ERPsim BI: a Problem-based Learning approach in Teaching Business Analytics

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Abstract: This paper presents a problem-based learning (PBL) approach developed to introduce students to business intelligence. Using a simulation game approach called ERPsim, students must manage the operation of a distribution company under an ERP system. The transaction data are made available to students through a database called ERPsim BI which is updated dynamically during the game. Learners must build a dashboard using standard Microsoft Office tools in order to track in real time the operational profitability of their company. Using these dashboards, they must actualize their strategy and adjust their decision in the ERP system. This approach was used as an MIS introduction course, which was given to a large AACSB institution in Canada. More than 1,000 students were involved in this simulation game during the 2010-11 academic year.

INTRODUCTION

Over the last two decades, most of the Fortune 2000 organizations have invested in some form of enterprise systems (Jacobson, Shepherd, D'Aquila, & Carter, 2007). The volume of transactional data generated by these systems is unprecedented, and some argue that companies are facing a data deluge (The Economist, 2010). Because it is often the case that, in the same industry, the main firms are supported by the same enterprise system technology and the same business processes. It has been argued that the only remaining battlefield is on the capacity to compete on data analytics (Davenport, 2008).

Despite the recession, the market for BI platforms has grown in double digits since 2008. The growth rate of the BI platform market is expected to continue until 2013, and CIOs continue to see BI as one of their top priorities (Gartner, 2011). One of the strong growth segments has been the data discovery tools which allow mainstream non-BI users to use a novel approach such as an interactive visualization to leverage corporate data (Gartner, 2008). Major industry players have, in the past few years, all been developing a large portfolio offering with regards to business intelligence.

With such a growing focus on business analytics, it is not surprising that companies are looking for talented graduates who are able to mix the technical and business knowledge required to use business intelligence software to its full potential (Gallo, 2009). Some even argue that the sexiest job, within the next ten years, will be statisticians[1]!

According to Watson (2009), "universities are behind the curve in recognizing and responding to this change". One issue is the traditional instructional approach that is generally used in teaching business analytics. In BI courses, technical skills are generally developed using static data set where learners apply pre-defined techniques. Unfortunately, because these datasets are not dynamic, it is not possible for the students to exert their decisional skills and, at the same time, experience the impact of their decisions.

This paper presents a problem-based learning (PBL) approach developed to introduce students to business intelligence. Using a simulation game approach called ERPsim (Léger, 2006; Léger, Robert, Babin, Pellerin, & Wagner, 2007), students must manage the operation of a distribution company under an ERP system. The transaction data are made available to students through a database called ERPsim BI which updates dynamically during the game. Learners must build a dashboard using standard Microsoft Office tools in order to track in real time the operational profitability of their company. Using these dashboards, they must actualize their strategy and adjust their decision within the ERP system.

In this paper, we first highlight the problem-based learning approach, and explain the value in using this approach to train students on authentic business analytics problems. We then focus on ERPsim BI, its architecture, as well as its associated pedagogical approach. We also give a description of the results obtained from a beta trial of ERPsim BI in the MIS introduction course offered at a large AACBS institution in Canada. More than 1,000 students took part in this trial. Finally, we are concluding with the lessons learned from this pedagogical experiment.

[1] Hal Varian, chief economist at Google.

TEACHING BUSINESS ANALYTICS USING A PROBLEM-BASED LEARNING (PBL) APPROACH

In the educational literature, a problem-based learning (PBL) approach is defined as an instructional approach where students are involved in authentic problem solving contexts (Walker and Leary, 2009). Students must use their own resources to find a valid resolution to the issues they are presented.

In a PBL centered pedagogy, the learner is guided through a series of open problems that are representative of real life problems, in authentic and complex contexts (Barrows, 1996). Students need to apply their knowledge and skills, but also to find the relevant knowledge using resources available to them (Walker and Leary, 2009). PBL has been reported to be an effective pedagogical approach, and a number of meta-analyses conclude that students learning in a PBL context are generally more motivated and will better retain the knowledge (Dochy, Segers, Van Den Bossche & Gijbels, 2003).

There are several defining characteristics to the PBL approach. First, the problem must be ill-structured. There must be multiple possible causes to the problem, and there must be more than one possible way to solve it. Second, the problem must be authentic and representative. This means that the problem must convey a meaningful and realistic context to the learner. Finally, the guidance from a facilitator or coach is necessary in order to support the learners throughout their problem solving journey (Dochy et al., 2003, Walker and Leary, 2009).

PBL is well suited to learn business analytic, and it could be argued that many curriculums use this approach when teaching these concepts. Indeed, many business analytical skills are related to mathematics and statistics, and many topics can be easily converted in complex and multifaceted problem. However, in many cases, traditional curriculums in business analysis are not able to incorporate appropriately the authenticity related to the task. In real life, business problems are not static. They evolve in time, and human decisions influence the outcome of this issue.

An immersive instructional strategy, such as simulation-based learning, enables PBL to occur in a situated cognition by recreating problem-solving experiences that are close to real-world experiences. Simulations are goal-oriented, letting the learners focus on the desired learning outcome. They also involve an interaction, which enables learners to test problem-solving strategies, experience the consequences of their actions, and adjust their decisions in a safe, risk-free environment. Well-designed simulation learning experiences are generally associated with an accelerated competence development, and are increased through in-depth understanding (Randel, Morris, Wetzel & Whitehill, 1992; O'Neil, Wainess & Baker, 2005).

The use of games, simulations, and case-based models is a well-established paradigm for teaching business skills. Beginning with the Harvard Business School's case model, through the Beer Game developed by the Systems Dynamics group at MIT, in the early 1960s, simulation is recognized as one of the most effective ways in teaching higher-order skills (analysis, synthesis, creation of new knowledge and categories, discerning value). Schrage (2000) believes that there is value in using simulation in business.

However, there are few studies in IT providing empirical evidence of the effect of this instructional strategy on the development related to IT competency. One issue is the fact that most IT simulations lack realism because learners are asked to solve problems and make decisions in a situation very different from the real business world, in which corporate information systems are critical to tackle any complex decision-making. Therefore, the few empirical results, which exist pertaining to the benefits from a simulation-based training in IT, have a low external validity, and are often based on simple business tasks.

In order to address this research question, the main challenge is to recreate realistic business environments, and have the participants use real-life IT artifacts in order to solve complex business problems.

ELEMENTS OF METHOD

Technological and pedagogical development

ERPsim BI builds upon previous developments under the ERPsim platform (Léger, 2006; Léger et al., 2007). ERPsim is a unique business simulation technology that enables the simulation of near-real-life business contexts in large corporate information systems. A critical aspect of ERPsim is that it simulates the passing of time. A simulated step typically lasts one minute. In order for a BI solution to work in association with ERPsim, this solution must be able to refresh its data source at the same speed. Most available BI systems cannot support such a high refresh frequency, as they are not designed to be refreshed so fast. We therefore needed to develop a custom data service made to support such frequency.

Figure 1 illustrates the overall architecture. ERPsim is tightly coupled with an ERP system. It extracts from the ERP system the players' decisions (Arrow 1) and reacts based on these decisions (Arrow 2). ERPsim will also automate operational tasks, leaving strategic and tactical decision-making to the players (i.e. procurement management, and sales & distribution decisions – Arrow 2). The users do not interact directly with ERPsim. Instead, they only observe the result generated by the simulator through standard reports available in the ERP (Arrow 3). When adding the ERPsim BI modules, new data related to the simulation (new decisions, such as price changes, and new results from ERPsim) are pushed in an ordered manner to the ERPsim BI Server (Arrow 4). These data are then stored into the ERPsim BI Database (Arrow 5). Once in the ERPsim BI Database, any data extraction tool can be used to process the data available (Arrows 6 and 7).

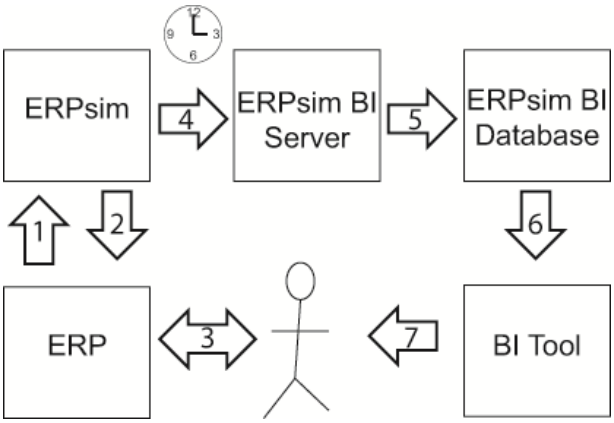

Figure 1. ERPsim BI Architecture

This architecture is different from typical BI systems, where the BI system is responsible for extracting the data from the system under analysis. Here, ERPsim decides which data should be pushed into the BI database. This way, there is no overhead to determine which data is new and which one must be updated. The ERPsim BI Database contains the BI data obtained either in multiple games or from multiple players within a single game. A number of database views are defined on the database tables to restrict access to a team's own data. Since the data from all teams are available, it is possible to create database views that will consolidate data from all the teams playing together. This allows us to simulate market reports showing the overall performance for all teams, as well as providing some information on the competition.

Currently, the ERPsim BI Architecture is implemented on a Microsoft SQL Server database. The schema is a normalized model of the master data and transactional data that is available in the ERP. Some of the master data changes over time. In this case, the value of the master data for each simulated step is provided in the database to track changes.

Any standard tools can be used to access the ERPsim BI database: standard tools provided with SQL Server, Aqua Data Studio, etc. We can also configure an ODBC or JDBC data source to the database. The simplest way to access the database is to define an ODBC data source and create linked tables into an Access database. It is then possible to easily create queries in Access using the QBE assistant. This ODBC data source can also be accessed directly from Excel. Queries can then be created using Microsoft Query. This approach, however, requires more knowledge from the user. Creating queries in Access, and, then, using these queries in Excel is the most preferred approach.

Description of the beta trial

ERPsim BI was used an MIS introduction course, which was given in large AACSB institution in Canada. More than 1,000 students were involved in this simulation game during the 2010-11 academic year. The course focused on the development of IT skills required to manage an enterprise. During the first six classes of the semester, students learned the processes of an enterprise using the ERPsim Distribution Game (see Fig. 2). In this game, the teams have to manage a company which distributes bottled water in the German market. They are competing against the other teams involved in their group. To do so, they only relied on the standard reports available in the ERP system. Specifically, the game was played in Classes 2 and 6. In Class 2, the teams made of 4 students played two rounds which lasted 20 minutes each. In the first round, the students only had access to a limited number of transactions in order to illustrate the operational silos. In the second round, they were given access to all transactions. In both rounds, the teammates could only communicate by using chat tools. In this game, all teams focused on selling fixed inventories of goods, setting prices, and investing in marketing.

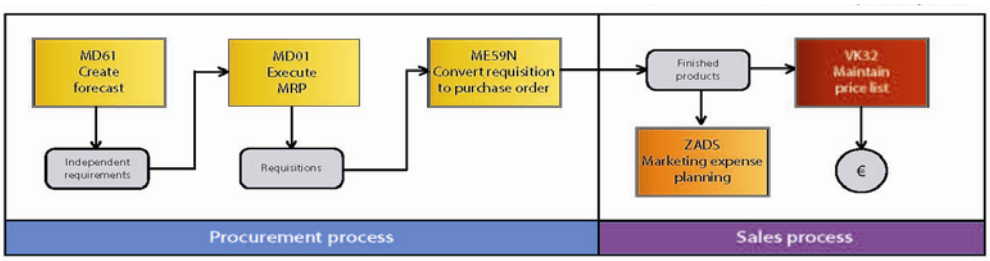

Figure 2. The business processes in the distribution game

In Class 6, the teams were sitting together, and were able to replenish on their own. They played two to three rounds (20 minutes each). Here, the goal was to reach operational excellence. Finally, results from Class 6 were used to populate the ERPsim BI Database, although students did not have access to it yet.

Beginning with Class 7, we introduced the notion of dashboards, and how they could be used in order to reach strategic goals related to the enterprise. Classes were organized to move from the strategic need of the dashboards to the construction of the queries required to populate the dashboards. Specifically, in Class 7, the concept of a balance scorecard was presented (Kaplan and Norton, 1992). Table 1 presents examples of indicators developed in class.

Table 1. Examples of indicators associated to each perspective using balanced scorecard

	Perspectives			
	Finance	*Market*	*Internal*	*Development/growth*
Retrospective indicators	Retaining earnings	Sales, Market share, Net margin	Unit cost of production, Capacity utilisation	Increase in capacity
Prospective indicators	Cash flow forecast	Customer satisfaction, Growth in market shares	Procurement disruptions,	Employee turnover, Introduction of new products

In Class 8, students were introduced to the notion of data cube and pivot tables, and showed how to construct them in an Excel table from existing queries and views available through an Access data source. In this case, the Access database was a materialized version of the data available in the ERPsim BI database. As we focused on the link between Excel and Access, we felt that setting up an ODBC connection, at this stage, was premature.

In Classes 9 and 10, we demonstrated how to construct queries in Access. At this point, we showed students how to set up an ODBC connection with the ERPsim BI database. This way, when the students played with the simulator in Class 12, their data was updated automatically as it was fetched directly from the ERPsim BI database. Between Classes 10 and 12, students could finalize the dashboard they would be using when playing the game in Class 12. During Class 11, we launched the simulator to allow teams to test the dynamic modification to their dashboard.

Class 12 was the final game. The teams were playing two to three rounds lasting 20 minutes each. In addition to the standard reports provided by the ERP system, they could use the dashboard they had developing over the course of the semester.

The winning teams from each class were invited to a final game. During the Fall 2010 Semester, three teams took part in this final game, which consisted in three rounds of 20 minutes each. The level of competition attained was quite high (Tab. 2). Indeed, after 60 minutes, there was only a 0.567% difference between third and first places.

Table 2: Results from Final Game in Fall 2010 Semester

Team	*Cumulative net income*	*Sales*	*Deviation from first place*
A	€ 104,556.89	€ 940,303.92	0.000%
B	€ 104,464.00	€ 993,383.97	0.089%
C	€ 103,963.57	€ 1,118,250.07	0.567%

DISCUSSION AND LESSONS LEARNED

ERPSim BI or how to create an authentic and customized learning experience

The ERPsim BI is a simulation providing an authentic context for problem-based learning. First of all, it puts the students in a position where they are confronted with an ill-structured problem: managing a distribution company using an ERP system in order to maximize the company's profits. In such a context, there are several approaches to analyze the data and strategies which can be used to manage the company. For instance, students can focus on lower prices or high marketing expenses or product specialization. There are many different paths that may be used to leverage the ERP system needed to achieve profitability. ERPSim BI even allows for dynamic problem-based learning; students have to regularly readjust their decisions based on the information made available to them on their company, but also the information they obtain on the market.

Secondly, the ERPSim BI provides the students with a representative and authentic problematic situation. The representativeness comes from the fact that students are using a real ERP system, i.e. SAP R/3. Furthermore, the students are put in a close to real-world situation since the decisions they have to make are identical as the ones made by a real manager. The authenticity comes from the fact that the students are engaged in a situation where they are put in competition, i.e. profit maximization, with other teams, just like companies in the real world are competing one against the other. This competitive dimension adds to the students' motivation, and creates a lively learning environment where students are very attentive and involved. In addition, the students have some control over the success of their company since they are the ones making the decisions, and the ones who have to live with the consequences. Finally, they also have to use their resources in order to resolve, in a valid way, the issues they are presented with.

In addition, during the ERPSim BI simulation, the students exert their decisional skills, and, at the same time, experience the impact of their decisions. They need to control the destiny of their organization, since they are making the decisions, and become more engaged in the process. Thus, the experience lived by each student in the ERPSim BI simulation is unique and genuine.

Finally, in the ERPSim BI simulation, students are given information on the game context and basic knowledge on how to use the system. However, at first, the students are not given any indications on which strategy to use, how to analyze the data, how to organize the team structure, etc. The students are left on their own throughout their problem solving journey. However, during the game, the professor is there to answer questions and give guidance in relation to the questions asked. Furthermore, between each round, there is a debriefing discussion on topics such as operational problems, team organization or communication challenges. These debriefing discussions are valuable moments for the students: they help them reflect on their own experience, and, at the same time, let them learn from the other students' experiences. The ERPSim BI provides a goal-oriented context which requires the students to interact, enables them to test different problem-solving strategies and allows them to experience the consequences resulting from their actions. Thus, the ERPSim BI simulation is a safe and risk-free environment. One important element, which is made clear at the beginning of the simulation, is that students are allowed to make mistakes, and that mistakes are a good way of learning. Thus, the professor's role is there to help the students understand "why" such mistakes happened, and help them reflect on different and better ways they could behave in the future.

ERPSim BI or how to mix technical and business knowledge

The students involved in the beta trial were sophomore or junior students having no or very limited business experience. By using the simulation, they were provided a "real business context" experience they can relate l to. During the semester, this ERPSim BI is used to introduce basic IT concepts such as business process, business performance evaluation, operational excellence, business process transformation, database, integrated systems. These concepts, which would have been abstract for most of the students, can now be linked to a true experience. Furthermore, since all students live similar experiences during the ERPSim BI simulation, they are all interested and involved in group discussions which increases the quality of the discussion and the student learning experience. In addition, very few students in these groups majored in IT; most of these students are specialized in other disciplines, such as finance, marketing, accounting, human resources, logistics, etc. Thus, using the ERPSim BI simulation, in the introduction class, and making the students develop their own BI tools allow them to transform a abstract concept into something more concrete. Furthermore, the use the ERPSim BI simulation sends three key messages to all business students:

1. BI is not about technology: BI is all about effectively using information to make better decisions.
2. BI is not only reserved to specialists: BI can be and should be used by anyone, within the organization, regardless of the hierarchical position or specialty.
3. BI does not require complex tools. BI can be realized using simple tools.

As mentioned previously, in traditional BI courses, technical skills are generally developed using statics data set where learners apply pre-defined techniques. In the ERPSim BI classes, pre-defined techniques are not presented, only general database frameworks and balanced scorecard perspectives). Furthermore, the students are taught on general spreadsheets and database techniques using Microsoft Excel and Access. Thus, the students have to decide which performance measures they want to use, and which information they need. Furthermore, they must go through the full development project process.

ERPSim BI or how to create a real decision-making context

The real time dynamics related to the ERPSim BI simulation forces students to reflect on their decisions and the consequences of these decisions, and on the information required to make better decisions. With the simulation, the students experience a full decision-making cycle (Fig. 3).

Through the full decision-making cycle, students get instant feedback on the decisions they make. First of all, the feedback informs the students on the quality of the decisions they made. Thus, they can reflect on what they did, and learn from it. Secondly, the students have the possibility to analyze the feedback they receive by developing their own customized BI tools. Thus, they can use the feedback received to improve the decisions they made previously. Finally, since simulation feedbacks are provided several times, i.e. almost every minute, which represents 20 times per round, the students experience the full decision-making cycle which provides, each time, a learning experience.

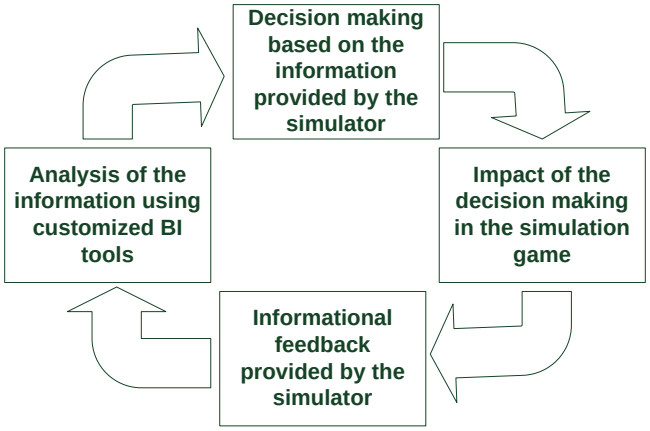

Figure 3. Full decision-making cycle experienced by student using the ERPSim

Instead of giving them the information available in the system upfront , only the basic elements of information are given to them, and, as the game evolves, the student realize that, if they had more information on specific elements pertaining to their organization or the market, they could make decisions which would help them increase their profits. These elements are identified during the debriefing sessions between each round. Thus, instead of providing the students with the information and the pre-defined techniques upfront, as it is done in more traditional BI courses, there is a shift of paradigm since the need for this information and these tools is coming from the students instead of being provided by the teacher. This means that the BI professor has to switch his mindset from a knowledge and technique provider to a coach or a facilitator who will be helping the students reflect on their organization and their decisions, and who will also help them identify the key information they need, as well as to help them use their skills in developing BI tools using relatively simple technologies such as Microsoft Excel and Access.

CONCLUSION

With the experience of this first year, we expect to deploy the ERPsim BI to a dozen universities that have agreed to participate in the second phase of this beta trial. We are currently preparing various multimedia and pedagogical guides to support this teaching approach. The next phase of this project is to make ERPsim compatible with major business analytics software such as Microsoft BI suite. Such development will make it possible to train managers and analysts on real life corporate analytics systems. Finally, several research projects are underway in order to evaluate the benefits of using a simulation-based approach in IT-related training (e.g., Cronan, Léger, Robert, Babin, & Charland, 2010; Léger, Charland, Pellerin, Babin, Robert & Cronan, 2010; Charland, Léger, Feldstein, Robert, Babin & Lyle 2010). ERPsim BI will help extend this research project to look at the competency developed by learning in dynamic and problem-oriented BI training.

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