Classroom Strategies for Simulation-Based Collaborative Inquiry Learning

Tom Murray, Larry Winship, Neil Stillings, Esther Shartar & Ayala Galton
Hampshire College School of Cognitive Science, Amherst, MA 01002
(413) 559-5001
tmurray@hampshire.edu,

Introduction and Description of SimForest

SimForest is a simulation-based learning environment in the domain of forest ecology that simulates tree and forest growth, the succession of tree species over time, and the effects of environmental and man made disturbances on forest growth (see www.ddc.hampshire.edu/~simforest/). With the simulation students can set environmental parameters such as rainfall, temperature, soil fertility, soil texture, and soil depth; they plant (or load in from a file) a plot of trees from a list of over 30 species; and they "run" the simulation and observe the trees as they grow and the forest evolves. A forest plot's sensitivity to natural and man-made disturbances can be evaluated, and emergent properties such as species succession can be characterized. This short paper summarizes some of the results of a research project involving several development and implementation phases: the development of the SimForest learning environment, development of curriculum materials and activities surrounding the software, software evaluation in college biology classrooms, a summer professional development institute teaching secondary school teachers how to implement the software and curriculum, and a study following these teachers as they used the software in their class over two semesters. In this paper we summarize one aspect of this project: the characterization of diverse pedagogical strategies used by an expert teacher to support simulation-based collaborative inquiry learning. We used these results to give suggestions to the participants during the teacher training phase of the project.

Method and Results: Inquiry as Distributed Problem Solving

We generalized our observations and analysis from 14 sessions to produce instructional strategies and pedagogical principles for leading collaborative simulation-based inquiry activities in classrooms. The majority of the strategies identified apply to scientific inquiry activities with or without computer simulations, but are particularly useful for simulation-based inquiry learning in collaborative contexts. We divide the strategies found into two classes: feedback and control strategies, and collaboration strategies. In this short paper only the collaborative strategies can be described. A list of the feedback and control strategies includes: leading questions, Socratic dialog, encouraging commitment to a hypothesis, various types of scaffolding and fading. and encouraging ownership through hypothesis commitment. For the collaborative strategies, we observed teaching methods that repeatedly brought the entire class into collaboration around an inquiry question, after individual or small group activities. We observed the following methods for structuring collaborative problems solving (these are not mutually exclusive strategies):

Alternating Convergent and divergent episodes. Every session could be described as a cycling between divergent individual simulation-based work and whole-class convergent consensus-building discussion.
Additive knowledge. The entire class is given a very open ended task, such as "run the simulation and note what you observe." The class then reconvenes to share what they learned, compare, synthesize, and combine findings.
Breadth search. In a related method, each group is allowed to pose their own inquiry question and investigate. When they reconvene students are exposed to issues and information beyond what they would have had time to explore on their own.
Two-phase search. Simulated annealing serves a an apt metaphor for a we observed a collaborative inquiry strategies in which students were first allowed to explore a parameter space unsystematically, followed by a more systematic approach as described below. In this method a certain amount of randomness is introduces to an otherwise systematic search to avoid the problem of local minima.
Jigsaw method state space search. We saw several cases of the instructor dividing a search space and assigning components of it to groups.
Collaborative hypothesis confirmation. Finally, we observed several sessions where students compared their results, building arguments to support or refute the hypotheses.

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