Toward Characterizing Best-Practice Pedagogy for Inquiry in Simulation-Based Leaning Environments

Tom Murray, Larry Winship, Neil Stillings
(tmurray,lwinship,nstillings@hampshire.edu)
Hampshire College School of Cognitive Science
Amherst, MA 01002

Introduction[1]

The project "An Inquiry-Based Simulation Learning Environment for the Ecology of Forest Growth" consisted of three main stages of approximately one year each: software development, curriculum development, and classroom implementation. We evaluated the software, SimForest, in clinical and college classroom settings, then ran a professional development program to support eight secondary school teachers in incorporating the software and curriculum into their classes. This paper focuses on our results from the clinical trials in which we analyzed the strategies used by an expert teacher. A primary goal of this phase of our research was to document a variety of successful inquiry-based methods for using simulations in the classroom.

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. In the simulation students 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 observer 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 observed.

Method and Results

Observations were made relating to the teaching behavior of the college professor who facilitated the College classroom and clinical SimForest learning sessions. This professor is considered an expert in inquiry-based science teaching methods, so the study is one of identifying 'base practices." In total of 51 college students used the software in classroom or mock-classroom sessions. There were a total of 14 instructional sessions which lasted one to two hours each. The Instructor varied the methods that he prepared to use, often adapting the lesson plan based on what was learned in previous sessions, thus allowing us to observe a variety of activities and "driving questions". In this paper we focus on methods for employing distributed problem solving in the classroom.

Collaborative Inquiry and Distributed Problem Solving. We observed teaching methods that repeatedly brought the entire class in to collaboration around the inquiry, after individual or small group activities. Simulation-based software provide rich a rich environment for such collaborative inquiry. Below we describe some of the methods observed and characterized:

- **Alternating convergent and divergent activities**. The instructor was facile with a spectrum of open to closed activities, and usually ran the class as a progression of convergent whole class episodes and divergent simulations-based episodes.
- **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.
- **"Simulated annealing"** (a term borrowed from a computer science search). Students were allowed to explore a parameter space unsystematically. Usually at least someone in the class will come near a solution. It is usually then followed by a more systematic approach as described below.
- **Jigsaw method state space search.** We saw several cases of the instructor dividing a search space and assigning components of it to groups. For example the instructor organized a systematic exploration of a multi-variable space of temperature, soil quality, and rainfall conditions, asking each group to chose one of these to vary which keeping the other parameters fixed at a value that, through a simulated annealing method, was found to be close to a solution.
- **Collaborative hypothesis confirmation**. Finally, we observed several sessions in which the instructor assigned groups with conditions to test alternate hypotheses.

We used these results to introduce teachers to possible ways to manage a simulation-based inquiry classroom in our professional development program (described elsewhere.)

[1] This material is based upon work supported by the National Science Foundation under Grant No. 9972486. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.