SeedMate: An Augmented Reality App and Game for Gardening Education

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Abstract
This paper describes various design considerations and challenges concerning the use of augmented reality (AR) and gaming for gardening education. In particular, it focuses on a system we developed called SeedMate - a combination puzzle card game and AR app which teaches the basics of how to spatially plan an actual garden plot. Building on ethnographic research we conducted with urban gardeners and agricultural specialists in Italy, SeedMate teaches a gardening technique called "companion planting," which involves planting certain crops in proximity to each other to increase growth and productivity. In modeling companion planting techniques within SeedMate, we hope to demonstrate the value of AR and gaming for education even outside the agricultural domain; specifically, for their ability to: 1) simulate complex systems and 2) provide real-time, encyclopedic information within a real-world context.

Author Keywords

Augmented reality; games; education

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): H.5.1 Multimedia Information Systems: Artificial, Augmented, and Virtual Realities

Introduction

Despite its apparent simplicity, gardening is actually a complex system involving the emergent interaction of multiple parameters. Successful gardeners must not only be able to identify pertinent species of plants, but also juggle highly technical knowledge about a plant's sunlight and shade requirements, water needs, and what plants grow well together when placed near each other in a plot. Being able to combine and tweak these parameters so that they maintain a healthy equilibrium requires much skill, a sense of proportion, and a wide catalogue of knowledge. Thus, because gardening (seen in this light) is almost combinatorial in nature, the modeling affordances of games seem particularly well-suited to support learning in this context. [1]

Working in collaboration with RAI, Italy's national broadcasting company, our team at the MIT Mobile Experience Lab created SeedMate, a combination puzzle card game and augmented reality app to teach the basics of a specific gardening technique called companion planting. Companion planting is a gardening technique used by agriculturalists all over the world, which we identified from a summer long ethnographic study with urban gardeners in Italy. [2] Initially developed by Native Americans, companion planting is a system for planting different crops in proximity to one another for pest control, pollination, nutritional benefits, and plant growth. For instance, one plant family called *alliums* (onions, garlic, leeks, shallots, and chives) grows especially well when placed next to tomatoes. While companion planting is effective as a scientifically proven gardening technique, the rules governing its use are complicated and very inaccessible to the everyday gardener (often taking the form of complicated charts, as seen below).

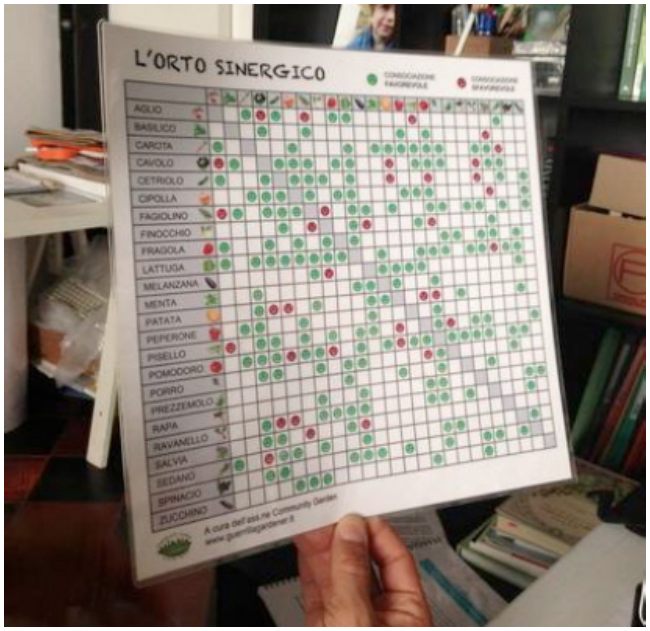

Figure 1. Giacomo Salizzoni, Companion Planting Chart

Seeking to make this complexity easy to understand, we intentionally situated our SeedMate game in a real world context: the playing field or board is an actual plot of soil and the playing pieces are biodegradable seeds cards. Players place the seed cards in the game on the soil according to companion planting rules, drawing on scientific principles for which plants benefit from being planted next to each other. In order to access information about companion planting compatibility, players use an augmented reality app on their

phone and point it at codes inscribed into the cards. Once all cards have been played, they can be planted on the spot, and the resulting board layout is a complete permaculture garden.

Game and AR Application Design

Figure 2. SeedMate being played on soil

Although digital games are, of course, well known for their ability to simulate complex systems, board and card games can achieve the same effects with simpler materials. For instance, in the renowned board game, *Settlers of Catan* (1995), players are forced to think about the proper allocation of resources (wood, bricks, sheep, and ore) that will allow them to build the widest settlements to overtake the real estate of the space of a board. How players allocate their resources affects the choices they can make later in the game, as well as the choices which are available to other players. Although there are only a few simple rules for placement of settlements and turn taking, extraordinary amounts of complexity and strategy are generated from within these few, productive constraints. Thus, much like an urban planning simulation games like *SimCity*(2013), a complex spatial planning process is prototyped, but with significantly less technical overhead.

Within SeedMate, we tried to achieve a similar level of complexity using real world planting materials, the rules of companion planting, and the sunlight and shade requirements of each plant as a base. After iteratively refining our rules with a group of play-testers from the MIT Game Lab, we eventually came up with the following constraints:

The start state for the game is a public pool of seed cards, which come in a variety of sizes and shades corresponding to the physiological needs of each plant. For instance, tomato seed cards are significantly larger in size than the cards for basil or chives, because tomato plants require significantly more space than basil or chives to grow in real life. Similarly, the shade of the tomato card is a darker brown, connoting that it can tolerate more shade than basil, which is colored white. Again, although these representational strategies have salience within the realm of the game rules, they also have real implications for the generation of a player's actual garden. As the seed cards are played directly on soil and planted in the exact spatial configurations which were generated in the game, we aimed to create rules that were based on scientific research in companion planting, the spatial needs of particular plants, as well as their sunlight and shade requirements.

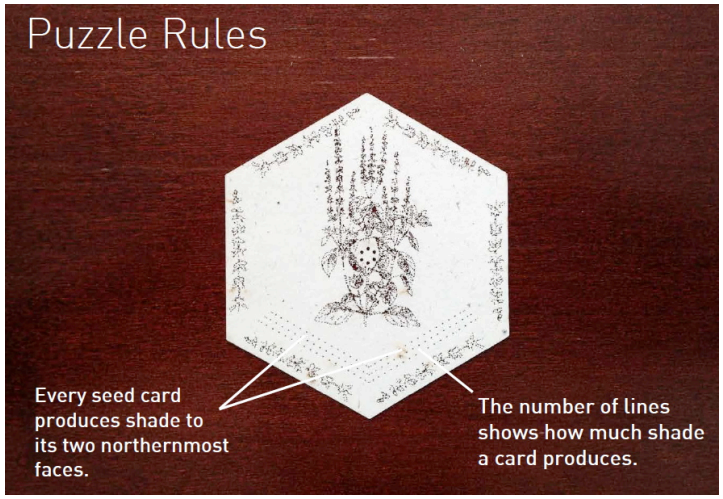

Figure 3. Rules related to sunlight requirements are embedded in the seed cards.

Information about companion planting relationships is accessed through the augmented reality app on a user's smartphone. Simply by pointing one's phone at the intersection of two seed cards, the user can check whether two plants are compatible, and consequently, whether they can both be played next to each other in the game and eventually planted adjacent in real life. This AR recognition is achieved by checking for the presence of unique patterns which are printed on the perimeter of the cards. For instance, if the patterns for both onions and tomatoes are detected, then the app will state that the pair are compatible and should be played/planted next to each other (as seen in Figure 4).

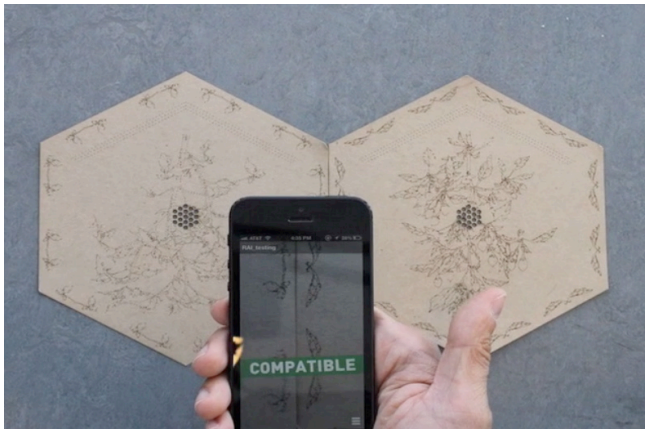

Figure 4. Augmented reality app used to check for companion planting relationships

However, when the player points the AR app at the center image of a single seed card (rather than at the intersection of two cards), he or she can also access ancillary information about nutrition benefits and cooking tips for that particular plant. While this information doesn't necessarily relate to the core mechanics of the game, we felt that including such functionality was especially appropriate given the educational aims of the initiative and for exploring the educational potentials of AR.

Although SeedMate can be played alone like Solitaire in a single window side plot, the game can also be played with a large number of players depending on the size of the desired field. The game can, thus, support the needs of a single player who is gardening alone on an apartment terrace, as well as those who are interested in using gardening on a larger scale to foster new community bonds. In trying to accommodate this community-oriented view of gardening, the main goal of the game is to try and collaboratively create the best companion garden possible, rather than compete and

"win" over another the player. Much like a Jigsaw puzzle, the nature of the game is to enter a quiet and contemplative state and to work together with other players to achieve a common task: building a real urban garden through play.

Future Directions

Although our key target user is the novice gardener who has little to no prior knowledge of gardening, we have also considered ways that SeedMate kits can be extended to accommodate more "hardcore" users. While our original kit of seed cards only features plants which (by design) are very easy to plant (i.e. basil, chives, shallots, tomatoes, dill, carrots, chili peppers, parsley, and thyme), we have also imagined "extension packs" (very much in the vein of Pokemon cards) that could be targeted toward a specific user type's wants and needs. For example, if a user wanted to plant an herb garden, he or she could buy a SeedMate "herb garden" expansion pack, which included biodegradable seed cards for cumin, paprika, and cilantro. Or perhaps if that same user wanted to plant a garden which will produce vegetables for a certain ethnic cuisine, they could buy a SeedMate extension pack complete with the vegetables directly suited to their family's needs.

In addition to simply adding more cards to the SeedMate system, we are also interested in the possibility of adding more functionality to the recommendation engine within the application, so that any number of parameters (from watering requirements to companion planting rules) could be combined to provide players with gardening tips tailored specifically to their needs. This could provide the user not only with a more personalized experience, but also help make the complex system of gardening education more legible to a novice or beginner.

Broader Educational Aims

Although this paper has described the specific educational benefit of using augmented reality and gaming for gardening education, we believe that these media genres (both together and in isolation) hold broader educational benefits for domains outside of agriculture. While games and education is a field with a particularly robust history [3], less focus has generally been placed on the capacities of card games to simulate complex systems and the specific benefits that can arise when physical and digital elements are combined. Furthermore, augmented reality has seen a number of interesting applications in the museum space, but the default functionality of these apps has mostly been limited to *identification*. In most educationally-oriented, AR museum apps, much like the analog placard placed next to a painting, AR simply provides the metadata for the object in a flashy, but on-the-whole unoriginal way.

With SeedMate, we attempted to do something a bit different. We wanted to use AR as an integral, rather than superfluous, part of gaming, and to use the app's computational abilities to compute the relationships between two cards and check for companion planting pairs. We believe this provides a more robust use of AR than simple identification, as it allows the user to engage with companion planting as a gardening technique through a more exploratory process of trial and error. These strategies of recombining and remixing modular parts within a system are very similar to those described by Jean Paiget's constructivist theories of learning. [4] We hope that by helping to facilitate in the player this more exploratory learning process and by situating the game in a real world context (i.e. directly playing the game on soil), SeedMate will provide a model for how AR and gaming can be combined to create more meaning educational experiences.

Acknowledgements

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References

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[2] You can read our full ethnographic study in the unpublished manuscript, Casalegno, F. and Lipshin, J. Transmitting Memory in the Digital World. Mobile Experience Lab, Boston, USA, 2013.

[3] See for instance Bogost, I. Persuasive Games: The Expressive Power of Video Games. MIT Press, Cambridge, USA, 2010.

[4] Piaget, J. The Child's Conception of the World . Rowan and Littlefield Publishers, New York, USA, 2007.