The Models Gallery: Supporting Idea Diffusion in Computational Modeling Activities

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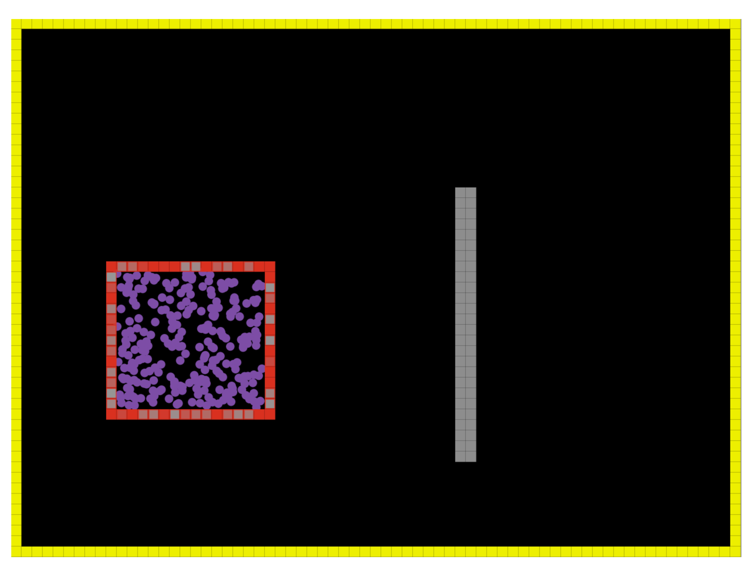
ModelSim

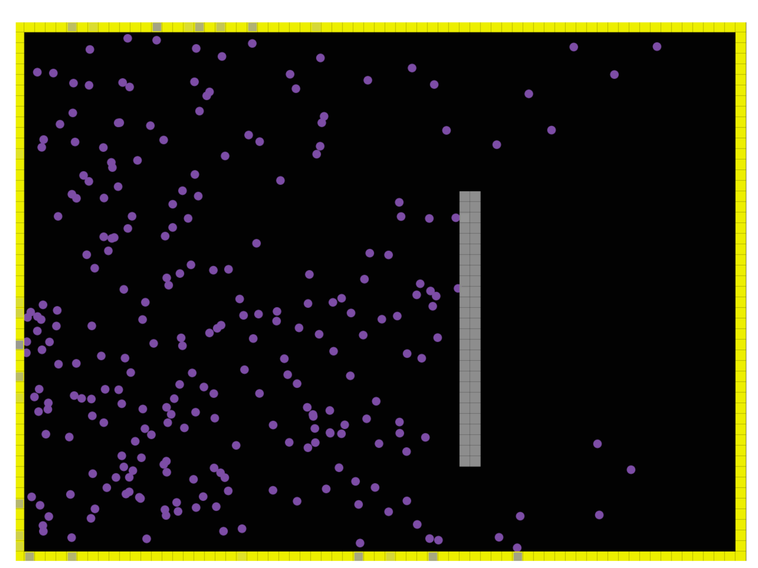
ModelSim—a four-year NSF funded project with the principal goal of investigating the scalability of model-based science inquiry activities, structured around agent-based models (ABMs). The ModelSim project is best characterized as design-based implementation research, or DBIR (Penuel & Fishman, 2012), involving the design and large-scale implementation of four units (Population Biology, Evolution, the Particulate Nature of Matter, & Electricity) each of which includes 5-7 activities that revolve around exploring or creating ABMs. ModelSim units have been deployed in more than 100 classrooms, across three states.

Purpose

One challenge using ABMs in educational contexts has been developing methods to scale ABM thinking and reasoning beyond individual students or individual classrooms. Because creating and meaningfully exploring ABMs necessarily engages individuals in choosing the direction of their investigation, in a given classroom there are often many different lines of exploration being followed.

Here we describe an innovation we call the *Models Gallery* for allowing students to present, discuss, and share both full computational artifacts as well as component features and ideas. Using data from a chemistry classroom exploring the particulate nature of matter by modeling the diffusion of an odor throughout a room, we illustrate the ways in which this tool facilitated the thinking and reasoning about complex scientific phenomena at the classroom scale.



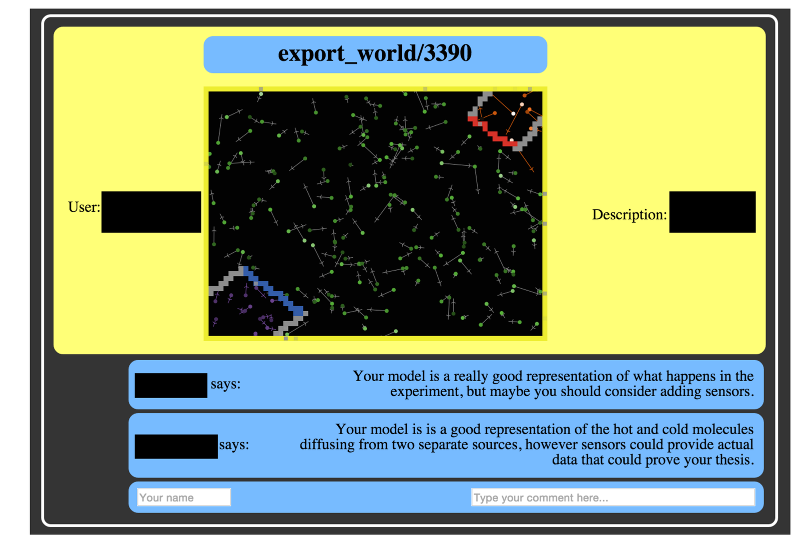


Emergent Systems Sandboxes

The models gallery was a core part of our Particulate Nature of Matter ModelSim unit. In this unit students interacted with specialized NetLogo (Wilensky, 1999) models we call Emergent Systems Sandboxes (ESS), which allow students to design systems or experiments by "painting" agents or objects into a blank space that encodes the predefined rules (see Brady et al, 2014). In the particular activity important to the data presented here, students explored the phenomenon of diffusion. After taking part in a classroom demonstration where the teacher released an odor at two locations in the room (one heated, one at room temperature), students attempt to explain their observations of the odor movement by constructing a virtual model of particle dynamics. The ESS model used allowed students to add obstacles such as walls and particles (which followed the rules outlined in the Kinetic Molecular Theory) and to modify the state of these objects (such as "heating" particles). To do this, they select the object or action they intend to perform from the "draw" tool, and simply click and draw to add the object into the model view. For example, many students created a small container that "held" the odor. This could be achieved by selecting the "wall" tool, "drawing" four walls, then selecting the "purple particles," and clicking and holding to place a large collection of particles inside. When the walls are removed, the contained particles begin to diffuse throughout the room, bouncing off one another and any other walls present.

The Models Gallery

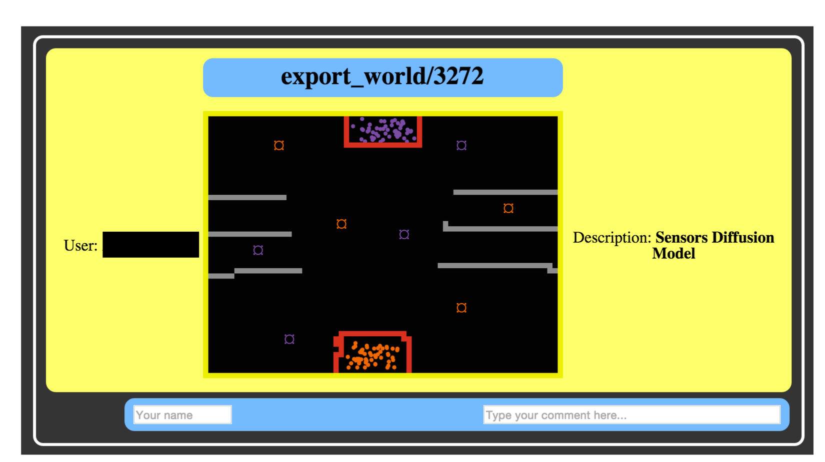
At its core the models gallery is composed of a shared database and a web interface. While creating or working with ModelSim models using the ABM modeling environment NetLogo (Wilensky, 1999) students can "post" these models to the shared database simply by pressing a button and adding a description of the artifact to be posted. Posted models include the actual artifact, the student-written description, an image of the artifact, and identifying information (the class, activity number, etc). In the web interface, students can then view posted artifacts made by classmates (or their own posted artifacts), leave comments for the author, and even download and run posted models. Downloaded models are opened in NetLogo, allowing the downloader to view and explore the artifact, make modifications to the model, and even repost modified models.



Methods

As students created models of the diffusion process they posted both "works-in-progress" as well as "final" experiments. In our analysis of these data, posted models were first coded for relevant or interesting features such as the inclusion of air particles, the use of walls to represent "desks," etc. Then, by examining the timestamps of posted models and comments left by classmates, we looked for patterns of objects or experiments as well as how ideas moved throughout the classroom over time. Though some model features were commonly used in nearly all student constructions (such as use of green particles as "air" and "desks" represented using the wall tool), evidence of non-standard or initially unique designs becoming commonplace across a classroom provides a robust measure of the effect of the gallery on the classroom-level sharing of ideas and construction elements. The data presented here is meant to be an illustrative example of idea diffusion using the model gallery and come from one sophomore chemistry classroom at a public school in a large Midwestern city.

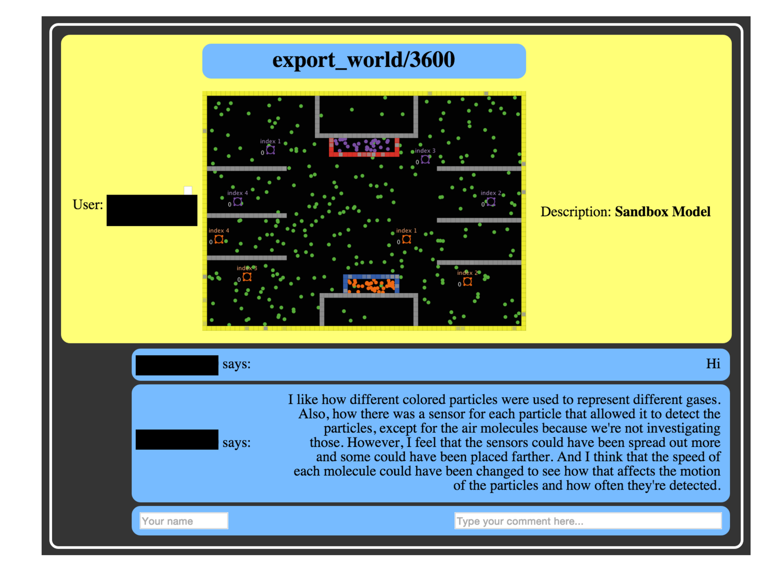
Results



Many students attempted to directly replicate the physical diffusion demonstration by constructing a literal depiction of their classroom. For these models, students typically recreated the room layout using the "wall" tool, used removable walls to create two containers placed at different locations, and then filled these containers with different colored particles. Once the experiment was "set up," students would open the containers and observe how particles moved through the room.

While students commonly create two containers to hold the odor, in this class one group chose to place these containers "on the edge" of one of the many "desks" they added to their model. While one might expect students would attempt to model the placement of the container on the teacher's desk, this was the first such case observed in any ModelSim implementation.

Soon after this model was posted to the model gallery, the design became commonplace throughout the class. Some groups directly replicated the container placement, some moved the container more completely 'inside' of the desk, while others, realizing some particles become caught inside of the desk after the container is removed, moved the container to the front of the desk. As the activity progressed students began to offer suggestions and criticism about the container placement and iterated the design moving the container to the front of the desk.



Seven of the twelve groups in this class incorporated this previously unseen design in some way throughout the construction process. Five of the eight groups used this design it in their "final" experiment posts. The regularity of this unique design, its increased usage over time, and the presence of student critiques iterating the design suggests the models gallery is responsible for the idea's diffusion.

Conclusion

In this poster we have outlined the design of the models gallery, a tool for facilitating the sharing of models and scientific reasoning at the classroom scale. We proposed that to facilitate the sharing of ideas around ABMs, models should be easily sharable, and students should have access to tools for viewing, running, and critiquing models.

This work indicates tools can be created to facilitate classroom-level sharing of ideas for highly open-ended modeling activities. Furthermore, these tools can encourage idea diffusion (both good and bad ideas) without direct teacher intervention. When an expert teacher deploys such tools, idea diffusion can be profitably amplified and classroom discussions involve critiquing student constructions and developing consensus around a highly diverse set of constructions can be encouraged.

http://ccl.northwestern.edu/modelsim

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