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ABSTRACT

This document contains three papers on simulation from the SITE (Society for Information Technology & Teacher Education) 2001 conference. "Simulations in the Learning Cycle: A Case Study Involving 'Exploring the Nardoo'" (William M. Dwyer and Valesca E. Lopez) presents a study of middle school students using a CD-based simulation program, "Exploring the Nardoo," in all phases of the learning cycle. "A Pilot Study of the Web-Based Environmental Simulation" (Tago Sarapuu and Margus Pedaste) presents a three-week pilot study in which nine groups of students from three different schools passed five virtual communities of the World Wide Web-based simulation "Hiking across Estonia." "The LPII Simulation: A Lesson-Planning Tool for Preservice Teachers" (Harold R. Strang and Ronald J. Clark) describes the key features of the LPII, a Visual Basic simulation designed to help preservice teachers gain insights in planning effective lessons for both motivated and unmotivated students. All of the papers contain references. (MES)

SIMULATION

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Though recognized as a legitimate and positive aspect of teaching and learning, simulations continue to be rarely used by authors for the 2001 SITE annual. Perhaps the wide variation in defining "simulation" in education has contributed to the dearth of studies. The range in availability of hardware, courseware, and software in international locations where many of these investigations were done certainly has contributed to the variation in sophistication of data treatment. Additionally, though the global economy and international testing have moved countries closer in terms of educational goals, differences in educational philosophies have certainly contributed to the issues addressed and undertaken by this year's contributors. These findings were cited in the 2000 SITE annual and continue to be evident by the lack of submissions in this area.

With only three submissions, the variety of definition is again seen as a strength of this technology driven teaching strategy . The way educators have chosen to define and then implement technology in the classrooms of their districts and countries is as varied as the geographic locations of the schools. Regardless of the complexity or simplicity of the technology available or the cognitive entry level of the personnel proposed for using the innovation, readers can certainly find a situation or discipline that mirrors their own. Reports of technology use for teacher-preparation as well as use with the P-12 students also increase variation.

The Papers

Dwyer and Lopez studied the effectiveness of simulations in learning cycles lessons for middle school students engaged in environmental studies. The Harper & Hedberg CD, *Exploring the Nardoo*, was used to enhance student performance. Upper elementary and middle school students served as a population for the study. Results of pre-instructional and post-instructional mapping showed a richer variety of concepts and increased linkage of concepts in environmental studies when simulations were included in the instructional plan.

Sarapuu and Pedaste used a simulation, *Hiking Across Estonia,* (http://sunsite.ee/tour/) developed in the Science Didactics Department at the University of Tartu, to develop students' higher order thinking skills. Problem-solving and decision making were especially emphasized in the field of environmental studies. Students were assigned to hiking groups after pilot studies were run to determine the most effective simulation process. The virtual hikes in five different communities with seven different environmental problems in each community were the problems of each group. Students were able to click to links of information providing help in addressing the each of the problems. During the hikes, students also came across other problems such as the lack of food and the necessity of determining if plants encountered in a community were safe to eat. Themes of the hikes were connected to the themes present in the State Curriculum of Estonia. Another essential feature of the simulation was developing students' communication skills in the small groups of the hiking group. Interviews before and after the virtual hikes and observations during the simulations were a part of the evaluation of the activity. Results of the study resulted in several editing changes in the design of the communities and the problems in them. However, results did suggest that the simulation program enhanced higher order thinking skills of the students, especially in the area of the ability to analyze texts and graphs.

Strang and Clark developed a Window-based simulation to assist teachers-in-training with preparation of lesson plans. LPII was designed to lead students through a decision-making process in creating lesson plans for a specific type of student. Activities appropriate for the assigned student are entered into the simulation. The final step of the simulation involves students to evaluate the effectiveness of the plan for each student. Several weeks after the initial simulation, a debriefing phase is held. This process is helpful in offering students opportunity to hone lesson planning skills with a built-in evaluative phase that improves the process.

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Simulations in the Learning Cycle: A Case Study Involving "Exploring the Nardoo"

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Abstract: This study of involved students using simulation software in all phases of the learning cycle. Middle school students used a CD-based simulation program, Exploring the Nardoo, which first provided preinstructional and exploratory activities to elicit and challenge students' alternative conceptions. Having set the context for formal instruction, simulations then were used in the invention phase of the learning cycle to help students learn new concepts. The simulations were used again to apply newly learned concepts in different contexts in the expansion phase of the learning cycle. In this study, middle school science students were observed using the simulations as they engaged in learning cycle lessons on environmental systems. The students were tested for their understanding of the concepts before and after completing the learning cycle lessons. Interviews also were made of the students and their instructor.

This study involved students using simulation software in all phases of the learning cycle. Research on the use of simulations in science education has shown that the simulations can be used effectively in preinstructional (Hargrave & Kenton, 2000; Gokhale, 1996) and exploratory activities (De Jong & van Joolingen, 1998). Preinstructional and exploratory activities elicit and challenge students' alternative conceptions. Having set the context for formal instruction, simulations then can be used to learn new concepts in the invention phase of the learning cycle. With the specific guidance in simulations such as Exploring the Nardoo (Harper, n. d.; Harper & Hedberg, 1996), students perform better (Lee, 1999). Simulations can be used again to apply newly learned concepts in different contexts in the expansion phase of the learning cycle.

In this study, 16 upper elementary and 17 middle school science students were observed using the simulations as they engaged in learning cycle lessons on environmental systems. The students were tested for their understanding of the concepts before and after completing the learning cycle lesson. Interviews also were made of the students and their instructor. Data collected included videotape transcripts, teacher journal, student field logs, student concept maps, student and teacher interviews, and products of student activities.

The use of simulations in all phases of learning cycles was shown to be an effective strategy for learning. The teacher was better able to bridge student understanding between print materials and real-world experiences. Results of pre-instructional and post-instructional concept mapping showed a richer variety of concepts and increased linkages among those concepts. This case study thus provides an example of the effective use of simulations in learning cycle lessons for middle school students engaged in environmental studies.

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A Pilot Study of the Web-based Environmental Simulation

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Abstract: Nine groups of students (total 36) from three different schools participated in a three-week pilot study and passed five virtual communities of the web-based simulation "Hiking Across Estonia". The members of hiking teams had to solve 35 different educational tasks. The analyses of students' answers in the pre- and post-tests and also in the semi-structured group interviews proved the program to be applicable for developing students' environmental problem solving and decision-making abilities. Students demonstrated the improvement of their skills in analyzing texts, drawings and graphs of the subtasks. Moreover, the participation in the virtual hike promoted students' involvement in cooperative learning and it also increased their interest in environmental problems.

Introduction

Web-based simulation, where the authentic surrounding is transferred into virtual environment, provides learners with strong support by a variety of sources of information and rich capabilities of multimedia. Computer-based learning applications as the cognitive tools can engage learners in higher order thinking and learning providing opportunities for the acquired knowledge to be generalized to new and alternative problem spaces and contexts (Oliver & Herrington, 2000). Problem-based activity unfolds the process of learning through the application of knowledge and skills to the solution of real-world problems, often in the contexts of real practice (Bligh, 1995). Most commonly it is based on experiences and empirical findings where students learn from problem-orientated tasks rather than fact-orientated ones. Another frequently reported finding concerned with the application of problem-based learning is related to promoting students' motivation and developing their critical thinking (Sage & Torp, 1997).

Promoting learning through problem-based activity provides considerable scope for designers of the web-based learning environment. Several approaches from cognitive theory can be used while designing web instructional pages (see Harper et al., 2000; Leflore, 2000). An essential feature issued from the appropriate guidelines is the authenticity of learning process. This could be achieved by appointing three seminal concepts: credibility, complexity, and ownership (Harper et al., 2000). All these concepts were taken into account in designing a simulation program "Hiking Across Estonia".

Simulation Program

A web-based situational environmental simulation "Hiking Across Estonia" (*http://sunsite.ee/tour/*) has been programmed in the Science Didactics Department at the University of Tartu. Several features of Java and Perl have been used to make the simulation more authentic and affective.

It is proposed that groups consisting of 3-6 students might form hiking teams and participate in the virtual hike. They have to pass five different communities: heath forest, meadowland, grove, waterside meadow and bog. All the communities are provided with informational windows of supplementary texts and illustrations of about 193 species of plants, mushrooms and animals. The information presented introduces the most common and interesting living objects of Estonian nature, but it also serves as a source material for solving the educational tasks. There are seven different environmental tasks in each community (totally 35) to be solved during the virtual hike. All the tasks are presented and can be solved on the web pages. Immediately after answering the questions and solving the problems students get feedback about their results – they have opportunities to get to know correct answers and their own mistakes. A certain number of points are awarded for each task. It enables to organize competitions between hiking teams.

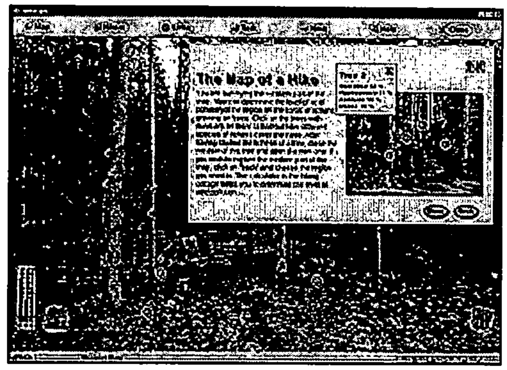
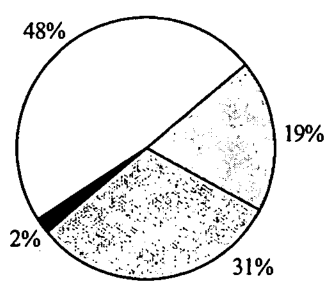


Figure 1: The front page of the simulation program (on the left) and a general view of the first community – heath forest – with an open window of environmental problem-solving task (on the right).

The participants have to meet another problem during the hike – they have to find edible food from different sources. Each team may take along a certain amount of food from the virtual home at the beginning of the simulation, but afterwards the hikers must find it from the communities: they have to decide if the species of plants and mushrooms available in the simulation are edible or poisonous. All the activities of the participants on the web pages including their answers are saved in the server and can be analyzed by the organizers of the virtual hike.

The goal of the program is to develop students' environmental literacy towards promoting higher order thinking skills, especially their problem-solving and decision-making abilities. The main target group of the simulation "Hiking Across Estonia" is suggested to be students of the upper basic and high school.



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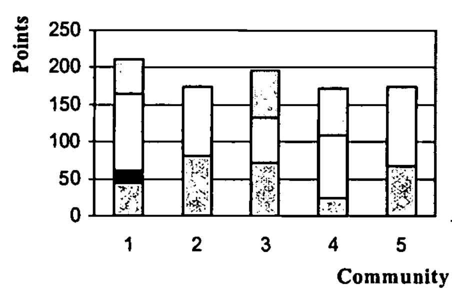

b

Figure 2: The distribution of percentages of total score between environmental tasks presented in the simulation program based on the knowledge and comprehension of facts (◻), application (■), analysis (◻) and synthesis (◻) (a). The distribution of points between environmental tasks based on the knowledge and comprehension of facts (◻), application (■), analysis (◻) and synthesis (◻) presented in five different communities (b).

At first, the participants of the hike have to examine the virtual community provided with extra information on several aspects of it and after that, open a new window with an educational task related to the respective community. Next, they must find additional information for solving the task. The information is usually available on the web pages of the simulation program itself or on the web sites listed on the links page. In some cases the necessary environmental facts must be looked up in different books.

Educational tasks have been composed on the basis of themes of school biology, environmental study and health education related to the themes of curricula of Estonia and other developed countries. It insures; that the questions and problems of the simulation are not only connected with Estonian local problems but might be understandable and applicable by students of other countries as well.

Students have to analyze texts, drawings and graphs for solving the environmental tasks presented in virtual communities. They can get up to 31% of the total score of 925 points on the basis of knowledge and comprehension different facts in simple questions. About 2% of the score is related to the students' ability of application of the information and 67% of points in certain problem-solving tasks can be achieved by analyzing and synthesizing presented materials and making decisions (Fig. 2.).

Another aim of the simulation program is related to developing students' cooperative involvement in groupwork, but it should also promote their interest in environmental problems.

Pilot Study

Nine hiking teams participated in a three-week pilot study. The main objective of the study was to carry out a formative evaluation of the simulation program and to clarify the applicability of it by the students of different age. The research design of the pilot study is shower in the figure 3.

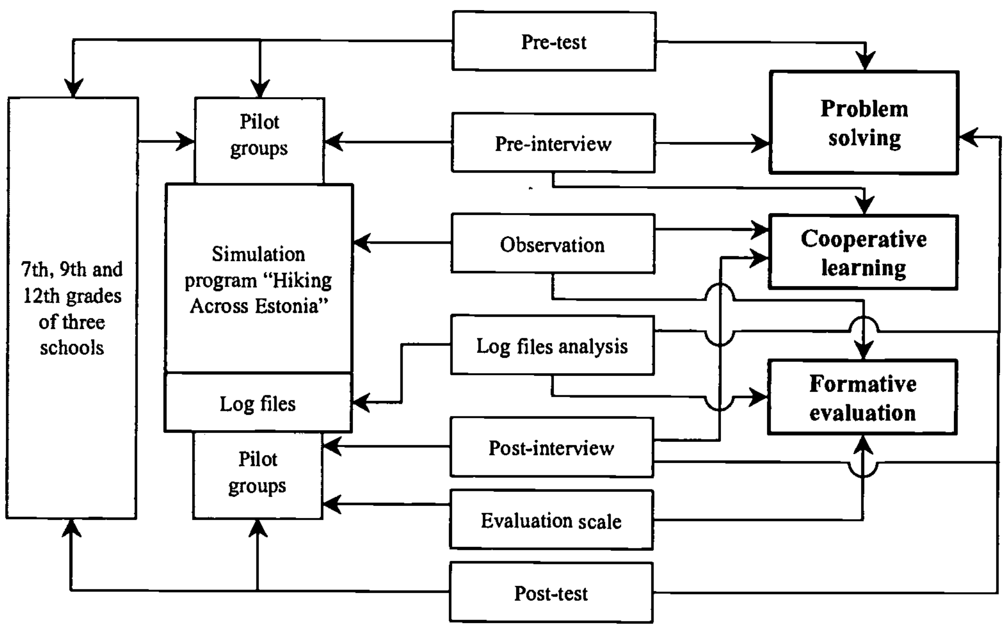

Figure 3: The research design of the pilot study.

At first a pre-test questionnaire consisting of six environmental tasks was composed. The questions presented in the test had been previously pre-tested to ensure internal validity of the latter both among the students of upper basic and high school. Three classes – the 7th (aged 13-14), 9th (aged 14-15) and 12th grade (aged 17-18) – were chosen from three different schools (9 classes with 235 students in total). All the students in these classes had to solve the tasks and fill in the pre-test. According to the results of their answers a group of students with average score was clarified from each class. Next, four volunteers from each group were asked to form hiking teams. As a result of it, nine teams were selected. During a three-week period they passed all the virtual communities and solved the tasks presented on the web pages. Soon after the hiking teams had finished the simulation program, a post-test was asked to be filled in by the participants.

This consisted of similar questions as the pre-test. The answers in pre- and post-tests were statistically analyzed to evaluate the applicability of the program for developing students' problem-solving ability and, particularly, promoting their skills in analyzing texts, drawings and graphs.

Three observers made notes about teams' embarrassments in the application of the program, students' impressions and also their cooperative learning abilities. It gave the information for the formative evaluation of the program and allowed to evaluate the students' progress towards cooperative involvement.

The members of hiking teams were interviewed before and after the virtual hike. A semi-structured group interview was used to clarify students' development as to collaborative work in the problem solving process. The activity of the hiking teams was being observed during the entire virtual trip. The results of nine students' groups in solving the educational tasks in each community were carefully analyzed on the basis of log files of the server. It allowed estimating students' progress towards environmental problem-solving process and the applicability of the program by the students of different age.

A lightly modified Evaluation Scale of educational web sites (Sarapuu & Adojaan, 1998) consisting of 43 questions was presented to a group of expert teachers. The scale consists of three parts: the composition of the site, pedagogical aspects and curriculum-related aspects. A selected number of the questions from the Evaluation Scale were asked to be answered by the members of the hiking teams as well. The students' questionnaire mainly comprised the composition of the site, users' impressions and some curriculum-related aspects. Their answers gave feedback for the formative evaluation of the simulation program.

Findings

The simulation program appeared to be applicable for both basic and high school students. It became evident that only two problem-solving tasks were too complicated – no any team was able to solve them completely. These tasks were simplified and the appropriate corrections were made in the simulation program. Some other improvements in the simulation program "Hiking Across Estonia" were undertaken as a result of the formative evaluation. The majority of corrections concerned texts. A small number of suggestions were about the quality of illustrations. In some cases the text of help files was revised to be more understandable for younger students (aged 13-14).

The teams achieved 60% of total 925 points in average. Each team from the 7th grade got about 48% of total points of the problem-solving tasks, the 9th grade – 45%, and the 12th grade 65% in average. The log fail analysis allowed estimating a significant progress of the problem solving tasks towards the virtual communities (Fig. 4).

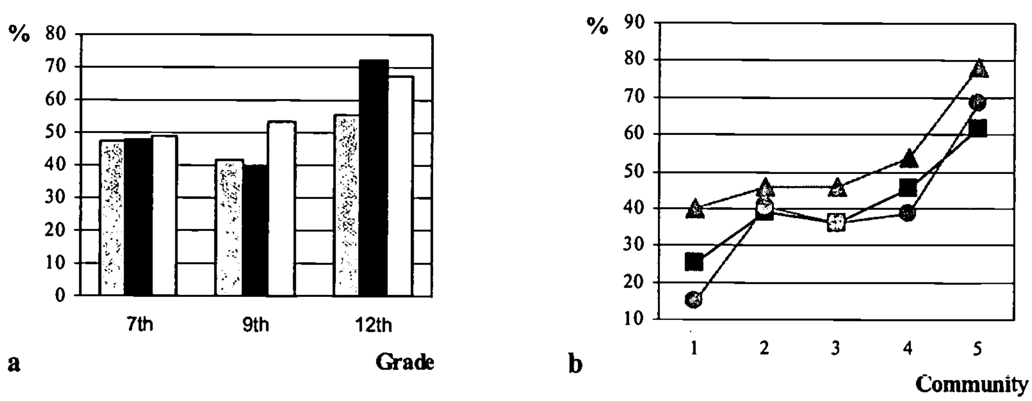

Figure 4: The average percentages of results of three teams from the 7th, 9th and 12th grade in problem-solving tasks of the simulation program (a). The progress of the 7th (■), 9th (●) and 12th (▲) grade teams towards environmental problem-solving process in five different virtual communities (b).

This finding was also supported by the comparison of the students' answers in the pre- and post-tests. A significant difference ($p<0.05$) was found in the results of the problem-solving tasks in the post-test between the students of the hiking teams and those who belonged to the control group (Fig. 5a). Furthermore, their ability to analyze texts, drawings and graphs was also under investigation. Students' answers demonstrated a statistically significant progress towards analyzing abilities ($p<0.05$, in all the cases). The best results ($p=0.02$) were obtained in promoting the 7th grade students' ability to analyze graphs.

The analysis of semi-structured group interviews revealed a remarkable promoting cooperative activity among the members of the hiking teams. The records of the observers demonstrated that this was due to the development of students' communication skills and their higher motivation.

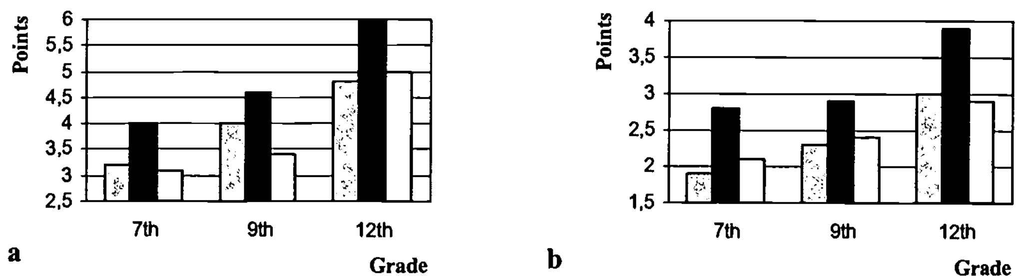

Figure 5: The average results of the 7th, 9th and 12th grade teams in problem-solving tasks presented in the pre-test (⊡) and post-test (■) compared with the results of the control groups achieved in answering the post-test (□) (a). The average results of the same groups on the basis of the students' ability to analyze the graphs (b).

Conclusions

The web-based simulation "Hiking Across Estonia" is supplied with both environmental simple fact-orientated and complex problem-orientated tasks. The member of hiking teams who participated in the pilot study demonstrated the applicability of the simulation program in promoting students' motivation and their progress towards the problem-solving activity. Authentic complex tasks provided learners with the opportunity of multiple roles and perspectives to be realizable by their collaborative construction of solutions. It encouraged learners to detect and evaluate relevant information, but also to analyze texts, drawings and graphs of the sub-tasks.

As a result of authentic activities the participants of the virtual hike revealed learning outcomes, which could be successfully applicable beyond the simulation program and environmental problems presented on the web pages. The promotion of students' skills to analyze and evaluate texts, drawings and graphs should be relevant in solving most real-life problems. The latter will be under investigation in a quantitative study of the participants of the interschool competition that will be held in the spring-term of 2001.

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The LPII Simulation: A Lesson-planning Tool for Preservice Teachers

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Abstract: This paper describes the key features of the LPII, a Visual Basic simulation that is designed to help preservice teachers to gain insights in planning effective lessons for both motivated and unmotivated students. The tool's four-step decision-making sequence will be outlined and the post-participation debriefing phase will be discussed. Finally, initial field testing results will be presented, and projected future applications will be suggested.

Introduction

As summarized by Strang (1997), over the past two decades Curry simulations have helped preservice teachers to translate their pedagogical knowledge about teaching into realistic, enactive experiences. This paper describes the latest version of a Windows-based simulation, a tool that is designed to help our teachers-in-training to gain insights in planning effective lessons for both motivated and unmotivated students. The LPII simulation, administered via a Visual Basic software program, can be customized to address content areas including language arts, science, math, and social studies and also to address academic levels including elementary, middle school, and high school. It is intended to be used as a laboratory component in an introductory methods or theory course in teacher education. In initial applications during the fall of 2000, its administration has consisted of a participation phase followed by a debriefing phase.

The Planning Phase

Collaborating in groups of two or three, preservice teachers complete the lesson-planning simulation via mouse and keyboard actions. After entering an ID number and name registration, each teacher group begins a four-step decision-making sequence. At any point during this planning process the participants are no more than several key clicks away from reviewing and/or changing previous decision entries.

Defining the Students

The first step in the planning phase builds on a paper-and pencil task introduced prior to the LPII simulation. During this task, group members collectively complete the Learning Pattern Assessment questionnaire (Golay, 1982) for two hypothetical students--one motivated, the other unmotivated. In discussing how to rate each of the students on the 40 items, the group develops a common impression of how these students differ. The group members complete their definitions during the first part of the simulation by deciding upon a grade level and genders for the two hypothetical students.

Defining Lesson Content

The second step involves three decisions that determine the content that the two hypothetical students will work with during the lesson. After deciding whether the lesson subject will be language arts, social science, mathematics, or science, one of three lesson subject areas is identified via the selection of a State of Virginia Standard of Learning (SOL) goal (Virginia Department of Education, 1999). Finally, one of three lesson goals linked to the SOL is selected.

Defining Lesson Activity

The third and most comprehensive step in the stimulation entails the creation of a lesson for each of the previously defined students. This process evolves from first determining the number of activities that will comprise each lesson to answering questions that address five facets of each activity. These questions ask (1) what the student will do, (2) with whom the student will work, (3) what learning aids will be used, (4) what type of thinking will be encouraged, and (5) how long this activity will last. Navigation through these decisions is completely nonlinear; any decisions can be changed via a single mouse click, and attention can immediately be shifted from one student lesson plan to the other. Finally, in contrast to its predecessors, the LPII simulation expands from a "point and click" experience to one in which participants can author their own options and can also construct notes to document and/or to explain their ongoing decision-making process. Figure 1 depicts the option window that participants work with in making the five types of activity decisions for the motivated and unmotivated students.

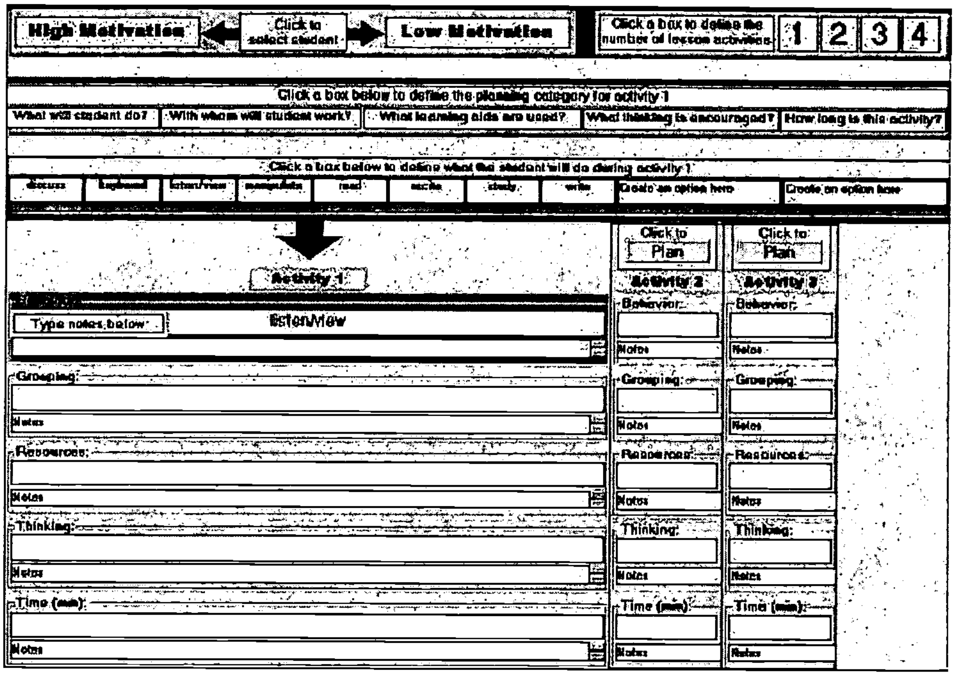

Figure 1: Option window for recording lesson activity decisions

Defining the Evaluation of Lesson Effectiveness

The fourth step in the LPII simulation offers a decision-making dimension not included in its predecessors—a dimension that allows participants to decide how they will evaluate the effectiveness of their planning for each student. Similar to lesson creation, opportunities are provided to tap program-defined options, to create new options, and to record personal notes.

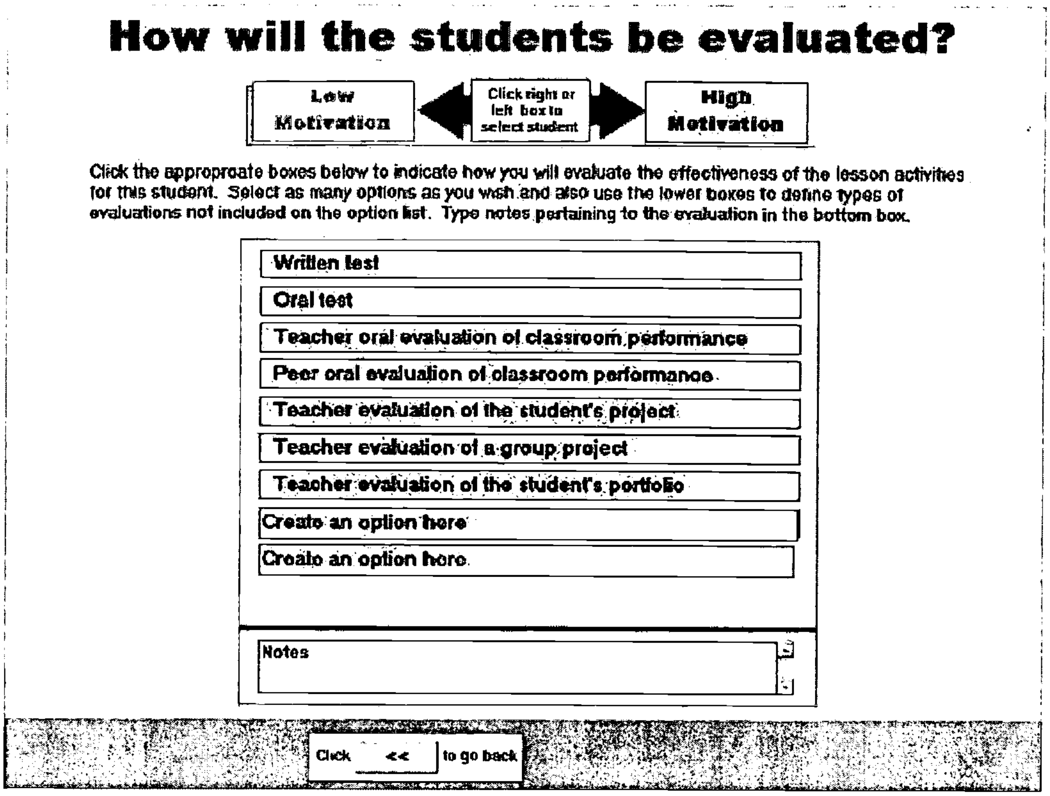

Figure 2: Option window for recording student evaluation decisions

The Debriefing Phase

Several weeks after completing the LPII simulation, participants congregate in small groups to discuss their lesson plans. This process is facilitated through the use of several printed reports that clearly depict for each collaborating group (1) the navigational path followed during the simulation, (2) the contents of the lesson plans for each of the students, and (3) a set of numerical values for key navigation and decision measures. A series of computer-projected graphical displays also allows participants to compare their navigation and decision scores with class averages or with averages generated from data collected from experienced teachers. The goals of this session are first to present these teachers-in-training with clear pictures of their lesson planning, then to stimulate them to comparison of these pictures with those of their cohort and those of an experienced teacher cohort. The preservice teachers are also encouraged to share and to discuss their plans with their colleagues beyond the debriefing session. Again, on their own initiative, participants can obtain from the Curry School Library individual lesson planning profiles of experienced teachers representing the three grade levels and the various subject areas. As the LPII simulation evolves into a vehicle that increasingly offers the opportunity for personal expression, we anticipate that its use as a satellite laboratory component in courses will be replaced by its integration into the mainstream of classroom activity.

Initial Results and Future Plans

After successfully field testing the LPII with several cohorts of experienced teachers enrolled in off-grounds education courses during the summer of 2000, the simulation was included as a laboratory component in a learning and development course that all Curry preservice teachers completed early in their professional program. Fifty-four groups of from two to three students each were constructed from the pool of 136 participants. Group assignment was based on matching two the students' anticipated teaching goals grade level (elementary, middle, or high school), and subject (language arts, social sciences, mathematics, or science.

Preliminary data analysis has focused on two major areas: (1) the reliability of the software, and (2) participant-rated usability of the learning tool. Regarding reliability, there were no software crashes or data losses during any of the 54 group sessions. Regarding usability, group participant ratings, obtained from a paper-and-pencil survey immediately following the completion of the lesson-planning simulation, revealed that 96% of groups found the software easy to use.

Several other ratings obtained from the post-participation survey provide additional insights as to how the simulation will be employed in the future. First, 98% of the groups believed that working together as a group on the lesson-planning task was more beneficial than working alone would have been. Second, 98% of the groups concluded that they would benefit if they had the opportunity to compare their lesson-planning decisions with those generated by groups of experienced teachers. Additional findings that address the decision-making strategies of participant groups will be drawn from two feedback instruments that map the decision path followed during the planning and the decision outcomes that define the resulting lesson. Of particular interest will be the individualized decision options and notes that the participants generate as they complete the planning task.

As findings on the newly developed simulation unfold, it is becoming increasingly clear that this tool's use as a stand-alone laboratory task needs to be rethought. With its evolving open structure, the simulation can easily be integrated into methods coursework and can even function as a diagnostic tool.

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