Original Paper

Urban vegetable gardens as an environmental education tool for promoting primary school students' engagement in EU Green Deal strategies

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Received: 28 August 2022 | **Accepted:** 17 December 2022 | **Published:** 22 December 2022

Keywords: sustainable cities; organic farming; hands-on; composting.

Abstract. *The Green Deal is a European Commission initiative to promote zero net emissions of greenhouse gases by 2050 in the European Union. Its multiple strategies, including circular economy and agriculture, should impact on all citizens. Environmental Education programs are powerful tools to improve literacy in sustainability concepts, namely those included in the*

Green Deal strategies, and to foster environmental attitudes. A hands-on pilot project "Nutrients Boomerang" was developed and implemented as part of the Environmental Education strategy of a Portuguese science centre, Fábrica Ciência Viva, to assess its applicability in a primary school environment. The project included the implementation of an outdoor model area, focusing on urban vegetable gardening and composting, complemented with workshops on biodiversity, circular economy, and organic farming, targeting primary school students and teachers. This pilot project was implemented from January to September 2021 and, in its final months, was also organized in a way to include the students' families, given their willingness to introduce parents and grandparents to the activities they had been doing. This pilot project showed its suitability to be replicated in primary school outdoor green areas and to promote hands-on activities aiming to inform people about the European Union Green Deal policy and foster a more conscientious behaviour in young students towards a more sustainable world.

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1. Introduction

Climate change has potentially negative consequences across the globe, including sea-level rise, climate instability, and increased frequency and/or intensity of droughts, floods, and wildfires (IPCC, 2018). The impact on forests and oceans could, directly or indirectly, place at risk of extinction every one of the eight million species existing on the planet (European Commission, 2019). The Mediterranean region is particularly sensitive to such alterations and is considered a climate change hotspot (Michaelides et al., 2018). This pressures Southern European countries to search for solutions to increase resilience and resource sustainability. Sustainability is seen as the paradigm where environmental, social and economic perspectives come together for the development of a just and prosperous future (UNESCO, 2012). The Rio Declaration mentions (UN, 1992) 27 broad principles for sustainable development, including equity among generations, gender equity, peace, tolerance, poverty reduction, environmental preservation and restoration, natural resource conservation, and social justice

(Agbedahin, 2019). Closely associated with sustainability is the concept of Circular Economy, which recently gained relevance on the European policy agenda (European Commission, 2020). Geissdoerfer et al. (2017) define Circular Economy as a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. According to the authors, such a system should be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling (Geissdoerfer et al., 2017). For the European Commission, a circular economy could be decisive in reaching the 2050 Green Deal goals while guaranteeing competitive European economies and decoupling economic growth from resource use (European Commission, 2020).

Scientific research can bring awareness of the problems faced by mankind while contributing with solutions. Science outreach enhances the positive contributions of scientific research by reaching the public and helping to change behaviours. In agriculture, for example, consumer choices can influence the market and so have a significant contribution to agro-biodiversity preservation (Botelho et al., 2018). In a circular bioeconomy, it is essential that public behaviour contributes to closing resource circuits, minimizing the extraction of natural resources, and ensuring that most products are recycled or composted at the end of their lives (Tan, 2021). In this sense, the European Commission states that schools, training institutions and universities are well placed to engage students, families, and the overall community in pursuing the required changes for a successful transition towards no net emission of greenhouse gases by 2050 (European Commission, 2019).

Environmental Education (EE), a discipline of science outreach, has become more relevant in the past forty years with an increasing number of research studies and with a focus on outdoor education, education for sustainable development and environmental literacy, among others (Rickinson, 2001; Stern et al., 2014; Ardoin and Bowers., 2020). According to the North American Association for Environmental Education's (NAAEE, 2022) EE "is a process that helps individuals, communities, and organizations learn more about the environment; develop skills to investigate their environment; and make intelligent, informed decisions about how they can help take care of it. It has the power to transform lives and society. It informs and inspires. It motivates action. EE is a key tool in creating healthier and more civically engaged communities" (p. 000) The creation of new patterns of behaviour in individuals, groups, and society was included in the outcomes of the EE by the Intergovernmental Conference on Environmental Education (UNESCO, 1977). In order to be effective in helping acquire new knowledge, and changing attitudes and behavior-related outcomes, EE program design is of major relevance (Heimlich, 2010), particularly to target behavioural outcomes. Active participation, Hands-on observation and discovery, Place-based learning and Outdoor instruction are some of the program characteristics that are associated with the best practices and outcomes (Stern et al., 2014).

With a strong influence in EE, Education for Sustainable Development (ESD) is now considered interdisciplinary and transdisciplinary, given that all disciplines, individually and/or collectively, can be involved with it (Agbedahin, 2019). According to UNESCO, ESD empowers learners to make informed decisions and take responsible actions for environmental integrity, economic viability, and a just society, for present and future generations, while ensuring respect for cultural diversity (UNESCO, 2018). ESD has recently gained visibility with the United Nations Decade of Education for Sustainable Development (2005-2014) and is currently part of Sustainable Development Goal 4 and a key enabler of all the other goals (UN, 2015). Educational communities teaching sustainability should thus integrate into the curriculum each of the three components of sustainability, environment, society, and economy, reflecting current knowledge and respecting local contexts and national goals (UNESCO, 2012).

Schoolteachers can have a strong influence on their students' behaviour and should be a privileged target for EE and ESD sessions. To become efficient, teachers must have the opportunity to acquire knowledge, part of it coming from ecological research, as well as teaching methodologies (Chatzifotiou, 2006). Gardens and green spaces inside schools are natural stages for EE and ESD sessions and can be improved to serve as models, allowing proximity to relevant subjects, such as biodiversity and sustainable food systems, benefiting from a daily presence in students' lives (Ferguson et al., 2019; Cortegano et al., 2021).

The main goal of this study was to develop a pilot EE/ESD program focused on circular economy and the sustainability of the food system following the European Commission Green Deal guiding principles and targeted at primary school students and teachers. This EE/ESD program was named the "Nutrients Boomerang" project and was composed of a physical area and a series of planned sessions. By promoting waste management and sustainable consumption habits, it aimed to achieve the target of public awareness of natural resource depletion and the need to make a transition to a circular bioeconomy. It was also expected to allow for a gradual transition, through behavioural adoption of a sustainable food system from production to consumption, towards fairer societies in balance with nature and potentially be used as a model for primary school EE and ESD programs. It could jointly contribute to the fulfilment of national, European, and international commitments assumed by Portugal in the field of sustainability. The main objectives were:

1. Implement a Pilot model (name used throughout this work) of circular bioeconomy, based on four components: composting, drip irrigation, organic garden, and a resulting attractive urban green space landscape
2. Develop and streamline a set of EE/ESD sessions, supported by the Pilot model, within the subjects of sustainable production and conscious consumption.
3. Assess its replicability on primary school grounds by promoting a group of sessions with both students and teachers.
4. Contribute to literacy in environmental, biological resources conservation and sustainability, through the presentation of Green Deal strategies.
5. Promote circular economy attitudes, fostering citizens' behaviour to separate urban bio-residues and so contribute to achieving European Commission goals while ensuring adequate management of urban waste.

2. Materials and methods

The "Nutrients Boomerang" project was developed as part of an ongoing EE program at Fábrica Ciência Viva Science Centre (FCCV). This Science Centre is part of the University of Aveiro, Portugal, and supported all stages of the project implementation. The project included components that related to each other during the sessions with the primary school students: the Pilot model and the Environmental Education/Education for Sustainable Development (EE/ESD) Strategy. The Pilot model was named "Botanic Garden", and the EE/ESD strategy, supported by the Pilot model was developed for the educational sessions with the students. This strategy was also designed to reach other audiences, such as families and the public in other devoted sessions.

2.1. The pilot model "botanic garden"

The Pilot model included four components: i) composting, including the biotechnology for nutrient recovery from materials classified as urban bio-residues and the use of the resulting compost as an agricultural fertilizer; ii) the drip irrigation system, consisting of a reservoir to collect and store rainwater from gutters and a drip irrigation system to distribute and optimize the water resources; iii) the organic garden, designed using ecologically-based solutions in order to stimulate biodiversity and ecosystem services, as an alternative to the use of pesticides, inspired in the European Regulation for Organic Agriculture (European Council, 2007); iv) an urban green space landscape, the global sensitive effect of the previous three components as a social benefit, providing a cultural, recreational and educational space through the citizen's contact with nature.

2.1.1 Composting

To implement this component three types of composting technics were used: the horizontal pile - to set the raised garden beds, the vertical bin - to collect urban bio-residues and complete the landscape, and the vermicompost - to be used in the EE/ESD sessions.

Horizontal pile

The horizontal pile was built on the location of the future vegetable garden by piling up gardening bio-residues over the bare ground. The pile was covered with a tarpaulin (an old canvas) in order to minimize the loss of water through evaporation. The gardening bio-residues consisted of a mixture of dry leaves from deciduous trees, crushed twigs, and fresh-cut grass from city gardens, with an ideal Carbon/Nitrogen ratio for a composting process (Chojnacka et al., 2020). It consisted of about 5 tons of material collected during January 2021 and was offered by a local gardening company. The compost pile was turned over 3 times during a 3-month period (January to March) and the resulting mature compost, weighing about 1 ton, was used for the construction of the raised beds in the circular and rectangular vegetable gardens. The 5 tons piled on the ground, at a single moment had the optimal volume to generate heat, due to the biological activity (essentially bacterial decomposition), warming the pile during the first days. Although not measured, it was predicted that the temperature at the centre of the pile reached 60 to 70 ºC (De Corato, 2020).

Vertical bin

The vertical bin was built with used wood pallets for a final volumetric capacity close to 1.5m^3. It was filled with approximately 50kg of urban bio-residues collected from a city restaurant, 150kg of dry straw and 300kg of fresh grass cuts. After 6 months of maturation (January to June), the volume reduced to about

0.5m^3. During this process there were moments where methane and ammonia odours were perceived, which were solved with the addition of dry straw to balance moisture. No disturbance to the neighbourhood was created at any time, since the compost was always located far from the buildings and in an area of strong aeration. Also, a net was placed inside the bin to prevent the entry of micro-mammals, such as small rodents, attracted by food residues. In urban areas, both issues are of great relevance for the success of the experiment.

Vermicompost

The vermicomposting was created exclusively for the EE/ESD sessions to demonstrate how it is possible to compost without a garden space. Moreover, this system supported the activities related to the nutrients cycle by providing compost as well as earthworms and small insects for observation with a magnifying glass. It was a simple system composed of 3 plastic boxes, 45 cm long, 25 cm wide and 25 cm high, all with covers. The boxes were placed on top of each other, in a pile, and the top two were perforated to allow the passage of the earthworms between the boxes. The system was constructed in March and started with the earthworms in the middle box. After 2 months (May) all earthworms had migrated to the top box, the bottom box collected liquid from the decomposition process and the middle box saved the resulting compost (fertilizer). The vermicompost was used in workshops 1 and 2, when the earthworms were fed from the top box during the EE/ESD sessions and the students could touch, smell, and observe them with a magnifying glass inside a Petri dish box.

2.1.2. Drip irrigation system

The Drip irrigation component included a rainwater collection and storage system, consisting of a 1 m^3 reservoir, connected to the gutter of the building, and the irrigation strips for the circular and rectangular vegetable gardens. The reservoir was installed with a slope gradient that would provide irrigation by gravitational force through the drop-by-drop system. It was necessary to apply water filters to the gutter water collection tube to prevent residues in the lower gauge piping of the drip system.

2.1.3. Organic garden

The organic garden component consisted of an organic food production vegetable garden, inspired by the European Regulation for Organic Agriculture (European Council, 2007). It was created in an overlooked outdoor area of FCCV with compacted soil covered with weeds (Figure 1).

Figure 1. The outdoor space in Fábrica Ciência Viva Science Centre where the project was installed.

Due to the high degree of compaction of the soil, the vegetable beds were manually aerated with a broad fork. The cultivated area was distributed in two distinct gardens: a circular garden inspired in a "mandala", with vegetables, flowers and aromatic plants in a circular geometrical arrangement, and a rectangular garden with the purpose of supporting the circle (Figure 2).

The Circular Garden

The shape of this garden alludes to the subject of circular economy in urban areas. It was designed to be aesthetically attractive, combining flowers, aromatic plants and vegetables. Several agroecological techniques and practices were used in its implementation and maintenance, such as intercropping and consociating of plants, crop rotation, organic fertilization and mulching (Wezel et al., 2014). No synthetic inputs of any kind were used in accordance with the EU regulation for organic agriculture (European Council, 2007). The spatial arrangement of the

Figure 2. Setting up the rectangular and the circular organic gardens, the composting vertical bin and the reservoir for the irrigation system.

plants considered their height and strata (e.g., herbaceous, shrubby, and arboreal), the natural succession of their life cycles (e.g., annual, perennial), the consociations of proximity between the various plants for crop protection (e.g., pests and diseases biocontrol, natural insect repellent plants), and pollination services stimulation through autochthonous flowers and aromatic plants (Staton et al., 2019).

The circular garden was built with a radius of 3 m, occupying 18 m^2 of the total 40 m^2 available area. The 18 m^2 area was divided into 3 vegetable beds interspersed by 2 paths. The vegetable beds were 0.8 m wide, the same as the paths, with a perpendicular path of 0.8 m at the base, joining all the paths (cf. Figure 2 and Figure 3). The area corresponding to the circular garden was filled with compost from the horizontal pill in March. Immediately after, commercial compost was added to the vegetable beds to a height of 20 cm, creating a "raised bed" effect. The paths were covered with wood chips to the same height (cf. Figure 3). This technique was inspired by the bio-intensive organic market gardening micro-farms (Jeavons, 2008), which are gaining popularity in urban and peri-urban areas around the world. The plantation was initiated in March 2021 and took place every month thereafter.

Figure 3. The Circular Garden.

The Rectangular Garden

The rectangular garden was designed to be used as a backup for the circular garden and provide extra space for the cultivation and exploration of biodiversity for the EE/ESD sessions. It also served as a wind barrier to protect the circular garden, and to stimulate the appearance of pollinators and pest and disease control species. In addition, it provided a visual barrier, hiding materials no longer used and stored for years at the back of this outer space. This garden comprised four straight vegetable beds, 80 cm wide and 4 m long, separated by 60 cm wide paths, covered by woodchips. A pair of nets supported by four wooden posts were positioned along the 1st and 2nd vegetable beds, to support the growth of taller plants (cf. Figure 2). The two gardens were created at the same time, followed the same timeline and compost application framework, and used the same "raised bed" technic. The rectangular garden also followed the same bio-intensive organic market gardening techniques used in the circular garden, but it was set with higher plant densities and less diversity to facilitate management.

 http://dx.doi.org/10.13135/2384-8677/6994

2.1.4. Urban green space's landscape

The Pilot model was conceived to promote cultural ecosystem service aesthetics through the final landscape, by replacing bare ground with a pleasant space to observe, learn and be involved in nature. The Urban green space landscape was the result of the implementation of the first three components of the Pilot model (Figure 4). It resulted from the transformation of an unused outer area in the FCCV, into an aesthetic and productive "garden", both from agroecological and educational points of view, fully aligned with the FCCV target audience and activities. The model also allowed the FCCV to implement activities in the outer space of the building, which had never been attempted before, due to the lack of suitable projects.

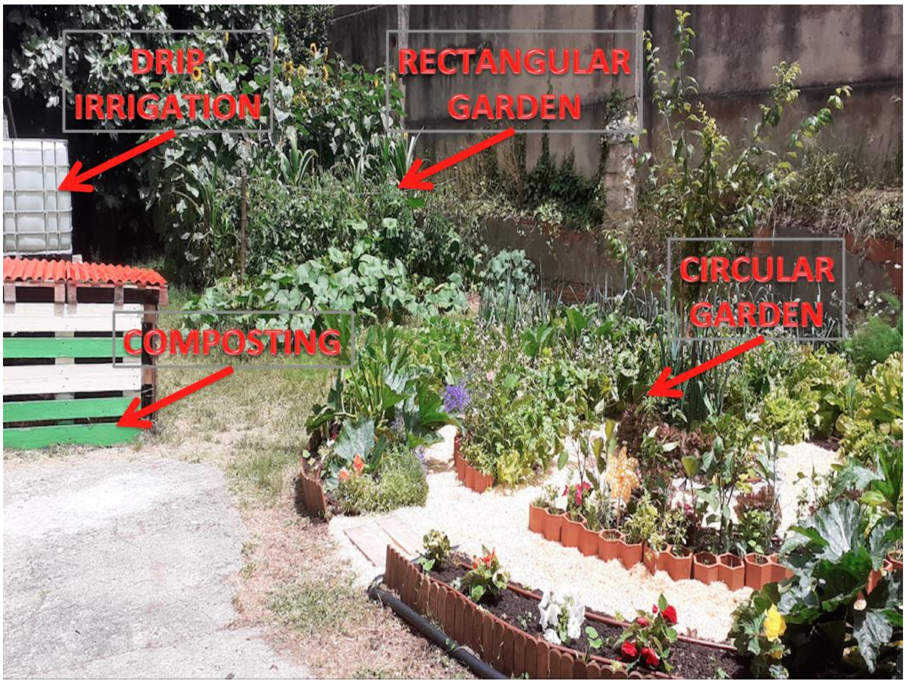

Figure 4. The Pilot model, showing all four components, the composting, the drip irrigation system, the circular and rectangular organic gardens, and the resulting urban green space's landscape. Photography taken in May 2021, close to the beginning of EE/ESD sessions.

2.2. The environmental education/education for sustainable development strategy (ee/esd)

Running as interconnected with the Pilot model, an EE/ESD strategy was elaborated, targeting primary school students. The EE/ESD strategy consisted of a series of workshop sessions held at the Pilot model area promoting a close connection with its four components. The workshops (WSs) covered four main subjects: composting, ecosystem services, biodiversity and local circular economy. Each WS was accompanied by corresponding European Strategy documentation, named "Farm to Fork", "Biodiversity", "Circular Economy" and "Green Deal", as a support of the science outreach goals. Each WS contained several hands-on activities, such as games, scavenger hunts, magnifying glass observations and gardening (Table 1). Didactic materials were developed for each activity in cooperation with the FCCV designers. Each activity had a predicted duration and goals, namely the concepts that students should incorporate and the expected results.

For the Composting workshop (WS1), a portable vermicomposting was created and kept alive and a didactic flyer on composting was prepared. Buckets with holes at the bottom and a lid on top were given to students and used to show how to do a domestic garden composter in order to motivate the students to continue this action at home with their own urban bio-residues. In this first WS, students should make a sowing in yogurt pots and transplant seedlings to the “Botanic Garden” using compost.

In the Ecosystem services workshop (WS2), students use hand magnifying glasses and binocular microscopes to explore soil and compost macrofauna, especially earthworms. To help earthworm observations, legend anatomy cards were created and placed close to the living invertebrates. Real nest-boxes and an insect hotel were also presented to improve the concept of ecosystem services as nature-based solutions in replacement of pesticides.

The Biodiversity workshop (WS3) comprises two games. One game includes a poster of a tree (Tree poster) and several cards with species (Species cards), aiming to demonstrate how a single tree can represent a complex ecosystem with several ecological niches and how species relate to each other as a community. The other game focuses on discovering the “Botanic Garden”. It includes several cards with species pictures on the face side and agro-botanic information in the reversal side. Students are expected to search for different species and mark the plant with a small flag with its name. At the same time, children harvest a leaf, a flower and fruit to smell, to taste and fully feel the plant they were looking for.

To complete this WS, students transplant flower and aromatic plants close to the vegetables already growing, transplanted in the first WS. They are then stimulated to take care and promote their growth.

In the final workshop, Local circular economy (WS4), students prepare ice creams after harvesting strawberries from the “Botanic Garden”, which they took care of in the previous WS. A synergy is set with the FCCV chemistry workshop, "Kitchen as a Laboratory", and part of the WS occurs indoors. At the end of this workshop, students should understand how urban bio-residues can be transformed into food, flowers, and a pleasant space, while enjoying a meal at the “Botanic Garden”.

3. Results

3.1. The pilot model

By the end of May 2021, the circular and rectangular gardens were fully cultivated, and all the components of the Pilot model were operational and ready to be used for the EE/ESD sessions. The drip irrigation was the most expensive and time-consuming component of the Pilot model to set up, but it allowed for saving time and to being water self-sufficient throughout the project. The nets added along the 1st and 2nd vegetable beds in the rectangular garden, allowed the cultivation of climbers and plants with higher strata and served as an additional windbreak. A dense plantation of sunflowers in the 3rd vegetable bed also provided a hiding effect of the unwanted rusty objects in the background area. At the beginning of the EE/ESD sessions, around 44 plant species were present in the circular garden and 11 species in the rectangular garden, for a total of 51 plant species. The number of species varied slightly over the duration of the project, with some plants being removed and others planted during the sessions. To better organize the available planting space in the circular garden, it was organized as shown in Figure 5, with 3 vegetable beds according to the rings (1, 2 and 3, from the outside to the inside), ring 1 was sub-divided in four quadrants (a to d, from left to right) and ring 2 in two halves (a and b, from left to right).

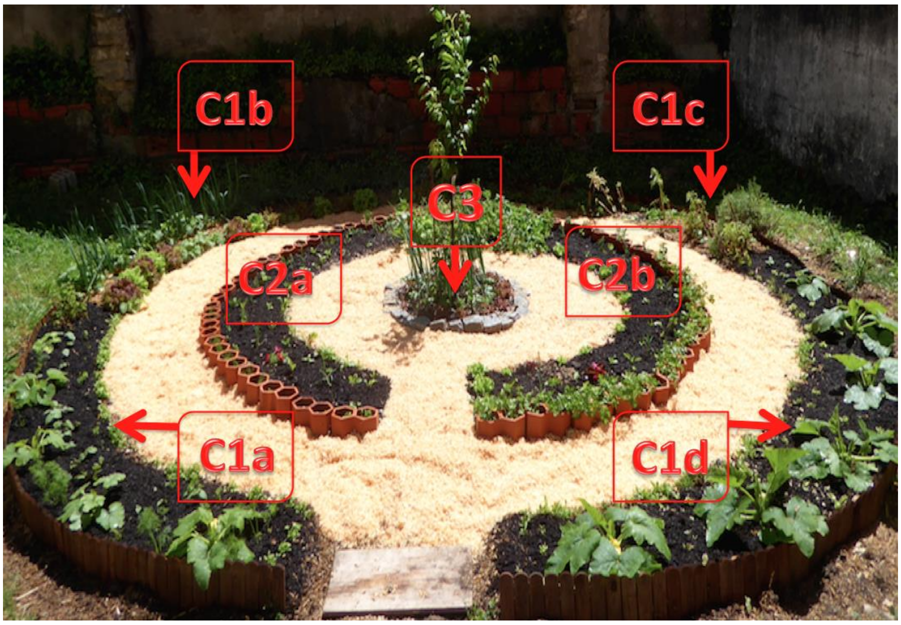

Figure 5. Organization of the circular garden by segments of plant consociation. C - circular garden; 1 to 3 - ring numbers; a to d - plants consociation segments. Photography taken in April 2021.

The species to be planted in the circular garden were chosen and combined according to, firstly, the height strata, life cycle, the ecological niche occupied and pollinators' attractiveness, and secondly, to pests' repellence and Nitrogen fixing ability (Fabaceae family), whenever possible. The plant species used included annual vegetables, flowers, aromatic plants, cereals, shrubs, and a fruit tree (Table 2). The combination of plant species, particularly in the circular garden, had the dual purpose of promoting better agronomic conditions for plants to thrive and at the same time serving as practical examples of ecosystem functions and services for EE/ESD sessions. During the project period, the two gardens produced a total of approximately 180 kg of vegetables, mainly lettuces, tomatoes, spinaches, courgettes, and eggplants (cf. Table 2). Maintenance activities were constant during the project with transplants required to replace old plants and those used in the EE/ESD sessions, as well as the plants removed by cleaning activities, to keep the Pilot model colourful and attractive for the audience of the EE/ESD sessions or others (Figure 6).

Figure 6. A public session to present the "Nutrients Boomerang" project to the academic community.

3.2. The environmental education/education for sustainable development strategy

The EE/ESD sessions started in June 2021 and lasted until September 2021 (Table 3). They took place in two distinct moments according to the target audience. The first moment was during June and consisted of the 4 chained WS, one per week, targeted to a fixed group of 14 primary school students. The group was divided in half with each WS having on average 7 students, except for WS4, which reunited the group (Table 3). In total, 7 workshops were conducted in this series. This group of students completed all the 13 activities planned in the EE/ESD strategy (cf. Table 1). Every WS lasted approximately one hour. All the workshops took place in the Pilot model area, except WS4, which was also conducted in another FCCV facility. Although no questionnaires were used to assess the efficacy of the EE/ESD sessions during the WSs, it became clear that some activities were more attractive to students than others. According to the monitors' perception, the students were more committed to activities 5 and 11 (cf. Table 1), which included transplantation actions, whereas exploring activities

6 and 7 generated more curiosity from the students. Activity 10, with the harvest and tasting of plants, created a highly sensitive impact with children enthusiastically exchanging experiences with each other. Activities 5 and 11 could be considered the most difficult for students, while the time available for activity 9 was short. In this activity, the ecological niche game, and the possibility of exploring nest boxes and insect hotels, generated lots of questions from the children and they showed great interest in sharing personal stories. Activity 13, in collaboration with the FCCV chemistry laboratory, was very well received by the children and very effective for them in grasping the concept of a circular economy.

In a second moment, the workshops targeted families and the public and took place from June to September 2021. These sessions were not initially planned in the EE/ESD strategy but were decided later to extend the project to different target audiences, taking advantage of the Pilot model already in place. For these sessions, a new model of WS was presented, the "Nutrients Boomerang" workshop. This single one-hour duration WS aimed to resume the "Nutrient Boomerang" project and consisted of a selection of activities retrieved from WSs 1 to 3. A total of 11 sessions/WSs were conducted, and the audience varied from 1 to 16 persons per workshop, in a total of 104 participants (cf. Table 3). Although involving children and adults with different levels of ecological literacy and knowledge in sustainable development, the WSs were seen as effective sessions for the purpose of transmitting environmental awareness and circular economy concepts.

4. Discussion

The Project's development focused on including as much as possible what is currently considered to be "state-of-the-art" or "best" practices in EE (Stern et al., 2014; NAAEE, 2022). Students and teachers were actively involved in the educational experience for all the time (Active Participation), while, by planting and manipulating the multiple living life forms (e.g., worms), all EE/ESD session activities have a Hand-on component. The "Nutrients Boomerang" project is intrinsically in line with the particular attributes of a place, using nature and agroecosystem as the context for learning (covering both "Place" and "Outdoor" practices). During the workshops, monitors asked questions and facilitate students' pursuit of answers. Still, students were stimulated to freely inquire and explore the area (Guided inquiry and Pure inquiry) (Stern et al., 2014).

In this project, the Pilot model (physical area) was concurrently built with (and for) the workshop sessions of the EE/ESD strategy. We consider this to be one of the projects' strengths. With this co-development strategy, we looked for an optimal "fit" between the area students were using with the activities they were enrolled in and the concepts transmitted. We expected, in this sense, to increase the probability of positive outcomes, make workshop sessions more fluid, and improve students' engagement in the Green Deal strategy.

The Green Deal is stringing influencing European policies and, as such, European citizens' lives (Ortega-Gil et al., 2021). In order to address the current environmental crisis, citizen actions are at the centre of EU initiatives. The Green Deal prioritized participation and citizen engagement more than any other previous environmental program (Hadjichambis, 2022). It is, though, mandatory to introduce the theme to primary students (and teachers) as part of EE/ESD programs.

This project opens the door to many potential EE/ESD sessions that can be developed in the primary school environment once the Pilot model is established there. It can be converted into a "toolbox" concept and be implemented in primary schools. The detailed and systematic information presented in Tables 1 and 2, such as vegetable species organization and WS activities characterization, allows for its replication outside Fábrica Ciência Viva. With some investment it could easily be developed as a framework for every school to implement, both the physical space of the Pilot model and the workshops of the EE/ESD sessions. Moreover, once implemented, new models of workshops can be developed, and even be adapted to the particularities of each school. By continuously accompanying the activities, students´ teachers get involved in workshop dynamics and are capacitated to implement and further adapt future EE/ESD sessions in each particular school context. The "Nutrients Boomerang" project can also include other science disciplines, physics, chemistry, or mathematics, promoting outdoor science outreach activities connected with nature and so better describe not only biology's concepts but also from other disciplines (Orsini et al., 2013). For these purposes, the plant combinations in the circular garden were design to be easily simplified to accommodate less skilled personnel, including students that could be actively involved in implementing and maintaining the gardens. By simultaneously contributing to safe, healthy, and green environments in schools, we believe this project can have a positive effect on the health of teachers and students, as noticed by Nogeire-McRae et al. (2018). Either by giving them responsibility, care of the gardens or by promoting the consumption of vegetables and legumes, there are evident external benefits that transcend the original EE/ESD educational purpose of this type of project.

By choosing primary teachers as a target audience for EE/ESD, projects such as the 'Nutrients Boomerang" are actively contributing to the up-skilling of Europe's workforce as required by the Green Deal (European Commission, 2019). And by doing so, primary students will indirectly also have the possibility to develop the skills they need to adapt to new future processes throughout their life and to the ecological transition Europe is facing.

Although a formal evaluation was not implemented at this stage, based on the monitors´ perception, we can extrapolate that the other goals of the "Nutrients Boomerang" project were also achieved. Besides the resort to the EE "state of the art practices" already described, the use of nature-rich pedagogical approaches and the incorporation of movement and social interaction between students and between students and monitors also make us expect greater effectiveness in reaching the aimed at outcomes (Ardoin and Bowers., 2020). From a subjective point of view, monitors could appreciate a change in children's behaviour throughout the sessions, from a repulsion or aggressive attitude towards the small animals they found in the "Botanic Garden" during the first workshops, to holding them in their hands, such as a small caterpillar, a butterfly or an earthworm, and looking to these organisms with affection and delight during the final workshops. The vibrant spontaneous stories told by the primary school students, during the last EE/EDS sessions, also valued different subjects. Some of the students became more sensitive to nature conservation, frequently seeking the attention of the monitors to the various living animals they encountered in the soil and in plants and extolling their beauty and fragility. Other students revealed a greater tendency towards sustainability, for example, by describing personal episodes of how they managed to reproduce parts of the Pilot model at home or in their school or showing a special interest in how it was possible to "transform" their waste into strawberries at their home balcony, replicating the experience with their parents and grandparents. We believe the success of changing the perception of something disgusting (or indifferent) into affection (to be cared for), results from the proximity permitted by "hands-on" activities. This was accomplished with the "touching", "smelling", "tasting" and intense "feeling" that simultaneously involve all sense organs, week after week, in continuous sessions.

The sessions of the "Nutrients Boomerang" project workshop for the families, with an occasional calendar, were perceived by the monitors as having more environmental awareness impact than educational. Although with a general positive acceptance by the families, all monitors pointed out that the 60-minute duration was insufficient to accomplish the programmed activities. In the future, it will be possible to open up the activities program into two complementary workshops and give more opportunities for families to be involved in EE/ESD sessions.

Acknowledgments

All activities were enrolled in Fábrica Ciência Viva's facilities, owned and managed by the University of Aveiro, in partnership with Ciência Viva – National Agency for Scientific and Technological Culture. Thanks are due to FCT/MCTES for the financial support to CESAM (UIDP/50017/2020+UIDB/50017/2020+LA/P/0094/2020), through national funds. The authors thank the Biology Department of the University of Aveiro and Fábrica Ciência Viva's staff. All students, teachers and families participating in the activities enrolled in the project are acknowledged.

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Funds

This research received no specific grant from any funding agency in the public, commercial, or no-profit sectors.

Competing Interests

The authors have declared no conflict of interest.

Citation

Vicente, M.M., Leitão, R., Quintino, V., Pombo P. and Rodrigues, A.M. (2022) Urban vegetable gardens as an environmental education tool for promoting primary school students' engagement in EU Green Deal strategies. *Visions for Sustainability*, 20, 6994, 525-547. http://dx.doi.org/10.13135/2384-8677/6994