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Simulation Gaming in Technology Management

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ABSTRACT

This paper discusses business games as teaching tools in Technology Management (TM). The discipline’s traditional teaching methods, while appropriate for the dissemination of foundational knowledge, do not provide the optimal platform for students to link abstract concepts and real-world problems. We suggest that business simulation games are an effective way to engage students in TM topics; that they compel students to understand and cope with the ambiguities associated with real-world organizations. Specifically, we discuss our experience with the International Operations Simulation Mark/2000 (INTOPIA), a game designed to channel students into a stream of entrepreneurial decision-making. We employed the game over 13 semesters with approximately 1000 advanced MBA candidates. Our findings indicate that business games represent a sufficiently novel approach to teaching and learning.

Keywords: Business Games, Pedagogy; Bloom’s Taxonomy

INTRODUCTION

From an educational perspective, games are important motivational and learning tools (Garris et al., 2002), a link between abstract concepts and real-world problems, a “learning by doing” or “hands-on” approach to learning (Martin, 2000; Kolodner et al., 2003). From a technical perspective, games help remedy education’s long-standing struggle to maintain fluency in end-user computing, the world-wide-web, distance learning and cooperative learning (Erkut, 2000). Educators desire to work with technology to create more meaningful learning experiences (Souza e Silva and Delacruz, 2006). Therefore, exploring novel approaches to technology-friendly games for teaching and learning is eminently justifiable.

Our focus is games as teaching tools in higher education. Organized in five sections, the next section explores current challenges in Information Systems (IS) and Technology Management (TM) education. Then, we define business games and their pedagogical efficacy. Next, we discuss business games and experiential learning. We also introduce a metric for report on a specific business game employed in a TM classroom. Finally, we present our conclusions and recommendations for future inquiry.

CHALLENGES FACING IS AND TM EDUCATORS

The reexamination of IS and TM education, prompted by concerns over a perception gap between IS/TM academics and IS/TM practitioners (Lee et al., 2002; Sutcliffe et al., 2005) reflects a broader problem facing the business disciplines. Reality today mandates a multidimensional teaching approach, where teachers (1) transmit core competencies and (2) provide a forum for students to think independently, to challenge assumptions and widely held beliefs (Prince and Steward, 2000). Lee et al. (2002) argue that IS programs do not adequately prepare students to understand and cope with the ambiguities they will inevitably face in the industry. The authors suggest that the teaching and learning models that dominate current academic practice do not provide sufficient preparation for the students. This is particularly problematic for graduate students to the extent that adult working students typically enroll in such programs as a direct result of their lived experience in organizations (Dehler, 2006, p. 637).
Another perennial problem in IS and TM education is curriculum integration. Integration assumes that postsecondary learning is a complex social and cognitive process of mastery and discovery (Warren, 2002). Yet, despite the literature advocating curriculum integration, which is neither sparse nor new (Bruner, 1977; Collins, 1996; Grubb, 2005; Huber and Hutchings, 2004; Lorents et al., 2003), students often graduate IS or TM programs with excellent analytical skills but have no idea how integrate them with existing business applications (Lee et al., 2002). Lee et al. (1995) point out that “…the requirements for IS professionals are becoming more demanding in multiple dimensions…the challenge for educational planners is to design a diversity of IS curricula to meet the career plans of IS professionals.”

Static, content-oriented teaching methods obviate curriculum integration, and weak curriculum integration minimizes desired educational outcomes. If knowledge is not translatable or transferable, its relevancy to students and the practice of IS or TM may be negligible. Knowledge in this field is a means to an end not an end in itself, and the acquisition of foundational factual knowledge is an early and important phase of the learning process but should not be the only one. An innovative approach of learning in the IS and the TM fields is doing; that is, performing empirical tasks (Léger, 2006).

LEARNING AND BUSINESS GAMES

The Nature of Business Games

Business simulation games address many of the challenges associated with IS and TM education such as integration. They also present a promising alternative to the fields’ traditional methods of instruction. In fact, literature documents the educational effectiveness of simulations (Cox, 1999; Parker and Swatman, 1999; Scherpereel, 2005; Tomlinson and Masuhara, 2000; Yeo and Tan, 1999). And emerging technology renders simulation exercises more sophisticated and user friendly. A method of learning through games—forcing adrenalin rushes, active involvement, and motivation to their peak—may be employed to excite students and internalize subject matter. Games energize behavior (Harper et al., 2000; Rieber, 1996; Parker and Swatman, 1999; Kafai, 2006).

A general-purpose business game is a highly complex man-made environment. Its objective is to offer students the opportunity to learn by doing, engaging them in a simulated experience of the real-world, to immerse them in an authentic management situation (e.g., Garris et al., 2002; Martin, 2000). The application of simulation gaming as a learning tool is occasionally described in IS literature. For example, Nulden and Scheepers (2001) suggested a system development simulation in which failure and escalation are introduced to Information System students; Draijer and Schenk (2004) and Léger (2006) used a business simulation game to teach Enterprise Resource Planning concepts; Ben-Zvi (2007) used a business game approach to teach Decision Support Systems.

The Model

Our modest objective here is to examine how business games create a new relationship between student and subject matter where a student moves from a concrete, observational realm (novice knowledge) to a more abstract, theoretical realm (expert knowledge) (Glaser, 1984). This will help us respond to various criticisms over the educational benefit of business games (e.g., Neuhauser (1976) stated that “the many benefits for business games are not supported by any but anecdotal evidence”). To achieve our objective, we briefly discuss the transformative nature of experiential learning and its interplay with transactional nature of simulation games. In turn, this will lead us to a metric for learning, teaching and assessing in the context of a specific business game course.

Experiential learning emphasizes the interaction between experience and learning by exploiting the subjective nature of the learning process (Kolb, 1984) and creating a transformation of experience that engenders knowledge (Mainemelis et al., 2002). Business simulation games relate directly to the nature of experiential learning. In fact, Garris et al. (2002) regard business games as a method that epitomizes experiential learning (see also Anderson and Lawton, 1988; Faria and Wellington, 2005; Ruben, 1977; 1999). Business games provide students the opportunity to (a) assume the roles and responsibilities of executives; (b) become intimately involved in decisions faced by real people in real organizations; (c) experience pressure; and (d) recognize risks. Moreover, this method is an excellent tool to test the understanding of theory, to connect theory with application, and to develop theoretical insights.

An assessment framework known as the Revised Taxonomy of Educational Objectives (hereafter Revised Taxonomy) typifies the relationship between experiential learning and business games. The Revised Taxonomy is a modified version of Bloom’s Taxonomy of Educational Objectives (1956) (hereafter Original Taxonomy). The Original Taxonomy represented an effort to standardize the language of intellectual (learning) behavior. This construct is a one dimensional continuum, a cumulative hierarchical system of learning classification that uses observed student behavior to infer the level
of student achievement, where more complex behaviors subsume the simpler behaviors (Athanassiou et al, 2003; Bloom, 1956; Krathwohl, 2002). The Revised Taxonomy augments this work. It is a two dimensional matrix that juxtaposes knowledge and cognitive processes. The knowledge dimension represents a continuum from concreteness to abstraction. The cognitive process dimension represents an assumed hierarchical continuum of cognitive complexity. Each cell in the taxonomy corresponds to an educational objective (Anderson and Krathwohl, 2001). Table 1 illustrates the structure of the Revised Taxonomy.

<table>
<thead>
<tr>
<th>Knowledge Dimension</th>
<th>Cognitive Process Dimension</th>
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<tbody>
<tr>
<td></td>
<td>Remember</td>
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<tr>
<td>Factual Knowledge</td>
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<tr>
<td>Conceptual Knowledge</td>
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<tr>
<td>Procedural Knowledge</td>
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<tr>
<td>Meta-Cognitive Knowledge</td>
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</table>

Table 1. The Revised Taxonomy.

The knowledge dimension includes four knowledge types: factual, conceptual, procedural, and meta-cognitive. Concrete, factual knowledge includes the introductory concepts, skills and details of a specific discipline. Conceptual knowledge represents a synthesis of factual knowledge and movement towards an understanding of principles and theories associated with a given discipline. Procedural knowledge involves one’s grasp of how to study something. This may include knowledge of subject-specific techniques and methods or informed judgments for determining when to use appropriate procedures. Meta-cognitive knowledge is summarizing knowledge; theoretical and conceptual knowledge that synthesizes the lesser dimensions. It is knowledge of cognition in general but also knowledge of one’s own intellectual prowess (Anderson and Krathwohl, 2001).

The cognitive process dimension ranges from remember, a basic cognitive retrieval process to create, an advanced pattern matching and planning process. The categories between remember and create represent a transition from recognizing and recalling facts to theory generation and successful learning habits (Anderson and Krathwohl, 2001). These middle categories are understand, apply, analyze and evaluate. Understand relates to one’s ability to determine the meaning of instructional messages through several modes of communication. Apply is the ability to execute or implement a procedure appropriate to a given situation and closely linked to procedural knowledge. Analyze relates to deconstruction: one’s ability to break material into constituent parts and determine how those parts relate to one another. The evaluate category involves making judgments based on criteria and standards: checking and critiquing. Those judgments lead to one’s ability to create, to generate hypotheses, to engage in research planning and to effectively articulate research outcomes (Anderson and Krathwohl, 2001).

This framework represents a practical heuristic for exploring the interplay between teaching, learning, assessment and business games. Thus, we discuss a specific business game course in the context of the Revised Taxonomy.

**THE BUSINESS GAME COURSE**

**Course Objectives**

Because the business game course is one of the summarizing courses in the MBA program, the primary, explicit course objective is to improve students’ management and thinking skills by practicing in “real conditions”. We consider the game as a tool that allows for learning to occur at multiple levels of the Revised Taxonomy. Thus, we had to exploit the more implicit course objectives manifest in assessment and instructional activities to identify where exactly the principal objective fit into the taxonomic table. Implicit course goals relate to: (1) strategy in decision making, where (2) students implement
lessons learned from previous coursework. We found that the first objective relates to understanding conceptual knowledge because strategy denotes a particular knowledge domain. Students must understand the basic elements of strategy and how those elements interact. The second objective involves applying procedural knowledge, as the summarizing nature of the course requires that students invoke skills and methods learned in other courses and integrate that knowledge.

The Game

This course utilizes the international version of a business game developed in the United States, commonly known as the International Operations Simulation Mark/2000 (hereafter INTOPIA™). The prime purpose of this business game reflects the course objectives. But the game is also meant to increase students’ general understanding of strategic management of international operations, particularly the multinational hi-tech corporation. Furthermore, the game is designed to yield substantial payoffs in management training. It forces participants into a stream of entrepreneurial top management decisions, where they search for logic and synergy in the business objectives-strategy-implementation sequence (Thorelli et al., 1995).

The game is highly realistic, meant to simulate the total environment. Students participating in the game immerse themselves in an artificially created world. The simulated markets are similar to the markets in the United States (US), the European Union (EU) and Brazil, where each company can operate a local branch. “Operate” is a broad concept and may cover one or any combination of the manufacturing, marketing, distributing, exporting, importing, financing and licensing functions. Incoming participants enter a “going concern” with four periods of simulated history and play six to ten additional game periods. The task of the companies is to make decisions which will guide operations (simulated by a relatively easy computer interface) in the current period and which will affect operations in subsequent periods.

Participants

The study was conducted in a university accredited by the Association to Advance Collegiate Schools of Business (AACSB). The participants were senior MBA candidates. Approximately 1000 students participated in business game classes. The study was conducted each semester from fall 2002 through summer 2006. In each semester the students were divided into groups (corporations) that included five participants assuming executive roles. The formation of companies and the allocation of executive roles proceeded without external intervention or manipulation.

Instructional Activities

The game is played for a full semester and is operated by up to 25 competing companies. It commences after five weeks of lecture, at which point the instructor adopts a rather passive role. That is, the class is expected to apply classroom knowledge to the game with little direction. This approach is designed to challenge the students’ ingenuity and creativity.

The game is conducted by three instructors, who emphasize the importance of teamwork. While each student becomes a specialist in his or her function, the game requires a collaborative effort to achieve the common goals of the company which the students themselves define. Teams make functional and strategic decisions once a week. The decision data are then e-mailed to the game administrator for database entry. After the program runs the data, it generates company outputs that include financial reports (e.g., a balance sheet; an income statement), production reports and market research. These outputs are then e-mailed to the companies and are used for decision-making in subsequent periods. The length of the each simulated time period in our game is one year.

In each period, the game requires dozens of decisions, typical of any large firm. The decision-making process is based on (1) analysis of the company’s history presented to players when the game commences; (2) interaction with other companies and external agents of the game (e.g., bankers; board of directors); and (3) constraints stated in the player’s manual (e.g., procedures for production; types of marketing channels available).

The performance of a company in a given period is a result of past decisions and performance, current decisions, simulated customer behavior, and competition—other companies in the industry.

Instructional activities promote learning at several of levels of the taxonomy. Lectures, for example, first emphasize knowledge of terminology. Then, they progress to integration of factual knowledge from different disciplines. Thus, instructional activities promote remember factual and conceptual knowledge. However, when the instructors adopt passive roles and the students play the game, the students are required to engage in progressively more independent strategic decision
making and therefore, learn at a higher level of the taxonomy. Students (teams) are forced to rely on self-knowledge. They have to analyze different management situations and evaluate their decisions based on their knowledge of procedures articulated in the lectures; to analyze and evaluate procedural knowledge. Further, at a more abstract level, the less invasive instructor role mandates that students understand how and why they make decisions. Such conditions make it important for students to understand their strengths and weaknesses; to understand meta-cognitive knowledge.

Assessment Activities

Grading is based on two quizzes, two written reports and two oral presentations. The first quiz measures the students’ command of rules and general information about the game. The second quiz assesses team-specific knowledge on periodic outputs and market research. The first oral presentation and written report include factual, baseline corporate information such as a description of mission and vision. They also include: (1) a description of corporate aims and positioning; (2) an initial strategic analysis; (3) a preliminary development of business and competitive strategy based on the strategic analysis; and (4) a preliminary projected profit and loss reports. The first presentation is presented only to the instructors who assume the role of board of directors. In the second presentation, before their classmates, the teams analyze their activities in the game, revealing their objectives and strategy. The second oral presentation and written report necessarily build upon the first. Teams must submit a fully strategic analysis (updated mission and vision statements), market analysis, operational analysis, and financial analysis based upon the game’s results. The expectation is that each team will learn from one another, given the different backgrounds of students. The final grade also incorporates the company’s performance (i.e., the decision making throughout the game).

The first quiz measures remembering information or facts (e.g., how much does it cost to build a plant in the United States?). So, we placed it at the intersection of remember and factual knowledge. The second quiz requires that students understand financial and market data (e.g., what was the average return on investment of European manufacturers?). As such, we classified the second quiz as understand conceptual knowledge.

The aim of the reports is to promote higher-order cognitive processes, such as strategic analysis and development. We classified both reports as applications of meta-cognitive knowledge because they are activities that require teams to articulate corporate aims and strategic knowledge. We categorized the first report as analyze meta-cognitive knowledge, as analysis is the highest level required for the first report. We also located the presentations at that cell. However, we suggest that the culminating final report requires learning to occur at the highest level of the taxonomy, based on two factors. First, teams were required to (1) hypothesize about subsequent business periods that are not actually played; (2) explain procedures on how to perpetuate their going concern; and (3) update their previous work based upon strategic knowledge. Second, the final report was (1) a self (team) critique of previous work; and (2) a vehicle for team’s to explain their command of the structure and function of the course. Thus, we classified the final report as create meta-cognitive knowledge.

The Taxonomy Revisited

Pursuant to business games, the Revised Taxonomy is an important tool. It allows educators to analyze the interaction of students with course materials. Simultaneously, it allows educators to analyze the ways in which an individual’s knowledge is structured. These two activities are fundamentally important in education (Anderson and Krathwohl, 2001). We also found the Revised Taxonomy a useful analytic framework for assessing the degree business games foster alignment between pedagogy and student learning. Table 2 illustrates our understanding of how the knowledge and cognitive processes relate to the INTÔPIA business game.

Our integration of the Revised Taxonomy indicates that business games allow for learning to occur at multiple levels; but not all. We also found a modest degree of alignment between teaching, learning and assessment. This is acceptable given that instructors may include activities which are not directly related to either objectives or assessments. The intent of such activities is to provide students with information they need to master an objective (Anderson and Krathwohl, 2001). Each instructional and assessment activity, therefore, serves as a vehicle for students to improve their managerial and cognitive skills.
Even with a modest degree of alignment, our experience with the Revised Taxonomy suggests that business games satisfy a longstanding need in IS and TM education: curriculum integration. Integration occurs because learning in business games spans from the lowest to highest levels of the taxonomy. First, students must remember, understand and apply their knowledge from previous coursework. Second, they must analyze their own strengths and weaknesses, relative to other teams. Last, they must create and simulate a corporate reality. These three factors, among others, underscore the importance and potential of business games for learning through integration. And more practically, the Revised Taxonomy confirms that business simulation games are an effective way to engage students in TM topics; that they compel students to understand and cope with the ambiguities associated with real-world organizations.

Course Evaluation

Our experience suggests that the INTOPIA game is an ideal platform for the gaming method because it enables students to understand information needs through participation in a real decision-making process. At the end of each semester the students were asked to complete a short course evaluation questionnaire. The students were also asked to compare this course to other courses in their curriculum. It was pointed out that their answers would have no effect on their grades; students were encouraged to respond fully and accurately.

Analyzing their answers, student reaction to the game was favorable. Most reported that they enjoyed playing the game and the competitiveness and realism that it brought to the classroom. Over time, the course earned high ratings in relation to other courses (means of responses are exhibited in Table 3; questions are based on the Likert scale (Likert, 1932) from 1 to 7). One of the students even remarked, “The only thing that I will take from this program is the game.”

<table>
<thead>
<tr>
<th>Question</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The Game</td>
</tr>
<tr>
<td>1. General assessment</td>
<td>5.97</td>
</tr>
<tr>
<td>2. The course helped develop an independent thinking</td>
<td>6.19</td>
</tr>
<tr>
<td>3. The course was interesting</td>
<td>6.09</td>
</tr>
<tr>
<td>4. The lessons encouraged intellectual challenge</td>
<td>5.97</td>
</tr>
<tr>
<td>5. The course taught important skills</td>
<td>6.23</td>
</tr>
<tr>
<td>6. The course contributed to the learning experience</td>
<td>6.32</td>
</tr>
</tbody>
</table>

Table 3. Means of Responses for the Business Game Course and Other Courses.

DISCUSSION AND CONCLUSIONS

More generally, our experience suggests that the efficacy of business games as educational tools is threefold. First, business games provide students an opportunity to immediately apply classroom concepts to real world situations. That is, business games enable students to apply scientific and mathematic methods to construct, solve, and analyze simulated management scenarios. The game also forces students to reason clearly and logically, as they must carefully sift through
available data and information. The students usually develop formal decision-making models and integrate them with information systems that they themselves build (Ben-Zvi, 2007). Thus, an ancillary benefit is effective data and information handling skills. Second, business games afford students the chance to practice the art of decision-making in a laboratory setting, with little corporate and personal risk involved, an experience otherwise unattainable away from the real-world. In essence, business games are to TM students what cadavers are to medical students. They represent the opportunity to practice on the real thing. Third, the simulation forces students to think independently, where they are actually engaged in an experiential process of learning how to learn. Therefore, we find that business games are an effective pedagogy and represent one of the most sophisticated and promising uses of technology in TM and IS education. We also find that the marriage of technology and experiential learning offers students a quality experience. This is important because everything depends upon the quality of experience, not the experience itself (Dewey, 1938).

In terms of pedagogy, we find that business games provide an effective alternative to traditional teaching methods. It is relatively difficult, for example, to convey the value of information; the realism and competitiveness of the game elicit excitement and motivation, where students strive to make better decisions, using information systems they developed themselves. Furthermore, the use of simulation games for enhancing participatory learning and teaching aligns well with the levels (depth) of knowledge aims articulated for IS education (see Gorgone et al., 2002, Appendix 4).

Future inquiry might investigate how to effectively integrate games with other TM curriculum offerings. Given that the literature is wrought with curriculum integration concerns, the novelty of games may promote the exchange of new ideas on teaching and learning within and across courses in the TM discipline. Another line of research might explore how to quantify student experiences. The architecture of business simulation games places students in a role of both teacher and learner. Therefore, documenting and quantifying these experiences may yield new ideas that substantiate alternative and promising pedagogical approaches in TM.

ACKNOWLEDGEMENT

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REFERENCES


