Student Perceptions of the Effectiveness System Dynamics-based Interactive Learning Environments: a Case Study

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Abstract: The aim of this article are (i) to describe the construction and the integration of an interactive learning environment in two educational settings, and (ii) to explore how undergraduate business students perceive SDILEs and SDILEs-based course approach. This research draws on data, 78 valid respondents, obtained from courses in undergraduate business program. Results of this study suggest that students enrolled in a SDILE-based course do indeed perceive important learning benefits and educational value. However, there is a need for additional resources to be developed and deployed to harness fully the benefits of experiential learning provided through SDILE-integrated course approach.

Keywords: System dynamics, simulations, ILEs, classroom, action research

Introduction

In essence, Simulations in general and computer simulation-based interactive learning environments (ILEs) in particular are developed and used to improve people's decision making in the context of the dynamic complexity of business settings by facilitating user learning [2, 15, 19, 21]. People learn from experience. Learning is the process whereby knowledge is constructed by the transformation of experience [13]. Simulations in general and ILEs in particular are one form of experiential learning. In an ILE session subjects make a series of decisions and have access to the instantaneous feedback. Subjects also have the opportunity to evaluate and reflect on their performance in the after-the-simulation debriefing session. Despite the promising potential and an increasing interest, ILEs benefit to the learning process in the classroom has rarely been investigated empirically.

From a methodological point of view, this study draws on data gathered based on action research in authentic educational settings [22].

1. SDILEs and Learning with SDILEs

1.1 Background Concepts

We use "ILEs" as a term sufficiently general to include microworlds, management flight simulators, DSS, learning laboratories, and any other computer simulation-based environments – the domain of these terms is all forms of action for the facilitation of learning in complex, dynamic environments. An ILE consists of three components (i) a computer simulation model to adequately represent the domain [4, 12, 14], (ii) a user interface capable of allowing the decision makers to make decisions and access the

feedback on interactive basis, and (iii) a human coach responsible for conducting briefing and debriefing sessions [4, 5, 16]. When an ILE's underlying simulation model is based on system dynamics methodology [8] we call that ILE as SDILE. Some popular SDILEs are People Express [25], FishBankILE [20], and Healthcare Microworld [20].

1.2 Learning with SDILEs

Learning about complex, dynamic tasks does not happen easily. There are some fundamental barriers to developing expertise in dynamic tasks: (1) *dynamic complexity*: our limited ability to understand the impact of time delays between our actions and their consequences coupled with the interactions between feedback loops that are multiple and non-linear in character and are ever present in most of the real world managerial tasks, (2) *information availability and quality limitations*: information we estimate, receive, and communicate is often oversimplified, distorted, delayed, biased, and ambiguous, (3) *information processing limitations*: when it comes to decision making people generally adopt an event-based, open-loop view of causality, ignore feedback processes, perceive flawed cognitive maps of the causal structure of the systems, fall prey to judgmental errors and biases, defensive routines [24].

1.2.1 Learning and Decision Support through System Dynamics Simulation Model

The core of SDILE is a system dynamics based simulation model [8]. System dynamics based models have strengths to map (i) the multiple stakeholders' interests, (ii) available but limited resources, and (iii) decisions at different levels in the organization—a general characterization of the most of the task systems e.g., health care system, education system, energy system etc. The significance of the modeling capabilities of this methodology lies in its contribution to our understanding of the structure and behavior of task systems [23].

1.2.2 Learning and Decision Support y through the User Interface Design

For effective decision making in complex, dynamic tasks, decisions makers must acquire some reasonably precise notions of relationships among key task variables and develop an understanding of the most influential delays and feedback loops in the task system [6]. System dynamics methodology provides powerful tools like causal loop diagrams and stock and flow structures, to represent qualitatively the link between structure and behavior of the task (for excellent illustrations please see [3]).

1.2.3 Learning and decision support through human support

In an SDILE session, decisional aids can be provided at three levels: pre-task, in-task, and post-task levels. Pre-task level decisional aids can be conceptualized as information provided by the human tutor to a decision maker regarding the model of the task prior to performing the task [5, 9]. In-task decisional aids attempt to improve the individuals' decision-making performance by (i) making the task goals explicit at early stages of learning, (ii) helping them keep track of goals during the task, and (iii) providing them with diagnostic information. Post-task level decisional aids aim at improving performance by providing the decision-makers an opportunity to reflect on their experiences with task [4, 5].

2. Method

This study draws on data gathered through action experiments in authentic educational settings [1, 13, 22]. Data captured by the FishBankILE program, and questionnaire and qualitative data obtained in these settings serve the purpose to explore whether the integration of SDILEs in classroom settings generates learning benefits. Data collection occurred between March 2006 and March 2007.

2.1 Measurements

Subjects' task performance (TP) was measured by the cumulative profits made by each team over a period of 30 years plus the remaining resource (fish) value in the final year. TP was automatically recorded by a programmed module of FishBankILE. To explore the perceived value of SDILEs, a questionnaire was adopted from Romme's work on the evaluation of the learning benefits of microworld simulation [21].

3. Results

A total of 33 students out of 36 students who took the undergraduate junior level course responded with completed questionnaires. Consequently, the data of only these 33 is stored and used in this study. The response rate for the undergraduate senior level is 96%. The responses from both groups are summarized in Table 1.

Table 1: Perceived values by juniors and seniors

	Juniors (n = 33)		Seniors (n = 45)		Difference between seniors and juniors
	Mean	SD	Mean	SD	Mann-Whitney (significance)
Using FishBankILE is					
1. fun	3.12	0.76	3.56	0.85	-1.155 (0.248)
2. pleasant	3.15	0.77	3.18	0.42	-1.964 (0.050)
3. exciting	3.10	0.86	3.12	0.41	-1.089 (0.978)
4. enjoyable	3.10	0.81	3.26	0.56	-1.000 (0.317)
5. is easy to use	4.10	0.66	4.66	0.72	-1.481 (0.139)
The SDILE, FishBankILE					
has well written user manual	3.66	0.56	3.87	0.80	-1.225 (0.221)
7. has user-friendly interface	3.80	0.66	3.96	0.80	-0.980 (0.327)
8. represents real business situation	2.98	0.46	2.90	0.44	-1.112 (0.266)
The information system					
9. has effective on-line help	4.10	0.66	4.23	0.34	-1.582 (0.114)
10. provides immediate & useful feedback	3.66	0.64	3.88	0.80	-0.671 (0.502)
The assignments related to FishBankILE were					
11. clear and relevant	3.68	0.44	3.98	0.56	-1.149 (0.250)
12. interesting	3.86	0.72	3.88	0.80	-0.872 (0.383)
We collaborated successfully by					

13. sharing ideas	3.12	0.44	3.88	0.56	0.000 (1.000)
14. appreciating ideas of fellow team members	3.10	0.51	3.97	0.66	-0.592 (0.554)
15. crafting decision strategy by consensus	3.55	0.62	3.78	0.44	-1.155 (0.248)
Feedback by the instructor at					
16. pre-task level was useful and aroused my interest	3.44	0.71	3.56	0.56	-2.309 (0.021)
17. in-task level was useful	3.02	0.45	3.24	0.80	-1.549 (0.121)
18. debriefing was very useful	3.44	0.44	3.66	0.52	-1.225 (0.221)
Overall, the SDILE course approach					
19. is more interesting than traditional textbook learning	3.88	0.44	4.12	0.46	-0.592 (0.545)
20. is more exciting than traditional textbook learning	3.91	0.61	4.06	0.44	-1.155 (0.248)
21. is more innovative than traditional textbook learning	4.01	0.45	4.22	0.66	-2.449 (0.014)
22. adds value for learning	4.22	0.56	4.44	0.46	-0.218 (0.827)
23. has my strong recommendations	4.20	0.76	3.45	0.66	-1.732 (0.083)
24. adds value relative to real world experience	3.61	0.66	4.34	0.46	-0.289 (0.773)

Subjects' actual task performance (TP) in the simulation task, FishBankILE, is given in Table 2.

Table 2: Actual task performance by teams of juniors and seniors

	Juniors (n = 71)	Seniors (n = 52)	Difference between seniors and juniors
TP	-0.65 (0.43)	-0.39 (0.33)	p= 0.009

TP = 0 means that the team's performance is equal to the bench mark. Standard deviation values are given in parenthesis.

4. Discussion and Conclusions

Although the majority of university classrooms are still dominated by traditional teaching methods such as lectures and discussions, the use of computer simulations in instruction is on the rise [7, 11, 15]. The widespread use of computer simulation based learning environments is concomitant with increasing attention to experiential learning methods.

The results described in the previous section also suggest that to accrue the learning benefits from a SDILE-based course a number of resources have to be crated and provided. These resources include a well-written and self-explanatory user manual, a user-friendly interface with easy-to-use help and information systems, a related business case based simulation model, relevant simulation assignments that motivate students to design and test their decision strategies in the simulated environment, and effective feedback at all levels i.e., pre-task, in-task, and post-task level, by the facilitator. Other studies have reported similar observations that reinforce the need for these resources [11, 17].

The difference with regard to perception of use of FishBankILE as a pleasant experience can be explained in terms of the background education course work. Senior

students have accumulated substantial business knowledge through a variety of courses, case studies, project work and internships. By itself, this is sufficient incentive for college/ university administrators and faculty to continue to emphasize the integration of simulation technology into most facets of postsecondary education.

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