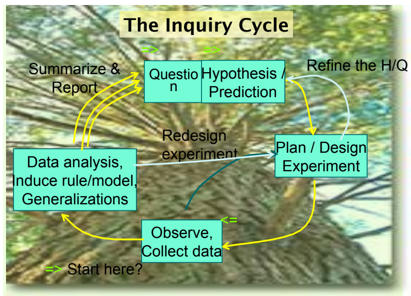
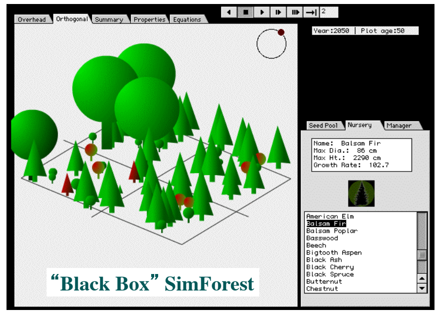
SimForest

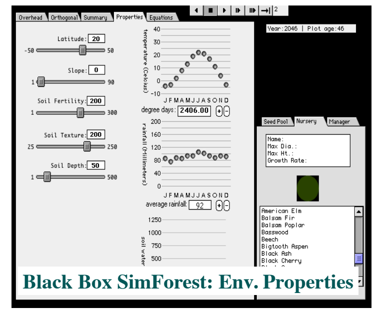
1) Toward Characterizing Best-Practice Pedagogy for Inquiry in Simulation-Based Leaning Environments
2) Measuring Inquiry Cycles in Simulation-Based Leaning Environments

Tom Murray, Larry Winship, Neil Stillings

Hampshire College, Amherst MA

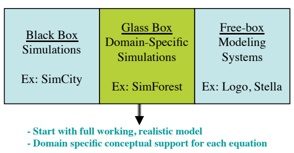




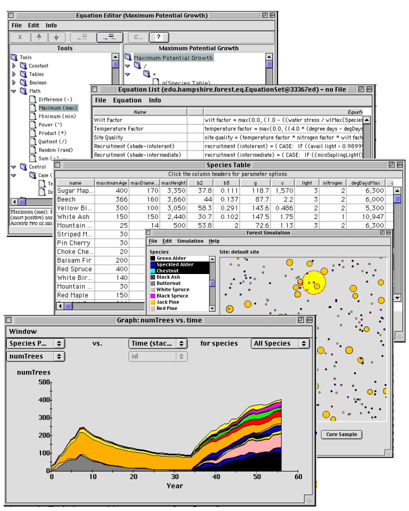


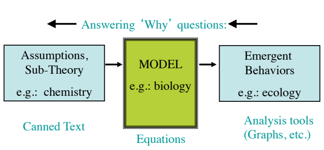
"Glass Box" SimForest
(& Glass Box Simulations)

Method: Glass box version has been implemented but not used or tested yet in clinical or classroom contexts.



Equation Editor, Equation Inspector, Species Table, Simulation, Graph





Equation	SQI = (1-BAR)/BAMAX
Textual representation of the equation	Soil Quality Index = (1 -Total Basal Area)/Maximum Plot Basal Area
Description	SQI is soil quality index, which determines how the intrinsic fertility of the site limits the growth of trees. It is a measure of ... [text book or URL reference].
Units	(The units in which the variable is measured)
Graph of relationship	Picture showing qualitative shape of relationship
Referents	SQI is referred to in these equations: ... SQI refers to these variables: ...
Assumptions, simplifications, and limitations to the equation	The equation assumes that tree circumferences are perfect circles.
Alternative equations	For a more complex equation that takes into account circumferences that are not perfect circles, see ...

College Classroom Observations

Method: observation notes from 14 instructional sessions by an experienced inquiry-based teacher over several semesters, including a total of 51 college students using SimForest in classroom or mock-classroom contexts.

Time on Group vs Whole Class Work:

- Sessions (1 to 1.5 hours) were dynamically organized into cycles of divergent individualized work and convergent full-class discussions.
- On the average the instructor cycled between whole class and independent work about 4 times; or every 20 minutes.
- Students were able to engage in about 1 to 3 inquiry cycles (see other chart) for each larger classroom cycle.

Conclusion: We see "20 minute segments" and "1 to 3 inquiry cycles" as a measure of how "far" into independent work the instructor let the students go before bringing everyone together to synthesize what was discovered and giving those who might be stuck the opportunity to ask questions in a full class context.

Observed Teaching Methods: Collaborative Inquiry & Distributed Probl. Solving

1. **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.
2. **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.
3. **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 better than they would have had time to explore on their own.
4. **"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.
5. **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.
6. **Collaborative hypothesis confirmation**. Finally, we observed several sessions in which the instructor assigned groups with conditions to test alternate hypotheses.

Episode-->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
SESSION A:																		
Ask question		x																
Refine question		x																
Make hypothesis			x															
Plan experiment				x														
Set-up experiment					x					x				x				x
Run Simluation						x					x				x			
Record data																		
Verbal observations							x					x				x		
Refine Method									x				x				x	
Data analysisi	x							x										
Summarize																		

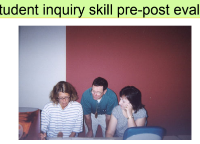
Measuring Inquiry Cycles

Method: In clinical settings, taped four pairs of college students using the software and analyzed video transcripts (sample data analysis above).

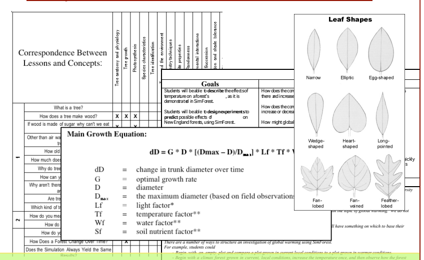
Results:
1. One can clearly see the occurrence of inquiry "cycles" in the data. The cycles do not always include all of the normal steps of inquiry, but there is a clear pattern.
2. Most of the cycles do not involve posing a new hypothesis, but rather students start a new experiment after making a verbal observation or conclusion, or after realizing they need to redesign the experiment to obtain the results they desire.
3. The average inquiry cycle over all subjects is approximately 10 minutes in length.

Teacher Professional Development & Middle School Evaluations

Method: 8 middle school participants; Science and technology teachers; One week summer institute; Two semesters of SimForest use in classrooms. Data types: classroom observations, teacher interviews, questionnaires and journals, student inquiry skill pre-post evaluation.



Sample curriculum and teacher resources:



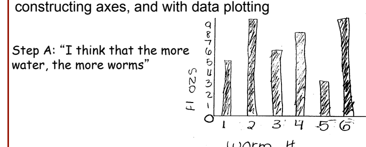
Three Evaluation Transfer Tasks: "Worms", "Fish", & "Flowers"

Given: description of situation and question

A. State a prediction
B. Describe an experiment
C. Reflect on the experiment
D. Construct a graphical representation of the prediction
E. Reflect on uncertainty in science
F. Critique an experimental design

Sample student respond to step D

Shows problems with correspondence to prediction, with constructing axes, and with data plotting



Eg. Coding Rubric
For step B "describe your experiment"

I. Systematic variation of the independent variable.
II. Measures the dependent variable.
III. Holds other things constant.
IV. Is feasible to do.
V. Is specific and quantitative (measure how often; how many fish?).
VI. Deals with random variation (n>1, e.g. ave. over 10 fish in each tank; ave. over repeated experiment

Results:

(Analysis in process…)

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.

tmurray@hampsire.edu http://helios.hampshire.edu/~tjmCCS/ July 2003