Bringing Outside in: Transplanting Experiential Garden Knowledge in Computational Models

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How can a garden simulation model motivate and enhance science learning in an outdoor setting?

Motivation

- School gardens have been adopted by many as offering valuable outdoor learning experiences, with numerous psycho-social and nutritional benefits. (Ozer, 2007)
- Classroom curriculum is not geared to incorporate the rich academic opportunities that these experiences could potentially offer. (Williams & Dixon, 2013)
- With the unveiling of Next Generation Science Standards (NGSS Lead States, 2013), teachers are tasked with creating new models of instruction and assessment, yet few structures exist connecting these standards to the outdoor environment.

Theory

Agent-based modeling environments such as *NetLogo* can help users understand how macro-scale phenomena emerge from micro-scale instances. (Wilensky & Reisman, 2006)

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The garden is a rich space that connects to intuitive science, providing access points to learners who might not initially engage with formal science. (Bell et al., 2009)

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When making sense of a simulation, especially useful to "loop" from real data to model and back. (Giere et al., 2005)

Contribution: Gardens as student-generated real world contexts for exploring simulations

Literature cited

Bell, P., National Research Council (U.S.), & Committee on Learning Science in Informal Environments. (2009). *Learning science in informal environments people, places, and pursuits*. Washington, D.C.: National Academies Press.

Giere, R., Bickle, J., and Maudlin, R. (2005). *Understanding Scientific Reasoning*. Wadsworth Publishing Company.

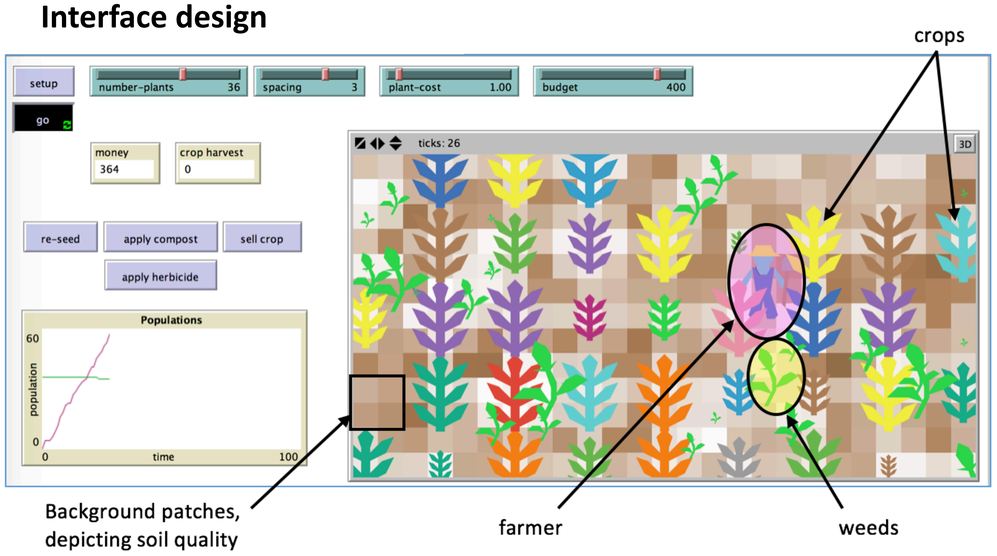
NGSS Lead States (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: The National Academies Press.

Ozer, E. J. (2007). The effects of school gardens on students and schools: Conceptualization and considerations for maximizing healthy development. *Health Education & Behavior*, *34*(6), 846-863.

Wilensky, U., & Reisman, K. (2006). Thinking like a wolf, a sheep, or a firefly: Learning biology through constructing and testing computational theories—an embodied modeling approach. *Cognition and Instruction*, *24*(2), 171–209.

Williams, D. R., & Dixon, P. S. (2013). Impact of garden-based learning on academic outcomes in schools: Synthesis of research between 1990 and 2010. *Review of Educational Research*, *83*(2), 211-235.

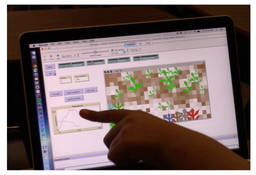
Interface design



Protocol & Implementation

Site
Public middle school where garden instruction is currently being developed to link with academic classes.

Participants
(3) 6th grade females- *engaged in two units of academic-themed garden instruction with their science class and math class*
(3) 8th grade males- *little previous garden instruction due to staffing and space issues at the school*



Interview
15 minute semi-structured; computer focused
Individual (*except one dyad, where one of the pair left early*)
Protocol piloted with a 9th grade student

Introduction: Who I am, purpose of interview
"Hi! Are you okay with having the camera here?"

Set-Up: Brief functionality tutorial, interact with simulation
"This is the set up button; you click it once you've set the sliders to the values you want."

Exploration: Freely explore patterns and simulation dynamics, concurrent think-aloud
"What do you think might happen if you click that button?"

Reaction: Provide feedback and answer questions about classroom /garden applicability
"Do you think you learned anything new by playing with this model?"

Results

Interviewer: What are the ways that you think you would use to figure out how this program works?

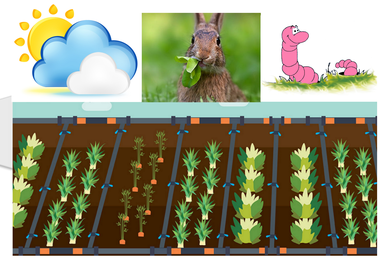
Jorge: Well **since I saw the coding**, that I think like white and black, and **that's like taking off the nutrients out of the soil**, which makes the plants grow not as fast, like grow slower, **but when it's all brown, it's like really nutrient, and like how in the beginning, the plants were growing really fast**, but now that it's white, the plants are growing maybe slower.

Interviewer: Yeah, so you figured that out by reading the code you said?

Jorge: Yeah because I saw that nutrients was like brown.

```
to add-herbicide
  ask weeds [die]
  ask plants [
    set energy energy - 2]
  ask patches [
    set nutrients (nutrients - 2)
    set pcolor scale-color brown nutrients 10 0 ]
set money (money - 30)
end
```

1. Existing Knowledge Generates Ideas for Model Additions



Additions students proposed:

- Weather (Jorge)
- Predators (Jorge)
- Worms providing compost (Catie)
- Row planting (Alecia)
- Crop variety (Alecia)
- Irrigation system (Alecia)
- Compost pile (Jorge)

2. Code Drives Inferences about Ecosystem Properties

3. Garden Experience Begets Perception of Applicability

Name	Grade	Math Connection	Science Connection
Catie	6	"You have to **figure out the area**, and buy, and all that stuff."	"Herbicide maybe, because **science is gardening, like gardening is science**, a part of science."
Alecia	6	"You can actually play with, **I'm gonna sell this huge full grown plant for 50$** so they can get more out of it."	"You can learn **how plants actually grow**, because some people think, 'oh, plants just grow tall,' but you don't actually see the spacing…you might just learn **how to space the plants… you can also learn how fast, how much patience you have to see a plant actually grow**, it's gonna grow in much more time than you actually think it will"
Jorge	8	(No answer provided)	"With the plants, and how like **herbicide has things that could decrease the nutrients in the soil**, so maybe they could like see which one of them is being, which is decreasing the nutrients in the soil."
Marco	8	"To maintain a certain amount of price to have and to sell, so you can like, **make more money."**	"**I don't know** how it relates to science. **I don't know how it's going to help** me with gardening."

Conclusions and Next steps

Design

- Revise garden simulation: Crop diversity allows for greater student ownership and connections to real garden
- Develop guiding tasks: Can you figure out how to harvest the most crops?
- Consult with site school teachers about curricular connections, classroom implementation

Research

- What can grade 6/7/8 students code in a reasonable amount of time?
- How can the model be used to make predictions and claims about ones own space?
- What is the impact of providing contextual or guiding information before introducing the model?