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SIMULATION AND GAMING MODELS: APPLICATION IN TEACHING AND EXTENSION PROGRAMS*

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I. Introduction

Management games are an accepted component of the education and training program for students on the university campus as well as participants in extension workshops. Numerous applications in agriculture and agri-business can be cited including the use of farm management games (Menz and Longworth, Boehlje, et al.), grain merchandising and feed supply management games (Webb and Disgruber) and more recently the use of games in area economic development (Boeksen). Our purpose is to evaluate simulation and gaming as an educational tool with reference to educational objectives and learning styles of individual students. The discussion briefly reviews concepts of educational objectives and learning theory, and then moves to the use of simulation and games as educational aids. Two examples of management gaming are reviewed and evaluated. Finally, issues confronted in evaluating the costs and benefits of using gaming procedures will be briefly discussed.

II. The Educational Process

Educational Objectives

We perceive the following four objectives as being paramount in most university and adult education programs: (1) Transfer of facts--this objective involves dissemination of that material which is accepted as factual. (2) Increase analytical capabilities--In the realm of economics and management, the basic concepts of the scientific method of analysis, logical reasoning, and economic concepts and tools that can be used to solve problems or make decisions are the core of educational activities targeted to accomplish this objective. (3) Improve capability to integrate--integrating the facts, values, and analytical concepts from a wide spectrum of disciplines including the social,

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physical and biological sciences is one of the more difficult tasks to be accomplished in the typical agricultural economics undergraduate curriculum or extension program. (4) Values clarification--A fourth objective that is found to varying degrees in university classrooms and extension education programs is that of providing information to the participant which will broaden his knowledge base and assist him in assessing the values by which he is guided as to both personal and vocational decisions.

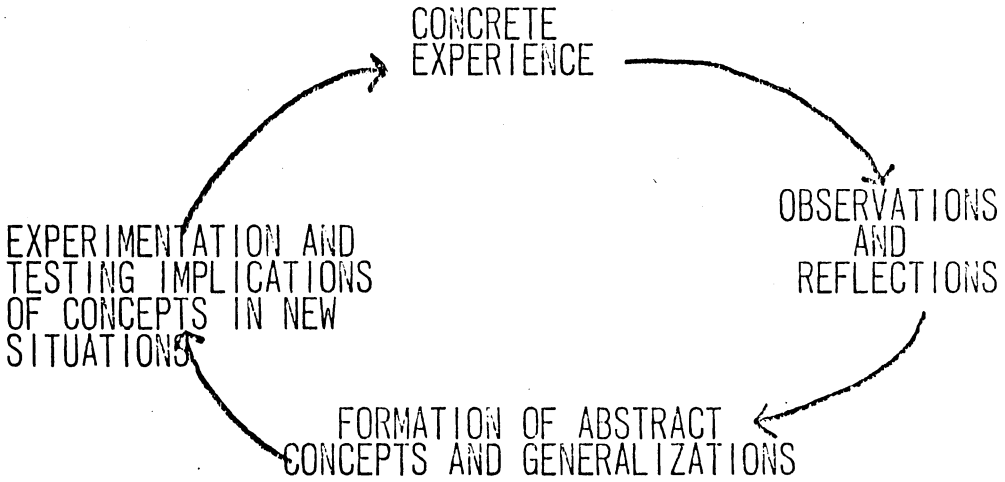
The Experiential Learning Process

Many analysts have attempted to determine how individuals learn(Bruner, Torbert). The experiential learning model presented by Kolb is one such conceptualization of the learning process. The process of experiential learning is perceived to be a four-stage cycle (Figure 1). Concrete experiences provide the basis for both observation and reflection. Based on these observations and reflections, the student forms abstract generalizations--in essence, a "theory"--to explain the concrete experience. Using this theory, the implications and behavior in new experiential situations is deduced. These implications are, in essence, hypotheses which can be tested through experimentation and which also serve as guides to create new experiences which initiate the cycle again.

Because of their hereditary background and developmental environment, most individuals find it difficult to master the skills required in all four phases of the experiential learning process, but excel in one or two phases. Thus, individual learning styles differ depending upon the ability of the individual to perform the various functions in different phases of the learning cycle.

Simulation and gaming procedures facilitate efficiently performing the learning functions in the testing and experimentation and concrete experience phases of the learning process. Gaming enables students to develop and test hypotheses concerning their conceptualization of the problem and its solution.

Figure 1. The Experiential Learning Model



The use of games accelerates the active experimentation and concrete experience phases of the learning process so that additional concepts can be introduced within a given time frame. Having all students participate in active experimentation in the real world would require more field trips and/or other "concrete experience" activities than can typically be accommodated with the time and budget available in most university curriculums or extension conferences. Through the use of the gaming procedure, the benefits of active experimentation, hands-on decision making and "pseudo" concrete experiences can be included in the learning experience.

Contribution of Gaming to the Four Objectives

The use of simulation and gaming contributes to the first three and perhaps the fourth educational objective in management courses. The transfer of facts and accounting and economic principles is typically an important objective in such courses. The initial coverage of a principle allows students to form the abstract concept and generalization. Gaming provides an opportunity to apply the concept, obtain concrete experience and complete the experiential learning model cycle by observing and reflecting. The understanding of accounting and economic concepts is reinforced if the biological and physical dimensions of the outcome are believable. Thus it is important that the resource base, technological relationships and input-output prices are "life-like."

Gaming can make major contributions to increasing analytical capabilities and improving student's capability to integrate. Problem identification is a difficult aspect of decision making to teach in a static setting, particularly when the students have not experienced similar situations. Problems of planning, implementation and control can be introduced rather naturally in a game. Unlike the use of static case situations, students are given an opportunity to experience the result and complete the experiential learning cycle. Learning

to interpret the results of such analytical tools as linear programming or decision trees and use the analysis as a basis for decision making is enhanced in a gaming situation. The capability to integrate facts, methods of analysis and values also is enhanced by the repetitive nature of the decision making.

Relatively little emphasis has been given to the use of gaming and simulation in values clarification in the agricultural economics literature. This is probably due in part to the emphasis placed on the first three objectives, the difficulty of measuring the fourth, and a common attitude that values are given. Emphasis is traditionally placed in management oriented games on the achievement of business goals, such as rate of return on investment and ending net worth, but "satisfying" behavior and leisure-work goals may also be relevant. Value or goal clarification can be reinforced during the critique of the game thorugh identification of strategies that are consistent with alternative values and the results of following these strategies.

The authors' experience indicates gaming contributes to learning by showing a use for facts, demonstrating a need for the analytical capabilities, providing an opportunity to practice integration and forcing participants to consider their values in making decisions. The interest and challenge generated by the gaming process carries participants through the cycle of the experiential learning model in a repetitive manner.

Gaming Procedures

The first and perhaps most important aspect in the successful use of gaming is to determine the purpose (or the role) of the game in meeting educational objectives. The purpose is basic to both designing and administering a game. An approach used by the authors and others (Menz and Longworth) is to develop class exercises around a case situation that is also used as the basis for the game. The game is used to generate interest in the exercises

and to reinforce learning through repetition. It also adds a dynamic aspect that is normally missed with the case study approach.

Two additional considerations, complexity and whether the game includes competition among decision teams, are important considerations in game design. The complexity of the game tends to increase as the number of decisions, the number of calculations and the computing complexity increases. The role of the game in meeting course objectives, the knowledge and ability of students, and the amount of time that can be devoted to the game are major considerations in developing a game of appropriate complexity. Frequently, the game can be structured to permit students to deal with increasing complexity in terms of decision alternatives and the decision environment through successive plays.

Most authors agree that participants gain a greater understanding of the concepts through competition among decision teams for resources or market share of sales (Babb and Eisgruber, p. 19; Wilson). In business management games such competition can occur in the input or product market with emphasis on the role of advertising, promotion and service as determinants of market share. In farm management games, competition among teams for resources such as land can illustrate concepts of land appraisal and investment analysis.

The proper method and time of introducing the game to the participants are important in game administration. It is probably useful to introduce participants to the mechanics of the game and illustrate play with sample input and output, or to have a "warm-up" play which is disregarded. If the game is constructed around a case situation, the case can be introduced early, allowing students to become familiar with resource availabilities, alternative uses for the resources and institutional constraints through illustrations and exercises. Team size and composition are also major considerations in game administration. The literature indicates that team size

should be small enough that all team members participate in decision making. Composition should be controlled to insure that team members have some diversity of background.

It is important that input be obtained and output returned to participants promptly to avoid loss of interest. Each team member and the game administrator should have a copy of the output from each play. After each play the administrator can evaluate the output and (1) discuss reasons for the success and failures that occurred; (2) provide modules of instruction on a topic or topics requiring more emphasis; and (3) identify teams which need special help. Some teams may become discouraged and lose interest unless the administrator can provide special instruction enabling them to play the game effectively.

After the final play, the game should be critiqued. The critique should focus on integrating subject matter and game experience. To accomplish this, the critique should emphasize the evolution of strategies and policies, the use of analytical techniques in making decisions, the reasons for the outcomes and the evaluation of the decision making exercise.

III. The Bank Management Game--An Extension Education Example

The bank management game is a deterministic, multiperiod management simulation game that typifies the policy management environment of a commercial bank in a rural market. The objectives of using the rural bank management game are: 1) Provide participants a learning experience in making policy decisions that affect the acquisition and use of funds for rural banks in an environment of changing market conditions and competition from other banks. Specific bank management tasks that are tested and reinforced in the game are summarized in Table 1. 2) Increase the participant's appreciation for the tools and payoff of financial planning and analytical decision making in bank asset and liability management. 3) Generate discussion during the

decision-making process among the bank management team members concerning their reasons for specific decisions.

The management team for each bank must make decisions in two basic areas: 1) price policy with respect to interest rates on loans, time deposits and service charge rates, loan officer's salaries and advertising expenditures, and 2) investment policy concerning the optimal portfolio of loans and investments. The game includes competition for deposits and loans among the banks. Six month reports which include specific details concerning the financial performance and progress of the individual bank being managed, the financial conditions of competitors, and the current and expected future economic environment in which the banks must operate are provided to the participants. The detailed computational procedures involved in the bank management simulator are documented elsewhere (Fisher, et al.).

An effort has been made to quantitatively evaluate benefits derived in using the bank management game. The tasks summarized in Table 1 were identified to participants in the 1978 Iowa Agricultural Credit School and Iowa School of Banking prior to playing the game as major areas that would be emphasized. The students were asked to evaluate the contribution of the game to their knowledge of and ability to perform each task on a scale of 1 (no contribution) to 5 (substantial contribution). The mean evaluation scores for the two schools are summarized in Table 1. Although the array of mean scores from the Iowa Agricultural Credit School is significantly larger than the array for the Iowa School of Banking, the differences between the score distributions for each task are not significant with the exception of tasks 4 and 7. One possible explanation for the lower scores at the Iowa School of Banking is the inability to schedule review sessions after each decision to evaluate the output and answer questions or review decision concepts. Note also the relatively low evaluation score for task 9 and the

Table 1. Summary of Bank Management Game Evaluation

Task	Iowa Agricultural Credit School*		Iowa School of Banking	
	Total Evaluations	Mean Response	Total Evaluations	Mean Response
1. Cash and liquidity management	57	3.93	46	3.61
2. Pricing of loans	57	3.82	46	3.48
3. Acquisition of deposit funds	57	3.67	45	3.80
4. Analysis of margins (the spread between the costs and returns on funds	57	4.23**	46	3.61**
5. Investment portfolio management	57	4.21	46	3.72
6. Loan portfolio management	56	3.41	46	3.11
7. Tax management	56	3.68**	46	3.04**
8. Evaluation of the impact of competition on profits and performance	57	3.51	45	3.60
9. Evaluation of the impact of the economic environment on profits and performance	57	3.07	46	2.98
10. Assessment of the determinants of loan demand and deposit supply	57	3.46	46	3.37
11. Assessment of the determinants of market share of loans and deposits	57	3.60	46	3.43
12. Understanding of the relationship between the objectives of profit and growth in market share	57	3.75	46	3.69
13. Understanding of the role of planning and analytical tools in bank management	57	3.89	46	3.80
14. Integration of the component tasks of bank management into a comprehensive plan	57	3.77	46	3.65

*The array of mean responses for the Iowa Agricultural Credit School is larger than that for the Iowa School of Banking at the 5 percent level of significance (Mann - Whitney one-tailed U test).

**Significantly different between the two Schools at the 10 percent level of significance (Kolmogorov - Smirnov two sample test).

high scores for tasks 1, 3, and 13. These evaluations by task provide useful insights into the areas where the game is (and is not) contributing to the participants' understanding.

IV. A Farm Management Game--A Classroom Example

Farm management games have been more widely discussed in the literature than application of gaming to other areas of instruction in agricultural economics. (For instance, see Boehlje, et al., Eidman, et al., Menz and Longworth, Babb and Eisgruber, Curtis). This discussion is limited to a game being developed for a northern corn belt farm for use in an introductory farm management course at the University of Minnesota.

Many students enrolling in the course are majors in other departments. The only prerequisite is micro economic principles. A case farm situation is used as the central focus for the course. The game simulates operation of the case farm for up to five years under conditions of price and production uncertainty. The major objectives in using the game are to reinforce the understanding of three accounting statements (the net worth statement, the net income statement and the cash flow statement), provide an opportunity to apply production economics principles, increase understanding of whole-farm planning procedures and investment analysis, and stimulate interest in the subject matter throughout the course.

The case farm is introduced during the first week of class, but students will not play the game until the latter part of the course after instructional material and exercises on accounting and whole-farm planning have been completed. The game is played using a remote terminal to reduce the administrative time required. The instructor maintains control of the exercise by approving any replays (if a mistake has been made) and by limiting the number of years a participant can complete.

Two decision periods are included in the game for each year, January 1 and August 15. The program indicates the current situation on January 1 and the participant is asked to input decisions on construction of facilities, purchase of feeder pigs, purchase of corn to feed, annual crop acreages and sale of crops in storage. The operation is simulated through August 15 and the participant is provided data on the status of the operation. Participants then input cattle purchase and crop sale decisions for the remainder of the year. The program then summarizes the year's operation and the financial status of the operator. One year's play can be completed by a participant who is familiar with accessing the program and has prepared the decisions in approximately 20 minutes. All data are stored in files making it possible to change the resource base to another farm size, soil type or geographic area, providing the same enterprises are produced. This feature also means the administrator can either use the game as a simulator or have teams operate different farms to illustrate comparative advantages in production and economies of size.

V. Evaluating the Payoff of Gaming Techniques

Curtis found combining simulation with the "resource-unit method" improved decision skills among adults. While most evaluations of gaming tend to be quite favorable, they are subjectively given and tend to be provided largely by those instructors that feel use of gaming has been beneficial. This suggests more objective testing is needed in both classroom and extension settings. It is possible to construct tests that measure differential rates of learning facts and knowledge of analytical abilities between teaching methods. However, it is more difficult to test for changes in the individual's capability to integrate facts, analytical capabilities and values in making decisions.

The resource requirements to use games include development time and costs as well as manpower, computer facilities and money for materials and computer time when the game is used. The amount of time and money required to use a game depends on the complexity of the game and how it is used. Two observations have been reported for farm management games. The western Oklahoma game farm (Boehlje, et al.) required 3 to 4 hours of administrative time per student (6 to 8 per two-person team) and about $10 of processing, printing and other costs per student. These estimates do not include key punching costs. Menz and Longworth indicate about 90 hours of supervisory time is required to simulate 10 farms by month for a five-year period, or 9 hours per team. Costs for materials and other items total about $20 per student. The time required to utilize the bank management game discussed earlier includes two hours for introduction, one hour per decision for review and administration and two hours for a final critique. Material and computer costs are approximately $1 to $2 per student.

The effectiveness of games as educational tools depends on the administration of the game, the consistency between the game and educational objectives, the interface with other teaching tools and the learning style of the student. If properly used, they are an important tool in the educator's tool kit.

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