to add the standardized residuals. These are useful to identify which combination of the categorical variables could deviate significantly from the expectation of the null hypothesis when they have an absolute value greater than or equal to 2 [72]. In addition, their sign indicates the direction of the association. The Bonferroni correction was used to control type I error. Finally, a non-parametric Mann–Whitney U test was run to assess whether PSTs who want to learn about sustainable agriculture have a greater connection to nature than those who want to learn about other topics, also determining how significant these differences were. The effect size for the Mann–Whitney U test was also calculated. According to Cohen [73], values between 0.20 and 0.49 are regarded as small differences, 0.50 to 0.79 as moderate differences, and values above 0.80 as large. All the analyses were performed using SPSS 26.

3. Results

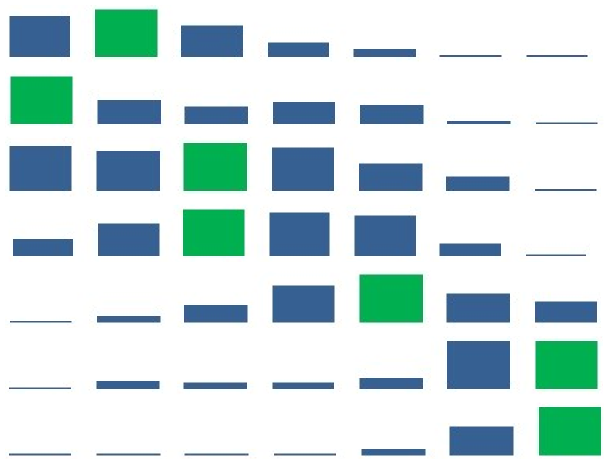
The purpose of this study was to explore PSTs' perception of the use of educational gardens in CCE. The results obtained in relation to the research questions are presented below:

3.1. Research Question 1. Do PSTs Think That Educational Gardens Are Good Resources for CCE? If So, What Sociodemographic Factors Does This Depend on?

As can be seen in Table 2, PSTs considered experiments (mean rank = 2.45) and audio-visual resources (mean rank = 2.71) as the most valuable for CCE in comparison with the others, leaving educational gardens in the third position (mean rank = 3.17). By contrast, media, textbooks, and models (mean rank = 5.94, 5.38, and 4.76, respectively) were considered less valuable. Furthermore, 58.8% of the students placed gardens in the first three positions (1, 2, and 3 values), 19.4% in a neutral position (4 value), and 21.8% in the last three positions (5, 6, and 7). Specifically, 19.7% (*n* = 175) of the students selected educational gardens as the most valuable resource for CCE, and only 1.91% (*n* = 17) ranked them in the last position.

Table 2. Descriptive analyses of the resources for teaching CC, *n* = 889.

				Rating of Resources						
Position	Resources to Teach CC	Mean Rank	SD	1	2	3	4	5	6	7
1st	Experiments	2.45	1.342							
2nd	Audio-visual and digital tools	2.71	1.624							
3rd	Educational gardens	3.17	1.62							
4th	Games	3.59	1.518							
5th	Models	4.76	1.453							
6th	Textbooks	5.38	1.771							
7th	Media	5.94	1.493							



Note: CCE climate change education.

In order to analyze whether there was a difference in the ratings of the usefulness of the CC's teaching resources, we used the non-parametric Friedman ANOVA test. The results revealed a significant difference among the educational resources for CCE, $\chi^2(6) = 2129.15$, $p < 0.001$. We ran a Dunn–Bonferroni post hoc test that indicated that there were significant differences between educational gardens and other resources for CCE, media ($p < 0.001$), textbooks ($p < 0.001$), and models ($p < 0.001$). Kendall's W was 0.40, which reveals a large effect size and good agreement between PSTs in ranking the usefulness of CC's teaching resources.

Aiming to analyze the reasons why PSTs consider educational gardens valuable resources for CCE, several comparisons with the available sociodemographic and academic data were made. There was a statistically significant association between PSTs who rated the importance of educational gardens (1 to 7 scale, 1 being very important and 7 being less important) and gender (χ^2 (6, n = 888) = 55.07, $p < 0.001$). The relevance given to school gardens as a primary resource for CC teaching was higher in female PSTs than in male PSTs (Table 3). According to gamma (0.336), this relationship was positive and moderate. A positive gamma means that column percentages tend to drop from upper left to lower right on the diagonal. The top positions ranking educational gardens as valuable tools for CCE were more likely to be given by female PSTs. Once again, this indicates a "positive" relationship because of the coding scheme: higher scores on the row variable (2) are associated with higher scores on the educational gardens variable (between 5 and 7).

Table 3. Educational gardens as an essential resource for teaching CC according to gender, *n* = 888.

		Educational Gardens							
Gender		1	2	3	4	5	6	7	Total
(1) Female	*f*	149	120	147	121	64	35	6	642
	%	23.2	18.7	22.9	18.8	10.0	5.5	0.9	100
(2) Male	*f*	26	40	40	51	46	32	11	246
	%	10.6	16.3	16.3	20.7	18.7	13.0	4.5	100

On the other hand, there was a statistically significant association between PSTs who rated the importance of educational gardens (1 to 7 scale) and PSTs' type of study (χ^2 (18, *n* = 885) = 31.69, *p* = 0.024). Of the 28 combinations between both variables, five showed standardized residuals with an absolute value above 2 (Table 4). This explains that these combinations presented a lack of fit of H0. However, after applying the Bonferroni correction, the only statistical significance was found when the PSTs studying the Double Degree ranked educational gardens as 1 ($p < 0.001$). This explains why these are the ones that possibly score the best for this teaching resource.

Table 4. Educational gardens as an essential resource for teaching CC by type of PST with standardized residuals in parentheses, *n* = 885.

		Educational Gardens							
Type of PST		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
(1) Early Childhood	*f*	25 (0.1)	22 (−0.2)	30(0.9)	28(0.9)	16(0.1)	4(−2.1)	1(−1.0)	126
	%	19.8	17.5	23.8	22.2	12.7	3.2	0.8	100
(2) Primary	*f*	95 (−1.6)	95 (−0.1)	109(−0.3)	103(0.0)	68(0.6)	47(1.6)	13(1.4)	530
	%	17.9	17.9	20.6	19.4	12.8	8.9	2.5	100
(3) Double Degree	*f*	49 (3.6)	33 (0.8)	31(−0.7)	22(−2.2)	16(−1.1)	12(−0.2)	1(−1.4)	164
	%	29.9	20.1	18.9	13.4	9.8	7.3	0.6	100
(4) Secondary	*f*	5 (−2.5)	10 (−0.6)	31(0.4)	22(2.1)	16(0.4)	12(0.0)	1(0.7)	65
	%	7.7	15.4	23.1	29.2	13.8	7.7	3.1	100

3.2. Research Question 2. Does Connectedness to Nature Influence the Use of Educational Gardens in CCE?

In relation to connectedness to nature and the usefulness of educational gardens for teaching CC, no significant differences were found (r = −0.049, *p* = 0.143). In other words, connectedness to nature and the use of educational gardens are variables that are not related in the studied sample. In general terms, PSTs were moderately connected with nature (mean value = 4.12 (over 7), SD = 1.35). Surprisingly, the highest mean value (mean = 4.41) in the connection with nature was obtained by students who placed educational gardens as useful environments to teach CC in the last position. By contrast, students who ranked educational gardens in the first position scored the second highest value (mean = 4.24). Students who put educational gardens in fifth position scored the lowest value (mean = 3.83) of connectedness to nature.

3.3. Research Question 3. Do PSTs Want to Learn More about Sustainable Agriculture during Their Teacher Education Studies?

Analyzing the question about which learning topics related to CC could be incorporated into teacher education studies, 81.9% of the PSTs expressed their interest in learning more about nutrition, health and CC, followed by responsible consumption and CC (72.5%), energy and CC (53.0%), biodiversity and CC (46.6%), sustainable agriculture and CC (41.1%), didactics of CC (36.8%), mitigation and adaptation of CC (20.1%), and physical and chemical principles of CC (12.49%). Therefore, sustainable agriculture related to CC aroused moderate interest among students.

We also analyzed whether students who ranked educational gardens for CCE in the first position wanted to learn more about sustainable agriculture. As shown in Table 5, there was a statistically significant association between PSTs who rated the importance of educational gardens (scale 1 to 7) and sustainable agriculture as a topic that should be learned (χ^2 (6, n = 889) = 30.55, p <0.001). According to gamma (0.210), this relationship was positive and weak. Therefore, students who indicated that educational gardens are ideal learning environments for CCE were keen on learning more about sustainable agriculture.

Table 5. Educational gardens as an essential resource for teaching CC as a topic to learn, n = 889.

		Educational Gardens							
Topic to Learn		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
(1) Sustainable agriculture	*f*	97	68	82	49	38	23	8	365
	%	26.6	18.7	22.5	13.5	10.4	6.3	2.2	100.0
(2) Other topics	*f*	78	92	105	123	72	45	9	524
	%	14.9	17.6	20.0	23.5	13.7	8.6	1.7	100.0

We analyzed whether PSTs who wanted to learn more about sustainable agriculture had stronger connectedness to nature as compared to those who chose other topics to learn about. Interestingly, the non-parametric Mann–Whitney U test revealed that PSTs who scored higher on connectedness to nature wished to broaden their knowledge of sustainable agriculture (Table 6). The effect size was small (0.15), which means that closer connectedness to nature seems to be unrelated to the use of learning gardens to teach CC, although it is significantly associated with the wish to learn sustainable agriculture.

Table 6. Comparative analysis between learning about sustainable agriculture related to CC and its connectedness to nature.

	Topic to Learn	***n***	**Med**	**M**	**SD**	**Z**	**MWU p**	**r_B**
Connectedness with nature	Sustainable agriculture	365	4.00	4.33	1.41	−7.49	<0.001	0.15
	Others	548	4.00	3.97	1.29			

n: sample size; Med: median; M: mean; SD: standard deviation; MWU p: Mann–Whitney U t-test and r_B: rank biserial correlation (effect size).

4. Discussion

4.1. Educational Gardens and Climate Change Education

The aim of this paper was to analyze PSTs' eagerness to use gardens as learning environments for CCE. The data demonstrate that a notable percentage of PSTs (58.8%) consider educational gardens as good learning environments for addressing sustainability and global CC. Specifically, a surprising 19.7% (n = 175) of the students selected gardens as the most useful resource for teaching CC and only 1.91% (n = 17) placed them in the last position. Gardens were ranked ahead of other widely used didactic indoor tools in environmental education, such as games, media, textbooks, or models. In the Spanish context, the high percentages achieved by the use of gardens for CCE are in accordance with the general data reported in the province of Seville, where 21.1% of primary teachers use school gardens in their daily routine to teach sciences [29]. Nevertheless, it is not consistent with the data provided in a study involving retired Spanish primary education teachers on the use of educational resources in science and social sciences education [68], which reported that only 5% of the teachers sporadically used school gardens to teach natural and social sciences. The percentage obtained in our study is also higher than that condensed by Blatt and Patrick [74] for PSTs in the southeastern United States, who reported that only 6.8% of PSTs discussed the possibilities of outdoor teaching through gardening. These discrepancies in using gardens to specifically address CC may be explained in two different ways. Firstly, PSTs are clearly aware that gardens are suitable environments to develop key aspects of CCE. That is, as mentioned before, gardens are real-world contexts that promote critical thinking skills while also engaging students in interdisciplinary and experiential learning about their local environments, food production, or global environmental change. Secondly, educational gardens are currently growing in popularity in most western countries. In the case of Spain, in recent years, higher education institutions have taken important steps towards the use of gardens as learning environments to teach science in the teacher training and to facilitate the development of students' competencies [12,75]. Thus, this effort could have impacted students' previous gardening experiences, playing an influential role in their enthusiasm for gardening. This argument is consistent with the study of Blatt and Patrick [74], who concluded that PSTs with positive outdoor experiences often have positive views of the environment and are also more willing to teach outdoors in their future careers.

The results also indicate, in an implicit manner, the importance that many PSTs give to outdoor education in CCE over other indoor educational resources. This perspective agrees with the data reported by Blatt and Patrick [74], who pointed out that many PSTs expressed a desire to expose their own students to nature (65.5%) and take them outdoors (56.1%). In this regard, it should be remembered that educational gardens have a number of advantages over other types of outdoor learning [76]: they are highly accessible, their cost is relatively low, health and safety issues are easily managed, and they are also available at all times throughout the year. Moreover, according to Prince [77], outdoor experiences can result in action and significant changes towards sustainable practice and pro-environmental behavior. Considering that many people, despite believing in CC, do not engage in climate mitigation actions [78], outdoor garden-based learning could promote changes in behavior to engage in climate action.

As to gender differences regarding the usefulness of gardens as learning environments to teach about CC, the data reported herein indicate that there are significant effects according to teachers' gender. The relevance given to school gardens as a primary resource for CC teaching is higher in female PSTs than in male PSTs, suggesting that it will be mostly women who will initiate and guide transformative approaches by participating in the design and implementation of educational gardens, and thus, any attempts to achieve sustainability and CCE through gardening that are not gender inclusive will be deficient. Nonetheless, the results obtained are somewhat controversial in the literature. In the Spanish context, our results disagree with the data reported by Corrochano et al. [68], who indicated that teacher gender was unrelated to the use of educational gardens in primary education. On the other hand, the findings are consistent with the results reported in a study on the use of urban green spaces as learning contexts in primary education in Zamora (Spain), where female teachers used these spaces far more often (79.1% vs 20.9%) than male teachers [79].

As noted in previous research, women have modestly stronger pro-environmental values, beliefs, and attitudes than men [80], while they are more emotionally engaged and show more concern about environmental destruction [81]. A study carried out with PSTs in Turkey showed that the attitudes of female PSTs towards the environment are more positive and that they engage in more pro-environmental actions than their male counterparts [82]. Indeed, it is well known that women express greater concern about CC than men [83]. However, what are the factors that make women more inclined to promote gardens in CCE than men, as evidenced in the present paper? Further research is needed to shed light on this aspect, although some plausible responses could be hypothesized. Firstly, most of the world's farmers are women growing for subsistence [84], gardens contribute to female empowerment [85,86], and gardening causes more emotional well-being in women than in men [87], so it is to be expected that women would be more inclined to promote and use this type of educational resource than men. On the other hand, the observed discrepancies may be related to the existence of gender differences in environmental attitudes that promote contact with nature and outdoor learning in the daily teaching routine. Finally, gender differences could be related to the university training that is delivered since the Degree in Early Childhood Education, which is more centered on hands-on learning than the others, is more popular among female students (Table 1). In this sense, the results may be indicative of the ethic of care. In Eastern European gardens, specifically in the Czech Republic, no gender differences were reported [88] but a clear ethic of care was found: caring for the land goes hand in hand with caring for others (both humans and other living things). These caring behaviors tend to be more strongly associated with the female world, especially with professions historically associated with women such as nursery or early childhood teachers.

There is also a noticeable and progressive decrease in PSTs' perception of the usefulness of gardens in CCE when they are training to teach higher educational levels. In other words, Early Childhood and Double Degree PSTs are strong supporters of gardening, whereas primary and secondary education teachers regard them with growing suspicion. In the context of this research, while early childhood education insists on the importance of hands-on and student-centered activities, secondary teacher education maintains a more traditional approach. This may be related to the type of pedagogical training they receive at university. Teacher education in Spain is organized so that secondary school teachers access the one-year-duration master's degree after a scientific or technological bachelor's degree. Primary Teacher and Early Childhood Education Teacher Degrees do not involve specialization in any environmental sciences. Thus, when they completed the questionnaire, secondary teacher students were at the beginning of their pedagogical training period and had probably had more traditional environmental learning experiences, and may, therefore, have been unsure about inquiry-oriented and hands-on based teaching methods. However, those enrolled in kindergarten and primary teacher studies were fully involved in educational approaches and pedagogical innovations.

4.2. Connectedness to Nature and Educational Gardens

Other relevant data yielded by this study are PSTs' connectedness to nature and its relationship with educational gardens. PSTs considered their connectedness to nature as moderate, with score values around five, which is lower than those reported in other studies with Spanish PSTs using the INS scale [34].

The data collected in this paper reveal no significant differences regarding teachers' connectedness to nature and their willingness to use educational gardens. In other words, scoring high on the connectedness to nature scale does not mean that the teacher believes gardens to be good educational contexts for working on environmental issues, in this case CC. According to Pérez-López et al. [34], the connection to nature shown by PSTs is more related to cognitive than to emotional or attitudinal aspects. This might explain the lack of relationship between connectedness to nature and willingness to use gardens displayed by the participants in our study. The next question to be addressed in future research is the extent to which new experiences in nature, such as garden-based learning, could promote connectedness to nature.

Despite all the above, one of the most relevant findings of this paper is the existence of a significant relationship between students' connectedness to nature and their wish to broaden their knowledge about sustainable agriculture. This may indicate that the degree of connectedness to nature may predict environmental attitudes, each influencing the other.

4.3. Learning about Sustainable Agriculture in PSTs' Initial Education

In a more general context, the reasons and barriers involved in teachers using or not using educational gardens in their daily routine could be contrasted with the data presented herein. In the literature, there seems to be something of a division between garden enthusiasts and those who are unconcerned with the potential that educational gardens might offer [76]. Blair [24] notes that "the very qualities that render school gardening a potent and multidimensional experiential learning experience—being outdoors and involved in hands-in-dirt digging, planting, and cleanup—may render it unpopular with teachers who prefer the safety, predictability, cleanliness, and ease of the indoor classroom". The results provided by [88] indicated that lack of time (67%), lack of teacher interest (63%), lack of experience (61%), and lack of knowledge (60%) were major barriers to using gardening for instruction. Interestingly, whereas the first could be considered a structural barrier, the last three factors could be achieved through teacher education at universities. In that sense, our data indicate that students are moderately keen on receiving training in the area of sustainable agriculture during their teacher education degrees. However, it is noteworthy that PSTs who are interested in learning about sustainable agriculture are twice as convinced that school gardens are a primary resource for CCE as PSTs who are interested in learning about other topics. Moreover, teachers with some agricultural training are more likely to use school gardens as learning environments [24]. Thus, it seems necessary to promote sustainable agriculture education programs in teacher education studies, so that all teachers can feel prepared to use gardens for addressing sustainability and the challenges of global CC. PSTs must experience and learn how to carry out experiential teaching in a school garden, just as they have to learn how to prepare inquiry-based lessons at the school laboratory, thinking in terms of minds-on activities and hands-on activities. PSTs need to be familiar with the entire process involved in the use of a school garden, from planning, through participation, to site selection, design, and construction. It may be meaningful for them to use the existing school gardening data and school and university networks [43,89] as part of the green schools movement all over the world [90].

Agriculture is directly dependent on climatic conditions and, thus, the Mediterranean region is especially exposed to CC [91]. Currently, agriculture has two sides, positive and negative, that depend on the management system used, the balance favored, or the sustainable practices followed. On the one hand, agriculture has negative effects because it contributes to the emission of greenhouse gasses into the atmosphere, and because the use of pesticides and biocidal products may negatively affect the surrounding water quality and other benefits or ecosystem services that nature provides us. On the other hand, agriculture can also contribute to sequestering atmospheric carbon and continue to produce the food we need while preserving the system's capacity to provide further ecosystem services that contribute to humans' well-being and to sustainability. In Spain, in addition to the industrial agricultural farms, there are traditional allotments in a large part of the territory, and they form part of the rural and even urban landscape in some areas of the country, associated with riverbanks. Vegetable gardens are part of the traditional culture and, nowadays, of the leisure time of many families, and it is not surprising that, in the current context, a large number of education students are calling for more training in this aspect to be able to put it into practice in their professional development. Therefore, it is essential to provide new generations with the fundamental scientific knowledge that underpins sustainable agricultural production.

Finally, this study has some limitations that should be highlighted. Firstly, students were not randomly selected, and the sample used was not representative of the entire reality of Spain. However, the elevated sample size (n = 889) and its wide geographical distribution in four different universities ensure robust representativeness. Although, in general, it is difficult to access school classrooms and teachers in Spain, it would be interesting to compare our data with the in-service teacher's daily routine to avoid potential biases regarding PSTs' perceptions of their future teaching. It would have been interesting to examine the previous academic exposure of PSTs to educational gardens and to the natural environment since earlier experiences could have influenced their connectedness to nature and their perception of gardens. Future research should look more deeply into the relationship between educational gardens and gender and its association with connectedness to nature.

5. Conclusions

As summarized in this paper, gardens provide powerful outdoor educational contexts for addressing the challenge of CC and fostering climate action. Our results indicate that a significant percentage of PSTs (58.8%) consider educational gardens to be suitable learning environments to teach about CC. Thus, they are well-disposed towards learning more about them and using them in their future teaching. Gender and the type of university degree were also found to play a significant role in this positive perception, revealing that women are more likely to use educational gardens than men, which probably indicates that female PSTs have more positive attitudes and stronger pro-environmental values and beliefs. The findings also indicated that Early Childhood and Double Degree PSTs are the most willing students to use gardening, whereas Secondary PSTs are the most reluctant. This suggests that the type of pedagogical instruction they receive plays a key role in their perception and highlights that training efforts should focus on the latter educational level. Although statistics revealed that the variables connectedness to nature and use of educational gardens are not significantly related, high scores on the former are associated with the wish for students to broaden their knowledge about sustainable agriculture. Therefore, it is possible to assume that the degree of connectedness to nature may predict environmental attitudes, each influencing the other.

To encourage students' willingness to use gardens in their future educational practice and their wish to broaden their knowledge about them, along with an awareness that many PSTs will have the responsibility for taking their pupils into gardens or into nature, providing knowledge, resources, and experiences related to educational gardens (and many other outdoor experiences) is essential during teacher training studies. In fact, as suggested in previous studies [92], teacher education should play a key role in facilitating PSTs' use of outdoor learning in their future teaching. To address the global challenge of CC, higher education institutions should empower PSTs to use their environmental competencies, such as problem solving of environmental issues or critical thinking. University teachers and academic authorities should consider incorporating garden-based learning and sustainable agriculture into the curriculum, either through a specific subject, through a broader outdoor learning program, or by integrating it into other subjects related to environmental education.

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