Two in a Pod: Promoting Sustainability And Healthy Eating In Children Through Smart Gardening

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Abstract
Two in a Pod is a smart toy designed to help children learn how to grow edible plants, getting to know them and sharing their progress with their friends. It is composed of a four-slot wood planter, equipped with soil sensors that interact with a mobile app. Children can plant their seeds, monitor their growth through the app, obtain points for each successfully grown plant and share pictures and their progress, from planting the seed to eating their home-grown vegetables. We designed the toy to help children learn about gardening through gamification and sharing, to increase vegetable consumption and raise awareness about sustainable eating.

Author Keywords
children; design thinking; sustainability; gamification; smart gardening

CCS Concepts
•Human-centered computing → Human computer interaction (HCI);

Introduction
Here we present Two in a Pod, a smart toy designed to address and elaborate on the challenges *Shop Assistant*, *Less Plastic*, *Echo-Live* and *Know What you Eat*. All focus on healthy and sustainable eating, and from which it ap-

Figure 1: Logo of TwoInAPod

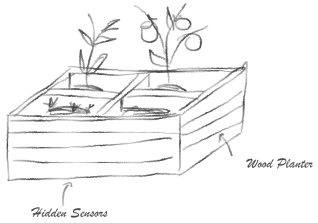

Figure 2: Sketch of TwoInAPod

pears that children are interested in knowing which foods are good not only for themselves but also for the planet. Two in a Pod is composed of a four-slot wood planter equipped with soil sensors, in which the child can plant and grow seeds of edible plants such as tomatoes, eggplants, lettuce, herbs and so on. The soil sensors interact with a mobile app which allows the child to register and follow the growth of their plants. The mobile app gives the option to name each plant, choose an avatar, and also employs game design elements such as points and badges. Notifications and tips will help the child remember to water and take care of the plant, and inform them of the ideal condition for each seed they plant - for example, how much water or sunlight is needed for each plant to thrive.

Related Work

Gardening is regarded as one of the most feasible pedagogical approaches to allow children to interact with different environments and ecosystems. A project conducted during the 1970s and 1980s in the California Bay Area [6], which consisted in the creation of a garden in a primary school schoolyard in the city, showed that the garden provided a direct source of children's emotional involvement with living systems: children were stimulated by the variety of flowers and vegetables that they could grow, and were able to develop skills in growing and preparing food. According to Robin C. Moore: *"Gardening is one of the most direct means through which people of all ages can acquire an awareness of themselves as part of the Earth's life and support system".*

A study conducted on a group of elementary school children also showed that children who participated in a one-year garden program at school increased their life skills, specifically the "working with group" and "self understanding" skills [11].

The use of gardening to support people growing food at home has been analysed both for adults and children; smart garden kits have been designed with sustainability in mind [2] [9] [12], and planting systems have been developed to teach children gardening through play [3].

Children's perception of plants as living beings is also a central theme of My Green Pet [5], an interactive plant which is personified and given human feelings and emotions. Children who interacted with My Green pet showed curiosity about the plant, and were able to identify plants as living beings to a higher degree than they did before the interaction.

Moreover, involving children in the preparation of vegetables has shown to improve liking vegetables, and therefore to increase their vegetable intake [10]. The research suggests that this is due to the IKEA effect, described as the increase in valuation of self-made products. [7]. However, according to Norton, Mochon and Ariely, the IKEA effect is only present when a task is successfully completed; when there is a failure, the effect dissipates. Therefore, it is important to minimise the chance of failure and to help the child succeed in the activity.

Design

The name of the project is a reference to the English idiom "like two peas in a pod", used to refer to two people or things that are similar and close to one another. The idea is to help the child get close to their plants, and help them see the similarities between them as they are both living beings, to nurture their sensitivity. Quoting Robin C. Moore again [6], *"Gardens provided the most direct sources of children's emotional involvement with living systems.*

We have also designed a logo for the system, shown in Figure 1. The design concept has natural materials and clean

Figure 3: Mockup of the mobile app

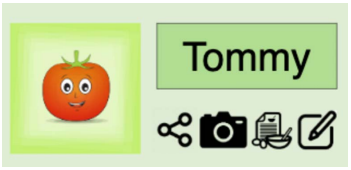

Figure 4: Detail of the screen, showing the avatar of the plant, its name and the possible actions - share, take picture, recipes, edit -

and straightforward lines (see Figure 2); we have chosen a four slot planter to allow children to grow more than one plant at the same time. We chose wood as a material because of its sustainability and the possibility to recycle. In our design, the wood planter is built using recycled pallets, which can be bought wholesale, as they are a cheap and sustainable solution. The electronic elements - the Arduino board and the sensors - are hidden from view, to offer a "natural" experience of gardening.

IoT capabilities

In our design, Two in a Pod is equipped with an Arduino Nano 33 IoT board. This board was chosen for its low price compared to its features: it has eight analog input pins, which allow us to connect eight sensors, two for each slot in the planter: a soil moisture sensor and a temperature humidity sensor. The whole setup has a commercial cost of roughly 30 dollars at the time of writing, which could be certainly lowered by buying the components wholesale. We tried to keep costs low to design a toy that could be accessible to a large number of children; the use of separate electronic components also allows for easy maintenance and recycling.

Unlike other projects such as [2] and [9], we decided not to support automatic watering or other features that would lower the interaction with the garden, to preserve the educational value of making the child entirely responsible for their plants. Two in a Pod is designed to enhance the holistic experience of gardening, instead of replacing it with technology.

Mobile App

We also designed a mobile app that would work in tandem with Two in a Pod. The app can display data from the sensors, allowing the child to monitor the state of their plants in real time. The app also allows a separate configuration for each slot in the planter: for each plant, it is possible to select the type - as different plants have different moisture and temperature needs - and give the plant a name and the avatar to personalise it. In Figures 3 and 4, we provide a sketch of the app, displaying the main screen for the plant *"Tommy the tomato"*, and a detail of the same page, showing the avatar and the name of the plant, and the possible actions: share, take a picture, list of recipes and edit. The avatar can be chosen from a predefined set of images, or the user can select their picture from the camera or the archive.

By interacting with the sensors, the app can also send notifications when it is time to water the plants or cover them (especially in winter or during the summer). The health of the plant is displayed using a colored bar, with red corresponding to a plant in terrible health, and green to a plant in excellent condition. Users can also use their device's camera to take pictures to document the growth of their plants and share them on social media.

Finally, once the plants are grown and ready to eat, the app can suggest recipes based on the grown produce, for example marinara sauce if the user has grown tomatoes and basil.

Gamification and social aspects

Gamification in garden systems has mostly been applied to virtual environments, such as [1] and [8]. More generally, gamification has been shown to be an effective tool to increase participation and behaviour [4]. We propose to use several game design elements in our design, for example, *points* and *badges*, where points will be acquired by interacting with the garden - watering the plants and taking care of them. Also, badges will refer to the depth and breadth of the gardening activities, for example, *"Grown 10 different kinds of plants"* or *"Grown 10 tomato plants in a row"*.

We have decided against leaderboards or other forms of competitions, to foster collaborative behaviour among children: we want the only competition to be with themselves, not with others. We have, however, considered social and sharing possibilities: in our design, the app allows users to share real time pictures of their plant, or to share their progress and badges on social media.

Research Opportunities

Two in a Pod can help investigate research questions such as:

- Can technology be used to improve children's understanding of sustainable and environmental themes?
- What kind of technology is more effective in changing children's behaviour and eating habits?
- What is the best design approach for a smart garden suitable for children?
- What roles can school and families play in designing and implementing smart gardens for children? How does gardening in school compare with gardening at home?
- Can a gamified garden improve children's vegetable consumption in the long term? How can we measure its impact?
- Can children reap the benefits of gardening even with a smart home garden? How does this compare with regular outdoor gardening? How does it compare with virtual gardening games?

Next Steps and Conclusions

The next step for this research would be a pilot study to better inform the design of Two in a Pod; following the pilot study, a larger scale study with a control group would be needed to investigate the effects of playing with the system on children. Equally interesting would be to include children in the design of Two in a Pod as co-designers.

Older children, in middle and high school, submitted most of the challenges that we addressed with Two in a Pod. Because of this, we believe it would be interesting to further inform the design of Two in a Pod by continuing to elaborate on those challenges, designing a system that can be suitable for older children and teenagers. It would be possible to elaborate on the *Know What You Eat* challenge by adding information about nutrition and ecological impact for each planted seed ("*You have reduced your carbon footprint by X by planting these tomatoes instead of buying them.*"). Or to help write shopping lists to better use the grown produce.

Another option would be to further elaborate on the *Less Plastic* challenge, by informing users about how much plastic they avoided to consume as they grew their own food instead of buying it.

This way, we believe that Two in a Pod could become a tool in a wide range of systems and designs to raise awareness about environmental and sustainability themes in youth, allowing it to be used both by younger children on its own and by teenagers together with other technologies that would enable them to make better and more sustainable choices.

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