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DESIGN AND DEMONSTRATION OF AN ONLINE MANAGERIAL ECONOMICS GAME WITH *AUTOMATED COACHING* FOR LEARNING AND *GRADED EXERCISES* FOR ASSESSMENT

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ABSTRACT

Much research and debate exists about the effectiveness of simulations as a learning and assessment tool. The questions that are typically raised are: "How effective is a simulation as a pedagogical tool?" and "How do we know that students have really learned something from the simulation?" The purpose of this paper is to present the design of a simulation game that includes both automated coaching to enhance student learning and graded exercises. The automated coach serves as a timely consultant to students to identify functional areas in the game that need closer attention to improve performance. The graded exercises serve two educational purposes: (a) to provide feedback to the students on their understanding of the theoretical principles embodied in the game; and (b) to serve as an assessment instrument for the instructor and college program.

Keywords: Design, Simulation, Game, Coaching, Innovative Teaching, Learning economics, Teaching economics, Economic exercises, Computer-aided Instruction, Microeconomics, Managerial Economics

INTRODUCTION

The effectiveness of a simulation depends, in part, on how it is designed. A review of existing business games indicates that there are two dimensions that are not "directly" included as part of the simulation game itself, i.e. automated "coaching" on student performance and automated "testing" or assessment of learning. In terms of coaching, the educational literature identifies the importance of providing some type of feedback to students by the instructor regarding their performance in the simulation. Many students do not understand why their performance in a simulation is below expectations and what they should do to improve performance. This need is particularly strong in the beginning stages of simulation play. It is at this time in particular that the instructor may get many questions from students and may be too busy to "coach" students and address all their questions in a timely fashion. The instructor may not even have detailed enough knowledge of the simulation parameters, at this early stage in the simulation, to adequately answer some student questions. From a learning perspective, this is likely to reduce the pedagogical effectiveness of the simulation experience. A study by Fletcher, et. Al. (2006) supports this view and shows, by a detailed review of the literature, that providing assistance during a simulation exercise will induce students to process material more deeply and increase learning.

In terms of testing or assessment of learning, quantitative performance in the simulation games are typically used to measure or infer the degree of learning derived from the game (Anderson, Cannon, Malik, & Thavikulwat, 1998). Yet there are a couple of significant problems raised with this approach. First, most simulations are based on group effort. Because of this there is a free rider problem that makes it difficult to assess individual performance (Hall & Ko, 2006; and Markulis & Strang, 1995). This difficulty has been overcome by some simulations that permit single player games, i.e. the student competes against computer managed firms. An innovative solution to the free-rider problem was overcome by Thavikulwat in his GEO game, a business simulation that enables participants to make global entrepreneurship decisions (available at http://pages.towson.edu/precha/GEO/index.htm). A unique feature of this game is that it uses a life span measure that is based on individual performance. Second, measures of student performance in a simulation that are typically used for assessment are broad in scope and do not directly capture the student's comprehension of specific business principles. For example, the understanding of the time value of money is inferred in many simulations by how well debt is managed or resources are allocated to by student participants to maximize profits or stock market returns. To address this issue, a more direct instrument is needed to assess the learning of specific theoretical concepts.

PURPOSE

The purpose of this paper is to illustrate the design of a simulation game that includes both automated "coaching" for student learning and individually graded exercises on specific theoretical concepts that are embodied in the simulation game. The automated coach serves as a timely consultant to identify functional areas in the game that need closer attention to improve performance. The graded exercises serve two functions: (a) to provide feedback to the students on their understanding of the theoretical principles embodied in the game; and (b) to serve as an assessment instrument for the instructor and college program.

DESCRIPTION OF GAME

Beat the Market (BTM) online is a microeconomics game that is focused on helping students learn how different market structures affect the optimal strategies and tactical decisions of the firm. The market structures in the game include: perfect competition, monopoly, monopolistic competition and oligopoly. The game allows students to directly apply fundamental economic principles and decision-making tools of analysis that are highlighted in the typical microeconomics or managerial economics course.

BTM is a fully online, internet based, game. The mechanics of playing BTM are similar to most business games. Students compete against firms in a simulated market that are managed by the computer or other students in the class. The general process for the student is to enter a firm's operating decisions for a given period and press the execute button to advance to the simulation to the next time period. There are up to eight decisions in the game that can be selected at the instructor's discretion based on the learning objectives of the course. The controllable decisions include: price, production, plant size, advertising, product development, e-commerce, process improvement, and training. The simulation evaluates a firm's decisions relative to the competition and market environment, and generates a set of reports that show how well the firm is doing. The game gives each student (or team) a performance rating between 0 and 100 percent based on their profits compared to the best firm. However there are two unique features of BTM: (a) an automated consultant that coaches the student on what to consider in the game to improve performance; and (b) a set of automatically graded exercises that require the student to play a game and answer multiple choice questions about the game's results. An online automated grade book is also provided for students and the instructor.

AUTOMATED CONSULTANT FOR COACHING

After decisions are entered and executed, the game provides a summary page, shown in Figure 1, which highlights the performance of the student (firm 1) and provides the advice of the "consultant" with respect to improving performance in the game. In the example in Figure 1, the student's net profit (firm 1) compared to the best firm is illustrated in a bar chart on the right. The best firm had net profits of $106,425 compared to the student's net profit of only $100,564. The student' quarter rating is 94.49%.

Based on this summary report, the student will want to know why his or her profits were below the top firm. Experiential learning, or learning-by-doing, may lead one to conclude that the student should discover the reasons independently without any help. Yet, the educational literature argues that some degree of coaching will facilitate learning by inducing students to process the information in the game more deeply (Fletcher, et. Al., 2006). But there is a problem with coaching because of the time constraints of the instructor. Providing individual coaching assistance to each student is not feasible for many instructors. However, a

FIGURE 1: THE CONSULTANT IN BTM

virtual instructor to coach students provides an intriguing alternative.

A virtual instructor may be modeled as an intelligent tutoring system that is part of the simulation game. The objective is to provide one-on-one coaching that is done in a timely and affordable fashion. The virtual instructor may be designed according to the learning objectives of the simulation. The virtual instructor could provide basic hints or more sophisticated feedback involving explanations, examples, and suggestions. The effectiveness of an ITS or computer added instruction (CAI) has been studied for many years with positive results. Ong and Ramachandran (2000) argue that "*In many simulations, learners can benefit from ITS tutoring. They may take far longer to learn missing knowledge and skills without coaching from a human instructor or an automated tutor.*"

The consultant in the BTM simulation is shown in Figure 1 highlighting two areas that the student should consider to improve performance. First, the "marginal cost was 36% lower than price"; and second "…total revenues declined by 14% from the prior quarter. This gives the student some initial direction, and reduces the burden that is typically placed on the instructor to provide some type of "coaching" in a timely fashion.

An important question is the type and level of the automated coaching. How much information should the consultant provide? What type of depth of advice should the consultant give to the student? It would clearly not be effective for the consultant to tell the student what to do. This would defeat the very purpose of "learning-by-doing". Much care and effort must be placed in the design of the virtual consultant (tutor). A vast body of literature is available on the effective design of tutoring systems.

AUTOMATICALLY GRADED EXERCISES FOR ASSESSMENT

Assessment can occur at the classroom level, or extend to the curriculum including the undergraduate and graduate programs of the college. At the classroom level, Angelo (1991) explained that assessment is "*a simple method faculty can use to collect feedback, early and often, on how well their students are learning what they are taught.*" At the curriculum or college level, the University of Virginia states on their website that the purpose of assessment is to "*… pose fundamental questions and find reliable, detailed answers about the purpose and effectiveness of the education the University offers its students. Ideally, assessment should reveal what students are learning…*" (www.web.virginia.edu/iaas/assessment/assessment.htm).

Figure 2 illustrates a set of graded exercises that can be assigned along with playing a simulation game. Each exercise measures the students understanding of a specific

FIGURE 2: ASSIGNING EXERCISES IN BTM

component of a microeconomics course. The exercises require the student to play a specific game, which is different for each student, and then answer questions about the game results. The exercises are then automatically graded and the results sent to the instructor's grade-book.

Specific games may also be assigned, without exercises, for each market structure, from perfect competition to oligopoly. Each game is algorithmically generated so that each student has a unique environment that is different from other students, but similar in the level of complexity. This way, students cannot get answers from other students, or learn of a common winning set of decisions or strategies. The games are graded individually for each student. Overall performance in the game may be used as a broad measure of the higher levels of learning or major categories of processes identified in Bloom's taxonomy, i.e. application, analysis, synthesis, and evaluation. Simulation games are well suited to measure these types of cognitive skills.

CONCLUSION

The paper presents theoretical arguments for including both automated coaching and direct testing instruments to assess learning as part of the design of a simulation game. The educational literature supports the role of coaching to improve the educational effectiveness of simulations, and the need for assessment instruments for accreditation is well known. As an illustration, the way in which this has been modeled in an existing simulation, Beat-the-Market: A Microeconomics Game, was presented. The game simulates the four market structures commonly taught in microeconomics. The design of the automated coach included in this game was demonstrated. The automated coach alerts students each quarter as to the functional areas in the game that needed closer attention in order to improve performance. The demonstrated game also included a set of exercises that were used to give feedback to students on their understanding of the theoretical principles embodied in the game. Given that these new design features have been implemented in Beat-the-Market, future research is now possible, and encouraged, to empirically measure its pedagogical effectiveness. The initial student reaction during the development stage to these features was quite positive but needs to be formally tested with a broad base of students.

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