Two Computer-Based Economics Games for Sixth Graders

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In an individualized learning situation, sixth graders play against computers and proceed at their own rate to learn about economic principles. Richard L. Wing is Coordinator of Curriculum Research at the Center for Educational Services and Research, Board of Cooperative Educational Services, in Northern Westchester County, New York.

■ Since 1962 the Center for Educational Services and Research of the Board of Cooperative Educational Services (BOCES) in Northern Westchester County, New York, has been experimenting with the use of computer-based games with simulated environments as an instructional methodology.* This paper will report on some of our experience with two of these games, both essentially one-person games in which the student plays "against" a computer program.

Perhaps the greatest potential virtue of combining simulation as a method and computer-based technology as a medium is its ability to provide *individualized instruction.* Unlike the typical classroom situation in which groups of students are training at a fixed rate with no particular attention to differences in abilities and interests, the computer games developed at BOCES allow in particular for:

1. *Variation in pace.* Students proceed at their own pace, so that they are neither held back nor forced to keep up with other students.
2. *Variation in scope.* The segments presented to the students were of differing length, depending on the student's previous success in the game.

The games to be described also allowed for easy variations of content (it was possible to switch from one game to another merely by signing off one game and signing on the other); of style (e.g., one game starts with an explanation in question-and-answer form and continues with a multiple-choice technique); and of mode of presentation (the games used both typewriter printout and slide-display, while relying primarily on the former).

Computer techniques also make it possible to vary the sequence and difficulty of the problems presented in accordance with the progress of the individual students. This possibility, however, was not utilized in the games here discussed.

DESCRIPTION OF GAMES

The first of the games developed at BOCES was the Sumerian Game, designed to teach sixth graders some basic principles of economics as applied to the time of the Neolithic revolution in Mesopotamia. During an introductory programmed tape and slide presentation the child playing the game sees himself as a ruler's son in the city-state of Lagash about 3500 B.C. At the conclusion of this orientation, the rules and the initial economic conditions are given to the child by means of typewriter terminals controlled by the computer. He then assumes the role of Luduga I, priest-ruler of Lagash, and is presented with his first problematic situation: "We have harvested 5,000 bushels of grain to take care of 500 people. How much of this grain shall be set aside for the next season's planting, and how much will be stored in the warehouse? The remainder will be given to the people to eat."

The child makes decisions and enters his answers at the computer terminal. The computer immediately returns a progress report, including the harvest reaped from the seed grain set aside for planting, a verbal description of the standard of living, and a report on his inventory. This kind of problem is repeated throughout the entire game, each harvest representing six months in the life of a ruler. As the game progresses, it becomes more complicated: the ruler must take into account a changing population, and is also faced with the problem of expansion, which entails the acquisition of new land and irrigation. At intervals the ruler is presented with technological innovations and disasters which alter the outcomes of his decisions.

The rule of the first Luduga is devoted to the solution of problems pertaining to an agricultural economy. In the second phase of the game the child, as Luduga II, is given the opportunity to apply his surplus grain to the development of crafts. In the third and final stage he is introduced to trade and the more complex problems which confront a changing economy. The rate and trend of development are dependent upon the wisdom of the child's decisions. (A sample printout from the Sumerian Game is contained in Appendix A.)

The purpose of the second game, the "Sierra Leone Development Project," is to simulate the economic problems of a newly-emerging nation, with a secondary emphasis on a study of the country's culture. The simulated economic and social situations used in this game are drawn from actual problems discussed in the ten-year Social and Economic Development Plan now in effect. An example is the land reclamation program in which former marshland is used to cultivate rice in order to diversify agriculture and to decrease expenditures for imported food, and thereby to obtain a more favorable balance of trade.

The mechanics of the situation are briefly as follows: (a) The student must pass a preliminary examination testing basic and general economic and geographic information on Africa; (b) Upon successful completion of this examination, the student is placed in the role of Second Assistant Affairs Officer for the Agency for International Development located at the American Embassy in Freetown, Sierra Leone; (c) The student pro-

AUTHOR'S NOTE: The first games were undertaken jointly by BOCES and IBM during the summer of 1962 and continued into 1964 under the terms of Cooperative Research Project 1948. This project was followed by another, #2841, devoted entirely to the development of economics games.

The games were prepared in consultation with experts in economics, ancient Middle East history, and modern Sierra Leone. Other persons who were instrumental in planning these games were Mabel Addis, a fourth grade teacher at the Katonah Elementary School; Walter Goodman, Chairman of the Social Studies Department at Briarcliff High School; and Jimmer Leonard, graduate student in the Department of Social Relations, The Johns Hopkins University. Programming has been done by William McKay of IBM.

gresses from problem to problem, at times carefully studying a specific geographic area in order to see the peculiar nature of that area's problems; (d) As the student satisfactorily completes and shows an understanding of the problems presented to him he is promoted to Assistant Affairs Officer and finally to Chief Affairs Officer in AID. The game is thus divided into three main parts, each part presenting new and different economic problems.

The Sumerian and Sierra Leone Games were played on three IBM 1050 terminals, two equipped with modified carousel projectors and the third with an experimental random access film strip projector. During each game about seventy five pictures were projected at appropriate times. The terminals were connected by Dataphone to a special-purpose 7090 Computer which was under supervision of a Time Sharing Monitor system (TSM). The coding language used was Fortran Assembly Program (FAP) with a few additional control cards for file loading purposes. To give some idea of the scope of the programs, the Sumerian Game uses about 15,000 lines of instructions and approximately 37,000 memory places in the computer system.

PROBLEMS INVESTIGATED AND EXPERIMENTAL PROCEDURE

The present experiment was intended to supply information concerning two groups of problems.

1. *Applicability of the games.* Whether sixth-graders indeed could play the games on the computer and develop the same interest usually generated by games and how much teacher-intervention would be required to enable them to play.
2. *Learning-effectiveness.* How this technique for learning basic economic principles compared with conventional classroom teaching in terms of amount of learning and time invested by the student.

From October 1965 to March 1966, twenty-five sixth-grade students from the Mohansic School in Yorktown Heights, New York, played the two games on three terminals at the Center for Educational Services and Research of BOCES. All students played both games, some starting with the Sumerian Game; others with the Sierra Leone Game. Meanwhile a control class of equal ability* studied the economics of life in Sumer and Sierra Leone by conventional classroom methods, with a teacher considered to be especially talented and creative. Each student in the experimental group played the game for about 90 minutes and then signed off, returning the following school day to continue. The three terminals were separated from each other in the same room with portable wall section dividers, so that in effect the pupils were separated from each other while playing the games.

Before the games, all students in both control and experimental classes were pretested with the "Test of Economic Principles Based on Ancient Sumer" and the "Test of Economic Principles Based on Sierra Leone" prepared for the project. As each student in the experimental class finished one of the games, he took the posttest based on the game. The students in the control class were posttested as they finished each of the two instructional units taught by the control class teacher. The same test was used for pretesting and posttesting. (A sample page from the Sumer test is reproduced as Appendix B.) Finally, the test was re-administered as a "retention-test" several weeks after the posttest.

Time on the computer was recorded for each player. Moreover, the supervisor kept an anecdotal record of incidents at the terminal and composed a summary describing the ways in which each student reacted to the experience of working with the computer. She also interviewed each student when he had completed both games and posttests.

FINDINGS

Applicability of the Games

It was found that instruction was self-sufficient to the extent that most of the students required no assistance with the instructional aspect of the games. Each student worked independently of other pupils and received no help from a teacher except in these cases:

1. When he had misplayed the game to the extent that the message "please call the teacher" appeared. In this case the student was started over again and required to read aloud the instructions.
2. Whenever any program errors or system failures occurred.
3. Whenever he failed entirely to understand a question, assignment or paragraph within the games. These occasions were rare.
4. When, in one particular instance, the terminal supervisor read aloud the bulk of the printout to a student with very low reading ability.

As distinct from the act of manipulating the typewriter terminal the gaming part of the program presented no real problem to the students. The rules of procedure were simple and explicit enough so that they had no trouble playing the game. Whatever rules there are in these games are explained or made evident as the instruction progresses.

With the exception of two students who had very low reading ability, the sixth graders seemed to have no trouble in reading the printout or following instructions.

The fact that the games are apparently self-sufficient does not mean that they could not be used to greater profit in conjunction with a teacher for one of many possible combinations. It does mean, however, that it is possible to instruct pupils with some degree of success on a completely independent basis.

In regard to the *interest* which students had in the game we found that almost without exception the pupils said they enjoyed playing these economic games on the computer and that this high interest was maintained throughout the two games, which lasted an average of 15 hours in total. Working with a computer terminal is such a novel experience for young students that they undoubtedly experience a rather exaggerated Hawthorne effect. We do feel confident that their interest in working games at the terminal lasts at least 15 hours; we do not know whether it could last for 1,000 hours.

Learning-Effectiveness

Amount of Learning. Table 1 presents the mean pretest, posttest and retention-test scores for experimental and control groups in respect to both the Sumer and the Sierra Leone test. (It may be noted that experimental and control groups do not differ significantly on the pretest, thus supporting the assumption that they were evenly matched.)

TABLE 1: PRETEST, POSTTEST AND RETENTION TEST SCORES FOR EXPERIMENTAL AND CONTROL GROUPS

	SUMER		SIERRA LEONE	
	Experimental	Control	Experimental	Control
Pretest	17.0	15.8	14.1	14.4
Posttest	24.2	19.3	24.9	26.9
Retention Test	23.9	22.5	21.8	25.4
Learning: Post-score — Prescore	+7.2	+3.5	+10.8	+12.5
Retention: Retention Score — Postscore	—.3	+3.2	—3.1	—1.5

* As determined by scores on intelligence tests and the Reading Section of the Iowa Test of Basic Skills.

The results are ambiguous. While the gain from pretest to posttest was larger in the experimental group than in the control group (statistically significant at the .01 level) in respect to the Sumer test, the opposite result (although not statisically significant) was found for the Sierra Leone test. The retention was slightly superior in the control group.

Although the only statistically significant difference is the one pertaining to the larger gain of the experimental group in respect to the Sumer test, the total of the data seem to impose a cautious conclusion: that no difference in amount of learning was demonstrated. Insofar as these data go, no claim to superiority can be made either by the computer game technique or by the conventional classroom method of instruction.

Time Invested Per Pupil. The picture is different when we turn to the time invested per pupil. Table 2 presents mean, minimum and maximum game-time per pupil for both games, compared with the classroom, where the teacher spent approximately an hour a day for three weeks on the subject matter of *each* game – i.e. approximately 30 hours in all.

TABLE 2: LEARNING TIME (HOURS) FOR SUMER AND SIERRA LEONE TOPICS

	SUMER			SIERRA LEONE		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Experimental	6:40	14:05	10:15	3:55	8:00	5:05
(Control)	(15:00)	(15:00)	(15:00)	(15:00)	(15:00)	(15:00)

It is seen that the mean game-time for both games is considerably smaller than the classroom-time (differences significant at the .01 level). Indeed, on neither game did any pupil spend as much time with the computer as the standard classroom-time. For both games together, game-time is only slightly more than half of classroom-time.

In other words, on the average, the students in the experimental group attained approximately the *same amount of learning* with considerably *less investment of time*. In this sense of "learning effectiveness," amount of learning by pupil time, the games appear superior to conventional classroom teaching.

DISCUSSION

It does appear that the computer can be used as a technology for enabling sixth grade students to play educational games and that these games are teaching something. Considering that the Sumerian Game, for example, requires about 16,000 lines of instruction, we feel that we are to a certain extent making use of the power of the computer to deliver programs of considerable complexity.

In addition to being a device for providing instruction, the computer offers a wonderful opportunity to compare methods or teaching logics under stable conditions, that is, conditions which are not influenced by the variable personality and teaching techniques of the human teacher. The computer also provides us with complete records of the student's performance and can, of course, be programmed to make calculations of any sort we desire regarding such things as success and failure, number of repetitions, time elapsed, etc.

The game technique used in this experiment needs a great deal of further testing and revision. At the same time we feel that our findings so far offer encouragement for such further effort. That is, insofar as our experience goes, computer-based games *can* be used in practice even with sixth graders; they do teach as well as conventional classroom methods; and they seem considerably more effective than conventional methods, when the time investment of the student is taken into consideration.

APPENDIX A

SAMPLE PRINTOUT FOR SUMERIAN GAME

Hello! Before we begin, will you please type your name, first name first, then your last name, and then press the Return key.

Ed Smith

Now, Ed, you are ready to operate the Sumerian Economic Model.

Imagine that you have just been made Ruler of Lagash, a City-State of Sumer, in the year 3500 B.C. Twice yearly your Royal Steward, Urbaba, will report to you the economic condition of the kingdom. Guided by these reports, you will decide the use of your grain and other resources, trying to keep your population stable and well fed. Between reports, your court advisor will come to you with news of your kingdom.

The Steward will use the typewriter to report and ask for your decisions. When the "Proceed" light comes on, type your answer in figures and press "Return." (If you make a mistake, press "Cancel" instead and try again.) Good luck!

Initial Economic Report made to the New Ruler of Lagash by his Humble Steward:

Total population now	500
Total farm land under cultivation, acres	600
Total grain in inventory, bushels	900
one season old	900
two seasons old	0
three seasons old	0
Total grain just harvested, bushels	13000
Total resources, harvest + inventory	13900

You must now decide how to use your resources.
How many bushels of grain do you wish to FEED your people?
4000
How many bushels of grain do you want PLANTED for the next crop?
9000
This means that zero bushels must be removed from storage. Is this all right? Do you wish to 1 – let your decisions stand or 2 – revise them?

1Resulting inventory	900

The steward will execute the royal commands and return in 6 months.

Sir, I am sorry to report that 225 bushels of grain have rotted or been eaten by rats this past season.

Economic Report of the Ruler's Steward for the SPRING Season in the year 1 of Luduga 1.

Population at previous report	500
Change in Population	—55
Total population now	445

The quantity of food the people received last season was far too little.

Harvest last season	13000
Harvest this season	14396
Previous inventory	900
Change in inventory	—225
Present inventory	675
Total resources, harvest + inventory	15071

You must now decide how to use your resources.
How many bushels of grain do you wish to FEED your people?
5000
How many bushels of grain do you want PLANTED for the next crop?
9000
This means that 396 bushels must be placed in storage. Is this all right? Do you wish to 1 – let your decisions stand or 2 – revise them?

APPENDIX B

SAMPLE PAGE FROM TEST ON ECONOMICS PRINCIPLES BASED ON ANCIENT SUMER

PART A: Multiple Choice

For each of the following questions or incomplete statements, choose the one best answer and place the corresponding letter in the parentheses at the right.

1. If the supply of a product increases at the same time the demand for it decreases, its market value will a. fall; b. rise; c. be undetermined; d. remain exactly the same. ( )
2. If the demand for a product increases, the increase in value which follows usually causes a. more of the product to be produced; b. less of the product to be produced; c. no change in production; d. the making of the product to be stopped. ( )

3. Specialization and trade between countries usually leads to a. the interdependence of both countries; b. the production of fewer goods; c. the economic instability of both countries; d. the fame of both countries. ( )
4. If the demand for a product declines a. the hiring of more workers follows; b. the rate of production slows temporarily; c. the value of the product increases; d. the product is worthless. ( )
5. Compared with the economy of the United States today, the economy of Sumer at about 3000 B.C. a. was much more productive; b. had more government ownership and control; c. better satisfied the wants of the people; d. had more private businesses. ( )
6. When a country overproduces a. trade for luxuries is made possible; b. the waging of offensive wars is encouraged; c. the worth of the craftsmen is increased; d. none of these. ( )
7. When a large company that manufactures television sets finds its profit has become very high due to a great demand for its sets, it will probably a. fire many workers so as to reduce the cost of making television sets; b. distribute all of the profits to the workers as a bonus; c. spend money on research so as to build better sets or different products; d. sell some of the machines in the factory in order to reduce the cost of staying in business. ( )
8. When technological inventions are encouraged a. production is increased; b. the study of science is no longer required; c. the standard of living is lowered; d. none of these. ( )

SELECTIVE BIBLIOGRAPHY ON SIMULATION GAMES AS LEARNING DEVICES

The following list contains only works relating to simulation games designed or used primarily for educational purposes. It does not contain references to simulations developed for theoretical or predictive purposes[1], or which do not have a game structure. Nor does it include references to the literature on "game theory," as developed by von Neumann and Morgenstern and their followers. There is also a body of literature on games in the anthropological literature, which is not included here.

In the case of games or research programs on which a number of papers and monographs have been published (e.g., the Carnegie Tech Management Game), we have tried to select those which are most recent and/or comprehensive.

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MAJOR CENTERS INVOLVED IN RESEARCH AND DEVELOPMENT OF GAMES WITH SIMULATED ENVIRONMENTS

Abt Associates, Inc., 55 Wheeler Street, Cambridge, Massachusetts 02138. Area Code 617, Telephone 491-8850.

This group became incorporated in February, 1965, and includes the following games designers: Clark C. Abt, president; Steven Bornstein, systems analyst; Ray Glazier, anthropologist; Martin S. Gordon, senior operations analyst; Alice J. Kaplan, historian; Holly J. Kinley, sociologist; Peter Merrill, political scientist; Peter S. Miller, systems analyst; Keith Moore, psychologist; Martha O. Rosen, economist; Richard H. Rosen, senior operations analyst; and John Blaxall, now with the World Bank in Washington, D.C.

SIMULATION GAMES
(age groups designated)

AGE GROUPS	NUMBER OF PLAYERS	HOURS NECESSARY TO PLAY
For Elementary School Level:		
Bushman Hunting	5-10	1
Seal Hunting	2-10	1
Market	20-30	2
Sierra Leone	4-30	2
Economy	12	2
For Junior High School Level:		
Adventuring (history)	3-20	1-2
Empire	10-50	2 (1+1)
For Senior High School Level:		
Manchester (economy)	8-40	1-2
Steam	6-15	2
Galapagos (evolution)	6-50	1-2
Grand Strategy (international relations) (for college students also)	20-50	2
For Graduate Students, Adults:		
Politica	50 (40-80)	3
Urbcoin (urban counter-insurgency)	20-50	3
Agile-coin	20-50	3
Adman (banking)		

Abt Associates are involved in research and development of games, primarily on a contractual basis. Basic game descriptions are available on request. Abt Associates does not manufacture or market their games, but can arrange for their quantity production.

Board of Cooperative Educational Services in Northern Westchester (BOCES), Center for Educational Services and Research, (First Supervisory District), 845 Fox Meadow Road, Yorktown Heights, New York 10598. Area Code 914, Telephone: 245-7031.

This project got underway in 1962 and was founded by Office of Education and private grants in 1963. The following people have developed games and/or are working on games at the center: Richard L. Wing, coordinator of curriculum research; Mabel Addis, teacher, Katonah Elementary School, Katonah, New York; Bruse Moncreiff, IBM Systems Development, Los Gatos, California; Jimmer Leonard, graduate student, The Johns Hopkins University, Department of Social Relations; Walter Goodman, project director of Title 3 Demonstration Project.

BOCES has focused on the development of computarized games for individual instruction (Sumeria, Sierra Leone, Free Enterprise). Some can be made available for research by special arrangement.

Carnegie Tech Management Game, Carnegie Institute of Technology, Graduate School of Industrial Administration (GSIA), Schenley Park, Pittsburgh, Pennsylvania 15213. Area Code 412, Telephone: 621-2600.

The Carnegie Tech Management Game began in 1957 as an experiment in business education; it was the first realistic management game to be developed and successfully used in a graduate business school curriculum. Instrumental in its formation in the Graduate School of Industrial Administration are: Richard M. Cyert,