

Evaluating Student Learning Through Problem-Based Learning Using an ERP Simulation Game

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ABSTRACT

Companies worldwide use Enterprise Resource Planning (ERP) systems to effectively manage business processes across organizational departments and information among global subsidiaries. Many colleges and universities have incorporated ERP systems into their CIS curricula to provide students with a better understanding of business process theory and information sharing concepts. For years we have used various SAP tools at our university to help students with these theories, and more recently the SAP ERP simulation game (ERPsim) to provide students with a live, competitive interactive experience. However, we have never measured student learning or satisfaction in courses where we use the ERP simulation game.

To address this, using a Problem-based Learning (PBL) approach and the ERP simulation game, we have developed a survey instrument that will help us ascertain if our methodology enables students to (a) enhance their knowledge of enterprise systems and integrated business processes; (b) enhance data analysis and decision-making skills; (c) develop effective problem-solving skills; (d) become intrinsically motivated to learn; (e) enhance team collaboration and communication skills; and (f) prepare for cross-functional, multidisciplinary challenges in their professional career.

INTRODUCTION

Students educated for the 21st century must develop habits of critical thinking, researching, and problem solving to succeed in an increasingly technical and complex world. The IT Industry is requiring more from our students than theory, knowledge, and application. Our graduates must be able to think critically on complex, unstructured problems, work effectively in interdisciplinary teams, communicate with stakeholders and peers, and be self-directed learners in order to cope with rapid changes [16]. As educators, we are faced with the dilemma of how to enable deep learning in the subject matter but also provide an environment for learning that enables the above characteristics while keeping the student motivated to learn. Problem-based Learning (PBL) with the use of a live simulation game is an instructional approach that may provide the solution.

Educating undergraduate Computer Information Systems (CIS) students is challenging in today's environment. In addition to technology skills (i.e., software engineering, database, and programming), CIS students should possess a hands-on, working knowledge of integrated business processes, enterprise systems, and data analytics. These students must be able to make business-related decisions in real-life situations where the solution is often not obvious and highly complex [3], [9]. Providing this type of education in a CIS curriculum is a challenge especially when most students have no exposure to *integrated* business processes either in the business curriculum or through personal work experience. In the undergraduate CIS curriculum at our university, we developed a Foundations of Information Systems and Enterprise Systems courses that apply a PBL learning approach using a live Enterprise Resource Planning (ERP) business simulation game called ERPsim, which was developed by HEC Montréal, a Canadian university. To evaluate our approach, we developed a study to investigate how effective this instructional approach is in the undergraduate CIS curriculum.

The goals of this study are to determine if using PBL and the ERP simulation game enable students to: (a) enhance their knowledge of enterprise systems and integrated business processes, (b) enhance data analysis and decision-making skills, (c) develop effective problem-solving skills, (d) become intrinsically motivated to learn, (e) enhance team collaboration and communication skills, and (f) prepare for cross-functional, multidisciplinary challenges in their professional career. To that end, a student survey is being conducted to assess the goals of the study. In this paper we describe how we implemented the PBL/ERP simulator approach in the classroom, our research on the subjects, and our survey instrument development. Study results will be presented after one year of data collection.

RESEARCH

PBL is an active approach to learning in which learners collaborate in understanding and solving complex, ill-structured problems [1], [15]. It is an instructional learner-centered approach that empowers students to think critically, to analyze and solve complex real-world problems, to find, evaluate and use appropriate learning resources, to work cooperatively, to demonstrate effective communication skills and to use content knowledge and intellectual skills to become life-long learners [7]. Critical to the success of the approach is the selection of ill-structured problems (often interdisciplinary) and a tutor who guides the learning process and conducts a thorough debriefing at the conclusion of the learning experience [6], [15].

Since PBL's conception in medical education nearly 50 years ago, it has been used in a variety of settings from middle school, higher education, and professional education. From a literature review, there have been studies on PBL in computer science education mostly in the area of pedagogy. Studies of students' actual engagement with the PBL process remains an open area for research in CS contexts. Likewise, issues pertaining to the overall goals of a CS PBL course, and the degree to which these met teamwork, and student motivation are still areas for research [13]. O'Grady [13] identified four outstanding knowledge areas where the harnessing of PBL is still outstanding; Computational Science, Social and Professional Issues, Information

Management, and Graphics and Visual Computing. Finally, the authors found that PBL has not been systematically assessed in CIS curricula, particularly in the use of an ERP simulation game. One of the challenges of teaching PBL is the development of an engaging ‘problem’ for the PBL scenario. The ERP simulation game is an excellent vehicle to deliver PBL instruction for it is based on a PBL approach.

ERPsim is an ERP teaching-learning software program which uses a live production SAP ERP to teach ERP concepts, integrated business processes, critical thinking, teamwork, data analytics and more. ERPsim simulates a real-world marketplace in which virtual companies can operate using a commercial version of the SAP ERP software [11]. Students must operate the full cash-to-cash business cycle where they must plan, procure, produce, and sell their products. They operate their business using a real-life ERP system which is used by the world’s largest companies. In order to be profitable, students must analyze real-time organizational data using reports in the ERP systems and data visualization applications such SAP Cloud Analytics and Tableau. The Open Data (OData) protocol is also supported. The ERPsim game simulates customer behavior for the market, administrative tasks (strategic and tactical decisions are left to the students), and the passage of time. In addition, ERPsim was designed to support a rich and representative manufacturing context typical for a medium-sized organization.

In the ERPsim, a business day is one minute, forcing learners to focus on making the best decisions in the most efficient way possible. As the simulation evolves, students need to find ways to elevate their knowledge of the ERP system and might come up with solutions to improve their decision making (for example, by creating data visualizations to support their decision model). As other teams of students do the same, the game becomes increasingly competitive, expanding knowledge even further [12]. Because pedagogical evidences suggest that ERPsim improves students’ learning performance in IS courses [11], [17], [5], we intend to survey students after extensively using this simulator so that we may obtain first-hand data related to student perceptions of the simulation game, team dynamics, motivation, the PBL learning approach, and course outcomes.

ERP Simulation Game Overview

The ERP simulation game (ERPsim) is a business game played by teams of three to five players. Each team runs a make-to-stock cereal company and competes with other teams. Teams have to plan, procure raw materials, schedule production, and market their products. To perform these tasks, participants must be able to use an ERP system, SAP, to support decision making. To be successful in the game (i.e. to maximize profits), participants must not only be able to interact with an SAP ERP, but must also be able to collaborate as a team, understand integrated business processes, and implement the best possible business decisions based on real-time organizational data [4].

The ERP simulation game is an innovative “learn-by-doing” approach where students are given a minimal instruction to start playing the game and learning the SAP ERP system. The main idea is to give enough information so learners can start exploring on their own. Participants are given a scaffold on which they can rely on which

eliminates the need for continuous help from the instructor [2]. In the ERP simulator world, scaffolding comes in the form of a well-designed job aid that students can refer to in order to get the job done quickly and simply. Learning takes place as students actually engage in the simulation and find solutions to problems they encounter [4]. Figure 1 below illustrates the integrated business processes in the Manufacturing Introduction game along with the dynamic big data environment.



Figure 1. ERPsim Manufacturing Introduction Game Environment. [12]

The simulation game is played in ‘Rounds’ to simplify the learning curve. First, in Round 1, students learn to market and sell their cereal products with a fixed amount of inventory. In Round 2, we add production to sales and distribution. Finally, planning and purchasing functions are added in Round 3 so that the entire business cycle is experienced. Each Round is normally 20 minutes where a minute represents a business day (20 business days/month). During the game each student takes on a role in the company such a Pricing Manager, Marketing Manager, Production Manager, Planning and Purchasing Manager or Data Analyst. Students are encouraged to change roles each time the game is played. At all times during the game, students use standardized and customized ERP reports to analyze real-time company data to make business decisions to ensure profitability of their operations. Students have the choice to use internal ERP reports which are tabular in nature or graphic data visualizations built using SAP Cloud Analytics or Tableau.

To be successful, teams must establish a sustainable cycle of procurement, production and sales that generates enough cash to cover fixed costs. As this cycle continues to repeat, students see the real value in this real-life simulation, needing to understand all aspects of a business from sales, to accounting to procurement, fulfillment, production, warehousing and distribution [12].

During the class, the students experience at least three complete games. There are normally two practice games and then a final game with rewards for winning the team. The winning team gets a 5-point bonus on their ERPsim Game Report. In order to qualitatively assess our students on the course outcomes, we require each student to reflect on their marketing, pricing, production and planning strategies, lessons learned along with their data analysis in a written report due at the end of the course.

ERP Technology as Platform for Enactive Learning of Business Intelligence Concepts

Labonte-LeMoyné [10] pointed out that in 2012, the Business Intelligence (BI) version of the ERPsim game was developed to allow quasi real-time data analytics. It relied on an extract, transfer and load (ETL) to provide updated data at the end of each virtual day. The extracted data was stored in a Microsoft SQL database. Then by using Microsoft Excel, students are able to extract views from database and refresh these views every minute. This approach was a bit cumbersome, but now SAP has developed HANA, a real-time in-memory database that enables real-time analytics on raw transactional data. Instead of using an ETL approach, where data used for analysis are available after the ETL process is completed, analysis can be performed directly on transactional data. Visualization tools, such as SAP Analytics Cloud can then be used to visualize the data and support the decision-making process during the simulation. Labonte-LeMoyné [10] also mentioned that as of 2015, more than 1,000 instructors have been trained to use ERPsim for teaching in more than 220 universities and colleges worldwide. Arguably, with this growth rate, ERPsim appears to be an excellent teaching tool, but we want to better understand the student experience, and thus this study.

METHODOLOGY: Instrument Development

To test our hypotheses, a survey instrument was developed based upon prior experience and research findings in the literature. We focused on two major areas, enjoyment and learning outcomes.

Enjoyment can be measured in many ways. Fu, Su, and Yu [8] developed a scale consisting of eight dimensions: Immersion, social interaction, challenge, goal clarity, feedback, concentration, control, and knowledge improvement. In modeling our questions based on their scale, we will be able to better evaluate student enjoyment. We feel this is important because these authors [8] believe that “the learner’s enjoyment acts as a catalyst to encourage his/her learning initiative.”

Learning outcomes can may be measured in several ways, however we focused on a grid developed by MIT professor Lori Breslow, et al., in 2007 that provides a way to categorize surveys of student attitudes when asking for reflections on their learning. As Rajkumar et al. [14] pointed out, learning outcomes can be measured with direct and indirect assessment methods. We followed the direct route similar to Rajkumar [14], developing a survey using a 5-point Likert-type scale with 31 questions.

Students will rate using the following:

1 - Strongly disagree, 2 - Disagree, 3 - Neither agree nor disagree, 4 - Agree, 5 - Strongly agree

The following survey questions will be administered anonymously by using Survey Monkey. Questions and methods have been approved by the Institutional Review Board (IRB)

Demographic

1. Age in years: (18-25) (25-35) (36-45) (46-55) (> 55)
2. Gender: (Male, Female, Other)
3. Course enrolled in (CIS 300, CIS 464)
4. Major: (CIS, Business)
5. Any previous experience working with SAP ERP? (Y, N)

After playing the ERPsim game in the class, rate your experience.

6. I feel that I have learned how to create, execute, and adapt a business strategy in a real-time environment.
7. I was able to learn from my mistakes quickly.
8. I was able to determine changes to our business strategy based on the results from the ERP simulation game.
9. The ERP simulation game gave me exposure to the real-world business problems.
10. The ERP simulation game helped me understand how an ERP can improve the business operations.
11. I feel I have gained a hands-on understanding of the concepts underlying ERP systems.
12. I feel I understand the flow of information from beginning to end in a typical organization using an ERP system.
13. I learned about the integration of business processes as a result of the ERP simulation game.
14. I was able to use real-time financial and operational data from the ERP simulation game to make informed business decisions.
15. The ERP simulation game increased my motivation to learn ERP systems.
16. The ERP simulation game increased my motivation to learn integrated business processes.
17. The ERP simulation game increased my motivation to learn data analysis techniques to make better informed business decisions.
18. The competitive nature of the ERPsim game motivated me to learn.
19. I felt it was an effective way to learn about an ERP system.
20. I felt it was a convenient way to learn about an ERP system.
21. I felt comfortable using it as a learning tool.
22. I found it intuitive to play the ERP simulation game.
23. Learning about ERP systems using the simulation game is more exciting than traditional teaching methods.
24. Team members help one another deal with problems or resolve issues.
25. Team members seek and give each other constructive feedback.
26. Team members are encouraged to express different points of view.
27. Team members willingly take on new responsibilities.
28. Team members follow through on decisions and action items.

Open-Ended Questions

29. What are the best aspects of the ERP simulation game?
30. What are the most challenging aspects of the ERP simulation game?
31. What recommendations do you have for improving the experience and administration of the ERP simulation game?

CONCLUSION AND RECOMMENDATIONS

Just like pilots use real-time simulators, without real-world practice, it can be a challenge for CIS students or even employees to understand integrated business processes and enterprise software usage. This study will examine how a PBL learning approach using an ERP simulator enhances student learning in a CIS course. We anticipate that the findings will reveal the effects of two important IS constructs, 1) enjoyment and 2) learning outcomes during students' involvement with ERPsim. We believe that this study will provide evidence that the SAP ERPsim game wrapped within a Problem-based Learning approach is an effective way to learn integrated business processes and ERP systems.

Note: To use the ERPsim simulation game, an instructor's institution needs to be a member of the SAP University Alliance. Information about how to become a member can be found at <http://scn.sap.com/docs/DOC-7876>. Because the games are complex, instructors must become certified through training at the HEC Montreal ERPsim Lab or other venues, ultimately taking a certification exam. Information regarding this can be found at <http://erpsim.ca> or by emailing erpsim@hec.ca. Finally, licenses for learning materials must be purchased to run the Manufacturing and Logistics Games while the Distribution Game is free.

REFERENCES

- [1] Barrows, H.S. *Problem-Based Learning Applied to Medical Education*, Southern Illinois University Press, Springfield, (2000)
- [2] Chen, L., Keys, A., Gaber, D. How Does ERPsim Influence Students' Perceived Learning Outcomes in an Information Systems Course? An Empirical Study. *Journal of Information Systems Education*, Vol. 26(2) Spring (2015)
- [3] Connolly, T, Stansfield, M. Using Games-Based eLearning Technologies in Overcoming Difficulties in Teaching Information Systems. *Journal of Information Technology Education*, Vol. 5, (2006)
- [4] Cronan, T.P., Léger, P., Jacques, R., Babin, G., Comparing Objective Measures and Perceptions of Cognitive Learning in an ERP Simulation Game: A Research Note. *Simulations & Gaming*, (2012).
- [5] Cronan, T. P. & Douglas, D. E. A Student Simulations Game: A Longitudinal Study. *Journal of Computer Information Systems*, 53(1), 3-13, (2012)

- [6] Dolog, P., Thomsen, L.T., Thomsen, B. Assessing Problem-based Learning in a Software Engineering Curriculum using Bloom's Taxonomy and the IEEE Software Engineering Body of Knowledge. *ACM Transactions On Computing Education*, 16,3, Article 9, 41 pages, (2016)
- [7] Duch, B. J., Groh, S.E., & Allen, D.E. Why Problem-based Learning? A Case Study of Institutional Change in Undergraduate Education. In B. Duch, S. Groh & D. Allen (Eds.). *The Power of Problem-based Learning*, Sterling, VA:Stylus, 2001, pp.3-11, (2001)
- [8] Fu, F., Su, R. and Yu, S. EGameFlow: A Scale to Measure Learners' Enjoyment of e-Learning Games. *Computer & Education*, v52, p101-112, (2009)
- [9] Hung, W., & Loyens, S. M. M. Global Development of Problem-based Learning: Adoption, Adaption, and Advancement. *The Interdisciplinary Journal of Problem-based Learning*, 6(1), 4-9, (2012)
- [10] Labonte-LeMoine, E., Léger, P.-M., Robert, J., Babin, G., Charland, P., Michon, J.-F. Business Intelligence Serious Game Participatory Development: Lessons from ERPsim for Big Data, *Business Process Management Journal*, Vol. 23 Issue: 3, pp.493-505, <https://doi.org/10.1108/BPMJ-12-2015-0177>, (2017)
- [11] Léger, P.-M. Using a Simulation Game Approach to Teach Enterprise Resource Planning Concepts, *Journal of Information Systems Education* (17:4), pp. 441-448, (2006)
- [12] Léger et al. Participants Guide, Manufacturing Game, ERPsim Lab, HEC Montréal, (2017)
- [13] O'Grady, M. J. Practical Problem-based Learning in Computing Education. *ACM Transactions on Computing Education*. 12,3, Article 10, (2012)
- [14] Rajkumar, T. M., Anderson, P., Benamati, J., & Merhout, J. W. Are Student Self-Assessments a Valid Proxy for Direct Assessments in Efforts to Improve Information Systems Courses and Programs? An Empirical Study. *Communications of the Association for Information Systems*, 28(31), 537-548, (2011)
- [15] Savery, J. Overview of Problem-based Learning: Definitions and Distinctions. *Interdisciplinary Journal of Problem-Based Learning*, 1(1), (2006)
- [16] Savin-Baden, M. Using Problem-based Learning: New Constellations for the 21st Century. *Journal on Excellence in College Teaching*, 25(3&4), (2014)
- [17] Seethamraju, R. Enhancing Student Learning of Enterprise Integration and

Business Process Orientation through an ERP Business Simulation Game. *Journal of Information Systems Education*, 22(1), 19-29, (2008)