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Using a Simulation Game Approach to Teach Enterprise Resource Planning Concepts

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ABSTRACT

This paper proposes an innovative "learning-by-doing" approach for teaching Enterprise Resource Planning (ERP) concepts. Based on turn-based simulation games, students are put in a situation in which they have to run their business with a real-life ERP (mySAP ERP). Using standard reports and the business intelligence module of the ERP, students must analyze these transactional data to make business decisions and ensure the profitability of their operations. The pedagogical objectives of this game are threefold: i) to develop a hands-on understanding of the concepts underlying enterprise systems, ii) to experience the benefits of enterprise integration firsthand, and iii) to develop technical skills at using ERP software. This approach was successfully tested with both undergraduate and graduate business administration students majoring in information technologies in an AACSB school.

Keywords: Enterprise Resource Planning, Business Simulation Game, SAP, Education

1. INTRODUCTION

Teaching the concepts underlying an Enterprise Resource Planning (ERP) system is a difficult task. Many students have very little IT experience to which they can relate these concepts. They may have acquired business experience in one or two functional areas, but many of them have only a limited understanding of the operational aspects supporting the value creation process in modern firms. Moreover, they usually have had no firsthand experience with the functional un-integrated software that the ERP system was designed to replace. For these students, the horizontal integration of the firm, one of the greatest benefits of implementing an ERP system, can be very abstract due to their lack of hands-on experience with legacy systems.

Yet business students are very computer-literate these days. Born after the first personal computers came onto the market, many of them have never experienced life without a keyboard or a mouse. Most of them had not even begun high school when the Internet started its exponential growth in the early 1990s. Therefore, if they get hands-on experience with an ERP system, undergraduate and graduate students can learn the system and its core concepts very quickly.

A number of authors have suggested the use of simulation games as an innovative pedagogical approach to teaching business concepts (Aldrich, 2003; Prensky, 2001). Simulation games replicate, in a simplified manner, the complexity of a real-life environment, giving the participants experience with a particular phenomenon. Simulation games have been widely used in different managerial disciplines such as strategic management, operations management and accounting (e.g., Mitchell, 2004; Sparling, 2002; Springer and Borthick, 2004). Simulations have also been used in the field of IT. For example, Nulden and Scheepers (2002) suggested a learning methodology to guide students through the experience of software development failure and escalation so that they can learn firsthand from this experience. Draijer and Schenk (2004) reported using business simulations in companies to teach ERP-related concepts and best practices. Bodoff and Forster (2005) used an e-market simulation to introduce IT students to market-oriented information systems.

This paper proposes an innovative "learning-by-doing" approach to teaching ERP concepts. Building on the approach proposed by Draijer and Schenk (2004), the article presents a simulation game in which students have to run a business with a real-life ERP (mySAP ERP). Groups of five to six students each operate a firm in a made-to-stock manufacturing supply chain and must interact with suppliers and customers by sending and receiving orders, delivering their products and completing the whole cash-to-cash cycle. A simulation software program and computer-automated script were developed to automate the sales process, so that every firm receives a large number of orders in each quarter of the simulation. Using standard reports and the business intelligence module of the ERP, students analyze these transactions and make business decisions to ensure the profitability of their operations. This business simulation is set to last seven weeks (half a regular semester) and

concludes with one day of business simulation games that replace the regular mid-term exam.

The pedagogical objectives of this game are threefold: i) to develop a hands-on understanding of the concepts underlying enterprise systems, ii) to experience the benefits of enterprise integration firsthand, and iii) to develop technical skill at using ERP software. This approach was successfully tested in an AACSB school (Association to Advance Collegiate Schools of Business), member of the SAP University Alliance[1]. The ERP course was offered to both undergraduate and graduate business administration students majoring in information technologies. The experience elicited much enthusiasm on the part of the students, who became genuinely involved in the game. With very high student ratings in both the undergrad and graduate programs, the SAP Simulation Game was awarded the 2005 academic prize for the best use of technology in teaching in the business school of the author[2].

The aim of this paper is to present an approach to conducting a pedagogical simulation game with an ERP system. While this paper used mySAP ERP as an example of an ERP system, it is our belief that the same approach could be used with another enterprise system. The paper describes the most important aspects of the game in order to help replication of the approach in a classroom.

This paper begins by presenting the supply chain setting and the rules of the proposed business game. The article goes on to present the organizational business processes on which the simulation game is based. Then the specific technologies developed to run the game are presented. The next section presents the seven-week curriculum used to train students to use SAP in order to prepare them for this business simulation. The paper concludes with a discussion of what has been learned to this day and future avenues for this new approach to teaching ERP concepts.

2. DESCRIPTION OF THE SIMULATION GAME

The business game requires between 15 and 30 students distributed among five companies (A to E). Each plant is an independent company fully accountable for its profits and losses. The five student companies are all involved in the manufacturing and distribution of muesli cereals. Each company can have a product line of up to six muesli cereals, each with its own distinct flavor. As shown in Figure 1, there

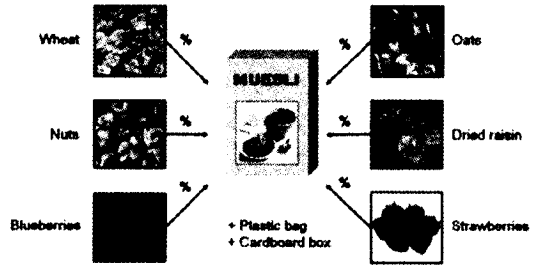


Figure 1: Bill of material

are six different muesli varieties that a manufacturer can choose to produce: Muesli Original, Muesli and Nuts, Muesli and Strawberries, Muesli and Blueberries, Muesli and Raisins and Muesli and Mixed Fruit. Six ingredients are available to produce the different varieties of muesli: wheat flakes, oat, strawberries, blueberries, raisins and nuts. Manufacturers create their own recipes for each of the flavors in their product line. In addition, cardboard boxes and plastic bags are needed to package the cereals. All grains are bought on a spot market.

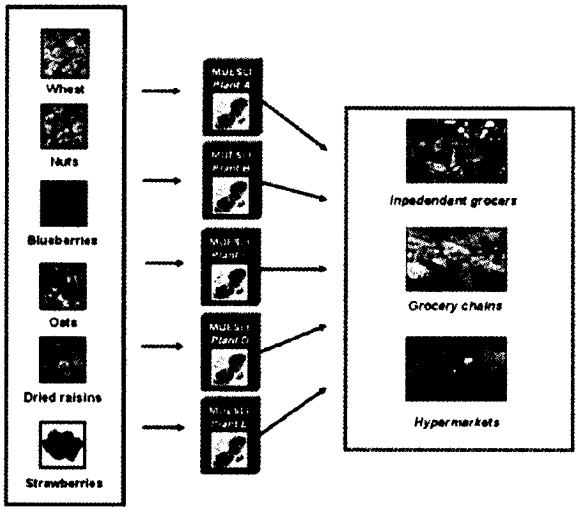


Figure 2: Muesli supply chain

Each commodity is acquired from a specialized commodity trader. The simulation manager manages these traders. Spot prices and information on market trends are published at the beginning of each quarter of the game.

All five muesli manufacturers sell their products in the German agri-food retail industry, composed of 100 retailers. There are three categories of retailers (distribution channels): independent grocers, grocery chains, and hypermarkets. The buying behavior of the retailer is driven by the needs of end customers and may be influenced to various degrees by prices and marketing investments.

Figure 2 summarizes the supply chain. All raw material suppliers and retailers are run by the simulation manager. Students in each plant have to use a real-life Enterprise Resource Planning tool, mySAP ERP, to run their businesses. More specifically, teams use the material management (MM), production planning (PP), sales and distribution (SD), financial accounting (FI), cost accounting (CO) and business intelligence (BW) modules of the application to conduct all their activities.

The simulation has been developed in such a way that participants do not have prior experience with mySAP ERP and do not need to configure the system in advance. The simulation uses a fictional company already configured in SAP: IDES (Internet Demonstration and Evaluation System). This fictional company is generally used to demonstrate the

system to potential SAP customers and to train new users of the software. Each company runs independently on a separate SAP environment (i.e., clients) just as it would in real life. It is almost as if each firm in the simulation has its own personal SAP system.

The simulation is a turn-based game that consists of successive business quarters in which plants receive orders, procure the necessary materials and produce the goods before shipping them to the customer and billing the customer for them. During a given business game, six to eight business cycles should be enough to familiarize students with ERP-based skills and give them a clear understanding of the underlying benefits of business integration. Within each business cycle, each team has to make several business decisions that will influence its profitability. Teams have to decide which market segment they wish to target and determine their pricing strategy and the level of marketing investments. These decisions are uploaded into the simulation software (external to SAP), which determines, based on a market algorithm, the number of orders that each plant will receive. This software generates a script that is imported into SAP, automatically triggering the sales process associated with each order obtained. After every business cycle, students must use the ERP system to analyze their financial situation. By extracting standard SAP reports, they have to calculate their profitability and decide whether their pricing and marketing strategy is optimal or needs to be changed for the next quarter. Finally, teams have to keep track of their cash flow with a standard report in the SAP treasury module. Should they run out of money, they have to negotiate a line of credit with the bank and pay interest on the loan.

3. THE BUSINESS PROCESSES: LEARNING TO OPERATE AN ERP

The cash-to-cash cycle is made up of two main business processes: 1) the procurement and production process and 2) the sales process. The first process (procurement and production) is executed manually by the students in each quarter of the game. The second process (sales) is automated through a script that is generated by simulation software developed specifically for this game. The next sections present these two processes.

3.1 The procurement and production process

Students carry out procurement activities entirely manually in the ERP system for every business cycle of the game.

The rules of the game are such that firms can only sell products that they hold in inventory. Cereal boxes therefore have to be manufactured according to a make-to-stock manufacturing strategy so that plants always have a quarter's worth of products in advance. Only products in stock at the beginning of the quarter can be sold to retailers. Therefore, the sales manager needs to forecast demand for the next quarter.

Based on the forecast sales units for the next quarter, demand planning is transferred to production planning. The planner then runs the materials requirements plan (MRP), which automatically generates the raw materials purchase requisitions. When a purchase requisition is received, the purchasing manager contacts the suppliers of the required products. The purchasing manager chooses the vendor who offers the best price. After assigning the chosen vendor to the purchase requisition, a formal purchase order is created.
When the goods are received, the receiving clerk checks that the goods delivered correspond to the purchase order. The invoice sent with the product is forwarded to accounting and posted by the accounting clerk. Since the goods are payable upon receipt, the accounting clerk carries out the transaction required to pay the vendor. A check for the amount owing is issued and sent to the vendor. The goods received are moved from the receiving dock to the raw materials storage shelves. Confirmation of this transfer is recorded in the system.
Once all the inputs required for production are available, a production order is created. The raw materials required are then transferred from storage to the production site. Confirmation of this transfer is also recorded in the system. Once manufacturing has been completed, the finished products are transferred from the production site to the warehouse. This transfer is again confirmed in the system.

3.2 The sales process and the simulation software

In each quarter of the game, food retailers (managed by the simulation manager) need to reorder a certain quantity of cereal boxes. These quantities are constrained by each retailer's storage capacity and fluctuate over time, being influenced by the economic context.

By a specific point at the end of each quarter of the game, firms communicate their marketing strategy and business decisions to the simulation manager. Through a web form, they provide different information such as their price list, their marketing investments, and the level of inventory of each product category.

Once all the decisions have been submitted, they are imported into a simulation program specifically developed for the game. Using a market algorithm that takes into account the business decisions and marketing strategies of all firms, the software calculates how many customer orders each firm receives. The market algorithm is sensitive to the price of all available products in a market segment as well as the publicity investments made by the teams. On average, firms receive between 50 and 100 customer orders per quarter.

The simulation software then creates an Excel file containing the data related to all customer orders. This file is formatted to be imported into SAP's computer-aided test tool (CATT)[3]. When this script is executed, it automatically generates the necessary transaction flow in SAP for each customer order. The script first creates a sales order with the price initially quoted by the participant and the quantity assigned by the simulation software. Then it creates a delivery note referring to the sales order, followed by the invoice. The script completes the process with the receipt of the payment. The script moves to the next customer order and this loop continues until all orders have been created in the system.
On average, the script takes from 10 to 15 seconds to complete the four transactions associated with one customer

order. Therefore, it takes about 15 to 20 minutes to generate the orders for all firms participating in the simulation.

4. THE ANALYTICAL PROCESSES: LEARNING TO ANALYZE TRANSACTIONAL DATA

The objective of this simulation is not simply to learn how to process operational transactions in an ERP system. First and foremost, the goal is to be able to extract transactional data recorded during the business process and analyze it to evaluate the firm's profitability and update its business strategy if necessary.

ERP systems contain large quantities of preconfigured reports. The philosophy of this simulation game approach is not to demonstrate in advance all of the analytical possibilities of the system. Of course, some tutorials are needed for the students to develop their technical skills at finding the appropriate report. But once these skills are developed, participants in the simulation are left alone to find what they need in the system so they can make good business decisions.

During the simulation game, after the simulation scripts have been executed in the system, participants can log back into SAP to analyze the financial results. By running standard SAP reports, they can mine the transactional data to grasp their customers' behavior and locate different customer segments. They can also use standard analytical cubes in the business intelligence module to uncover trends in the overall data set or concentrate on specific cross sections of the data. The simulation is designed in such a way that not all customers are sensitive to price and marketing in the same manner. Using these results, students can choose to keep the same marketing strategy or they may opt to update their pricing and marketing investments to better target the most lucrative market segment.

Participants also need to run cost control reports to analyze the profitability of their different product lines. Based on this analysis, a team can choose to change its sourcing strategy and/or its cereal recipe to achieve better economies of scale. Using these insights as well as the economic news distributed at the beginning of each quarter, teams can resume the simulation by forecasting the next quarter's sales, planning production, ordering the necessary raw materials and executing production.

5. THE SEVEN-WEEK CURRICULUM AND THE SIMULATION SCHEDULE

To participate in this simulation game, one does not require an in-depth knowledge of SAP. None of the students who tested the simulation had any prior knowledge of the application before the start of the business game. This section presents the curriculum used to introduce students to the ERP concepts necessary to operate the software, to run a simulated factory and to make analytical business decisions with the system.

Obviously, learning to use an ERP such as SAP can be a colossal task. The proposed curriculum does not pretend by any means to provide an exhaustive coverage of all aspects of this software. The pedagogical philosophy is to teach key concepts and to have students create by themselves the necessary master data (products, customers, vendors, etc) they will use during the simulation.

The proposed curriculum includes a seven-week course outline (half a normal semester) that is used to prepare students for the one-day business game (see Table 1). During week 1, students are briefly introduced to ERPs, their core functionalities and benefits, and the business simulation game. After being familiarized with the underlying concepts of data integration and centralization, students are coached in the creation of the master data required for the simulation game (week 2). During the third week, students are introduced to the FI and CO modules. Each team has to create a bank account and capitalize its company. The teams also learn how to post the various fixed operating expenses

	Theme	***Hands-on experience with the ERP***
Week 1	Introduction	*The participants are introduced to basic navigation functionalities of the ERP.*
Week 2	Introduction to master data	*The participants create some of the master data required to operate their company (customers, products, suppliers, etc.)*
Week 3	Financial and managerial accounting	*The participants are introduced to the main financial and controlling master data (e.g., chart of accounts, cost centers) as well as basic processing and reporting transactions (e.g., payment processing and cost center reporting)*
Week 4	Operational transactions 1	*The participants go through the first part of the business process by forecasting the demand, running an MRP calculation and processing purchase orders to suppliers.*
Week 5	Operational transactions 2	*The participants continue with the second part of the business process as they complete all the necessary steps to receive the goods, put them in production, transfer them on the shipping desk and finally ship and bill them to the customers.*
Week 6	Analytical reporting and business intelligence	*Participants are presented data extracting strategies and analytical tools in the system. Participants use an analytical cube to analyze cross sections of data collected during the training runs of the simulation.*
Week 7	*Final preparation*	*Analytical reporting and business intelligence. Review of the business game,*

Table 1: Course outline

that they will have to process during each business quarter. During weeks 4 and 5, teams are introduced to the SD, PP and MM modules and the internal business processes they will be using during the simulation. The first of these two weeks (week 4) is devoted to PP and MM. In this class, teams learn how to create a forecast and a purchase order from the purchase requisition generated by production planning and assign a specific vendor to this order. The following class (week 5) is dedicated to the ME, IM and SD modules. During this class, participants learn how to post a receipt of goods, transfer material to the warehouse, post and pay the vendor invoice, release and execute a production order, ship the manufactured products to customers, bill customers and, finally, send the bill and post the customer's payment. The sixth week serves as an introduction to analytical reporting and business intelligence. From a standard analytical cube, participants have to mine the transactional data gathered in the training runs of the simulation and they are briefly introduced to ways of focusing on different cross sections of this data. Students also learn how to use different standard reports in SAP, such as financial statements, sales reports, procurement reports, etc. The seventh week serves as final preparation for the business game.

Students are booked for a full day during the mid-term exam quarter to participate in the business game. During this time, students go through approximately five to six business quarters, in each of which a complete cash-to-cash cycle is completed across the supply chain.

Table 2 presents the schedule of a typical business simulation day. Each quarter is meant to last about 1.5 hours. First, using a web form, all teams must send their business decisions within a specific timeframe. In the 30 minutes after the deadline has lapsed, the simulation manager runs the simulation software to assign orders to plants and then imports the generated simulation script into SAP to automatically execute the sales order process.

After the order generation, participants are gathered for the announcement of the intermediate results. Teams are ranked according to the profits they have generated so far. These announcements are very important, as they help to keep up the game's momentum and to stir up competition between the teams.

Upon returning to their rooms, the teams can log back into the system to analyze their financial results. Market news is released around the same time, so that the firms can take market trends into account in their strategy. At this point, teams must decide on their forecast product level for the next quarter based on their market expectations.
Once the strategy has been determined, teams then have the rest of the hour to complete the whole operation cycle in SAP (forecasting, procurement and production) before submitting their new business decisions (price, marketing investment and inventory for each product).

These cycles loop until 3:00 p.m., when the simulation ends. Students then have two hours to prepare a 15-minute presentation to the board of directors on their performance during the course of the simulation. Whether their performance during the simulation was good or bad, the participants have to be able to use the data gathered in the simulation to explain their success or failure.
It should be noted that it was found useful to perform 2 to 4 training quarters before the simulation day. These training periods occurred in weeks 5, 6 and 7 and helped to get students up to speed with system use and development of operational strategies.

6. LESSONS LEARNED

This section reviews the main lessons learned from this pedagogical experience. We discuss the learning process of the students, the participants' evaluation and improvements to the simulation game based on the students' comments.

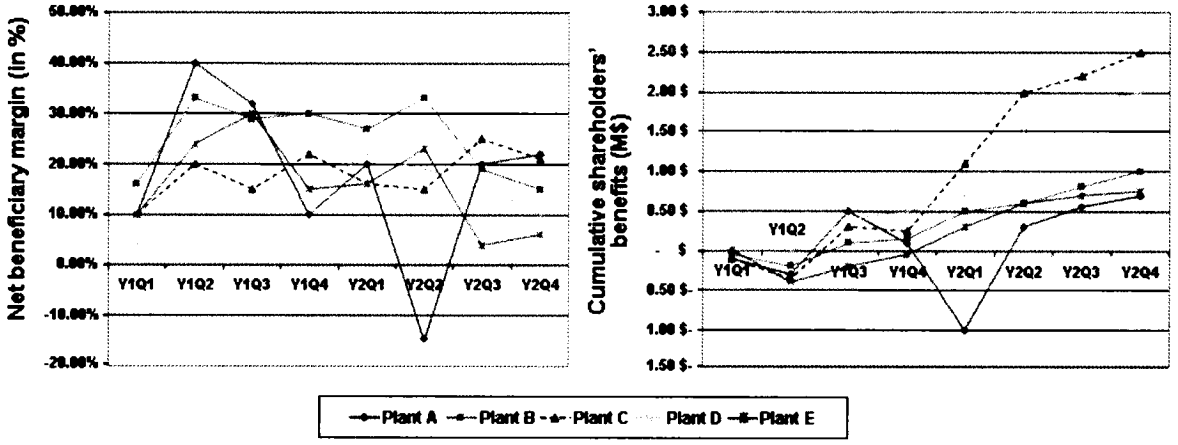
6.1 The learning process

The analysis of the financial results of the team participants is enlightening with respect to the learning process of the key ERP concepts by team members. Graph 1 presents the results from the undergrad simulation game that took place in November 2005. Five teams participated in the simulation. The left side of the graph presents the net beneficiary margins and the right side shows the cumulative shareholder benefits generated along the 8 quarters of the game.

The first few quarters of the game illustrate the adaptation that teams have to go through in order to improve their financial performance. One of the main reorganizations that teams usually undergo is the moving from a silo organization to a process-oriented team. At first, students usually tend to distribute the business processes along functional roles. Because of the need to communicate a lot of transactional information between participants, this method tends to slow them down significantly. Some teams even start building a parallel system to keep track of this transactional information, which rapidly becomes a burden. Students

	Market news	Manual operations	Submission of decision	Simulation script	*Results*
Quarter 1	8:00 a.m.	8:00 a.m.-9:15 a.m.	9:15 a.m.	9:15 a.m.-9:45 a.m.	*9:45 a.m.*
Quarter 2	9:30 a.m.	9:45 a.m.-11:00 a.m.	11:00 a.m.	11:00 a.m.-11:30 a.m.	*11:30 a.m.*
Quarter 3	11:15 a.m.	11:30 a.m.-12:45 p.m.	12:45 p.m.	12:45 p.m.-1:15 p.m.	*1:15 p.m.*
Quarter 4	1:00 p.m.	1:15 p.m.-2:30 p.m.	2:30 p.m.	2:30 p.m.-3:00 p.m.	
Preparation	*3:00 p.m.-5:00 p.m.*				
Team presentation	*5:00 p.m.-6:00 p.m.*				

Table 2: Typical simulation day schedule



Graph 1: Results from the November 2005 undergrad SAP simulation game

gradually find that reorganizing the task around a business process enables them to benefit from an integrated system. As they start capitalizing on this integration, their cash to cash cycle time decreases and they start to be able to better analyze the transactional data gathered by the system. The best teams can reach a point where they start spending up to half of their time analyzing the data in the BW module to better refine their marketing strategy. In the graph, we see that plant C gradually increases its profit margin because it can better analyze its data. This company ultimately wins the game, as it is able to constantly increase its shareholders' benefits.

6.2 Evaluation of the participants

Evaluating the participants throughout the simulation is the key challenge in this pedagogical approach. Above all, the simulation game is a teamwork experience, and the student evaluations must take this into account. Moreover, the evaluation must measure whether the participants achieved the pedagogical objective of this simulation, which is a better understanding of what an ERP is and what benefits this software provides to modern organizations. But the idea is not to measure whether students were able to correctly key data into the system. The evaluation must assess whether participants were able to make good use of the system by making good business decisions. This can be measured objectively by taking into account the actual financial performance of the firms during the simulation in the students' evaluations. In addition, the evaluation should also measure whether the students were actually able to explain the financial performance they achieved during the simulation. This is why a major part of the simulation evaluation depends on the final presentation that teams make to their boards of directors at the end of the simulation day. Whether they performed well or badly during the simulation, the students need to be able to explain their results using reports extracted from the system. In this presentation, students also need to provide evidence to the board of directors about how ERP use improved their performance. All teams attend the presentations, and participants are usually very intrigued about the strategies used by others and how transaction data is analyzed.

6.3 Improvement to the simulation game

Over the last year, this simulation game has benefited from the feedback of the graduate and undergraduate participants. Many of the comments helped us provide a better flow for the simulation day, as continuous momentum is critical to the success of the experience. We fine-tuned the market algorithm to make it more sensitive to participant decisions: it is important that participants feel that their business decisions have a significant impact on the market outcome. More time was also allowed for each quarter so that participants could fully appreciate the analytical capabilities of the application. In response to comments from participants, the simulation day was held in a room where each team could be isolated from the others in order to ensure that business strategies remained confidential.

Further improvements are under way to extend the scope of the simulation to other modules (e.g., human resources) and to expand the number of business decisions that participants can make in each quarter (e.g., buying machinery to extend production capacity). A second version of the simulation software is being planned for the near future to take advantage of the capabilities of SAP Netweaver's open architecture using Webservice to automate the sales order processing. We also intend to develop an interuniversity competition out of this simulation game concept. Different universities have already shown interest in joining, allowing teams from different universities to compete against each other. More information on the future developments of this simulation game and the simulation software can be found at www.hec.ca/sap/ERPsim.

7. CONCLUSION

Based on our initial experience, students who participated in the business game appear to have better assimilated the concepts underlying ERP systems than those who have not. They also seem to be better prepared to attend reengineering

and ERP configuration classes as a result. In addition, at the end of their academic program, students can attend the SAP ERP Integrated Business Processes certification[4] offered by the SAP University Alliance; 93% of the students who participated in the simulation game received their SAP certification (i.e. 35 students). It appears that the pedagogical approach used in the simulation game is more than just a simple hands-on experience with software; it is an opportunity for students to experience what it means to run an integrated enterprise and to experience the benefits of data integration.

The experience also appealed to the students. A post simulation survey revealed the enthusiasm the simulation game elicited among the participants. In terms of overall satisfaction, both graduate and undergraduate versions of the ERP course now rank within the first quintile of all courses offered at the business school. In the survey, a participant commented: "The simulation game really helped tie in theory with practice." Another participant reported that the simulation was "insightful on how reports provided by the ERP can help make the appropriate strategic decisions". Among the other comments that were collected: "The whole simulation is intensive and a lot of fun" and "Gives everyone a sense of what it is to work with an ERP".

The simulation game approach has proven to be quite an effective and appropriate pedagogical strategy for teaching ERP-related concepts. The practical experience allowed the participants to discover the benefits of integration and the advantages of using the available analytical tools to mine the transactional data gathered in the game. This simulation game provides a live case experience where students come to realize on their own that an enterprise system is not sufficient in itself to generate benefits. It is the process-based reorganization of the work that helps uncover the value of doing business in an integrated manner.

The simulation helps connect theory and practice and fosters students' understanding of the power of such tools in the modern organization. Students can read articles on ERP and attend seminars on integration topics, but it is really when they start role-playing with the system that they capture the true essence of enterprise systems.

8. ENDNOTES

[1] The SAP University Alliances program provides, at a reduced academic price, the mySAP Business Suite family to more than 600 member schools worldwide: www.sap.com/company/citizenship/education/universityalliances.epx

[2] www.hec.ca/en/headlines/2005/2005046i_en.html

[3] Such script usually serves to test business process integration in the quality assurance phase of an implementation.

[4] www50.sap.com/useducation/curriculum/course.asp?cid=60161141

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