Using a Paper-Based Supply Chain Game to Enhance Student Learning with Enterprise Software

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Introduction

One particular method of educating students on business processes is through the use of computerized simulations [1]. Research suggests that the 18 to 22-year-old higher education student demographic from Generation Z, born 1995 to 2012 [2], gravitates to activity-based learning that merges theory with some type of immediate gratification [3]. Further, literature suggests that students appear to learn best when using technology that allows them to actively develop knowledge through a combination of experience, structured interaction, and interpretation [4]. Simulations are a complex type of active learning, and when used in higher education, the goal for the instructor is to create the right balance and synergy between course pedagogy and students to affect engagement [5].

In the pedagogical sense, simulations may also be seen as a form of Problem Based Learning (PBL) due to requirements for discovery, versus prescription of knowledge [6]. PBL typically begins with presentation of a problem followed by instructor interaction to lead students to “discover” course concepts and knowledge as they work to solve the problem. The goal is a richer and longer-lasting learning experience than a lecture-based approach. Use of PBL helps students experience realistic cases and not just theoretical scenarios, forcing them to define problems and make proper decisions [7]. This approach shows strong support for a pedagogy’s positive impact on student attitude, being more nurturing and enjoyable than traditional means [9]. In summary, PBL advantages include: 1) increased motivation, 2) enhanced learning, retention, and recall, and 3) development of problem solving and self-directed learning abilities [8], [9].

A research area identified focuses on how higher education has had to identify pedagogical advances in ways of teaching concepts and processes related to enterprise resource management (ERP) systems [9]. Cronan and Douglas [10] stated that a challenge exists for instructors to teach, and students to learn, business processes through means engaging live commercial software environments, since students often lack knowledge of real-world business processes [11]. The term “business process” for this paper is defined as a series of steps undertaken by non-direct-labor staff to produce an output, typically a business-related transaction or document. Previous research indicated that introducing concepts before the engagement of hands-on exercises or cases with software has been thoroughly under-addressed [6]. This gap has been identified as being critical to student development since students need to have a basic understanding of business processes and their cross-functional nature before then can fully understand and gain knowledge from hands-on experience [6], [12]. Literature suggests the following key principles and success factors for using simulations in business management related courses: [13]

1. Develop students’ understanding of business process complexity and dynamics
2. Utilize decision making in different, challenging situations in a time-based environment

3. Allow students to experience cross-functional information sharing in a silo-based structure
4. Measure performance against benchmarks and peers

The purpose of this paper is to show the effectiveness of using a paper-based supply chain simulation as an introductory tool for teaching fundamental business processes as a foundation for coursework utilizing software to teach ERP and related information technology concepts.

Background

As ERP software continues to expand into the business world, employers and higher education institutes must adapt training of employees and students to meet this challenge [14]. Many Fortune 1000 organizations have adopted ERP into their organizational operations, which in turn has kick-started the evaluation and redesign of business processes [6], [9], [14]. Consequently, the demand for graduates who have hands-on experience with ERP software has increased significantly [14]. More so, graduates who have completed ERP coursework have seen a nearly a \$4,000 higher average salary than their peers who have no ERP experience [10]. This is comparable to previous research that has shown career success regarding salaries and promotions for students related to performance on simulations [8].

An effective set of simulations to develop student knowledge of business process and ERP systems has been developed by the ERPSim Lab at HEC Montreal <https://erpsim.hec.ca/en>. The ERPSim Lab has a suite of business simulations using a live SAP ERP software environment accessed through the SAP University Alliance (UA). The SAP UA has over 3,200 member institutions worldwide from over 110 different countries; more than 130 universities across 16 countries have incorporated the ERPSim Lab's innovative teaching tools [8]. As an introductory tool, the ERPSim Lab also developed a manual (non-software based) "*paper game*" to introduce business processes and concepts to students before engagement with the more complex software based simulations.

The *paper game* uses sheets of paper as a raw material to produce a product within a simple three-tier supply chain. Students manage the manufacturing company at the center of the chain, with a single downstream customer and single upstream supplier, managing functional areas of sales, materials management (purchasing and logistics), manufacturing, and accounting. For PBL and active learning, students are placed into teams of four, with each assigned to a functional management role. The simulation is played on a virtual week-by-week basis, repeating a series of steps that also incorporate the materials requirement planning (MRP) heuristic:

1. Raw materials are received (MRP recognizes receipts at the start of a time bucket)
2. Finished goods market price determined
3. Sales order created: initiates production\consumption of raw materials within time bucket
4. Delivery of finished goods; customer invoice generated
5. Customer payment received for shipments two time buckets prior
6. Raw material market price determined
7. Purchase order for raw material created (based on ending inventory at end of time bucket)

The game is played over 10 rounds, each equal to a simulated week. Each “week” generally takes ten minutes at the start of the game, reducing to about 5 minutes as students progress up a learning curve. The game is played over several class hours with pauses to reinforce teaching concepts. Teams are provided templates to create business documents onto post-it notes. External documents such as purchase orders and invoices are written and placed onto large (customer or supplier) game boards to track activity. Sales orders, as internal documents, are passed from sales to manufacturing to accounting as the primary communication tool. The instructor uses playing cards to determine random weekly market sales prices and raw material cost, and also generates post-it notes to represent customer payment. In support of this study, an Excel spreadsheet, shown in Figure 1, is provided and each functional manager asked to keep track of information as the game is played.

Sales	Week	1	2	3	4	5	6	7	8	9	10	Total	Ave
Market Price													
Units Sold													
Revenue (total sale)													
										Average Selling Price			

Purchasing	Week	1	2	3	4	5	6	7	8	9	10	Total	Ave
Market Cost for a Sheet of Paper													
Purchase Quantity													
Total Expense													
										Average Material Cost per FG			
										Average Profit per Finished Good			

Manufacturing	Week	1	2	3	4	5	6	7	8	9	10	Total	Ave
Production (sections of paper cut)													
Ending Inventory (finished units)													

Accounting	Week	1	2	3	4	5	6	7	8	9	10	Total
Invoice to Customer												
Invoice from Supplier												
Cash on Hand	10											
Income Statement												
Revenue												
Purchasing Expense												
Net Income (Profit)												

Figure 1. *Paper Game* Manual Data Tracking Spreadsheet

Raw material is a blank sheet of paper and the manufacturing process is a pair of scissors used to cut the paper into six sections. Teams may sell as many finished goods as they can produce and have on-hand in inventory. Raw material may be purchased but only in limited quantity, and only if they have enough cash on hand to pay the supplier’s invoice when due. Students place post-it note invoices onto the current week in the customer game board, and collect payment from the board two weeks later. Purchase orders (PO) post-it notes are placed on the supplier game board, a post-it note payment is placed over top of the PO the following week as the materials manager receives the sheet(s) of paper purchased. Accounting writes all invoices and supplier payments, and must track cash-on-hand.

At the midway point in the simulation, the game takes a time-out as teams are asked to analyze information they (should) have been collecting. Requested analysis includes averages on sales

price per case, weekly demand, and average raw material cost. Teams are also asked to identify their current finished goods inventory, accounts payable, accounts receivable, and profit. Averages are to be calculated, with teams encouraged to think about how averages may be used to forecast for the balance of the game. The intent of this break is for students to appreciate how businesses need to collect information in order to make decisions.

The second half of the simulation continues like the first half with the exception of week 9. During week 9 teams are informed of a supply chain disruption and are not allowed to purchase raw material for the balance of the game. At the end of week 10 students were asked to update the information from week 5 and draw a business process flow chart based on their experience in the simulation. Students are also asked to update their Excel spreadsheets and are not allowed to review any post-it notes that are not at their own workstation. In the post simulation review, which is the most critical learning aspect of the game, the business processes are reviewed to ensure the information flow and transactional concepts are understood. Also, the instructor asks each functional manager to report average market sales price and raw material cost. While this should be the same for each team, empirical evidence shows that it is usually not, providing a segue into discussion on the importance of data accuracy and the value of information technology.

Research Method

The research site was an undergraduate introductory course on ERP systems, intended to expose students to information technology used to manage business processes. The course utilizes a live SAP ERP environment to demonstrate the software and tools used within the distribution channel of a supply chain. Inherent in this is understanding the business processes needed to manage sales, materials, production, and warehousing. The *paper game* is used as an active learning technique within an introductory module during the first two class weeks. The active nature of game also serves as a tool for students to meet and engage with each other, providing a foundation for peer-to-peer assistance throughout the course.

The focus of the study is student self-assessment of knowledge learned after playing the simulation versus the self-assessment prior to playing the simulation. The survey also contained questions regarding student attitudes toward the simulation and instructor. Data was collected via a Qualtrics survey immediately after the post simulation review to limit influence from further coursework. The data collection spanned two academic years, encompassing three class sections during spring 2017, fall 2017, and spring 2018. Students were informed that responses were anonymous and had no impact on their course grade.

Results and Discussion

The total number of survey participants was 48 students. Table 1 summarizes the effectiveness of instructor, simulation, and introduction of business processes. Responses were coded using a Likert scale with 5 representing the high end of the scale, 3 as neutral, and 1 as a negative perception. For instructor effectiveness, over half of all respondents felt the instructor was “extremely effective” on use of the *paper game* simulation. Again, over half the students rated the simulation as “extremely effective” in helping understand business process concepts.

Furthermore, it should also be noted that the highest rated mean (4.68) was observed and lowest standard deviation (0.47) are associated with the simulation's ability to help students understand the business processes.

Overall it seemed that student feedback was relatively consistent and students both liked and found the simulation engaging. In both instances, over 50% of students responded with "like a great deal" and "very engaging" respectively. This is critical due to previous research concluding in order for simulations to be effective, students must both enjoy the simulation as well as find the simulation engaging [6], [10]. Students also stated that they believed the objectives of the simulation were "clear." The importance of instructor effectiveness cannot be downplayed as research has stated that for students to gain max enjoyment and benefits of simulation, they must "buy-in" to the instructor and the instructor's teaching methods [6], [10], [13].

Table 1. Student Perception of Simulation Effectiveness (n=48)

Question	Mean	Median	Std. Dev.
1. Did you like the simulations?	4.43	5.00	0.65
2. Did you find the simulation engaging?	3.87	4.00	0.82
3. Were the simulation objectives clear?	4.09	4.00	0.69
4. Was the instructor effective in using the simulation?	4.35	5.00	1.00
5. Did the simulation help you understand course material?	4.68	5.00	0.47

Table 2 displays descriptive statistics of student self-assessment of understanding terminology and processes before and after participating in the simulation. Responses were coded using a Likert scale with 3 representing "very proficient," 2 as "somewhat," and 1 as "not proficient." Zero represented "no knowledge or understanding" of a concept. Students were very open in their pre-simulation assessment, admitting to being "not proficient" in many of the categories associated with the topics covered in the simulation. The highest rated pre-assessment was regarding sales and distribution terminology with a mean of 1.61, placed squarely between somewhat- and not-proficient. Students self-rated lowest for the "importance of integrated business processes via ERP" at 0.87, which is to be expected as most students were unfamiliar with ERP systems before enrolling in the course.

For the post-simulation self-assessment, all students recorded an increase in ratings. Literature suggests that when conducting self-assessments, students may often view their ability higher than the reality of attainment [15]. Interestingly, this study's results were somewhat muted in this respect. Surprisingly, although perhaps an honest appreciation for what they didn't know, none of the question means observed showed students believing they have achieved "very proficient" status in any category. Over half the class surveyed believed that their abilities firmly rated into being "somewhat proficient." This is interesting as one critique of student self-assessment has been students having higher confidence in their abilities than what may be a reality [6].

Table 2. Descriptive Statistics for Business Concepts (n=48)

Student Proficiency Self-Assessment (knowledge and skills)	Mean		Median		Std. Dev	
	Prior	Post	Prior	Post	Prior	Post
Procurement Terminology	1.22	2.16	1.00	2.00	0.72	0.59
Procurement Business Process	1.43	2.14	1.00	2.00	0.82	0.56
Sales & Distribution Terms	1.57	2.33	2.00	2.00	0.65	0.56
Sales & Distribution Processes	1.61	2.33	2.00	2.00	0.71	0.56
Financial Terminology	1.30	2.24	1.00	2.00	0.75	0.53
Financial Accounting Processes	1.09	2.24	1.00	2.00	0.72	0.75
Importance of integrated business processes via ERP	0.87	2.14	1.00	2.00	0.68	0.64
Interdependencies between procurement, sales, distribution	1.04	2.14	1.00	2.00	0.75	0.64
Ability to analyze integrated information for managerial decision making	1.30	2.14	1.00	2.00	0.69	0.71
Ability to analyze individual employee actions on operation of other functions	1.43	2.33	1.00	2.00	0.82	0.64

Limitations and Conclusion

The primary purpose of this study was to assess whether student knowledge of business processes was expanded during the usage of the *paper game* simulation. Based on feedback given during the self-assessment of surveys, it does appear that this may be the case. Though it appeared that students viewed the simulation as engaging and the instructor effective, it is also worth exploring the self-assessment section of prior- and post-test results. It should not be discounted that while self-perceived knowledge was shown to increase in all areas, this should be expected. Research has shown that learning occurs naturally because of participating in a simulation exercise [8].

That said, this study is a positive for the use of an activity based learning experience to develop a frame of reference for students as they proceed further into ERP concepts. Besides providing building blocks for business terminology and transactional data needed to support an ERP system, the *paper game* also serves as a team building activity. Teamwork and relationships created the *paper game* carried over into the course, and even execution of an end-of-semester SAP based distribution simulation from the ERPsim Lab. This is noteworthy as team composition and skills have been identified as being a critical success factor for ERP system implementations [10].

Another point of interest to observe in limitations would be in regard to the difference of teaching an ERP course with and without using the *paper game* as an introduction, researching significant differences between classes. By obtaining data in this manner, the importance of using the *paper game* as an enhancement may be observed more objectively. A possible method would be to compare the assessment differences between the face-to-face students playing the *paper game* to their online peers in the same course who do not participate in the game before using ERP software. The challenge is to control for the level of potential ERP experience with distance students in either business processes or ERP systems.

Furthermore, while insight was gained, the opportunity to gain further beneficial research using a paper-based supply chain game may be garnered through pairing the self-assessment with an objective measure, such as grade analysis, to truly grasp what the impact of the *paper game*. However, this study gave the researchers insight on the benefits of using a paper-based supply chain game simulation prior to taking 18 – 22 year-old students into an ERP course. Based on the data, students felt more confident after participating in the simulation, enjoyed the simulation itself, and felt that the instructor helped make the simulation effective. These are all essential keys to have a successful immersion into business simulations.

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