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LEARNING AND TECHNOLOGY: AN EXPERIMENT

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Abstract

Distance Learning (DL) has become a very popular alternative to face-to-face teaching. Educators long for new teaching methods and new technologies help in creating more meaningful learning experiences. This study examines the learning outcomes and benefits of using a simulation in a DL class. Our findings show that DL does not appear as a superior approach: students using DL do not demonstrate higher learning levels or higher levels of control over their learning experience. Those results lead us to conclude that the benefits of DL have yet to be realized.

Keywords: Distance Learning, Education, Simulations.

1 INTRODUCTION

In the past few years, Distance Learning (DL) has emerged as a new method of teaching (Chang and Cho, 2009). Some universities, such as Open University, Athabasca University and the University of Phoenix, have built their entire missions around the delivery of off-campus programs (Wolfe et al., 2002). Other universities, such as Devry University (France), University of Sydney (Australia), Tsinghue University (China), and New York University (USA) offer online degrees in addition to their traditional on-campus programs. Although some DL efforts ended up in failure (for example, Pensare, Inc., which developed MBA programs for Duke University and the University of Pennsylvania's Wharton School, filed for bankruptcy in 2001), the number of students enrolled in DL programs is now measured in millions and corporate spending on this method dramatically increased to several dozen millions of dollars.

As the Internet offers a great potential for DL in several disciplines, business schools have been major adopters of this computer-driven teaching technology (Wolfe et al., 2002). One of the main modes of DL application in business schools is business simulations. Business simulations have been developed since the 1950s; however, one of the main reasons that deterred instructors from frequently using them in the classroom was their complexity and their seemingly low educational value (Ben-Zvi, 2007). With the growth of the Internet, however, several simulation developers have been distributing their simulations solely on the Internet**,** while simultaneously administering the simulations for the instructor. This facilitates the endorsement of business simulation as a teaching tool in education (e.g., Burns, 1998; Griffin et al., 1999).

Since DL requires a high level of resource commitment from the university, a rigorous examination of the learning results associated with a DL is warranted. This study presents our experience with a DL simulation and examines whether DL simulation is superior to the traditional face-to-face method. Our focus is simulations and the DL experience. Organized in six sections, the next section explores DL education and business simulations. We also present a learning model. Then, we state this study’s hypotheses and methodology. Next, we present the test results. Finally, we discuss those results, draw some conclusions and make recommendations for future inquiry.

2 LITERATURE REVIEW

2.1 Distance Learning

DL can be defined as a formal approach to learning during which the majority of instruction occurs while the learner and the educator are at a physical distance or time difference from each other, allowing learning to be self-paced rather than instructor-paced (Grisham and Smith, 2009; Wu and Fang, 2009). A large number of studies have examined the effects of DL on students, instructors and their institutions. The conclusions of these studies have been summarized in several review papers, such as Schlosser and Anderson (1994), Moore and Thompson (1997) and Lesh and Rampp (2000). Studies found that when contrasted with traditionally-taught, on-campus classes, for certain student populations, DL may appear as a superior course delivery method (see, for example, Boucher et al., 1999).

Several studies that explored DL showed that DL produces better learning outcomes compared to traditional methods, and usually these outcomes come at lower costs to both the students and the institutions using the method (Russell, 1999; Clark, 1999). However, other studies found that DL gave the students a sense of empowerment but the remote environments were judged "less rich" than those experienced by those taught in locally-controlled environments (Webster & Hackley, 1997). Griffin et al. (1999) noted that sometimes students presented negative attitudes toward DL; this was associated with the technology being used and the students' inability to deal with it.

2.2 Business Simulations and the Learning Experience

A business simulation offers students the opportunity to: (1) learn by doing in authentic management situations; (2) engage them in a simulated experience of the real world; and (3) produce experiential learning experiences (e.g., Garris et al., 2002; Kolodner, 2003; Martin, 2000).

Business simulations related to the Information Systems field have been studied both in academia and industry (e.g., Asakawa and Gilbert, 2003; Dasgupta, 2003; Dickinson et al., 2004; Dickson et al., 1977; Michaelson et al., 2001). In 2003, a special issue of Communications of the ACM, named "A Game Experience in Every Application", was dedicated to simulations and games in diverse applications. Furthermore, 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 to teach Enterprise Resource Planning concepts. Parker and Swatman (1999) explored an Internet-mediated business simulating an electronic commerce environment; Yeo and Tan (1999) used a simulation in supporting a course in decision technology; Ben-Zvi (2007) studied DSS in business simulations.

Business simulations also present an experiential learning experience. That is, they emphasize 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). They also provide students the opportunity to become intimately involved in decisions faced by executives in real organizations, to test the understanding of theory, to connect theory with application, and to develop theoretical insights (Garris et al., 2002; Ben-Zvi and Carton, 2007).

A well known framework that models learning experiences is the Revised Taxonomy of Educational Objectives developed by Anderson and Krathwohl (2001). This model can typify the relationship between experiential learning and business simulations (see, for example, Ben-Zvi and Carton, 2007). The Revised Taxonomy of Educational Objectives is a modified version of Bloom's Taxonomy of Educational Objectives (1956). The Taxonomy represents an effort to standardize the language of intellectual learning behavior. The taxonomy's knowledge dimension represents a continuum from concreteness to abstraction and 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. Table 1 illustrates the structure of the Revised Taxonomy. Each cell in the taxonomy corresponds to an educational objective (Anderson and Krathwohl, 2001).

Knowledge Dimension	Cognitive Process Dimension					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge						
Procedural Knowledge						
Meta-Cognitive Knowledge						

Table 1. The Revised Taxonomy

This framework represents a practical heuristic for exploring the interplay between teaching, learning, assessment and business simulations. Thus, we discuss the learning experience using a specific business simulation course and measure each knowledge type accordingly.

3 HYPOTHESES

This study follows the Revised Bloom's taxonomy and makes a comparison of the learning experiences between DL and on-campus classes. We employ the Revised Bloom's taxonomy elements as variables. The study's first hypothesis tests whether learning outcomes experienced by DL students were equal or superior to those experienced by on-campus students while keeping all other parameters equal. This hypothesis is based on the general finding that DL students perform at least as well as other students (see Boucher et al., 1999; LaRose et al., 1998). The learning experiences will be tested against each of the elements of the Revised Taxonomy of Educational Objectives.

Hypothesis 1. Students using the business simulation through DL will demonstrate learning levels that are equal to, or higher than, those achieved by the on-campus students.

One of the benefits supposedly associated with web-based education is its ability to give students a sense of control and self-direction. This control allows the students to plan their own study times and pace their learning based on their own needs and thus allowing for greater pedagogical flexibility (Hazari & Schnorr, 1999; Kosmahl, 1994; Webster & Hackley, 1997). Therefore, the study's second hypothesis is:

Hypothesis 2: Students using the business simulation through DL will express higher levels of control over their learning experience than those of the on-campus students.

Another benefit attributed to the DL approach is the satisfaction of students from their instructor (Grisham and Smith, 2009; Wu and Fang, 2009). Studies have shown that students taking the DL approach are more satisfied with the role of instructor in the course (see, for example, Gagne & Briggs, 1992; Kosmahl, 1994). Thus the following hypothesis deals with the students' level of satisfaction:

Hypothesis 3: Students using the business simulation through DL will express higher levels of satisfaction with the instructor's role in the course than those expressed by the on-campus students.

In addition to satisfaction from the role of, the instructor, he or she should also provide useful feedback to the students (Hazari & Schnorr, 1999). Studies exploring feedback techniques suggest that students or participants usually prefer face-to-face feedback over impersonal feedback provided by emails or other web methods (Andrusyszyn et al., 1999; Cragg et al., 1999). Accordingly the next hypothesis is:

Hypothesis 4: Students using the business simulation through DL will express lower levels of satisfaction with the quality of feedback received from the distant simulation instructor than those expressed by the on-campus students..

The last hypothesis deals with technical problems student come across when using DL and the technical support they receive. Burns (1998) and Griffin et al. (1999) have noted that many technical problems accompany DL's use. It is possible that these problems damage the learning environment rather than serving as an aid to learning. It is also possible that high technical support is a necessity to insure a satisfying experience in this environment. Therefore, we state his hypothesis as follows:

Hypothesis 5: Students using the simulation under high support conditions will have fewer interface problems than those of the on-campus students and will present higher satisfaction rates.

4 METHODOLOGY

4.1 The Capstone Simulation

The simulation we used was Capstone® (2000). This simulation is used in approximately 500 schools globally from major universities to community colleges. This simulation aims to increase students' understanding of strategic management of operations in big corporations. Furthermore, the simulation is designed to yield substantial payoff in general management training. It forces participants into a stream of truly entrepreneurial top management decisions of business philosophy and a search for logic and synergy in the business objectives-strategy-implementation sequence. The simulation involves the students in the executive process, motivates their need for decision-making aids and forces them to adopt a managerial viewpoint.

The simulation is used for a full semester. Participants are divided to teams (companies). The companies can invest in research and development processes, develop new products, produce, market one's own products or sell them to distributors, serve as a distributor or become a subcontractor. The incoming participants enter a start-up company and perform a run over 8 simulation-periods, simulating 8 years. The task of the companies is to make decisions which will guide operations (simulated by the software) in the forthcoming period and which will affect operations in subsequent periods. As the software itself contains a randomness component, data obtained in one run (one semester) can hardly guarantee success in the next one.

Decisions are made once a week. The length of the each time period simulated is usually referred to as one year. Dozens of decisions, covering the entire range of a typical business, are required of a company in each period. The decision-making process is based on an analysis of the company's history, interaction with other companies and the constraints stated in the participant's manual (e.g., procedures for production, types of available marketing channels).

The performance of a company in each period is affected by its past decisions and performance, the current decisions, simulated customer behavior, and the competition – the other companies in the industry.

The simulation has become highly realistic as a result of the efforts invested in it to simulate the total environment. Participants in the simulation immerse themselves in this artificially created world. They form teams (without external intervention or manipulation), allocate responsibilities for specific functions, and work to achieve common goals which they themselves define. While each of them becomes a specialist in his or her function, a joint effort is required to pursue the common objectives of the company.

4.2 Participants

The study was conducted in a large US university. The study was conducted in the Summer and Fall terms of 2008. The participants were MBA students. We recruited 98 students from our DL business simulation classes for this study (42 in the summer and 56 in the fall). At the same time we ran our on-campus business simulation classes with 115 students (50 in the summer and 65 in the fall). For each group (DL and on-campus), we averaged the results from both semesters. In each semester, the students were divided into teams, representing corporations that included four or five participants assuming executive roles. The formation of companies and the allocation of executive roles proceeded without external intervention or manipulation and students had the freedom to choose their teammates. A demographic investigation using t-value revealed that both groups had roughly the same age, gender and Grade-Point-Averages (GPA) distributions (Table 2 presents the mean of each variable for each group).

All participants received the same jointly-presented simulation orientation sessions and technical briefing. The only difference was in the delivery method – the DL students got the orientation using DL tools and the on-site students got it in face-to-face sessions.

Variable	DL Group (n=98)	On-Campus Group (n=115)
Mean Age	31.2	32.0
Mean GPA	3.47	3.39
% of Female	31	38

Table 2. Demographic Statistics for the Two Investigated Groups

Each semester, both groups were administered separately: the on-campus students used the simulation in class. They were coached through face-to-face interactions with the course instructor. In addition, the instructor provided in-class technical assistance and helped participants access their files and input and interpret their decisions. Furthermore, weekly in-class simulation discussions were administrated by the course instructor. The DL students operated in a more laissez-faire environment where the instructor was always available for team coaching on the web (even late night) but did not supply dedicated technical support. The students interacted asynchronously with the instructor through e-mail. Their decision sets were processed and the period's results, along with commentaries on their decisions made by the instructor were returned through e-mail within twenty-four hours from the submission deadline (we experienced one exception that is detailed later). We underscore that to avoid any biases related to the instructor himself, the same instructor taught both classes. Communication between different teams and between the teams and the instructor was made through email in both groups. In addition, we employed an electronic bulleting board we created on the web with the ability to post electronic messages.

By the end of each semester, after the simulation was over, the students were asked to complete a short questionnaire evaluating the knowledge levels obtained during the simulation. This questionnaire used simple terms and notions associated with the Revised Taxonomy of Educational Objectives. The goal was to test the knowledge levels the students achieved during the simulation. In addition, the questionnaire measured the students' subjective reactions to activities and relationships associated with the gaming experience. The questionnaire was based on a seven-point Likert-scale (see the appendix for the text of the questionnaire).

5 HYPOTHESIS TEST RESULTS

This section provides a summary of the questionnaire's answers (subjective data) and results from the game itself (objective data). In the next section we analyse the results and conduct a discussion.

The first four questions of the questionnaire refer to the first hypothesis, testing the course-related learning effects associated with DL versus traditional teaching methods. They represent the different knowledge levels of the Revised Taxonomy of Educational Objectives. We present the main results in Table 3. Our findings show that the DL group learning levels were equal to, but not significantly superior to those obtained by the other group (the Z values were low and the p-value were higher than the 5% significance level).

In addition to the subjective measurements, we also consider two objective ones: quiz results and company performance. Each semester the students were tested by a quiz. The quiz measured the students' command of rules and general information about the simulation, and thus it relates to factual knowledge. Company performance, which was measured by the total profits each group accumulated during the simulation, serves as an indicator to integrated conceptual and procedural knowledge at the highest level. Therefore, it may be considered as an objective measurement for meta-cognitive knowledge. The findings are presented in Table 4. Consistent with the subjective measurements, the results show that the DL group learning levels were very close and not significantly different than those obtained by the other group. Thus, hypothesis 1 was accepted.

Variable	DL Group		On-Campus Group		Z	p-value
	Mean	S.D.	Mean	S.D.		
Factual Knowledge	5.12	0.67	5.02	0.56	1.14	0.2549
Conceptual Knowledge	5.22	0.45	5.12	0.58	1.39	0.1646
Procedural Knowledge	5.43	0.86	5.19	0.89	1.95	0.0509
Meta-Cognitive Knowledge	5.01	0.85	4.89	0.82	1.02	0.3083

Table 3. Means, Standard Deviations (S.D.), Z values and p-values of Responses for the DL and On-Campus Groups.

Measurement	DL Group		On-Campus Group		Z	p-value
	Mean	S.D.	Mean	S.D.		
Quiz Results	78.5/100	11.2	82.3/100	10.8	1.72	0.1021
Company Performance (Accumulated Profits)	16,480	8,845	17,123	9,845	1.12	0.2846

Table 4. Means, Standard Deviations (S.D.), Z values and p-values of the Quiz and Company Performance for the DL and On-Campus Groups.

The second hypothesis stated that DL participants would feel they had greater control over the learning experience. This hypothesis was not confirmed, as the DL group did not present greater control (5.55 compared to 5.62 with 0.4421 as the significance level). The study's third hypothesis evaluating student satisfaction from the instructor was also rejected due to similarity in the results (5.12 compared to 5.07 with 0.6238 as the significance level). Both results along with the statistical tests are presented in Table 5.

Variable	DL Group		On-Campus Group		Z	p-value
	Mean	S.D.	Mean	S.D.		
Greater Control	5.55	0.68	5.62	0.62	0.76	0.4421
Satisfaction with the instructor	5.12	0.75	5.07	0.69	0.49	0.6238
Satisfaction with the feedback	5.26	0.43	5.32	0.51	0.89	0.3710
Experiencing problems	5.86	0.58	4.59	0.42	17.49	<0.0001

Table 5. Means and Standard Deviations (S.D.), Z values and p-values of Responses for the DL and On-Campus Groups.

Hypothesis four dealt with the perceived quality of the feedback participants received from the simulation and the instructor. The results, illustrated in Table 5, show that both groups rated the quality of the simulation's feedback approximately the same (5.26 compared to 5.32). Thus, this hypothesis was rejected.

The final hypothesis dealt with the additional technical burden placed on DL participants, due to the fact that they had to interface through the Internet, and how that affected their behaviors and the nature of the communications conducted between participants and the simulation instructor. Based on the information presented in Table 5, it can be concluded that Internet-use problems, rather than simple learning, dominated participant communications for the DL group. The results present a significant difference between the two groups. We also measured a high reversed correlation (-0.8) between the amount of experienced technical problems as reported by the participants and the satisfaction level they reported. We discuss those results in the next section.

6 DISCUSSION AND CONCLUSIONS

Much has been published on the special learning environment created through the use of DL education. Despite this assertion of uniqueness**,** this study's subjects usually rated their DL situation no better or worse than their traditionally-taught counterparts despite the fact that their interactions with the simulation, and their access to information and coaching were completely different from those of the other group. We also found that numerous problems arose which could have materially mitigated DL's supposed virtues. These problems mainly related to Internet operating skills the administrative load placed on the instructor.

Our investigation reveals that it took from at least 5 hours to more than two days on one occasion to return the results to the students in the DL group (due to technical problems). The average turnaround time over the simulation's competition amounted to almost 14 hours. Based on this performance it must be concluded that the goal of speedy turnaround times was not obtained using DL.

We conjecture that those results are not necessarily unique to the university nor do they represent a poor software choice. We believe that DL still faces several challenges and creating timeliness is one of them. Future research can compare DL experiences using different software in different schools. We suggest focusing on the factors that cause those challenges and how we, as educators, can address them.

The volume of communication traffic was higher for DL students. This amounted to 13.8 messages per company that were not dispersed evenly over the run of the simulation. Message content was also different: most of the DL communications dealt with problems associated with the mechanics of working with sending, recording and retrieving files, apologizing for late decisions, improperly recording their decisions, etc. The on-campus students had very few problems in this area and communicated most-often regarding the simulation's teaching components such as asking for judgments about contemplated decisions.

This study's results make it possible to draw a number of conclusions about DL instruction using business simulations while also suggesting a number of areas for future research. Although DL is not associated with lower learning results, it did not realize its many theorized benefits. Its only benefit was one of relieving the instructor of simulation-processing chores. It also appears that DL, or the simulation used in this study, is very robust. Despite the many problems the participants had with sending and receiving their results, and the extra hours they spent because of this, their overall reactions to the experience were the same as those of the other group. In Table 6 we summarize the course evaluation by the participants. Those results were obtained using common course evaluation forms used in many universities world-wide. It seems that the overall course evaluation got higher ratings with the DL group, although still within the same range of the on-campus group.

We also point out that the simulation used in this study, as is the case with most other top management simulations, was an interactive market simulation and accordingly entailed batch processing. This meant turnaround speeds were determined by the swiftness at which the slowest team in the industry submitted a usable decision input which robbed the DL situation of its often-cited self-paced learning.

In the on-campus group the use of the simulation produced relatively weaker relationships between simulation use and course-related learning. For the DL group, it appears the simulation was an important factor in the learning equation. However, an important insight is that if students do not possess computer fluency, strong technical assistance must be provided. This leads us to highlight the role the instructor plays in creating an optimal learning environment as well as indicating how different approaches to teaching the same material may bring about different learning results.

Variable	DL Group		On-Campus Group		Z	p-value
	Mean	S.D.	Mean	S.D.		
Course Evaluation	5.35	0.68	5.12	0.43	1.69	0.1124
Simulation Evaluation	4.95	0.79	5.10	0.51	1.05	0.2996

Table 6. Means and Standard Deviations (S.D.), Z values and p-values of Responses for the DL and On-Campus Groups.

We note that we have not studied the role of within-team variances in participant aptitude, academic achievement and simulation technical knowledge, as we leave that for future research. The role of team cohesion as a precursor of high simulation performance has been cited and studied in the business simulation literature (Wolfe et al, 2002). An element in a firm's cohesion is the degree of homogeneity or similarity that can be found amongst its members. Thus, it would be ideal for team members to have a high average level of simulation technical knowledge; yet, this level of knowledge should to be at the individual level so that they could all be more-equal decision making partners. This is usually the case for DL groups, where team standard deviations in work experience, academic achievement and simulation technical knowledge are significantly correlated. We suggest an extensive study of this topic, as well as other learning effects produced by simulations. For example, comparing different kinds of DL: (a) DL without video and audio support, (b) DL with audio support, and (c) DL with video/audio support. It would also be interesting to consider alternative lenses such as task technology fit to view this and subsequent cases through. Research into the advantages and disadvantages of this type of learning could offer more detailed insights and is clearly warranted as DL becomes more and more popular in education.

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Appendix

Game Evaluation.

The following questions relate to the business game evaluation and the quality of the learning experience. Please indicate your answers:

		Disagree			Neutral	Agree		
1.	I am now more familiar with the terminology and the technical vocabulary of the business discipline.	1	2	3	4	5	6	7
2.	The course made me understand theories, models and structures associated with the business discipline.	1	2	3	4	5	6	7
3.	I learned how to use different methods, techniques and algorithms.	1	2	3	4	5	6	7
4.	What I learned in class can help me create “new knowledge” (e.g., generate hypotheses and be able to test them)	1	2	3	4	5	6	7
5.	The course method made me feel greater control over the learning experience.	1	2	3	4	5	6	7
6.	I am satisfied with the instructor’s role in the course	1	2	3	4	5	6	7
7.	I am satisfied with the quality of feedback received from the game instructor	1	2	3	4	5	6	7
8.	I experienced several interface problems during the game.	1	2	3	4	5	6	7