Simulation Games, Learning, and Retention

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Educators are always looking for better ways of fostering the development of young children. New methods, new materials, new subjects, and new goals are constantly being tried. Among the most promising innovations are simulation games. In simulation games, participants try to attain specific goals by interacting in an artificially produced environment that recreates some aspect of social reality. To make the simulated environment as realistic as possible, players assume the roles of individuals or groups in the social system being simulated.

Simulation games can be successfully incorporated into most curricula. Bruner (1) has described the academic value of simulation:

> The most persistent problem in social studies is to rescue the phenomena of social life from familiarity without at the same time making it all seem "primitive" and bizarre. Four techniques are proving particularly useful in achieving this end. The first is contrast; the second is the simulation and use of informed guessing, hypothesis making, conjectural procedures. The third is participation—particularly by the use of games that incorporate the formal properties of the phenomena for which the game is an analogue. In this sense, a game is like a mathematical model; an artificial but often powerful representation of reality. The fourth is the ancient approach of stimulating self-consciousness . . .
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> Games go a long way toward getting children involved in understanding language, social organization, and the rest; they also introduce . . . the idea of a theory of these phenomena. We do not know to what extent these games will be successful but we shall give them a careful try. They provide a superb means of getting children

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to participate actively in the process of learning—as players rather than spectators [1: 92–93, 95].

Educational simulations are still in their infancy, and consistent evidence of their effectiveness has yet to be developed. Indeed, because they lack strict objectives, games are not easily evaluated by traditional techniques. Several studies have been done to determine the effectiveness of simulation games.

Paul DeKock (2) reported a study of racial attitudes using the game Sunshine, a simulation of current racial problems. In this game, high-school students in his American Studies classes took roles typically found in a community. The teacher introduced pressure cards designed to initiate tension and move the community toward racial crisis. DeKock found that attitudes changed significantly as a result of the simulation experiment. The results must be viewed with caution, however, because the designer of the game taught all the classes.

In a similar study, Karen Cohen (3) found that junior high school students who played Consumer and Democracy as part of a special summer-school program for unmotivated pupils overwhelmingly preferred the games to traditional classwork. Participants explained why they liked simulation: 87 percent thought the games were more interesting than traditional methods; 82 per cent thought the games allowed pupils more freedom to work on their own; and 61 per cent thought the games gave a better idea of pupils' progress.

Wing (4) compared two groups of sixth-graders. One group played Sumerian Game and Sierra Leone individually at computer terminals. The control group studied the subject matter of the games by traditional classroom methods. The experimental group outperformed the control group on the criterion test for the Sumerian Game, while the control group outperformed the experimental group on the criterion test for Sierra Leone.

Little research has been done on simulation games, especially in the elementary school, and only a few studies have focused on retention. Many of the benefits attributed to simulation as a learning device are not convincingly supported by the available evidence. The problems of doing conclusive, scientific research on simulations are many: the lack of a theoretical framework, the influence of the teacher or the director in setting the tone, the question of whether outsiders should evaluate the effectiveness of the simulation game and their possible influence on the activity, the environment and the type of pupils who engage in the games, the difficulty of getting accurate and valid instruments to measure short-term and long-term changes in attitude, the consideration of the Hawthorne effect, and the immense problem of generalizing about simulation games from one particular game. All these problems have produced conflicting data that have softened the stand held by previously enthusiastic supporters who insisted that simulation games could do almost anything better than more traditional methods.

In a recent review Coleman, Livingston, Fennessey, Edwards, and Kidder (5) explain that simulations and other types of experiential learning processes are not always effective in helping participants generalize from the particular experiences provided in the game to a general principle applicable in other circumstances. These authors argue: "It is probably because [generalizing] is the weakest link in experiential learning that post-game discussions appear to be very important in the experiential learning that takes place in simulation games" (5: 5). Coleman and his associates conclude that learning in school might be made considerably more effective by "the appropriate mix of experiential and information-processing modes of learning" (5: 6). Indeed, simulations that include certain elements of information-processing designs may be a particularly useful way of facilitating the learning of basic concepts and facts. Simulations of this kind would provide the symbols helpful for generalization and the actions useful for application to particulars.

The strategy described by Coleman and his colleagues supports an analysis of instructional design presented by Case (6). Case contends that learning theories such as Gagné's ignore the possibility that young learners are not developmentally ready to benefit from certain learning experiences. Young children have a limited capacity to coordinate the various elements of many learning tasks. They also have certain innate response tendencies that prevent them from evaluating phenomena adequately. More specifically, Case contends that children must learn to respond logically rather than intuitively if they are to accomplish certain tasks. Case observes that the most effective instructional experience is one in which the child acquires a "concept," "plan," or "structure" for attacking a problem area. With this structure the child can successfully discriminate among alternative strategies for solving a particular problem and select the correct one. Once the structure for a problem area has been learned, that structure will be elicited each time a new problem in that area is encountered, Case contends.

The purpose of the present study was to examine the effectiveness of a simulation game designed to incorporate learning activities at three hierarchical levels. The game includes activities in the information-processing mode of learning as well as in the experiential mode of learning.

Fifth- and sixth-grade classes from two elementary schools in Kansas City, Kansas, were used for this investigation. The eight classes participating in this study were randomly assigned to experimental and control groups. The total number of pupils in the classes was 183, including ninety-one in the experimental group and ninety-two in the control group.

The investigator met with the teachers of the experimental and the control groups one week before beginning the treatment. At this time the two groups of teachers received the same instructions on the purpose of the study and the testing. The meetings for the teachers of the experimental and the control groups were conducted separately.

Teachers in the control group were instructed to teach a lesson on map skills that included facts and concepts. They were to teach the lesson in the way they usually teach. The lesson used for Grade 6 was from the textbook *Exploring American Neighbors* (7), and the lesson for Grade 5 was from *Exploring Regions of the Western Hemisphere* (8). The lesson was to be taught in four consecutive sixty-minute periods. Time was allowed after the presentation for discussion and questions.

In the meeting with the teachers in the experimental group, the game Phantom Submarine was played. The teachers were asked to play the game because teachers do a better job of teaching a simulation if they have first played the game themselves. Before the teachers played the game, the general procedures were explained to the group. At this time the teachers became familiar with the game, discovering the rationale, the techniques, and the procedures.

Both Bruner and Taba suggest that instruction should alternate between the learning of factual knowledge and the use of that knowledge for mind expansion. Taba identifies three cognitive tasks involved in the learning process: concept formation, interpretation of data, and application. The Phantom Submarine game is a simulated learning situation that develops all three of the cognitive tasks defined by Taba (9). The game provides opportunities for the teacher to extend pupils' participation through peer interaction, role-playing, and decision-making.

The primary emphasis is on active rather than passive participation to give pupils a meaningful learning experience. Active participation leads to intrinsic motivation that Bruner and Taba say is important in helping children develop greater interest in a subject. The increased interest, in turn, leads to longer episodes for learning.

Phantom Submarine centers on a German submarine that was believed to have sunk off the coast of Florida during World War II. It has been discovered that the submarine did not sink to the ocean floor, but has remained afloat in the Gulf Stream two hundred feet below the surface. Pupils who take part in the simulation are asked to study the physical characteristics of the floor of the Atlantic Ocean and to apply what they learn to a problem presented by the submarine. Each pupil participates in the learning and the problem-solving by contributing information on the Gulf Stream and the floor of the Atlantic Ocean. Each child is assigned a role. The members of each simulation group decide, by consensus, what to do about the problem presented by the submarine. For the simulation the class is divided into groups of five children each. The groups represent people who have been called to a meeting because of their knowledge and interest in the phantom submarine. Each member of the group has a card (called a map card) that displays some physical characteristic and factual data about the floor of the Atlantic Ocean. Each member also has a role card telling him whom he is to represent at the meeting and a blank master map for recording the data about the ocean floor.

The group begins the simulation by compiling factual knowledge about the floor of the ocean and its currents (Taba's first level). The information is reported on five different map cards (one for each member). These small map cards portray relevant graphic and verbal information about the ocean topography, the ocean depth, the mid-Atlantic Ridge, and the route of the Gulf Stream. Each member of the group shows and reads his card in turn to the rest of the group. As each member reads his card, the other members enter the graphic and the verbal information from the card onto their master map. Crayons are used to duplicate the graphic information presented on the map cards. All members of the group now have the same information.

In the second part of the simulation (Taba's second level), the group decides what to do with the submarine. The decision is based on the information on the children's maps. Discussion of the Gulf Stream, of hazards of mountain ridges, and of ocean depths by members of the group can lead to the sharing of valuable information.

The third part of the game (Taba's third level) begins with the problem presented on a worksheet given to the children. The problem is that the submarine is carrying two hundred tons of mercury to keep the ship stable. Mercury is a poison. If it should spill into the ocean it would bring disaster to fish and plant life. The ecology of the entire world could be affected. The ship is believed to carry a self-triggering device that will cause it to explode if any attempt is made to enter it or to bring it to the surface. Recently a man by the name of John L. Greedy, who is a deep sea treasure hunter, has learned of the submarine and has made plans to bring it up. The mercury on the submarine is worth about a million dollars. It would make him a very rich man. A meeting has been called by the United Nations Committee on World Pollution Control. The meeting involves five persons representing parties who are interested in the submarine problem. Each participant is given a role card describing whom he represents at this meeting. The children will need time to discuss—enough time to reach a decision and to record clearly the reasons for the decision.

At the end of this discussion, each group reports to the class at large on its decisions and its reasons.

After discussing the game at length, experimental teachers established timetables: On the first day the experimental pupils used the sixty-minute period allotted to familiarize themselves with the game and to complete the first task of transferring information from the cards to their individual maps. On the second day the experimental pupils determined cause-and-effect relationships through the various kinds of information found on the master map. After the groups completed this task, they discussed their decisions with other groups. On the third day in the final task of the game, the pupils applied their knowledge of the maps and the generalizations they had formed from the previous tasks to reach a decision on which all members of the groups agreed. The next day was set aside for completing any unfinished tasks and for discussing all decisions made by the groups.

On the fifth day of the study, the posttests were administered to the experimental and the control groups. The map portion of the Iowa Tests of Basic Skills was used to measure map skills, and a Concept Development Test was used to measure map concepts.

Two weeks after the posttest a delayed posttest was given to both groups to measure retention. The same two instruments were used for the delayed posttest.

Table 1 reports means and standard deviations for the Iowa Tests of Basic Skills and the Concept Development Test. One-way analyses of variance were used to examine differences in the mean performances of experimental and control groups on each dependent measure. On the posttest no significant difference between groups was observed on the Iowa Tests of Basic Skills or on the Concept Development Test. On the delayed posttest no significant difference was observed for the scores on the Concept Development Test. However, on the delayed posttest a significant difference was observed between experimental and control groups on the scores for the Iowa Tests of Basic Skills ($F=5.52, df=1, 181, p<.05$).

A significant improvement on the map skills portion of the Iowa Tests of Basic Skills was noted for the experimental group from the posttest to the delayed posttest ($F = 4.51, df = 1, 181, p < .05$). No similar improvement was noted for the control group.

Interpretation of the results of the statistical analysis led to several conclusions. First, even though the mean posttest score for the experimental group was slightly higher than the mean for the control group on the Iowa Tests of Basic Skills, the analysis of variance indicated that there was no significant difference between groups immediately after termination of the unit. One probable reason for this result is that the simulation focused on

TABLE 1. *Mean Scores and Standard Deviations for the Iowa Tests of Basic Skills and the Concept Development Test*

	Experimental Group		Control Group	
Test	Mean Score	Standard Deviation	Mean Score	Standard Deviation
Iowa Tests of Basic Skills				
Posttest	16.82	4.73	16.19	5.42
Delayed Posttest	17.58	5.23	15.59	6.23
Concept Development Test				
Posttest	9.21	4.02	8.50	4.20
Delayed Posttest	8.99	3.79	8.43	4.68

theory rather than fact. At the time the posttest was administered, children in the experimental group may not have understood the abstract concepts dealt with in the game well enough to apply them to the concepts and the facts assessed by the Iowa Tests of Basic Skills.

There was no significant difference between groups on the Concept Development Test—although again the mean score for the experimental group was slightly higher than the mean score for the control group. One possible explanation is that the Concept Development Test may be too difficult for the age level assessed in this study. Some of the questions on the test are at the analysis and synthesis levels according to the Taxonomy of Educational Objectives for the cognitive domain (10) or at the application level on Taba's cognitive scheme (9).

A second conclusion, and perhaps the most important one to be drawn from the study, is that the simulation procedure seems to be effective in promoting retention.

The experimental group showed a significant improvement in map skills from the posttest to the delayed posttest. This improvement, coupled with a decline in performance on the part of the control group, resulted in a significant difference between experimental and control groups on the delayed posttest. This finding indicates that Phantom Submarine facilitated retention of map skills. Phantom Submarine appears to teach relatively abstract concepts that are useful in promoting learning of lower-level knowledge and concepts. In the present study the posttest may have provided pupils their first encounter with certain facts or at least questions about facts. The test may have actually presented a learning experience for the children in the experimental group. Through their previous experience with using information from maps to solve the problem of the submarine, they may have developed a kind of "theory" about map symbols and usage. Because children in the experimental group understood the theory, they could better understand the errors they made about facts on the posttest. Thus, the second time they encountered the test questions about these facts, they could improve their performance. These findings are similar to findings reported by Case (6) when he trained children to do maze tasks. After training on abstract concepts, the children in Case's study tended to improve in additional encounters with the maze tasks.

In sum, this research indicates that the type of simulation used in the study is valuable for classroom instruction, especially in social studies map skills and concepts. Simulation provides an enjoyable change of pace from traditional methods of instruction and is effective in promoting retention of basic knowledge. Simulation should not be the only method of instruction, but it should be incorporated into the total curriculum. Indeed, future research might be directed toward comparing the effectiveness of simulations and more traditional methods in a total curriculum package.

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