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ABSTRACT

A brief case study of the resistance to technological change is presented using DOG, a small scale deterministic business game, as the example of technology. DOG, a decision mathematics game for the purpose of providing an environment for application of mathematical concepts, consists of assignments mostly utilizing matrix algebra but also some calculus, linear programing or free form modeling. It is a simulated environment originally written in BASIC, and now also available in FORTRAN IV. The problems involved in implementing DOG into the undergraduate curricula of the Georgia State University School of Business are discussed. It is concluded that it is possible to successfully introduce computer applications into large multi-section undergraduate courses, but not painlessly. If only the physical and technical aspects of the problem receive serious attention, then the likely outcome is disaster. Only careful coordination, much support, some sugar coating of the pill, and occasional genteel bullying will assure success. (Author/KKC)

COMPUTERS IN THE UNDERGRADUATE CURRICULUM: AN ASPECT OF THE MANY SECTION PROBLEM

by

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It is *de rigeur* in planning movement toward undergraduate use of computers to carefully consider the physical/technological aspects of the problem. Space requirements, computer capacity, job dispatch and/or terminal facilities, operating hours all customarily receive attention (which is not to say that they are by any means optimized). Unfortunately, in large courses with multiple sections, this is only one side of the problem.

Where one individual offers all sections of a given course, or where the syllabus is a highly conventional one, the problem of uniformity of approach is minimal. Where there are many sections and the course involves an innovation such as a computer application, the problem may be severe. In a sense, it amounts to the classic problem of resistance to technological change. This paper is essentially a brief case study of such a problem.

Background

At Georgia State University, the School of Business is in the unusual position of servicing the freshman/sophomore mathematics requirements for students planning to major in business. Since these are listed as business courses, students have high expectations for immediate and apparent relevance; these expectations have been difficult to satisfy. As a result, the decision was made in early 1973 to develop a decision mathematics game for the purpose of providing an environment for application of mathematical concepts.

The process of development of this game also led to the development of a set of design criteria. These criteria fall into two major categories: those which relate primarily to ease of implementation and use, and those which relate primarily to effectiveness of use. Ease of implementation seems to be influenced by portability, extensive documentation, reliability, and stability. Effectiveness of use is believed to require explicit objectives, an appropriate level of verisimilitude, simplicity, adequate instructional materials, and sufficent flexibility.[1] A serious effort to meet these criteria was made in developing the game described below.

The Game

DOG[2] is a small scale deterministic business game designed to provide an environment in which to teach elementary modeling and Decision Science concepts. Most of the assignments utilize matrix algebra as the fundamental tool, although others do rely on calculus, linear programming, or free form modeling. Little or no prior background in business, economics, or accounting is required.

Each quarterly decision in the game is associated with a specific assignment, although the assignment will not relate to all items in the decision. It is not necessary to use all assignments, but some assignments do rely on previous assignments. For this reason it is highly desirable to plan quite carefully prior to selecting a sequence of assignments to use. It is normally quite feasible to assemble a sequence which will be consonant with both available time and course objectives.

The amount of classroom time devoted to the game is optional, depending upon course content and objectives and upon the level of student preparation. A rule of thumb that is descriptive of its use at Georgia State University is that about 25% of the class time is directly game-related; some instructors have also designed game-related supplementary materials and exercises to take advantage of heightened student interest and of familiarity with the simulated environment.

The simulated environment was originally written in BASIC, to take advantage of a large time-sharing system with a number of convenient features. Since these convenient features are not universally available, a Fortran IV version has since been developed.

The Use of the Game

DOG is used in two courses as a standard part of the course; it is optional in a third. Both of the courses in which it is required are beginning courses, one for entering freshmen and one for transfer students with some college credit for mathematics. In a typical quarter there are a total of ten to twelve sections involving six to ten instructors. Of those, typically about half of the sections are taught by full time faculty.

Clearly this exemplifies a situation in which a major coordinative and supporting effort is required. Such an effort has developed in the process of learning how to most effectively use the game.

Coordinator

One faculty member serves as the coordinator for this complex of courses. This person's responsibilities include the maintenance of current syllabi, coordination of departmental examinations, computer center liason, and making arrangements for certain other aspects of the supporting effort.

Graduate Assistant

A graduate assistant is employed to do the actual running of the game. To prevent overloading terminal facilities, his role involves the input of student decisions as well as game execution. A standard "run sheet" is used to avoid ambiguity regarding desired instructor inputs. Thus, instructors are relieved of most of the logistic burden of game administration.

Laboratory

A laboratory facility is provided which serves a dual function. In part, it serves a traditional role, providing work areas, calculators, and such. Additionally, however, student assistants staff the lab to provide consultation on homework and game assignments as well as to provide a limited amount of tutorial help. This facility is available to students nearly sixty hours per week.

Mini-computers

A portion of the lab area is devoted to six mini-computer terminals. These terminals are connected to a pair of Wang 3300 systems which are quite adequate in capacity for the needs of these courses. A library of perhaps a hundred programs is available. Some particularly game-related programs in this library include

MATRIX MULTIPLICATION
MATRIX ROW OPERATIONS
MATRIX INVERSION
LINEAR PROGRAMMING
MATERIALS EXPLOSION
SIMULTANEOUS POLYNOMIAL SOLUTIONS
EXPONENTIAL MODEL.

These programs are designed in each case to reduce the student's computational effort, not to replace thoughtful modeling. They are not essential to the successful use of the game, but are a useful adjunct.

Instructor Orientation Sessions

The use of a game in a college entry level mathematics course, especially when combined with student use of teminals, is obviously an unconventional approach. To underscore this, it should be pointed out that no instructor now teaching these courses has even taken a comparable course.

This presents two kinds of problems to contend with. First, there is no initial pool of experience to draw upon, and little identifiable expertise. Second, there is a normal reluctance to take the risks involved in trying something new. The absence of a pool of experience can only be conquered through use of the game, but steps were taken to develop some expertise.

Orientation sessions have been held at approximately six month intervals since the game was first released for general use. The major thrust of these sessions has been to familiarize new instructors with the game and its potentials. An additional use has been as a forum for the exchange of experience. An important by-product has been the improvement of the game and its documentation' based on this exchange of experience.

The Results

It is clear that DOG is both a delicate and a powerful instrument, and as such is both easy and dangerous to misuse. It is tempting to simply overlay an existing course outline with the game; this certainly holds down the preparation effort required of the instructor. It is similarly tempting to require two or three decisions and/or assignments per week, perhaps in an attempt to exhaust the list of relevant assignments. Unfortunately any of these courses of action will also exhaust the students, thus creating resentment toward course, game and instructor, and possibly distracting students from the fundamental elements of the course.

Another way to cause the game to bomb also reduces the instructor's preparation time. It is really quite simple: don't bother to learn the envionment, don't read the manuals, don't explore the assignments, and above all, never attempt to play the game yourself. Students seem much more comfortable when they can regard their instructor as an expert; destroy the image of expertise and they may assume that experitse is too difficult to attain. Not learning the environment also prevents the instructor from editing student decisions to prevent major disasters.

A final way to generate difficulty is also tempting. Place heavy emphasis on firm performance; really put the students under pressure. This results in very conservative play, a heavy game workload, and intense frustration when an early misjudgment puts a firm far behind.

The goodwill and presistance of most instructors involved with the course, combined with the coordinative and supportive facilities being used, have caused the incidence of the difficulties cited above to decline rapidly over about a two year period. It is possible to foresee the day when these sources of trouble will be at or near a negligible level.

The remaining problems are unlikely to disappear entirely. Occasional new faculty arrivals must be acclimated to the environment. Usually, once the initial reluctance to face extreme change is overcome, these newcomers acquire the new skills and patterns needed and, indeed, make contributions of their own. Those few who refuse to follow the standard syllabus because they are "the bearers of the only true light" must be worked into more conventional courses or, on occasion, find an unconventional environment so uncomfortable that they leave for greener (or at least different) pastures.

When properly used, DOG, does seem to consistently provide useful benefits. Perhaps the most crucial of these is student involvement in the course. This is almost inevitably cited as an advantage of gaming, but it is perhaps more critical here than in many courses. A large and vocal subset of undergraduate business students seem to regard mathematics courses as a colossal and irrelevant imposition. For many of these, the DOG experience erodes their objections to the point where quite a few even become enthusiastic about the course. Some even get so involved that they actually study even when no quiz has been announced.

Beyond the question of involvement, there are other benefits to be obtained. A typical goal in a business-oriented mathematics course is the development of situational problem-solving expertise, and toward that end large numbers of "word problems" are frequently used. DOG cannot entirely replace word problems, but it can enhance them. Beginning students often have little or no business/economics background; developing a bill of materials by matrix multiplication or maximizing a revenue function through the calculus of extrema frequently presents no clear issue. The game forces questions of terminology to the surface early in the course. Furthermore, continuing use of an environment that all students then have in common provides a universe of discourse accessible to all. Since half the difficulty in situational problem-solving is in grasping the situation, this common universe of discourse can provide a bridge toward development of general problem-solving capabilities.

Conclusion

It is possible to successfully introduce computer applications into large multi-section undergraduate courses, but not painlessly; if only the physical/technical aspects of the problem receive serious attention, then the likely outcome is a disaster. Only careful coordination, much support, some sugar coating of the pill, and occasional genteel bullying will assure success.

FOOTNOTES

[1]Churchill, Geoffrey, "Decision Mathematics Operational Game: An Attempt to Meet Design Criteria," in Proceedings of 13th Annual Symposium, National Gaming Council (NASAGA), forthcoming.

[2]Churchill, Geoffrey and Rachel Elliott Churchill, *Decision Mathematics Operational Game*, (Atlanta), Georgia State University, 1974.

[3]Churchill, Geoffrey, *Decision Mathematics Operational Game Instructor's Guide, (Revised)*, (Atlanta), Georgia State University, 1974.