Using Collaborative Agent-based Modeling to Explore Complex Phenomena with Elementary Preservice Science Teachers

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Abstract: This poster investigates preservice teachers' abilities to use, evaluate, and revise participatory agent-based models deployed with the Group-based Cloud Computing (GbCC) platform. This poster discusses two cases within a larger design-based implementation research study with preservice elementary science teachers. By implementing models with preservice teachers, we hope to (a) make adjustments to the GbCC learning technologies, and (b) develop more informed and aligned pedagogies for teaching in socially-mediated and generative learning environments.

Introduction

For classrooms to engage in more socially mediated and generative teaching and learning, instructors must design situations for students to construct relations between prior knowledge, experience, and new information (Wittrock, 1991). Using, building, evaluating, and revising agent-based models are critical to the practice of science (Petrosino, 2003; Schwarz et al., 2009); however preservice teachers require support before feeling confident in implementing modeling lessons in the classroom (Valanides & Angeli, 2006). To address this, agent-based models, such as *NetLogo* (Wilensky, 1999), engage users in manipulating variables and recompiling code as they run simulations using multiple agents, extending our ability to understand emergent phenomenon. Furthermore, engaging in models in classrooms can typically be done independently, which doesn't leverage the group-nature of classrooms.

Group-based Cloud Computing (GbCC) is a web-deployed, agent-based modeling program, powered by NetLogo Web, that allows learners to collaborate, reprogram, and share models (Petrosino & Stroup, 2017). In line with the focus of this conference, GbCC models provide opportunities for *extending* and *embedding* learning about complex phenomenon. This study discusses two cycles of research using GbCC models with preservice teachers to explore ecosystem change and disease transmission. The GbCC platform is a powerful computational tool; however, "powerful technological tools, in the absence of powerful pedagogy, detract from rather than contribute to learning" (Philip & Garcia, 2013, p. 313). With this insight in mind, the goal of this poster proposal is to:

1) discuss two efforts to engage preservice teachers in higher-order modeling uses (evaluating and revising); and
2) determine supports for engaging teachers in developing knowledge and practices of using models in instruction.

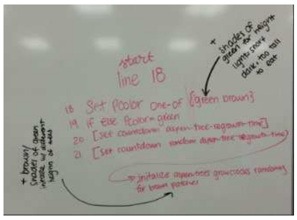

Figure 1. Example of attempted code

Methods

This research is part of a larger design-based implementation research study (Fishman, Penuel, Allen, Cheng, & Sabelli, 2013). This poster summarizes two sequential case studies which seek to explore how preservice teachers engage with and attempt to evaluate and revise computational models about collaborative models. Each case study occurred in an elementary science methods course in a teacher preparation program. Both case studies involved two 3-hour lessons with between 20 and 30 students enrolled in the course. Both cases used a modeling framework to engage teachers with the simulations; which includes: (a) exploring models; (b) planning and revising models based on a task; and (c) discussing affordances and limitations for teaching. Classroom artifacts were collected after teachers evaluated and attempted to revise the models (photographs of student work, pictures of white board plans, and notes). Pre- and post-questionnaires were delivered, collected, and open-coded in both case studies to investigate: (a) conceptions of models and simulations in case one; and (b) beliefs about the necessity of vaccination in case two.

Cycle 1: Ecological modeling

Our first modeling lesson engaged 24 preservice teachers in using GbCC models to learn about tritrophic cascades in Yellowstone. Using a modified NetLogo Wolf Sheep Predation model (Wilensky, 1999), participants were encouraged to explore the model, evaluate the model for affordances and limitations, and attempt to modify the model. Findings from this cycle of research showed that preservice teachers were hesitant to make programming modifications using the GbCC recompile and share features; however, they demonstrated significant efforts to show what their model *would* look like, and even engaged in pseudo-coding and some coding (Figure 1) to plan *how* the model might function. Pre- and post-questionnaires asked participants to reflect on the nature of models and simulations as well as their functions for science and science education. Results showed that students tended to view models as only static and simulations as dynamic; and attributed most functions to simulations rather than their idea of models.

Table 1: Frequency of codes related to theme 3 - functions of models and simulations

Function (model)	Pre	Post	Change	Function (simulation)	Pre	Post	Change
Dynamic	0	0	0	Dynamic	5	8	3
Interactive	0	0	0	Interactive	7	9	2
Observe	0	0	0	Observe	2	0	-2
Static	1	2	1	Static	0	0	0

Figure 2. Example of participant model

These findings illuminate the need to: (a) provide more supports for ways to re-program the models; and (b) provide more time to engage in drawing and pseudo-coding before engaging in actual reprogramming of the models.

Cycle 2: Disease transmission modeling

In the Fall of 2018, 44 preservice teachers engaged in a series of GbCC modeling experiences related to vaccination and disease transfer in populations. Similar to case one, participants were asked to modify the model to think about a new scenario where the model would represent schools with varying socioeconomic conditions and vaccination rates. Learning from the first case, the researchers provided participants with more time to visually plan their model modifications before attempting to pseudo-code or code to make changes. All participants were able to generate complex *visual* models which incorporated many social variables to predict vaccination rates for differing schools. Planned models were all visual, and the researchers ran out of time before encouraging participants to make programming changes to the models. Models tended to either show three screens to represent three differing schools or were more sophisticated and planned models which could *predict* the rate of vaccination based on socioeconomic status (Figure 2).

Implications of the work

These data as well as other information not included in this poster abstract support that preservice teachers are able to engage with and evaluate models which represent complex phenomena which are socially and ecological relevant. Future cases and design work will provide more time to move from visual modifications to computational changes as well as supporting preservice teachers in planning with collaborative agent-based models.

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