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ABSTRACT

A project formulated a computer simulation game for use as an instructional device to improve financial decision making. The author constructed a hypothetical firm, specifying its environment, variables, and a maximization problem. Students, assisted by a professor and computer consultants and having access to B5500 and B6700 facilities, held 16 three-hour meetings to write a computer program for finance decision-making simulation game. Task forces were established to investigate information requirements for the program and to write in FORTRAN the necessary statements. The completed program ran under 900 cards, was compiled on a B6700 in .2 minutes, and required .02 minutes to simulate a firm's decisions. Up to 99 firms could be included for 40 periods of play. Participants could make decision inputs on 11 variables such as loan acquisition, debt retirement, etc., and balance sheets and income and other statements were output to enable decision-making. The program enhanced the decision-making abilities of the players and the project also provided useful training for the designers. They were well motivated, and the goal-centered activity gave them practical experience in the application of theoretical skills and techniques. (PB)

UNDERGRADUATE STUDENT TASK GROUP APPROACH TO COMPLEX PROBLEM SOLVING EMPLOYING COMPUTER PROGRAMMING

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A project was initiated with the objective of formulating a computer simulation game that would be employed by others as an instructional device for improving financial decision making. The undergraduate students involved in the project constructed a hypothetical firm. This included: (a) the design of the environment in which the test firm operated, the firm's parameter set; (b) the specification of the variables over which the operators of the firm had control, the decision set; and (c) the definition of the firms maximization problem. The project provided the students with some experience in structuring their decision processes in a formal manner in finding a solution to a complex problem. A computer program served as the vehicle for obtaining this goal.

This is a report on the task group that constructed the computer simulation program. This was the first of a three phase program required to develop the game for classroom use. Phase II used another undergraduate task group in testing and modifying the model while also establishing and formalizing the set of operating procedures to be used by the students in playing the game. Time constraints prevented the original group from completing phase II. Greater objectivity and reliability in testing could be expected by employing a different group for this phase. Phase III introduced the simulation into classroom use.

The resources used in starting and operating the project are described first. The nature of the organization and operation of the group is then presented. The computer simulation game is the most objective and verifiable evidence of the group's success; therefore, a synopsis of the project's game is presented. Observations and conclusions on the educational form employed and the possible role of the computer in this setting are then stated.

Input Resources

The objective of the project could have been easily accomplished and would be of little value to report if the talent pool committed to the project had substantial background in computer usage, finance, economics, accounting, and both problem structuring and solving. This was not the case. The project included ten undergraduate junior and senior business administration majors and one faculty project director. All of the students had previously completed introductory mathematics, statistics, accounting, economics, and finance courses. Most also had completed a second finance course where they had played a financial decision-making simulation game. All had completed a two credit computer science course sometime within the previous three years. The computer course had used FORTRAN IV and required the writing, keypunching, and correction of at least two fairly simple computer programs, a few students had limited exposure to computer programming in other courses. None of the students had previously worked in a task group requiring the structuring and solution of a complex problem. During the project, the students could access both time sharing, on a B5500, and batch facilities, on a B6700. Computing center consultants were available for aid in error detection for aborted programs, they would not perform any of the programming functions.

Time served as the major constraint. The project participants had sixteen meetings of three hours each over a four week period. Time outside of the meeting was used in preparing material for the following meetings. The course was for one to three semester credits depending on the hours of the meeting time attended and the work tasks completed by the member during the project. Nine of the ten students selected three credit loads while the tenth chose two. The project was given in a "short term" where students could only attend one course. Thus, the students only had responsibility for this single project and full time involvement could be, and was, both demanded and obtained.

Organization and Operation of the Group

A preliminary letter was circulated indicating that students could participate in the project. The purpose of the project, requirements for being a participant, and time and

credit information were disclosed. For managability the size of the group was limited to ten students.

The first three meetings were used in establishing the general structure of the problem to be solved while also reviewing and refamiliarizing students with the tools they would need to complete the project. One meeting was used to review FORTRAN IV and write a simple short program. It was the group's decision to have this review since many had completed the computer course at least a year earlier. Sources for answers to questions in finance, economics, and accounting were provided so that the students could access this information when it was needed.

The group started with the stated objective of the project; this was to write a computer program for a finance decision making simulation game. The objective of the game was to improve the knowledge in both finance and general decision making of the participants that would later play the simulation written by the group. Attainment of this objective required the group to establish the set of decisions that the game participants would be making in the game, this set will be presented later. Small task forces of two and three students were established by the group to first investigate the information requirements of each subsection of the program required for each of the decisions of the decision set. Thus, for example, one group researched capital budgeting techniques and the information generally required to make correct capital budgeting decisions while other groups reviewed dividend stability and payout policy.

Project members were in multiple task groups. Each group had different membership so that interaction with more than one or two other members was required in fulfilling their tasks. The meetings were unstructured at first. Fairly rapidly, the group established operating procedures that were maintained for the rest of the meetings.

After investigating and recording the information input requirements for each subsection of the program, the group met and determined the location of each of the subsections in the master program. Some of the information output of one subsection was required input for another. For example, a capital budgeting decision affected labor and overhead costs and had to be located before the production sub-program. Some problems of joint dependence on information generated from two subsections existed and were solved or eliminated by the appropriate task forces. A high degree of both cooperation and coordination was obtained during the process. The group rapidly adapted procedures for accomplishing the many small problems of coordination; like the assignment of variable names, statement numbers, and the combining of DIMENSION statements of the separate task forces. Other major problems of a given task force were presented to the entire project group for suggestions and solutions. Each task group prepared their subsection in FORTRAN statements and presented them to the project group for further modifications and directions. By the end of the project, each task group submitted their final subsection in punched card form for an initial computer run. The time constraint prevented the running of an error free completed program before the end of the project. Some changes and corrections were made after the project and the program was successfully run. The completed program was under 900 cards in length, compiled on a B6700 in .2 minutes and required .02 minutes to simulate the decisions of one firm. The results were made available to the original project members.

The project director acted as a technical consultant. The solution technique employed, the task assignments, methods of coordination, and structure of the meetings were established by the students. Little effort and direction was required by the director after the third meeting.

A Synopsis Of The Computer Program

The simulation is a sequential financial decision making problem. From one to ninety-nine firms could be included in the game for up to forty periods of play. The participants would make decision inputs on:

1. The purchase or sale of marketable securities
2. Discount terms on receivables
3. Short term loan acquisition
4. Three, four, and five year intermediate term loan issuance
5. Long term debt issuance or retirement
6. Preferred stock sale or repurchase
7. Common stock sale or repurchase
8. Dividends on common stock
9. Machine and plant capacity purchase
10. Three capital budgeting projects
11. Production of units of output

Further financial decisions were controlled by the above. For example, many of the decisions affected cash flow and thus, the combination of the above decisions determined cash balances.

To enable the game player to make decisions, a balance sheet, income statement, and a statement of other relevant summary data was outputted from the program for each period of play and each firm.

The project group constructed the environment that the firm operated in so that better decisions by the game participants leads to a higher performance measure. The environment in the game was a fairly simple model derived form the project members' perceptions of rules and relationships that existed in the real world. For example, the interest costs on the different types of debt were made a function of the distance to maturity, the riskiness of the earnings stream of the company, and the level of the economic indicator used in the game's environment. Some of the models were simulated before the inclusion in the master program to test their reliability in approximating either a real world situation or a situation that would motivate the game player to make valid and sound financial decisions. For example, the stock price model was used to simulate the prices of both computer and heavy machinery stocks and was not accepted until the degree of error was narrowed substantially. The dividend payout and stability policy were constructed and simulated to limit the effect on performance to not more than a ten percent penalty and to allow for a reasonable margin of error before a penalty was applied.

The completed program fulfilled the original stated project objectives while also providing an interesting and novel training situation for the undergraduate students.

Conclusions

Several observations can be made and conclusions drawn on involving undergraduate students in a complex group decision making situation. Motivation seemed very high. This can be attributed to several factors. First, the sense of accomplishment would be greater in a situation where the results of one's efforts were actually to by used by others. The simulation was to be used by other students. Second, continual reinforcement for attaining task achievements was obtained in a group situation where a great deal of interaction was both needed and desired. The need existed because of the complexity and size of the problem while the desire came from the satisfaction obtained when a given member's accomplishments were recognized by the remainder of the group. Third, the students were not in a subordinate or passive role as students are in many instructional situations. This increased both their contributions and their sense of accomplishment. Fourth, since the project was held both over a short period of time and while students were not involved in other course work or projects, full time involvement and interest could be maintained and achievement of the group's established goals came rapidly.

The project also served as a useful educational technique. First, it was interdisciplinary, drawing on and increasing student knowledge in both general decision making and in many functional areas. Analytical tools and techniques and underlying rules and relationships that were previously covered in statistics, computer science, finance, accounting, economics, and other disciplines had to be applied to a single problem. Knowledge in many of these areas had not been employed by most of the students in an actual problem situation before the project. In some cases, the students drew on their own perceptions gained outside of course work in forming rules and relationships that either existed or they believed should exist in the areas of finance and economics. They used this material in constructing the environment and reward system included in the simulation game.

There are different possible reasons for believing that more was gained by the students through using a computer program as the stated objective of the project. First, it provided a situation where the aim was "goal" centered, specifically, toward obtaining a program that would enable the game player to acquire specific skills in finance. Most functional courses tend to be "education" centered; where definitions, rules, and relationships are taught and applications are provided to the student to prove that usefulness exists for retaining this information. Methodology and tool courses tend to be "technique" centered; where methods of solving problems are taught and applications are again provided to the student to prove that usefulness exists for retaining knowledge of the methods. The project required the application of both the tools and functional area information in obtaining the solution to a problem. . Second, student motivation was heightened by their recognition that their program would be used by others. The structuring of the same problem without a usable program would have easily been interpreted as an academic exercise leading to no concrete or usable results. Third, and last, the problem had to be fully specified and solution well structured before it could reach the final form as an operable computer program on punched cards.