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Supply Chain ERP Simulation: A unique learning experience

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ABSTRACT

Simulation games are an effective educational tool that offer life-like scenarios and develop valuable functional business knowledge and decision-making skills. These skills have been shown to be invaluable in the current job market.

This paper describes a novel adaptation of the HEC Montreal Enterprise Resource Planning Simulation Game into an inter-institutional competition. Teams of university students and academics from five Melbourne-based universities, aided by industry mentors, put their business skills to the test for an intensive simulation game using a real world ERP system: SAP. Teams were required to complete the full cash-to-cash cycle, by interacting with suppliers and customers, sending and receiving orders, and delivering a range of muesli bar products. To develop a range of business and 'soft' skills, participants adopted individual business roles and made life-like decisions in a competitive, time-constrained environment. Participants found the game exceeded expectations by fully demonstrating the interaction of a life-like supply chain.

Keywords
Supply Chain, simulation game, ERP, education, experiential learning

INTRODUCTION

There has been much debate about the disparity between the quality and adequacy of the skills possessed by IS graduates and those required by the IS/IT industry. This is better known as the skills gap (Boyle & Strong, 2006; Kim, Hsu, & Stern, 2006; Mackrell, 2009; Rosemann et al., 2001; Scott et al, 2002).

A classification of five main skill requirements, expected by organizations from graduates of university programs, were identified by Boyle & Strong (2006): ERP technical knowledge, technology management knowledge, business functional knowledge, interpersonal skills and team knowledge and skills. The Economist Intelligence Unit (Murray, 2008) found that the main concerns expressed by chief executives was the difficulty they expected, over the next three years, in finding new staff who had the ability to manage change, think strategically, to communicate effectively with people and to analyze and problem solve. These skills were the most critical to the success of their organizations. Executives felt that the ways universities could improve curricula to provide graduates with the skills valued by industry, was to expand training in: soft skills (leadership, teamwork, communication, work in virtual teams), improving the quality of functional business education (finance, marketing, production etc), improving training in IT skills, improving the relevance regarding practical, real-life scenarios and by offering more opportunities to partner with companies (Murray, 2008).

These findings indicate a strong need for IS curricula to effectively meet the needs of organizations' by offering better educated IS students with a variety of business and soft skills. This requires students to not only understand the technology but to have the ability to apply that knowledge in a practical business situation and to do so using soft skills that can be offered in the competitive job market. This ensures that firms and recruiters can effectively hire staff with current, up to date skills (Kim et al., 2006). To bridge the skills gap, the adoption of such tools as enterprise simulation games have been used effectively to educate students not just on the workings of the system but to provide the opportunity for students to think critically and quickly when analyzing real world problems. Additionally simulation games also provide the opportunity for students to learn and practice management skills within a team environment.

Simulation Games in Education

Using computer based simulation games to teach enterprise concepts is not a new approach (Leutner, 1993). The Beer Game was developed at MIT almost 30 years ago to simulate 'hands on' experience of supply chain management problems for business training (Anderson & Morrice, 2000). Another early example is the 'Tailorshop', a computer simulation game where participants undertook the role of manager to run a small simulated production company (Putz-Osterloh, 1981 cited in Leutner, 1993). These systems are referred to as 'complex' and 'dynamic' as decisions made in one part of the system can impact and have influence on other parts of the system often without direct manipulation by the participant (Leutner, 1993). Using simulation games has provided educators and business trainers alike with an alternative to traditional and conventional modes of classroom instruction.

Pedagogical objectives of using computer based simulation games are many and diverse. Simulation games are known to: 1. Demonstrate how information systems support business strategies; 2. Develop conceptual knowledge underlying the enterprise system; 3. Develop technical skills by using the enterprise software and 4. Teach participants to work collaboratively using a variety of skills to achieve a common goal (Leger, 2006). These objectives are often difficult to achieve in the context of standard pedagogical teaching practices. With the growth in ERP implementations in the 1990s a high demand for ERP skills from graduates was required. Unfortunately much of the curricula did not provide adequate coverage of ERP concepts in order to educate and adequately prepare graduates for a working environment (Watson & Schneider, 1999). Because of this significant research over the last ten years, has been conducted into enterprise resource planning (ERP) systems and their integration into the educational curriculum (Antonucci et al., 2004; Hawking, et al., 2004; Watson & Schneider, 1990).

ERP in education

ERP systems are standard software solutions that automate and integrate business processes by incorporating the core functionality (such as materials management, production management, sales and distribution, accounting and human resource management) by using one single logical database to capture the data (Rosemann et al., 2000, p1). For many companies, ERP systems are essential infrastructure to manage their daily operations and a critical foundation for business transformation (Davenport et al., 2003). Since they are the single largest and most important investment in an organisation's history, their importance as a major system for organisational change and transformation has not gone unnoticed in the information systems research arena.

These systems are of particular significance in the field of education. The introduction of the University Alliances program, a global SAP endeavour for providing universities with the tools and resources to teach ERP systems and their associated extended software, has made a considerable difference to the way these systems are taught and portrayed in an educational setting (Antonucci, 2004; Joseph & George, 2006). Many educators in the IS and business area find that using an ERP system to demonstrate business concepts is an excellent way to integrate curricula, while optimizing the use of real world technology. Results from a worldwide survey conducted by Gable et al., (1999) on enterprise systems teaching, demonstrated that hands-on experience is the main success factor for learning ERP software.

Although these systems demonstrate key concepts such as integration of core business functionality and best practice business processes, practice in learning real world business functionality and 'soft skills' still seems to be lacking. One approach to ensure students not only obtain ERP knowledge in a business setting but also applying this knowledge while developing 'soft skills' is offered by the ERP supply chain simulation game. The most well known is the HEC Montreal ERP simulation game.

The HEC Montreal ERP simulation game

This simulation offers the opportunity for participants to operate a muesli bar business using enterprise system concepts. It has been described as a 'serious game for learning ERP concepts,' has been played in more than 100 universities worldwide, and organizations such as Deloitte, Coca Cola and Croyola use it to train their end-users (Leger, 2010).

The game is coupled with ERP technology and operates as it would in a real world context. The simulation software, ERPsim, serves three functions:

1. Provides a simulation of a make-to-order manufacturing supply chain where buyers and sellers behave as they would in a real-world setting;
2. Participants operate the full business cycle; plan-procure-produce-sell to experience the value of up and down stream information flows. SAP transaction reports and dashboards enable participants to execute business decisions;
3. Simulate the passing of time: This ensures that the impact of decisions can be evaluated and participants are able to adjust their decision-making in line with the performance of their business.

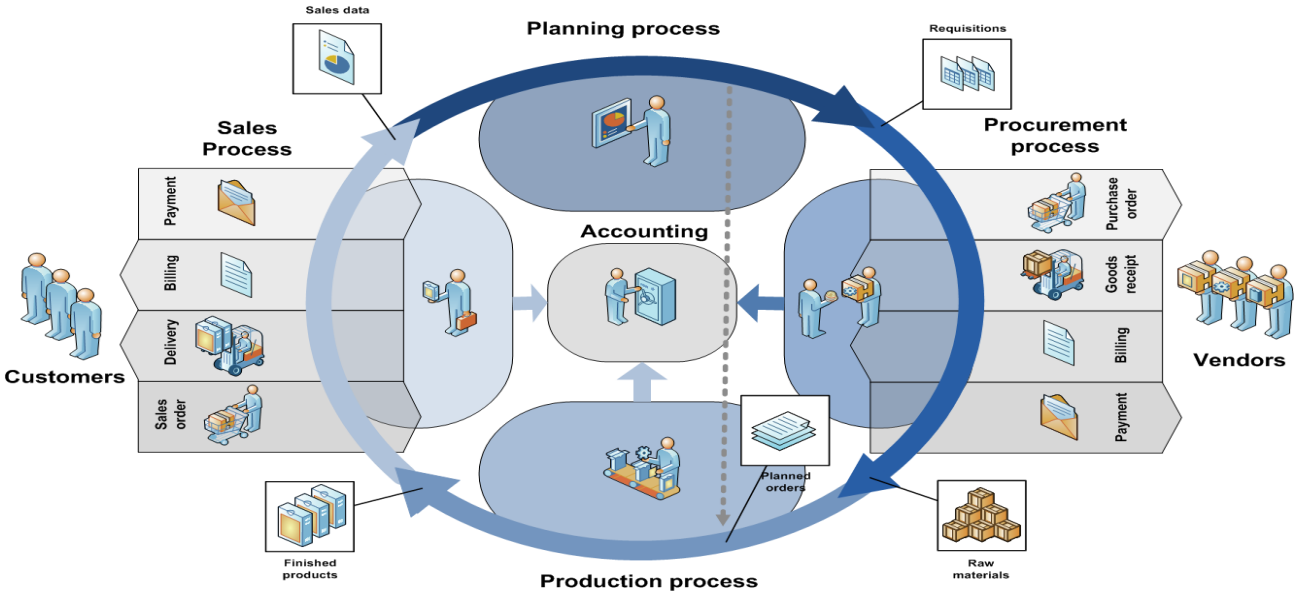

Figure 1: Scope of the simulation (adapted from Leger, 2010)

Figure 1 demonstrates the scope of the game by not only identifying the ERP functionality and the integration points but also the interrelationships between the different business partners in the supply chain. Customers' orders (demand) provide the catalyst for production planning, creating planned orders, procurement of raw materials (supply) and ultimately production leading to revenue generation. The planning process is based on product sales information: e.g. if sales fall below an optimum level for a particular product(s), teams must make quick and informed decisions about the future pricing and marketing of that product and take the necessary steps to increase sales; usually by reducing price. Similarly decisions need to be made in the event of an upsurge in product sales: should stocks be replenished or should pricing be increased and how long should this last?

Teams have to deal with the urgency of supply chain decisions, impacting on all parts of the supply chain, whilst managing the system functionality in a time-constrained environment. This made it difficult for some teams, in the initial part of the day, to increase sales and revenue; however as the day progressed most teams mastered the integrated nature of the supply chain business process and gained valuable business insights and skills.

To establish the value, skills and functional business knowledge acquired by team members, research was conducted over the course of a one-day simulation game. Since the game was simulated and the data held and reported upon, it provided the researchers with a plethora of data that is not typically available; additionally the team environment lent itself well to research. Leger et al., (2009) proposed that an ERP simulation game constitutes a controlled laboratory experiment and thus can bring a new dimension to ERP research.

The Victorian Universities ERP Simulation Competition

The original HEC Montréal ERP simulation game was adapted into a one-day inter-institutional universities competition held in Melbourne, Australia, by changing some characteristics of the original structure and team roles. Two novel elements were

added to the existing simulation format: firstly, students from five major universities were brought together to play the game against each other and secondly, industry practitioners were on hand to offer expert guidance and advice to their teams. The game consisted of six teams of four (N=24 overall participants); five of the teams comprised of three student representatives, from five major Melbourne-based Universities (N=15 students), and an industry practitioner (N=5). A sixth group was made up of four academic staff from the representative universities, with no industry expert (N=4). The practitioners, senior managers from logistics company Linfox, everyday users of Enterprise Resource Planning（ERP) systems, acted as mentors to coach the teams in their supply-chain decision making. The teams worked collaboratively in a state-of-the-art business centre. Establishing a team identity was essential, teams being advised to conduct preparatory meetings beforehand, and to research information about the simulation game and SAP ERP systems in particular. The teams differentiated themselves by wearing matching and distinguishing caps and/or tee-shirts. SAP provided the facilitator for the event, access to the simulation software and documentation (which included a glossary of terms and standard SAP functions), and prizes of HTC Smartphones and Apple iPods were awarded to the teams finishing first and second respectively.

Using the leading ERP software from SAP, the team members undertook roles as executives of a muesli bar company. This required them to interact with suppliers and customers through the entire supply chain cycle: buying raw materials, managing budgets, developing products, organizing production and distribution schedules, and selling their products. The teams responded to changing real-life variables such as an increase in grain prices or a decrease in the foreign exchange rate, with every 25 minutes in real life simulating 30 days (representative of a quarter). At the end of each 25 minute session the results showing how each team performed were displayed. This enabled the teams to adjust their strategy. At the end of the day the winning team was determined based on the highest sales. It should be noted that a number of students had not accessed or had any experience with SAP before.

The event was comprised of two identical games, run over three timed rounds. Game 1 was divided into two halves, representing the first and second halves of a year, Round 1 and Round 2. The second game, representing a full year, was run in a single session; Round 3. Prior to this an introductory 'trial round' was conducted to familiarize the participants with the workings of the game, the system interface, and the different roles within each group.

The game was designed to give students the emotional and intellectual experience of managing a real world company in a modern supply chain setting.

Methodology

A mix of both qualitative and quantitative data was collected: quantitative data from the system and a mix of qual- and quant-data was recorded from two self-completion questionnaires. The simulation system automatically captured performance data and recorded all the teams' actions. Self-completion style questionnaires were distributed at two stages throughout the day; the questionnaires involved a mixture of quantitative, yes/no and Likert scale responses, as well as longer, more descriptive, qualitative answers. Questionnaire 1 was issued near the start of the day, after the trial round of the simulation; and Questionnaire 2 was given out at the end of the day, after the final round of the simulation had been completed. Questionnaire 1 contained seven questions designed to capture initial data about the learning experience of the participants; for example, how they viewed teamwork within their particular group, what their expectations were for the event and whether or not they were planning any change of strategy based upon their 'learned' experiences thus far. Questionnaire 2 contained fifteen questions designed to capture participants' reflections on their team experience, especially of working with a mentor, level of skill development, experience gained from working with SAP ERP, and general reflections regarding whether the game lived up to expectations.

The questionnaires were positioned throughout the day to capture participants' immediate attitudes, beliefs, and opinions about each round in the simulation, how they thought their team had performed, their significant learnings, and what (if anything) they would change as a consequence of what they had learnt.

RESULTS

Questionnaire 1 Results

The results from the first questionnaire, completed after a 'test' round at the start of the day, unearthed some interesting data about the experience level of the participants, their expectations, their initial impressions of the simulation game and their opinions as to how realistic an experience they found it to be.

i Participant experience level

Participants were asked to rate their previous exposure to supply chain data using a scale of 1-5; (where 1 = no experience, 5 = expert). The outcomes are shown in Figure 2.

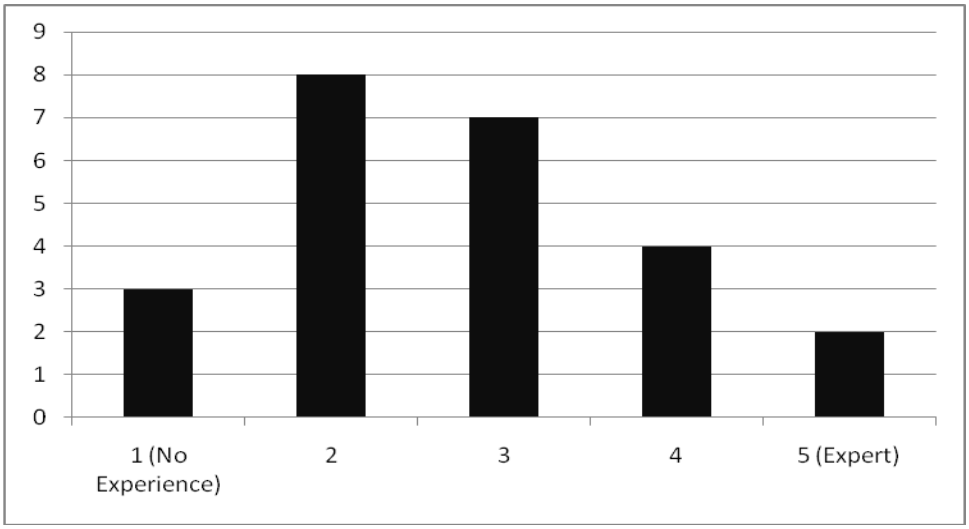

Fig. 2: Level of previous exposure to supply chain data

The majority 72% (N=24) of participants identified that they had little previous exposure to supply chain data; while two participants (both industry mentors) described themselves as an 'expert'. In general the experience level of the cohort was low.

ii Initial impressions

Respondents were asked to provide their initial impressions of the game. The responses from the students from the different universities varied from 'exciting,' 'engaging,' 'enjoyable,' and 'fun,' to 'hard,' 'complex,' and 'challenging'. The overall response was positive. There was no difference in comments between universities.

iii Realism of the first simulation

Respondents were asked to indicate how realistic they thought the first simulation trial round: 84% rated it as either moderately realistic or realistic. Two particants thought it was 'very realistic' with the same number intimating it was very unrealistic (Figure 3).

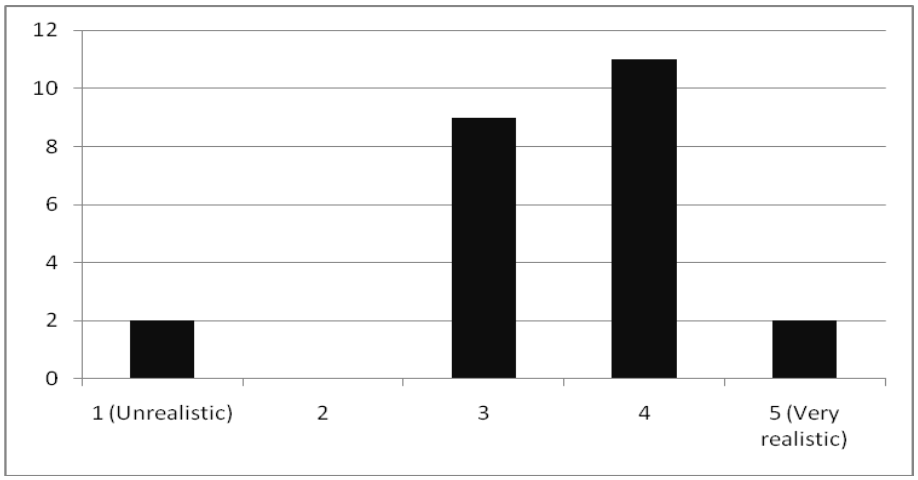

Fig. 3: Participants' perception of how realistic they found their first simulation game

iv Changes to the simulation

Respondents were asked to suggest anything about the simulation game that could be changed to make it more realistic, in general students would have liked to incorporate fixed and variable cost, overhead costs and inventory holding costs; manage inventory on a time basis; slow the timer down; automate price changes, and provide a summary of key KPI data.

v Working together in a team (1 to 5)

Of the 22 respondents who commented, 27% (N=6) stated they had worked very well together; 55% (N=12) said they had worked well; 13% (N=3) worked Okay together; only 1 academic stated the team had worked very badly together. Students seemed to work better togther in general than the academics. This could be because the students are expected to work together in teams in a university setting with some of the team members already knowing each other; while the academics in this game had not met each other before but had had some experience with SAP indicating that they may have had set ideas about how to interact within the requirements of the game but making it difficult for them to interact together in a team environment.

vi Improving the team work

Respondents were asked to state how teamwork could be improved in the next round of the game; in general respondents would have liked more time to work as a team and plan and discuss options; have more experience with SAP; make less errors and have slightly better communication. In general across all teams they felt there should be more time for team planning and discussion.

vii Expectations for improving management of supply chain information

Respondents were asked to rank their expectations in terms of improving their ability to manage realistic supply chain information. Of the 22 respondents, 63% (N=14) stated they had high expectations; while 36% (N=8) stated they had some expectations.

Game 1 Data

As outlined earlier, Game 1 of the simulation event was split into two sessions; Round 1 and Round 2. The first round of performance data, captured automatically by the system, indicated that the Team C performed the best, generating a net income of $6,471,872.26 and total sales of $9,390,824.38, with F and A a close second and third. The mixed staff team, without the benefit of guidance of an industry mentor, performed the poorest and failed to break even for the first six months (Table 1).

Rank	Team	Net Income ($)	Total Sales
1	C	810,880.65	2,227,421.07
2	F	784,697.06	2,186,492.48
3	A	720,239.41	2,123,055.81
4	D	184,495.75	1,226,105.75
5	B	91,632.72	1,737,712.50
6	E	-368,312.79	1,301,056.60

Table 1: Summary of Results from Game 1 (Round 1)

The game data captured for Round 2 indicated an improvement in performance from all teams, as the participants continued to become familiarized with the game structure, system interface, and their roles within their team. All teams managed to double their total sales figures for the second half of Game 1 whilst subsequently greatly improving their net incomes (Table 2).

Rank	Team	Net Income ($)	Total Sales
1	C	2,619,725.34	5,747,265.77
2	A	2,136,089.02	5,450,234.71
3	F	1,357,396.84	4,410,397.50
4	B	645,633.22	4,115,663.20
5	D	438,550.81	2,967,786.84
6	E	-22,202.97	2,805,253.65

Table 2: Summary of Results from Game 1 (Round 2)

Game 2 Data

In the second game, a repeat of the first two rounds ran as a single session, all teams continued to exhibit stark levels of improvement. Team C came out on top again, and managed to improve their net income by 323% and total sales by 258%, in comparison with their performance in Game 1. The mixed staff team, whilst still finishing last, made great improvements achieving net income and sales figures that would have earned them a 1st place finish in Game 1 (Table 3).

Rank	Team	Net Income ($)	Total Sales
1	C	6,471,872.26	9,390,824.38
2	B	6,428,891.79	9,409,879.55
3	D	6,182,406.02	8,547,821.09
4	A	5,341,647.25	8,097,122.25
5	F	5,300,508.43	8,094,675.40
6	E	4,691,214.01	7,787,083.33

Table 3: Summary of Results from Game 2

Questionnaire 2 Results

The objective was to ascertain the level of skill development and functional knowledge acquired while working in a team environment using SAP/ERP to simulate a real world Supply chain. The results, completed after the final round of the simulation, indicated a high level of satisfaction amongst the participants with playing the game (Table 4).

How did the day live up to your expectations in terms of:	Did Not Meet Expectations	Met Expectations	Exceeded Expectations
Learning how to handle realistic supply chain information?	7%	53%	40%
Learning the basics behind SAP/ERP	0%	53%	47%
Working in a team to achieve a common goal	0%	40%	60%
Working with an industry mentor	8%	15%	77%
Learning about a real world supply chain in a safe environment	0%	47%	53%

Table 4: Results representing the extent to which expectations for the event were met

When asked if they thought a general knowledge of SAP/ERP was required before playing the simulation game, 60 per cent of the participants responded 'No.' Similarly, when questioned about whether the skills gained from playing this game could be later applied in a real-world scenario/situation, the response was an overwhelming 'yes' (87%).

Participants were asked if they would recommend the game to others, 100 per cent of respondents said 'yes.'

In general respondents indicated that they had learned a level of skills and experiences that they could take away from the event. Such skills and experience included; 'team communication,' a 'better' or 'initial understanding of SAP,' an

understanding of how 'information flows through an integrated system,' the 'importance of team roles,' and 'how to act in a fast-paced environment.' The game itself was seen as 'realistic,' 'hands on,' 'interactive,' and a great way of 'learning practical skills and then applying theoretical SCM knowledge to a realistic situation.'

Comparing the perceptions of the different groups of participants

When comparing and contrasting the responses from each of the three different groups of participant (students, academic staff and practitioners) a number of interesting issues were identified (Table 5).

As expected the practitioners regarded themselves as the most experienced, in terms of previous exposure to supply chain data, and the student group the least. Impressions of the first simulation were similar across the three groups, with the practitioners interestingly rating it the most realistic, and expectations of the simulation improving the ability to manage realistic supply chain information were also similar across the three groups.

In terms of rating how the event lived up to expectations the practitioners were clearly the most satisfied, with all of them stating that it exceeded their expectations in terms of how the simulation prepares the participant for handling realistic supply chain information and for working in a team towards achieving a common goal. The academic staff emerged as the least satisfied group, responding unanimously that the simulation only 'met' their expectations in these areas.

	Students	Academics	Practitioners
On a scale of 1-5 how would you rate your previous experience in terms of exposure to supply chain data?	2.5	3	4.2
On a scale of 1-5 how realistic would you describe the first simulation?	3.3	3	3.6
As the day progresses what expectations do you have in terms of improving your ability to manage realistic supply chain information?	2.3	2.25	2.4
How did the day live up to your expectations in terms of learning how to handle realistic supply chain information?	Met (54%) Exceeded (38%)	Met (100%)	Exceeded (100%)
How did the day live up to your expectations in terms of working in a team to achieve a common goal?	Exceeded (62%)	Met (100%)	Exceeded (100%)
Do you think you needed a general knowledge of SAP/ERP before you played this game today?	69% No	100% Yes	100% No
Do you think the skills you have gained from playing this game could be applied to a real-world scenario/situation?	85% Yes	100% Yes	100% Yes

Table 5: Comparing results from the different groups of participants

The area where there was greatest disparity was in opinion as to whether prior SAP/ERP knowledge was needed to play the game. 100% of practitioners said 'no' whilst 100% of academics said 'yes.' However, these two groups agreed unanimously that they believed the skills gained from playing such a game could be applied to a real-world scenario/situation.

Summary of findings

Results indicated a high level of satisfaction amongst the participants: firstly the game met their expectations; secondly, participants felt prior knowledge of the SAP system was not necessary; and thirdly they felt that the skills they gained from the event could be applied in a real-world environment. The results from the first questionnaire indicated that whilst there was a reasonably low level of experience amongst the participants there were still high expectations of the simulation game for improving participants' ability to manage realistic supply chain information. While outcomes from Questionnaire 2 validated the high level of satisfaction felt amongst the participants in terms of how their expectations for the game were met after completing both games.

In general the comments indicate that although the game was fast, hard and at times complex, in general it was interesting and engaging and a great way to learn supply chain concepts. Furthermore, the impact of the industry mentors appeared to be significant, with the one group without an industry mentor finishing lowest in every round of the games.

CONCLUSIONS

The Victorian Universities ERP Simulation Competition is an innovative learning experience, which uses a 'learning by doing' educational approach to teaching ERP concepts, effectively capturing primary performance data. This adaptation of the HEC Montreal ERP simulation utilizes students, academics and mentor practitioners in creating an original inter-institutional universities competition, combining performance data and participant feedback to establish evidence of performance improvement and satisfaction for the skills learnt from participation in the event.

Competition has long been recognized as beneficial to learning situations (Johnson, 1975), and this format strived to increase the sense of competition by pitting rival institutions against each other, in a time-constrained environment, and awarding prizes. The results depicted a high level of performance improvement with teams continually improving their income/sales figures as the rounds progressed. Qualitative evidence highlighted how well teams worked together and how the simulation allowed participants to immediately see the effects, good or bad, of their decision-making. Trevor Byrne from SAP Education, observing the event, added "just like in real life, teams pay for poor decisions or those not made in time."

The simulation was viewed as a realistic experience where the skills gained could be readily taken away and applied in a real-world environment. It improves the participants overall appreciation of business, gaining skills that can be applied to a real-world scenario/situation, preparing them for handling realistic business information, in time-constrained situations, whilst operating in a team environment. In essence the simulation game proved to be an excellent way of marrying a range of soft skills; such as thinking strategically, communicating effectively, analyzing and problem solving, while improving functional ERP knowledge in a safe 'virtual' setting. Therefore providing students with many of the skills needed to make them eminently employable.

While prior experience of SAP may not be essential it appears that the guidance of an industry mentor, with experience of the system and in handling high-pressure real-life situations, is beneficial.

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