See It! Draw It! Make It Move! Dynamic Representations of Causal Models: The sTc Project

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The science theater/teatro de ciencias (sTc) project is investigating the use of models to create dynamic representations of scientific concepts with elementary school students. Our research uses the Apple© KidSim application as a tool for students to create their own models. KidSim enables students to represent scientific phenomena through the use of pictorial-based models, by allowing them to apply 'rules' to the 'pieces' of their model. The dynamic interaction that occurs between the student, computer, and resulting model challenges students' existing representations of the phenomena being modeled (Hutchins, 1995) -- as one fifth grader said, the challenge "is getting the model to work." This dynamic distinguishes our approach from other models created through different mediums -- story boards, clay, manipulatives, etc..

Scientific knowledge has been classified into two categories: experimental facts and current conceptual models (Walker, 1963; von Glasersfeld, 1995). Traditional science instruction emphasizes experimental facts, with the resulting view of science as a discrete, arbitrary body of facts and assertions. We, however, think that manipulation of conceptual models in concrete form yields an experience that embodies science: learning through a process of inquiry. Thus, through the use of KidSim, students engage in practicing science instead of just reading about science. The goal is to present science as an evolving process, rather than a rigid discipline that decontextualizes learning with no thought given to how it is used in the scientific community.

Goals

Our curriculum is aimed at developing the following cognitive skills: meaningful question generation, explanation, planning, and problem-solving. The generation of meaningful questions is inherent in successful models; addressing both explanatory and descriptive questions. The task also demands conceptual planning of the model, i.e., what pieces, relationships, appearances, sequencing, and rules will be included in the model. Problem-solving occurs as the students are challenged to accommodate their conceptual understanding to the computer application (Winograd & Flores, 1986).

Results

Our initial work during the past seven months indicates positive student affect and an increased understanding of the utility of models with regards to scientific phenomena. Examples of student projects include models of genetics, ecosystems, evolution, and etiology of skin cancer. On an open-ended survey completed by 25 fourth and fifth grade students, 24 responded favorably when asked if they liked using computer models. Some of the students' rationale for their responses are as follows: the graphical capabilities of the program, being able to make pieces move, and coming up with a working, polished product. In an interview probing whether students preferred these computer models over traditional school-project models (i.e., posters and clay), a student who did not produce a working model responded, "I would still use the computer, because I can explain things better."

Thus far, the project has been an observational study of individual students creating models. Future instructional approaches will incorporate the scaffolding of the following strategies involved in the process of modeling: social generation of questions, discussion and selection of viable questions for modeling, group planning sessions, observation and manipulation of models, small group model creation, and peer critique.

We believe, when combined with the appropriate curriculum, this technology will aid in the development of cognitive skills requisite for scientific reasoning.

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