CRITICISMS OF THE USE OF SIMULATIONS IN ECONOMICS: A REBUTTAL

Steven C. Cold, Rochester Institute of Technology
Thomas F. Pray, Rochester Institute of Technology
Suzanne L. Clarridge, SUNY Brockport

ABSTRACT

While simulations and computer-based exercises have been acclaimed (and extensively used) by business academics as effective tools for reinforcing management (and general business) principles and decision making under uncertainty, similar types of exercises in economics have not been well-received. A careful review of previous economic studies, which generally challenged the effectiveness of such exercises, raises serious questions concerning the way in which simulation exercises were incorporated in the classroom. Further analysis suggests the dissatisfaction with simulations in economics were related to two key factors: (1) design and (2) the implementation of the exercises.

The authors present a number at suggestions for effective design and use of computer-based simulations. Some of the recommendations include fundamental design requirements such as: ease in data entry, detailed and comprehensive manuals for both instructors and students, regular status reports on student performance, worksheets and guidelines for both decision making and applications of economic concepts, and computer generated summary reports for the instructor. For effective implementation of an economic simulation the activity must be treated as a supplement and not a substitute *for* traditional lectures and that regular assignments relating economic concepts to the simulation are required.

If properly designed and integrated into the classroom, the authors argue that computerized simulations would prove to be beneficial pedagogical tools in economics.

INTRODUCTION

Instructors of economics are continually faced with the challenge of teaching economic principles and concepts in a manner that is both educational and Interesting to their student clientele. For many years advocates of learning theory have purported that the single most important ingredient in student learning is motivation, and that motivation is highly correlated to student interest.[1]

Unfortunately, studies continue to show that undergraduate students consider traditional courses in principles of economics to be “disappointing”. Dale Truett [18], In a recent article, concluded; “Very few undergraduates understand what microeconomics of the firm has to say the first time around, and almost none see any application of its principles in the introduction”. One possible explanation for such a finding is captured in the words of George Stigler, a 1982 Nobel laureate:

“The watered-down encyclopedia which constitutes the present course in beginning college economics does not teach the student how to think on economic questions. The brief exposure to each of a vast array of techniques and problems leaves the student with no basic economic logic with which to analyze the economic questions he will face as a citizen. The student will memorize a few facts, diagrams, and policy recommendations, and ten years later will be as untutored in economics as the day he entered the class”.[2]

This type of criticism is not new and has been reiterated in the literature on economics education since 1950.[3]

In an attempt to address some of these concerns and heighten student motivation, there was a surge of interest among economic educators between 1964 and 1974 in the development and use of computerized simulations as pedagogical tools.[4] As the use of computerized simulations grew, it was even proposed that a central clearinghouse for economics software be established at Northern Illinois University through the Office for Economics Education.[5] However, simulations exercises have not become widely adopted and have not generally been well received by the economics profession. This lack of acceptance may be attributed to Insufficient availability of “user friendly” computer software and, more importantly, to the rather pessimistic reviews that early computer-oriented exercises received during the seventies. A notable example is the extensive review of computer-assisted instruction (CAI) in the Journal of Economics Education by Siegfried and Eels [12], which concluded: “Overall, games and CAT in economics do not appear to be the route to nirvana they were once expected to be. CAI appears to generate no more (or no less) cognitive achievement, but probably costs more than conventional pedagogical methods.[6]

PURPOSE

The primary purpose of this paper is to carefully examine the basis for the negative findings regarding the use of simulations in economics education and to make suggestions for effective use of this pedagogical approach. Proponents of experiential learning argue that simulations are effective pedagogical tools and

[1] See Ramsett, Johnson, and Adams [11]

[2] Stigler [15], p. 657

[3] Examples of these criticisms may be found in Taylor [16], Bach [1], Leftwich & Sharp [9], and Hartman[6].

[4] An extensive discussion of the use of simulations during this time period is given by Soper [14].

[5] Soper [14], p. 23

[6] Siegfried and Fels [12], p.942

cite the literature on "learning theory" to support their case. Simulations and computer based exercises have also been widely acclaimed and utilized by educators in the field of business. This raises two interesting questions. What are the alleged benefits of using computer simulations and why haven't they appeared in the economic studies?

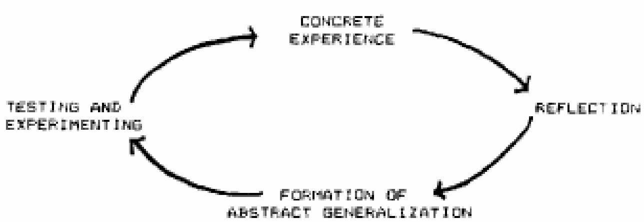
The first part of this paper examines the theoretical arguments favoring experiential learning via simulations. The second part reviews the past economic studies that have challenged the effectiveness of such exercises. These studies are then critiqued and shown to have some serious methodological weaknesses resulting from the manner in which the computer exercises were integrated into the classroom. The final part of the paper offers a set of suggestions to overcome past deficiencies and effectively design and implement simulations in economics education.

REVIEW OF EXPERIENTIAL LEARNING THEORY

Proponents of simulations purport that these exercises enhance learning by providing an excellent opportunity for students to "think critically" and apply some of their newly acquired knowledge in a dynamic setting. The experiential learning process portrayed in Figure 1 reflects the pedagogy.[7]

FIGURE 1

The Experiential Learning Process



An economic simulation provides a CONCRETE EXPERIENCE that supplements and reinforces the more abstract lecture. It attempts to bridge the gap between economic theory and practice. The computer results stimulate critical thinking through observation and REFLECTION. Students learn quickly the need to understand the economy in order to make intelligent policy decisions. This highlights the role of theory and reveals the purpose of formulating ABSTRACT GENERALIZATIONS. Students can then TEST their theories and generalizations (i.e. hypotheses) by EXPERIMENTING and making alternative policy decisions.

Advocates of experiential learning argue that it is an extremely effective teaching method for several reasons. First, student interest and motivation are heightened because it gets students actively involved and illustrates directly the relevance and application of economic theory. This improves student attitude which is an important factor in learning.[8] Secondly, student comprehension of the theoretical models is reinforced by evaluating the simulation results, making decisions, and receiving continuous feedback. Finally, experiential learning gives students a working knowledge of the subject matter. Students remember their mistakes as well as their successes.

LITERATURE REVIEW ON SIMULATION EFFECTIVENESS

The pessimistic conclusions pertaining to simulations and computer exercises by Siegfried and Fels were based primarily on four published journal articles. These articles are reviewed below.

Wentworth, and Lewis Study

The wentworth and lewis [19] study was based on data collected from 2 two-year colleges in Minnesota during

the first quarter of 1971-72 (149 students were involved). The authors stated that the courses involved in the study were basically current issues oriented with a minimal amount of mathematical models, formulae, or graphs.

At both two-year colleges each instructor was assigned a control and experimental class. The experimental classes played the MARKETPLACE GAME as a substitute for both class periods of conventional lecture.[9] Besides stating that the MARKETPLACE GAME "attempts to translate basic economic concepts into a series of transactions which simulate a microeconomic situation" (p.114), no detailed information was provided to explain the game or how it was used to Increase cognitive knowledge.

The test instrument for cognitive achievement was a pre and post-TUCE (Test of Understanding in College Economics). A multiple regression analysis which controlled for differences in student background indicated that the control group performed significantly better than the experimental group in terms of significantly better than the experimental group in terms of increasing the post-TUCE score relative to the pre-TUCE score.

Chismar, Hiebert, and McCanney Study

The Chismar, Hiebert, and McCanney [3] study was based on data collected at Illinois State University in the Fall semester of 1975 (380 students). The course was macroeconomic principles and the students were divided into CAI and non-CAI users.

The CAI system consisted of 3 types of programs labeled 'reviews, simulations, and demonstrations, developed by Bonello and Davisson at the University of Notre Dame. However, no additional information was given in the article describing the design of the CAI package.

In this experiment the CAI system was used as an "appendage" to the traditional macroeconomics course. The students were told the CAI package was OPTIONAL, i.e., they were given the choice of using or not using it! An incentive system was created to encourage utilization but the nature of the incentive system was not explained in the article.

Again, the output measure was the difference between the pre and post-TUCE scores. A regression analysis was performed which controlled for differences in student background. Based on these results the authors concluded that the CAI users performed slightly

[7] Learning models similar to this one have been previously developed by: Bruner [2], Kolb [8], and Torbert [17].

[8] Two notable studies supporting this are; McConnell [10] and Ramsett, Johnson, and Adams [11].

[9] The MARKETPLACE GAME was developed by Security National Bank and the University of California at Los Angeles. It is a noncomputerized exercise.

better relative to non-users. However, the authors noted that the users had more ability as measured by GPA than non-users. This difference in GPA, they claimed, explained the performance differences. After controlling the GPA the effect of CAI is negative but small. However, the authors add the caveat that the results do not necessarily imply CAI is cost ineffective. Students may simply be substituting CAI review packages for class attendance.

Emery and Enger Study

The Emery and Enger [5] study was conducted during the Fall semester of 1970 at St. Olaf College (86 students were involved). Two sections of an introductory economics course taught by the same instructor were selected and served as the control and experimental group. There were no statistically significant differences in average SAT scores, age, or pre-test scores between the two groups. However, the authors noted that there was a higher portion of science majors in the control group.

[he control group received a standard lecture and discussion format. The experimental group, however, did not receive any of the lectures on fiscal policy. Rather, they were required to play the FISCAL POLICY simulation developed by one of the authors of the Emery and Enger study. The simulation substituted for a week of class time and the students were required to~ submit written answers to a question set with their computer printouts. (Again, only a very brief description of the nature of the FISCAL POLICY simulation was provided in the article).

The effectiveness of the experimental approach was determined based on improvement between pre and post scores on a test instrument. The instrument had 5 multiple choice questions in each of the 3 categories established by TUCE: recognition-understanding, simple application, and complex application.

A regression analysis was performed which controlled for differences in student background. The results indicated that there were no statistically significant differences between the two groups in recognition- understanding. However, the experimental group performed better on the questions pertaining to the simple and complex applications at the .10 and .05 level of statistical confidence, respectively.

Cox Study

The study by Cox [4] was done at Arizona State University during the Spring semester of 1972. Two sections of macro-economic principles taught by Cox were used as the control and experimental groups (173 students in total).

In the experimental section, 8 computerized macroeconomics simulations of increasing complexity (developed by Cox) were used. However, the pedagogical approach utilized by Cox to integrate the simulation into the classroom varied significantly from the past experiments and studies. In this case, the instructor made all the decisions for the students and specified the fiscal and monetary policy changes in all 8 simulations. This approach differs dramatically from the conventional pedagogical procedure which requires the student to make the policy decisions not the instructor.

ox decided to use this new approach for two reasons based on past experiences with simulations:

(1) The students did not really understand what they were doing; and
(2) Class discussions were practically impossible for many to follow because each student made different decisions and, thus, each student's results differed from those of the instructor and other students.[10]

Consequently, Cox made ALL the decisions, and one class period before each simulation was discussed in class, students were given a copy of the results along with a set of questions directing their analysis.

Two output measures were used to determine the effectiveness of this approach: (1) test score differences (constructed in part from TUCE exams); and (2) interest and motivation differences based on classroom questionnaires. The author controlled for differences in pre-test scores and GPA by including these factors as independent variables in the regression analysis.

The results of the study indicated no statistically significant difference between the control and experimental groups in either test performance, interest, or motivation.

CRITIQUE OF PAST STUDIES

A major concern with the studies cited is the way in which the researchers integrated the simulations into the classroom. Two of the studies substituted the simulation exercise for lecture and discussion. Went- worth and Lewis [19] allocated 20% of classroom time for simulation play, and Emery and Enger [5] cancelled the entire set of lectures on fiscal policy and stabilization. In these studies the simulation replaced the instructor for an important component of the course. This approach expects too much of a simulation. Rather the simulation should be treated as a complement not a substitute for lecture.

The simulation exercises in the Chizmar, Hiebert and McCanney [3] study were optional The degree to which the students used the simulation was not even mentioned. The ineffectiveness of the simulation in this study may simply be due to its lack of usage.

Students were not permitted to even use the simulation in the Cox [4] study. The instructor made all the policy decisions and discussed the simulation results with the students. This approach reduces the simulation to another instructor-designed handout and destroys the primary pedagogical function of the simulation, e.g. learning-by-doing. Why should class interest and motivation increase in this case? Is this approach any different than the typical lecture with handouts illustrating a hypothetical case? Although this may be an interesting lecture technique, it is definitely not a test of the effectiveness of simulations (as generally perceived).

A secondary concern is the paucity of information about the nature of the simulations used in the studies. A simulation must be well designed if ft is to be an effective learning tool. What were the student input decisions and the resulting outputs (reports)? What objectives were inherent in the simulation? What type of information or manuals were provided to the student? None of this type of information was provided in the studies.

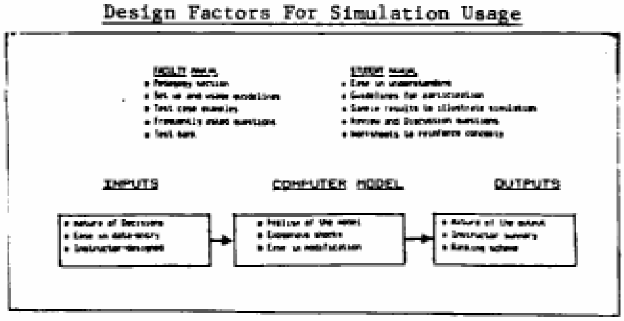
[10] Cox [4], p. 30

A third concern is the extent in which the simulations were integrated into lectures, classroom discussions, assignments, and exams. Did the students have an incentive to perform in the simulation? What type of analysis were the students expected to do? Did the instructor encourage classroom discussion of simulation results? Were students tested on issues relating to the simulation? A simulation, like any other classroom activity, will not be effective unless it is properly incorporated into the course. These issues were not detailed in any of the studies.

SUGGESTIONS FOR DESIGN AND IMPLEMENTATION

This section addresses a number of design and implementation issues that warrant consideration prior to judging the overall effectiveness of simulations (our discussion assumes the simulation is computerized). The design of the simulation and its intended use are crucial not only in increasing students understanding of principles and theories of economics, but also in effective classroom usage. Figure 2 presents some of the key design elements that should be considered in the decision to use an economic simulation. These elements are discussed below.

FIGURE 2
Design Factors For Simulation Usage



Supporting Information

First there should be a student manual describing the simulation. Second, it must be clear and understandable and be short enough so that it does not overwhelm new students of economics. Because most students have never participated in a simulation activity, it is advantageous to have guidelines for decision making and participation. These guidelines will assist students in understanding the process and in preparing decisions. Worksheets which tie the economic concepts to the simulation are a vital component in insuring that the experiential learning process occurs.

For example, a microeconomic based simulation can have a worksheet guiding students in the calculation of price elasticity by using data from the simulation. The Student Manual can then highlight how the measurement of price elasticity can be used to improve decision-making.

A FACULTY MARTIAL is another important component of a simulation. Since many users of simulations are novices, it is important that the manual contain a pedagogy section elaborating how the simulation can be incorporated into a traditional course. A course "Menue" is a helpful tool in that it shows the instructors the options available to them in designing a course with a simulation embodied in it.

The Instructor's Manual must give clear and concise steps and guidelines concerning how the simulation should be set-up and run. For computer-based simulations, test case data should be available with the corresponding results to verify that the model (i.e. program) is loaded properly.

Additionally, for instructor convenience, exam questions should be available for testing students on background material. Often the designers have extensively used their simulations and are aware of frequently asked student - questions about the details of the simulation. These questions, along with answers and explanations. should be part of the Instructor's Manual.

Even with the student manual and the instructor's manual, the instructor will not always have the necessary background to simulation prior to placing it into classroom usage. In the process of testing the simulation, it is wise to be critical of the underlying "production function" of the simulation. A careful investigation of the inputs, the model, and outputs during (and even prior to) the testing phase is needed to fully understand the strengths and weaknesses of the simulation.

The Inputs

On the INPUT side of Figure 2 the following questions should be addressed:

- What are the nature of the student decisions?

Do they reflect the theory and concepts that are being covered in class? Are there too many or too few? Can some of the decisions be considered optional or postponed until the material is covered in class? Can the simulation be started with just a few decisions and then expanded as the students gain more of the basics from the classroom lectures?

- Is it easy for the students and the instructor to enter the decisions? Do the decisions have to be turned in to the instructor or can the students enter their decisions independently of the instructor? What happens if a team or a student fails to enter their decisions? Will the program fail to run or will the instructor have to chase down the delinquent individual or make up some arbitrary decisions?

- Does the simulation allow the instructor to design and control the economic environment? Can this be done simply and at anytime during simulation play?

While the user of the simulation need not be a "computer-wiz", it is important that the administrator understand certain aspects of the underlying model.

The Model

In reference to Figure 2 and the Model, the following points should be considered:

Is the model realistic? Does the simulation adequately model the concepts of economic phenomena? If the simulation is designed to represent a short run production function, does it cover all three stages of production? Does the underlying demand curve have the desirable properties in terms of the elasticities? Will the students observe the dynamics of the market? In essence are the results going to be consistent with the theory described in the course? Many times these questions can be answered without examining the underlying equations. One suggestion is to contact the designers of the simulation and address your questions and concerns to them. Another method is to find a number of people who have actually used the simulation in a classroom setting. Find out what their experiences have been.

Additional concerns for selection of a simulation should include whether the instructor has the capability to place exogenous shocks on the system.

Can the instructor increase autonomous investment Or savings in a macro economy? For a micro simulation, is it possible (and easy) to change market structures or cause the supply or demand functions to shift in a predictable fashion?

While the administrator need not be an expert in the design of the simulation, it is important to realize that sometimes the simulation must be altered after play starts. For instance if a team misunderstands the instructions or incorrectly encodes a decision; Is it easy to correct such mistakes? (Remember the primary purpose of such an exercise is to reinforce concepts and not to penalize students for faculty inputs).

The Outputs

On the Output side of Figure 2 the following points play a significant role in determining whether or not a computerized simulation is effective;

What is the nature of the output? Do the students receive enough information so that tedious calculations are minimized? Do the students know where they stand relative to the other participants? (i.e., is there an over-all measure of economic effectiveness and relative ranking in the simulation)? Does each participant receive a hard copy of output or are they forced to share results?

From an administrative point of view, is it easy for the instructor to get a copy of each teams results? Do you receive an administrative summary which summarizes the major decisions by each firm along with key measures of effectiveness?

It is out conjecture that the early computer economic simulations would not be able to answer “yes” to very many of these questions. This may be part of the reason for the lack of wide--spread acceptance of economic simulations. It may also explain in part the inability to validate statistically that learning was occurring.

SUMMARY

Instructors of economics continue to be faced with the challenge of making their discipline both meaningful and interesting to their student clientele. During the late sixties and through the seventies interest in simulations and computer-based exercises surged forward in economic education circles, but widespread acceptance of simulations, games and CAI never occurred. While there are a multitude of reasons for the lack of acceptance of economic simulations, it appears that two principle reasons may be (i) the critical review that these exercises received in the literature and (ii) lack of user-friendly software when computer- based exercises were used.

In this paper we have attempted to show that the studies, which generally concluded that the simulations were not effective pedagogical tools, each had a serious methodological weakness as a result of their experimental design.

Academics in business have also challenged the effectiveness of simulations. In fact since the introduction of business simulations into the curriculum in the early sixties, there has been considerable debate about their effectiveness [7, 13, and 20].

The difference, however, is that through the use of scientific and comprehensive experimental designs, the evidence now appears to support their pedagogical effectiveness~ One such study by Wolfe and Guth [22] summarizes the current findings.

“The games results came from improvement across almost all (examination) questions rather than outstanding improvement on just a few Class participation was higher in games sections and it was easier f or these students to talk personally and make their experiences with the management game relevant”.

The paper concludes with suggestions for implementing economic simulations as well as designing computer- based simulations. Prior to being critical of simulations, economist should carefully consider how to integrate the simulation into the course, review both student and instructor manuals, and test the simulations and exercises paying particular attention to the inputs, the model and the outputs.

REFERENCES

[1] Bach, G.L., “Student Learning in Basic Economics: An Evaluated Experimental Course, in New Developments in the Teaching of Economics, edited by Lumsden, K. (Englewood Cliffs, NJ; Prentice-Hall, 1967), pp. 74-91.

[2] Brunner, J.S., Toward a Theory of Instruction (New York: W. W. Norton, 1966).

[3] Chizmar, John F.; Hiebert, L. Dean, and McCanney, Barnard J.. “Assessing the Impact of an Instructional Innovation on Achievement Differentials: The Case of Computer Assisted Instruction”, Journal of Economics Education, Fall 1977, 9 (1), pp. 42-46.

[4] Cox, Steven R., “Computer-Assist& Instruction and Student Performance in Macroeconomic Principles”, Journal of Economics Education, 6 (1), pp. 29-37.

[5] Emery, E. David, and Enger, Thomas, P., “Computer Gaming and Leaning in an Introductory Economics Course”,

[6] Hartman, David G., “What Do Economics Majors Learn”? Journal of Economics Education, Spring 1978, 9 (2), pp. 87-91.

[7] Hegarty, Harvey, “Contextual and Pedagogical Differences in Teaching Business Policy Among Academicians”, Academy of Management Proceedings 36th Annual Meeting, 1976. p. 125.

[8] Kolb, David A., “Individual Learning Styles and the Learning Process”, Sloan School Work, paper No. 535-71, MIT, 1971.

[9] Leftwich, Richard H. and Sharp, Ansel M., “Syllabus for and ‘Issues Approach’ to Teaching Economics Principles”. Journal of Economics Education, Winter 1974, Special Issue, Number 1.

[10] McConnell, Campbell, R., “Factors Affecting Student performance in Intermediate Macroeconomics”, American Economic Review, pp. 30-41.

[11J Ramsett, D.E., Johnson, J.D. and Adams, Curtis, “Some Evidence on the Value of Instructors in Teaching Economic Principles, Journal of Economics Education, Fall 1973, 5 (1), pp. 57-62.

[12] Siegfried, John J., and Fels, Rendigs, “Research on Teaching College Economics: A Survey”, Journal of Economics Literature, Vol. XUII, Sept. 1979, pp. 923-969.

[13] Snow, Charles, “A Comment in Business Policy Teaching Research, Academy of Management Review, Vol. 1, October, 1976, p. 136.

[14] Soper, John, "Computer-Assisted Instruction in Economics: A Survey", Journal of Economics Education, Fall 1974, pp. 4-28.

[15] Stigler, George, "Elementary Economic Education", American Economic Review, May, 1963, 5 (2).

[16] Taylor, Horace, ed., "The Teaching of Undergraduate Economics. Report of the Committee on the Undergraduate Teaching of Economics and Training of Economists", American Economic Review, Dec. 1950, Supplement, Part 2, 40 (5).

[17] Torbert, W.R., Learning From Experience Towards Consciousness (New York: Columbia University Press, 1973).

[18] Truett, Dale B., "Managerial Economics; A Neglected Area in the Business Curriculum", Collegiate News and Views, Fall 1979, pp. 19-23.

[19] Wentworth, Donald R.; and Lewis, Darrell K., "An Evaluation of the Use of the Marketplace Game in Junior College Economics", Journal of Economics Education. Spring, 1975, 6 (2)~ pp. 113-119.

[20] Wolfe, Joseph and Guth, Gary, "The Case Approach Versus Gaming in Teaching Business Policy: An Experimental Evaluation", Journal of Business, July, 1975, p. 349.