

Introduction

Organizations are increasingly changing the way they think from a functional perspective to a process-based one - concentrating on grouping activities that perform a task of value to an organization. The perceived benefits of doing this include improved product development (Valle and Avella 2003), being more competitive (Huang and Newell 2003), better decision-making (Pinsonneault and Kraemer 2002), and a better understanding of their overall performance (Amrani et al 2006). Higher education, however, has lagged behind in teaching business processes and, hence, students are not suitably prepared to work with cross-functional problems in today's fast-paced environment (Cannon et al 2004). As a result, business schools are rethinking their functional orientation (Becerra-Frenandez et al 2000). For example, the current AACSB (US Business School Accreditation Board) standards emphasize integration of business areas and cross-functional education (Aurand et al 2001) and some schools offer separate classes in business process modeling (Recker and Rosemann 2009). In addition, some institutions have been using Enterprise Resource Planning systems to illustrate integrated business processes (Wagner et al 2000; Seethamraju 2007; Wang 2009; Rienzo and Han 2010).

Enterprise Resource Planning systems are very large software programs that control every aspect of a company from sales to accounting to supply chain to human resources. This integrative approach takes an organization from a functional view to a business process view. Functional area legacy systems "represent one of the heaviest drags on business productivity" (Davenport 1998, p. 123) and have been increasingly replaced by a single ERP system - via a single central database and common reporting tools; each functional area within an organization is integrated by the software. ERP systems allow for efficient business processes with all functional areas connected to the central database and they ensure accuracy of work. In today's rapid-paced and competitive business environment, any business process that can be made more efficient can give an organization the edge needed for success.

ERP systems are now a cornerstone of many organizational information systems. Given this it is unsurprising that, since the late 1990s, universities have been teaching ERP systems and using commercial ERP software in the classroom. Even though ERP pedagogy is popular, the SAP University Alliance having 1,000 members for example, it is of importance to note that little conclusive research has been done to determine the success of using this software in the classroom - particularly in relation to the integrative (or process-based) understanding that students may gain of business organizations. Research studies involving the assessment of ERP education have resulted in somewhat mixed results. We argue here, however, that it is important for the future of business education to fully understand how ERP systems affect the outcomes of the students' knowledge of business processes.

As a consequence, this paper reviews the literature on assessing business process comprehension and ERP in higher education and describes new research in progress. The paper is structured as follows. Section 2 discusses the teaching of ERP to university students. Section 3 provides a review of past assessment studies. Section 4 examines those studies more critically in order to provide an agenda for future research studies. Section 5 describes the research approach and the current status of this research in progress. The major conclusions of the paper are then drawn.

Teaching ERP to University Students

ERP systems are an excellent vehicle for promoting business processes and process integration from an educational point of view (e.g., Draijer and Schenk 2004). They note (*ibid* p.263), for example, that: (1) Sales can't deliver any goods that are not in stock, goods have to be produced first; (2) without an invoice being generated by the sales department, no revenues are realized and noticed by the financial administration department; and (3) that no personnel costs are booked without the payroll run (including the posting to accounting). ERP systems can thus give the students examples of integrative functionality and the business process view.

Business schools have realized the potential value of using ERP systems as an educational tool to teach business processes. As a result, there are now ERP University Alliance programs that provide academic institutions with (a completely) functional ERP systems for research and teaching at limited or no cost (Watson and Schneider 1999). Some ERP providers share exercises with universities for educational

purposes. Academic course books have been written to aid in pedagogy - some of which have complete exercise sets using commercial ERP software (e.g., Monk & Wagner 2009). The largest ERP provider for example (SAP) runs a repository for academic exercises, lectures, webinars, and collaboration. They also hold an annual conference for academic coursework exchange and research.

Using an ERP system in the classroom as a hands-on vehicle for learning about business processes is an example of experiential learning. Experiential learning theory tells us that learning is a process that is constantly updating and changing, absorbing and reforming, where the student experiences, observes, conceptualizes, and experiments (Kolb 1984). To fully learn, students must include experience, not just absorb book-learning; traditional memorization of the facts may not stimulate thinking like experiences can (*ibid*). In information systems higher education, emphasis is placed on hands-on experience. Specifically in the area of Enterprise Resource Planning Systems, the largest of the information systems in a business, students experience using a true business information system. This experiential learning should lead to a deep understanding of the underlying purpose of an ERP system: more efficient business processes.

Details of Past Research

When students experience a real enterprise business software package, what are they really learning? Educators hope they are learning about how the entire business fits together with business processes through a holistic view. Past research has attempted to measure the learning outcomes, but most research is focused on self-reporting, not true comprehension, as described next.

Nine key studies have been identified in the literature for discussion and are outlined in Table 1.

Table 1. Past Research Summary

Author/ Publication Date	Method of Assessment	Delivery of ERP	Results
Winkelmann and Leyh 2010	Anonymous questionnaire	S&ME ERP software used in case study class	Good knowledge acquisition; undergrads felt it was too difficult
Cronan et al 2009	Self-reported knowledge, skills, and attitude	SIM Game	Self-reported knowledge, skills, and attitudes increased
Rienzo 2007	Student exam, self-assessment, qualitative comments	Undergrad MIS course for business students	Only statistically significant for certain learners in one exercise
Seethamraju 2007	Questionnaire – self assessment	Graduate course within Business Information Systems	Perceived knowledge gain; good satisfaction rating
Johnson et al 2006	Student Exam Self-efficacy survey	Labs in traditional classes	More learning MRP Less learning scheduling
Noguera and Watson 2004	Student Exam Self-efficacy	Hands on SAP Hands on simulator	Simulator and SAP gave similar gains over no ERP
Davis and Comeau 2004	Learning log; configuration exercise; take home case; lab exam	Senior undergraduate enterprise integration class	Knowledge gain of business processes below expectation (positive learning experience)
Nelson and Millet 2001	Self-reporting knowledge; mid-term evaluations; end course evaluations	Lectures, case studies, discussions, guest speakers, SAP lab	All self-reporting knowledge increased
Wagner et al 2000	Survey	HR Management with ERP; vs. no ERP	Positive results but no statistical significance

Throughout many of these studies there is a theme of self-efficacy. Questionnaires or similar self-assessment tools were used to determine the effectiveness of using an ERP system in the classroom in 7 of the 9 studies identified. Out of those 7, 5 studies showed positive results for this self-reporting. Winkelmann and Leyh (2010), Cronan et al (2009), Seethamraju (2007), Johnson et al (2006), and Nelson and Millet (2001) all reported positive student feelings towards using ERP as an educational tool. The remaining 2 studies using self-efficacy, Davis and Comeau (2004) and Wagner et al (2000) were inconclusive. Although feelings and attitudes of students towards learning are important, what did the students actually learn from these classes? Only a few studies have attempted to objectively measure just that.

An objective exam to test business process knowledge was given in 4 of the studies. Out of these four, Rienzo (2007), Johnson et al (2006), Noguera and Watson (2004), and Davis and Comeau (2004), only the Noguera and Watson study showed conclusive results in favor of teaching with ERP systems (the others showed inconclusive or conflicting results). In this conclusive study, three different sets of classes were run, one without ERP, one with a live ERP system, and one with a simulated ERP system. There was a statistically significant difference between the control group and the two groups using ERP. No difference was found between the groups using ERP, that is, the simulated ERP package caused similar outcomes to the live SAP software. These outcomes are important in directing future research in the area. Using ERP systems in the classroom has a beneficial effect, but the vehicle for delivering ERP systems might not matter much. ERP systems may be delivered live through a commercial ERP software package, or it might be delivered in some other method, such as a simulator. Simulations are in fact, being currently used to teach ERP concepts. The ERP Sim game was developed at HEC Montreal to allow a new type of experiential learning. Instead of the traditional lab exercises where students work on ERP systems in a step-by-step fashion, the simulation game allows teams of students to run a company through a live ERP system (Cronan et al 2009).

Most of the research done thus far has been measuring outcomes on the undergraduate level. Graduate educational outcomes were measured by self-assessment in only the Seethamraju (2007) study and the Winkelmann and Leyh (2010) study. In addition, the latter tested across different universities. Table 2 illustrates other differences between the nine studies showing that out of those 9, only 3 pretested their classes and only 3 used a control group without any ERP education.

Table 2. Past Research Pretesting and Control Grouping

Author/ Date	Post ERP Class	Pre ERP Class	Alternate class without ERP
Winkelmann Leyh 2010	X		
Cronan et al 2009	X		
Rienzo 2007	X	X	
Seethamraju 2007	X		
Johnson et al 2006	X	X	X
Noguera Watson 2004	X		X
Davis Comeau 2004	X		
Nelson Millet 2001	X	X	
Wagner et al 2000	X		X

Comment on the Assessment of ERP Education

This review illustrates that there is surprisingly little conclusive research on the effectiveness of teaching ERP systems in a university setting, especially when measuring business process learning. When asked whether teaching ERP helps a student to understand the integrative functionality of an organization, most educators would answer a resounding 'Yes'. This view, however, is based mostly on anecdotal evidence, not on substantive research (either quantitative and/or qualitative) that has been addressed with any rigor. It is therefore difficult to understand whether a student gains in knowledge of business processes after learning ERP systems. Testing a student through a multiple choice exam on book knowledge or knowledge of keystrokes within an ERP system may not measure accurately whether a student can understand the linkages between functional areas of an organization. In each of the studies outlined in this paper, the researcher gave an objective exam to a student and/or compiled results from questionnaires that probed feelings on the learning experience. Some experts feel that standard exams are no longer able to assess all the knowledge students gain using today's technology (Kozma 2009). As for the outcomes of the questionnaires on the learning experience, most of the research reviewed stress positive feelings. While students need to be feel positive about their learning environment and confident about their own abilities and understanding, self-efficacy may not translate to better understanding of business processes and better decision making in an organization. In summary, a more concrete measurement of knowledge is required for conclusive evidence.

It is challenging to create a measure of students' understanding of integrated business processes and "as of yet there is no generally accepted method of assessing business process understanding" (Rienzo 2007, page 11). The core measurement of ERP educational effectiveness should be business decision making in a realistic scenario because understanding integrative functionality in an organization contributes to better business decision making. The view of the entire organization is considered, not just functional silos. Reactions to various business scenarios would measure business decision making. One possible method of appraisal is to measure how well a student can make a business decision that will impact the organization as a whole. Another alternative might be to measure how a student would react in certain business circumstances that require functional integration knowledge. The existing research in the area thus far has not used these types of measurements and it is not unreasonable to assume that integrative decision making capabilities could be captured in a business simulation. Business simulation games, such as the MIT beer game, are used to teach systems concepts, management interaction, and illustrate communications problems within an organization (Goodwin and Franklin 1994). Using a business simulation to assess the students may then give a clearer picture of their knowledge of business processes gained from exposure to ERP systems. Simulation games are currently being used to teach ERP systems; they should be effective in measuring the results of ERP education (Leger 2006).

All of the research cited in this paper use ERP systems with experiential learning in the classroom in some form. However, many of the measurements of self-assessment or testing of the students' understanding were performed after only a few classes or exercises with ERP. An improved study would be one that uses the entire academic semester or year to determine whether the delivery of ERP had any effect on students' understanding of business processes (only two of the comparative studies utilized the whole semester). ERP systems are highly complex and concepts surrounding business processes are also complicated. If a student had an entire semester to digest the complexities of these concepts, perhaps the outcome of research would be more conclusive.

Research in Progress

In an attempt to address the above issues, students will be asked to play a business simulation game as a test of their understanding of business processes. A business simulation game may be a superior measure to that of a traditional exam in that it may measure the understanding of how organizations must operate in a cross-functional manner. The business simulation game results may show whether the key facets of business processes are comprehended. Once the game is played, focus groups of students will be formed to interpretively understand why some students performed in certain ways on the simulation game with relation to business processes. Details of the research plan and its development are explored next.

Research Approach

The problem of measuring learning is a complex task, as evidenced by the aforementioned studies, and may require multiple approaches. This research initially uses a quantitative approach, where concrete values are assigned to the research outcomes and statistical methods are applied to analyze the data, and then moves to a qualitative approach, where the focus will shift to language and the social environment of the subjects to understand why students acted as they did (Myers 1997). Therefore, this research is currently being conducted with a view towards multi-method philosophy, known as critical realism (Bhaskar 2008, Mingers 2008). Critical realism attempts to understand the mechanisms beneath causal relationships (Danermark et al 2002) and will manifest itself as varying research methods; one research method alone often cannot explain complex situations (Mingers 2001). By using more than one research method, known as triangulation, the researcher can plug any holes in the work, thereby making it stronger (Orlikowski and Baroudi 1991). In addition, research is often not a one-step project, but goes through phases and hence each phase might need a differing approach (Mingers 2001).

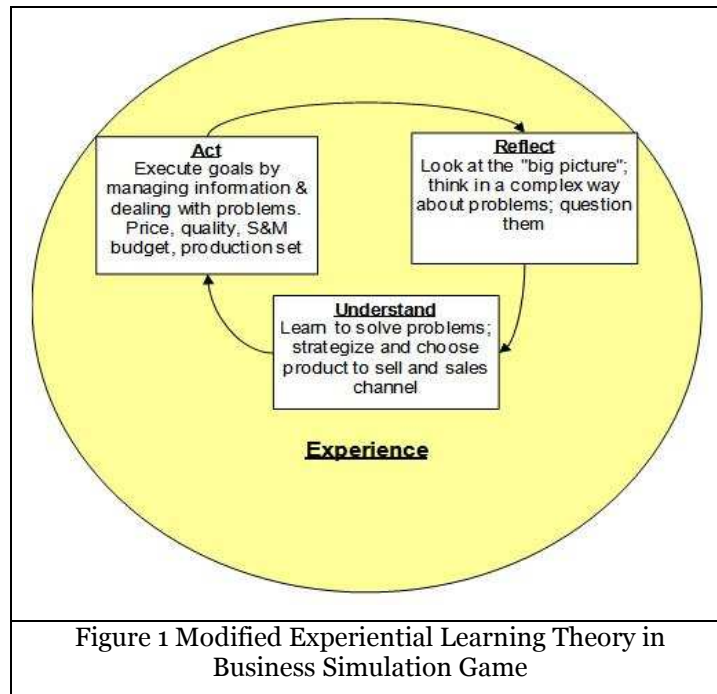
In order to execute this triangulatory research approach, the first phase will employ an experimental simulation. This type of research method simulates the real world (Jenkins 1985). By using a computer business simulation game, students' real-world decision making will be measured in objective data collection and analyzed by statistical techniques. Making good decisions about how to run a business requires business process knowledge. Making good decisions about running a business on a computer simulation should give similar results. Simulations are models of reality, not exact replicas. However, they can still be excellent learning devices and help students make real-world decisions. In the actual business world, problems are so complex that, as humans, we need to break them down into smaller subsets in order to digest and solve them. So the way that computer simulation games might simplify a business situation actually mimics how we make decisions in real life (Cannon 1995). This phase will answer what the students have learned about business processes with or without ERP pedagogy.

The benefit of using a simulation game as opposed to a written exam to assess the students' knowledge is that it is "performative" (Biggs 1999, page 35). Biggs' term performative means that a high level of comprehension alters the learner's view so that he/she performs differently. If students fully understand a concept, then they will be able to use those concepts to solve new problems in unknown circumstances. This performative type of assessment, in this case a simulation game, is superior to verbal assessment because it gets at a deep level of comprehension (*ibid*). Past studies on assessing students' knowledge of business processes with ERP systems education have all used written exams or self-efficacy studies, which may remain at a superficial level of understanding, one that is not sufficient to show the true pedagogical outcomes.

The classic educational theory of Bloom's Cognitive Taxonomy further supports this performative simulation game assessment. Bloom categorized learning objectives into 3 domains: cognitive, affective, and psychomotor. Within each category, there exists levels that must be achieved in order; that is, one depends on the previous level. The cognitive domain is the domain of higher interest for educators today, dealing with understanding, knowledge, and problems solving. The levels within that domain begin at the lower end with knowledge, and continue onto comprehension, application, analysis, synthesis, ending in evaluation at the upper end (Bloom et al 1956). Any assessment of business process education, which is a complex topic, needs to be at the higher end of Bloom's taxonomy since the assessment should match the subject matter. Instead of testing at the lower level of thinking skills, such as a multiple choice exam (Anderson and Lawton 2009), the simulation game tests at the higher end and may show true learning outcomes.

Just as using an ERP system in an educational context is experiential; playing the simulation game is experiential too. During the game, the player is immersed in a business world, experiencing it and making changes that affect its outcomes. The player must choose a product to sell and a sales channel in which to sell that product followed by a period of controlling manufacturing and selling. Outcomes of the game are recorded and financial results are displayed at the end of the game (Pixelearning 2010). The simulation game, the assessment of the students' knowledge, can be theoretically traced on a modified Kolbian experiential learning theory, just as is the actual learning of business processes through the experience of an ERP system. As shown in Figure 1, the stages of the game can be juxtaposed over this modified experiential learning cycle. The act of playing the game is the experience. Students reflect on

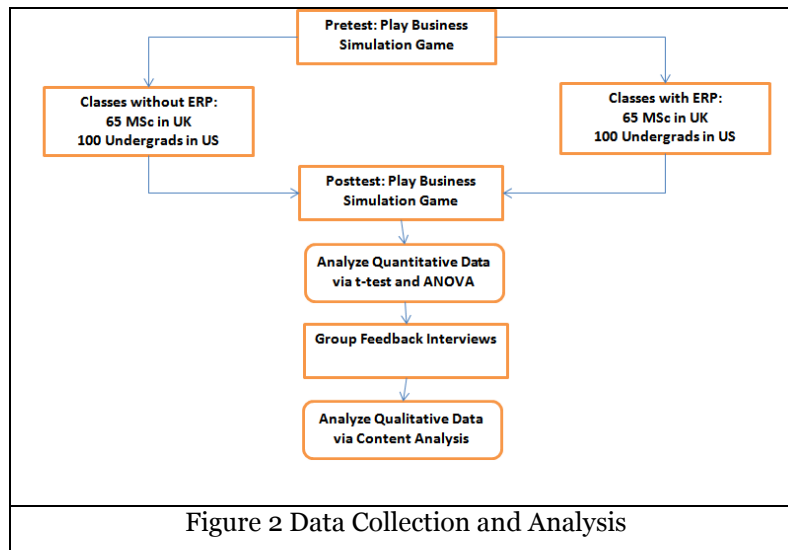
running the business, taking into account the integrative nature of organizations. As they understand, they choose products to sell and sales channels, finally acting on their strategies as the company manufactures and sells product. Those students understanding more about business processes will be better equipped to strategize and act to maximize profits for the virtual company.



The second phase of this research will be a group feedback analysis, where the results of the analysis of the simulation game will be discussed via group interviews. This phase is interpretive and the resulting data will answer why the students played the game as they did, understanding the influence of ERP knowledge on using business processes to run a virtual company. For this data collection, the students will form focus groups to discuss the outcome of their exercise. The focus groups will get the participants talking in a non-threatening, casual atmosphere which should reveal their thought processes. Others' comments during the focus group will hopefully prompt some students to recall their logical approach to the game and encourage further discussion.

Data Collection and Analysis

The data collection will occur in both the UK and in the US. Both sets of data collection will follow the plan outlined in Figure 2. Pretest data will be collected from every student, by requiring them to play the simulation game. The educational treatment then occurs. In the UK, this will consist of 2 entire Master of Science programs in information systems (one with and one without ERP), with about 60-70 students in each program. In the US, this will consist of a semester's undergraduate classes in information systems (one with and two without ERP), with approximately 100 students taking information systems classes without ERP and the same number taking them with ERP. At the end of the program/semester, the students will play the game again.



The business simulation game employed is a commercial product written by Pixelearning. (This is not to be confused with the ERP Sim game (Cronan et al 2009), which is unsuitable for assessment since it would be biased towards ERP-learning students.) Their web-based games, The Enterprise Game and The Business Game, test the user's ability to run an organization. Once the game is complete, financial outcomes will be collected and their results analyzed statistically using the software SPSS. Since the same participants will be playing the simulation game twice (before and after the educational experience), and there are only two types of classes (with and without ERP), a good way to analyze the data is through a t-test. This type of analysis is used for measuring the means of two groups with only one independent variable, that being the educational treatment (Hair et al 2006). In this experiment, data is being collected by the same measures (the outcomes of the simulation game) from the same group of participants, after being treated to different conditions (classes with or without the experiential learning of ERP). To ascertain whether the experiential learning has any effect on learning business processes as evidenced by the results of playing the simulation game, the difference between the mean scores of the game outcome will be analyzed by the statistical software. In addition, the outcomes of the game for each type of class from the pretest will be put through a t-test to determine if the students in each type of class are equal in terms of their learning capabilities. Once the pre and post data are compared between the classes with and without ERP, the results of the simulation game will also be compared across countries (US and UK), which is also across level of curriculum (undergraduate and graduate). This comparison of means then becomes a test with 2 independent variables: with and without ERP, and US and UK. To statistically analyze this data, a multifactorial ANOVA must be used, the best procedure for two independent concurrent variables. Business process knowledge gain will hopefully be measured in the results.

The students will be asked to join focus groups to discuss their decision making strategies while playing the game. To analyze the qualitative data from this research, the constant comparative method, also known as content analysis, will be used with the software, nvivo. Overall, this method allows for coding of the interpretive data along with a continual refinement of the proposition or theory of the research. Firstly, various phrases that would be considered codes within categories are defined by the researcher. Qualitative data is then collected and categorized under these codes. As these codes are populated with phrases from the interviews, the researcher can stop and write notes about the results of these identified codes, and then continue to identify and classify codes within the interpretive data. As data is collected, it should be coded and written about so as to refine further data collection in the research project. As more and more data is analyzed in this method, theories start to emerge and the subsequent data coding can be refined and pared down to the most important concepts. Finally, the theory can emerge, from this comparative analysis (Glaser and Strauss 1967). This constant comparative method allows any variety in the data to be included in building the theory, therefore inductively developing a theory as the data is analyzed, moving from observations to theories.

The t-test/ANOVA design and the constant comparative method for data analysis fit well with the critical realism approach in this dissertation. The research begins with a proposition that experiencing ERP systems will help business process understanding. That proposition will be tested and criticized quantitatively with the business simulation game. As the qualitative data is collected, understanding of the students' knowledge of business processes will be abstracted, and a revised theory built up successively.

With all the resources put into teaching ERP systems, the assessment of students' knowledge should be quantifiably conclusive. Past research studies have not explored the correct measurement of students' understanding of integrative functionality. By using a business simulation game to measure business process decision making, and by filling any gaps with interviewing groups of students, decisive results should be attained.

Conclusion

Enterprise Resource Planning systems are important software tools for integrative functionality in an organization, allowing for efficient flow of business processes. ERP systems are run by most large organizations, and increasingly by many mid-sized and small organizations. At the same time universities are using commercial ERP systems to experientially teach students business processes within an organization. This paper has compared 9 research studies centered on assessing ERP education. However, little conclusive quantitative or qualitative research exists in those studies that prove that ERP systems help students learn integrative functionality and business processes. The authors present research in progress to improve on the existing work.

- To assess the students' knowledge, a business simulation is used to measure integrated decision making. By measuring their performance in a business simulation, students' understanding of how functional areas in an organization may be more definitively assessed than by measuring their performance with a multiple choice exam.
- Any gaps left in answering the research question will be filled by interviewing groups of students to understand why they made the decisions in the simulation game that they did.
- This assessment of the students should take place after an entire semester's or year's work has passed as opposed to just after a few classes using ERP systems. ERP systems are highly complex, and exposure to these information systems over a period of 3 or 4 months to a year could yield significant results.

The proposed research results should validate the efforts of many universities who teach ERP systems, and perhaps suggest improvements or refinements to this cutting-edge education. Proof of gain in knowledge of business processes would encourage other schools to begin to teach ERP systems.

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