Using Models to Stimulate Children's Interactions and Understanding of Science

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The Science Theater/Teatro de Ciencias (sTc) project is exploring the use of qualitative models to help young students understand science phenomena and gain a broader view of scientific activity. In this particular pilot study, we're using models within a classroom discussion of ethical issues surrounding the science topic of genetics. We would like to know what effect the models have on students' participation, what types of models are most effective in this context, and whether this use of models increases students' understanding of modeling. Ultimately we would like the students to understand that the role of science is to inform but not necessarily make decisions, particularly where value judgments are involved.

The Study

In this study, we are working with a combined 4th/5th-grade class using a visual simulation program from Apple Computer called KidSim©. KidSim uses a programming-by-example approach to creating graphical rules, where the rules specify the "before" and "after" pictures that drive the simulation. During the fall semester, students went through a familiarization phase to learn the KidSim environment. The students then divided into small groups to explore various aspects of genetics, their class science topic. Each group selected one question and built a model that would "answer" that question, often by showing an explanation of the underlying mechanism.

Although the students generally enjoyed creating their own models, we did not think that they had adequate time to reflect on and use their models within the larger framework of scientific inquiry. To provide the opportunity for students to see other ways to utilize models, we created a series of models to use as the focus of a classroom discussion. We chose to discuss ethical issues within genetics because the students can see how these dilemmas are pertinent to their own futures. Problems without simple solutions also encourage a diversity of viewpoints. Drawing on the knowledge acquired during the fall, the students could use the focus models to comprehend and to propose solutions to genuine societal problems.

In our first discussion we used six models, four to provide background information (i.e., how protein is synthesized and causes/effects of mutation) and two that illustrated situations with ethical ramifications (use of DDT and a nuclear power plant). The general format was to present a model, ask for hypotheses about how the model might function, run it, then discuss it and ask for feedback. For the second discussion we added two situation models (a revised DDT model and a DDT in the food chain model) but no new background models. In this discussion we asked more questions to elicit comments on specific issues.

Preliminary Results

Our analysis is based on teacher comments and student responses to a survey completed after the second discussion.

The teacher noted that discussions focused on dynamic models differed substantially from other class activities. The models were presented as tools for examining ideas. Students could ask questions more easily because they could reference explicit objects within the models. Running models in single-step mode allowed students to examine the processes in closer detail and to make predictions about program operation.

The survey responses indicate that students also thought the models made the discussion clearer. Many of their comments indicated that the visual aspect was very important (i.e., "It helped me because instead of just hearing it, I could see it."). Students also rated how much each model helped them understand, with 1 = Didn't Help to 4 = REALLY helpful. The weighted average score for all models was 2.83. The average rank for the more abstract background models was 2.62, while the ranking for the more concrete situational models was 3.16. The teacher also indicated that the concrete models were more accessible to the students.

We have no way to separate the effects of the various activities on students' understanding of how scientists use models. Most of their answers to the question "What do scientists do with models?" displayed an understanding that models have a purpose (i.e., to show ideas or help people understand) and some students even realized that models can be used for experiments or to test ideas. In the discussion, the students understood and took advantage of the dynamic, flexible representations provided by the models and used them as vehicles for reasoning.

Summary

The results of the pilot study are encouraging. Our next step will be to devise a more systematic method for evaluating this activity in light of our goals.

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