Evaluating the Effectiveness of Simulation-based Instruction about Water Resources in the Middle School Science Classroom

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Abstract

This poster describes a research study comparing the effect of system dynamics-based instruction versus traditional teacher-directed instruction about water resource management in 6th grade science classes. The study tests the hypothesis that learner use of a simulation model promotes greater understanding and better retention of the material presented than a teacher-led presentation of the same material. Approximately 180 sixth grade students from a Middle School in Las Vegas, NV participated in the study. Half received a "traditional" teacher-directed lesson using visual aids (in the form of a powerpoint presentation) followed by a discussion led by the teacher. The other half received the same introduction followed by a session in which students used a simulation model to explore the issues on their own. Both groups were given a pre-test, a test immediately following the instruction, and another test approximately one month after the instruction. This poster presents and discusses the results of the study.

Introduction

Barry Richmond (1990) and others (e.g., Forrester 1992) have made a strong case for using system dynamics models as a learner-directed teaching technique in K-12 education. They claim that system dynamics-based instruction promotes a more constructive, versus an assimilative, learning process than traditional teacher-directed instruction, and that when students have to construct their own knowledge, they learn better and retain more. There is a good deal of qualitative evidence supporting this view, but few experiments have been conducted that directly compare the two instructional approaches and attempt to quantify the difference in learning.

The study described in this poster is an experiment that measures differences in learning between students exposed to the same material in teacher-directed versus system dynamics-based instruction. Study subjects are sixth grade students. The study is one part of a larger study evaluating the effectiveness of system dynamics models for communicating resource management issues in general. The overall study uses a simple model addressing water resource management in Las Vegas, Nevada. Stave (*in press*) describes the model and its development. In the first part of the overall study, the model was used in seven public workshops to test its effectiveness as a tool for increasing public understanding of water management issues. Eighty-three adult community members participated in the study, which is described in Cloud and Stave (2001). Following the study described in this poster, a similar experiment will be conducted with college students in Fall 2003. Finally, the same material will be put on the web and used to test

the potential for web-based public education using system dynamics simulation. Preliminary ideas for the web-based experiment are described in Little and Stave (2001).

Hypothesis

The purpose of this specific study is to determine if among classes of sixth grade students, those who are exposed to a learner-directed instructional technique, based on using system dynamics modeling, will more completely understand the material presented, score higher on an immediate assessment, and retain the information longer than those exposed to a teacher-directed instructional technique involving lecture and a related activity not involving the use of a computer-simulated model.

Procedures

Participants for this study were six classes of sixth grade students from Roy Martin Middle School in Las Vegas, NV. Classes were randomly assigned to receive either the "traditional" teacher-directed instruction or system dynamics model-based instruction. All students began with a pre-test to determine their current level of knowledge related to the issues of the Las Vegas Valley water supply and demand. All students received a powerpoint presentation introducing them to water management issues in Las Vegas, followed by a discussion of management options. Following the discussion of options, the model users were introduced to the model's input/output screen, shown how to run the model, given a worksheet to record the results of their experimentation with the model, and given approximately a half-hour to experiment with the model. The non-model users were given graphs showing the results of choosing different management options and led in a discussion about the differences. At the end of the session, both groups were led in a discussion about the most effective management strategy. Immediately after the instruction took place, students were tested to see how well they learned some of the basic concepts. Finally, approximately one month after the instruction, students were given a retention test to see how well the information they learned was retained.

Student scores on the evaluation tests immediately following and one month after the instruction were compared with scores on the pre-tests to measure the amount of learning and retention. The learning and retention measures for the non-modeling group were compared with the measures for the model users to evaluate the hypothesis.

Results and Discussion

This study is currently underway. The presentations and testing were conducted in the week of April 28, 2003. Results are being analyzed in May. All analysis will be complete for the conference presentation in July and will be included in the poster. Papers describing the results, instructional material, evaluation instruments will be available at the conference.

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