

EXECUTIVE SUMMARY AND TOC FROM:

Final Report for NSF Grant DUE-9972486 (CCLI Program)¹

An Inquiry-Based Simulation Learning Environment for the Ecology of Forest Growth

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1 Executive Summary

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. The software development included two products: "black box" and "glass box" versions of a learning environment in the domain of forest ecology called "SimForest" (i.e. SimForest-B and SimForest-G). The glass box version allows students to "open up," inspect, and modify the underlying mathematical model driving the simulation, whereas the black box (or regular) version does not. From a research perspective the project had two main threads. The first centered around professional development and classroom implementation issues for simulation-based inquiry learning. For this first research thread we used SimForest-B. We evaluated SimForest-B in clinical and college classroom settings, then ran a professional development institute to train eight secondary school teachers to incorporate the software into their classes. As part of the project we developed curriculum materials and a web site, and we supported the teachers in their classroom implementations. We studied the teacher's and their students' experiences with the software and curriculum.

The second research thread involved SimForest-B and glass box simulations in general. Whereas the first thread focused on learning inquiry skills, the second focuses on learning about quantitative modeling as well as inquiry skills. To build SimForest-G we first built a domain-independent software architecture, SimGlass, for creating glass-box simulations in any domain. SimForest-G was built starting with SimGlass and adding the domain-specific forest visualization interface and the specific model for tree growth. While SimForest-B is a mature software application, SimForest-G is a prototype that has not

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been used in classrooms yet. However we have articulated some of the theory and pedagogical issues surrounding the use of glass box simulations and learning modeling skills, and believe that this work is a unique contribution to the field of educational software.

Results and contributions of the project, described in detail in this report, are as follows (this final report, and all tangible products are available from our website at <http://ddc.hampshire.edu/simforest/>):

- The SimForest-B (black box) software, as used by hundreds of students.
- The SimForest-G (glass box) software prototype, including the SimGlass generic architecture for building "knowledge based" glass box simulations in any domain.
- Curriculum materials for using SimForest in secondary and post-secondary contexts, including: Teachers Guide; Users Guide; suggested activities, lessons and driving questions; concordance table relating important concepts and skills to the sample lessons; templates for student worksheets and lesson planning worksheets.
- An analysis of "best practice" pedagogical strategies for using simulations in inquiry-oriented classrooms, including: methods for measuring inquiry steps and cycles; sample classroom scenarios; an articulation of a number of pedagogical strategies, including novel whole-class strategies for collaborative inquiry activities.
- An evaluation of the professional development and classroom implementation components of the project, including: "Professional Development Guidelines" and lessons learned (applicable to most inquiry-based learning PD workshops and programs); and case studies of the effect of the PD intervention on the participating teachers.
- An evaluation of inquiry skill improvement in the secondary school science classrooms where SimForest was used, including: novel instruments for evaluating inquiry skills and subskills.

During its three years the project had direct impact on:

- 51 college students who used SimForest in class or mock-class situations.
- 195 secondary school students whose teachers used SimForest in the Fall of 2000 (evaluated).
- Over 150 secondary school students whose teachers used SimForest in the Spring of 2001 (not evaluated).
- Over 200 students in middle school classes whose teachers did not use SimForest in the classroom but introduced it to students to use at home; and used inquiry-based methods in their classrooms.
- 12 undergraduate and 1 graduate students who participated as staff in the research project.
- 8 middle school teachers who participated in the project.

The project will have far larger impact as the teachers we worked with continue to use the software and methods that they learned; and as others use the software and curriculum

available from our web site. We are currently in discussion with several companies around distributing and/or productizing the software. The SimForest software has been registered or submitted for review to the following on-line educational resources: MERLOT, www.merlot.org; Eisenhower National Clearing House (ENC Online), <http://www.enc.org/>, GEM: Gateway to Educational Materials, <http://www.geminfo.org/>, BioQUEST Curriculum Consortium (and BioQUEST Library) <http://www.bioquest.org/>; Tapped In, <http://www.tappedin.org/>; EduPlace, <http://www.eduplace.net/>.

Future work based on the accomplishments of this project include:

- Further development, research, and implementation of glass-box simulations in several domains (grant proposals have been written to NSF and DOE).
- Expanded program of professional development for secondary school teachers in the general area of using simulation-based software (SimForest and other off the shelf and research prototypes) for inquiry-based learning (NSF proposal submitted).
- Planned proposals for further professional development and implementation in post-secondary contexts.
- Productization, distribution, and outreach as mentioned above.
- Further research publications.
- Note that the teachers trained in our summer institute continue to use the software and maintain contact with us.

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