INTEGRATED SYSTEMDYNAMICS LEARNING ENVIRONMENTS (ISLES)

COMBINING SYSTEM DYNAMICS MODELING WITH THE LEARNING OF PHYSICS

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In recent years, considerable progress has been made in our understanding of learning processes in introductory physics and in the development of learning environments.[1] In addition, the tools for data acquisition, data analysis, and modeling and simulation, have become very powerful. As a result, new learning environments have sprung up. Many of these are activity oriented; they use experiments more flexibly; some employ simulation activities; and a few have attempted to integrate different learning modes in a single environment. However, with the exception of one approach[2], none of the developments stress explicit modeling; and none have questioned the very structure of the physics to be learned.

Here we present results of didactic developments which began in Winterthur some 15 years ago[3], and which are culminating today in the creation of an Integrated Systemdynamics Learning Environment (ISLE) for introductory physics. We have redesigned the physics curriculum using continuum physics as the guiding metaphor.[4] The result is a physics of spatially homogenous dynamical systems[5] which includes completely novel developments such as a theory of thermal dynamical processes[6] and makes use of didactic developments known as the Karlsruhe Physics Course.[7] The subject matter is brought across by explicit use of system dynamics modeling[8] that employs simple yet powerful modeling (and simulation) tools.[9] Lately we have begun to combine our modeling oriented approach with computer based laboratory learning. And finally we are integrating all of this in a single learning environment fashioned after the studio[10] model introduced at Rensselaer Polytechnic Institute.

The Integrated Systemdynamics Modeling Environment (ISLE)[11] for introductory physics that is being developed now at Winterthur and the University of Applied Sciences Fribourg (Switzerland) uses Learning or Design Cycles as the guiding metaphor for an activity based learning environment. The Learning Cycles combine the Experimental Cycle with the Modeling Cycle. Students use these to guide their activities in a Real ISLE. Learning in this environment centers on experiments carefully chosen to exhibit the principles of dynamical (physical) systems. Learners observe an experiment, make first steps in analysis and (mental) modeling, perform the experiment (either live or in form of a virtual experiment), take and analyze data, analyze the processes, create a system dynamics model, perform simulations, and compare their experimental results to the simulations. If necessary, students go through these cycles several times. All the time students are guided by materials implemented in the form a Web site on their computers.

This Personal Virtual ISLE provides them with a Guide to Assignments and Projects, a Real And Virtual Experimental Laboratory, and an Active Modeling Environment.

The subject matter (arranged in ten chapters or Parts for the first year, ranging from hydraulics and electricity, through rotation and heat, to mechanics and fluids) is presented in electronic form (Hypermedia Library), as a sequence of system dynamics models (Models Study Environment), and in a book.

A first unit of a Real ISLE was taught and investigated in the Spring of 2000 at Winterthur. Results of this trial run will be presented. In general, we can say, that students liked the experience and seemed to have learned more effectively.[12]

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