

**Measuring the Effectiveness of Enterprise
Resource Planning Education on Business
Process Comprehension**

**A thesis submitted for the degree of Doctor
of Philosophy**

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Abstract

Enterprise Resource Planning Systems (ERP) are very large and complex software packages that run every aspect of an organization. Increasingly, ERP systems are used in higher education to teach business processes, essential knowledge for students competing in today's business environment. Past research attempting to measure learning business processes with ERP has been inconclusive and lacking in rigor. This dissertation contains a comprehensive research study that uses a critical realist approach to measure business process learning from experiential ERP. Using a business simulation game as a proxy for understanding business processes, students from (1) a US undergraduate program in three separate classes, one using ERP experientially, and (2) two UK postgraduate programs, one experiencing ERP and one not, are assessed both quantitatively and qualitatively. The data analysis results in a causal mechanism for learning, complemented by a list that trigger or suppress that mechanism in particular cases. The results validate the efforts of those using ERP in the classroom, and reaffirm other educational business school endeavors, with educational implications as follows.

First, before attempting to learn business processes, students must know about business in order to enable them to learn this complex topic. Second, experiencing ERP systems indeed helps students understand business processes, with a cohesive curriculum integrating ERP benefitting students the most and students at the postgraduate level learning more deeply. Third, students are using the knowledge gained in university classes to make business decisions. Fourth, students should be encouraged to use all information possible for making business decisions instead of relying on their personal understanding of today's current market, relying on their own business intuition or work experience. Last, teaching methods may need to be adjusted for postgraduates, especially those coming into programs with significant work experience.

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Publications

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Chapter 1. Introduction

Nothing is a waste of time if you use the experience wisely. Auguste Rodin

1.1 Background to the Work

This research examines students' understanding of business processes after experiencing ERP in the classroom. The educational study of business processes is important because business organizations are increasingly emphasizing them. From global competition to the speed of today's transactions, organizations are changing the way they think from a functional perspective to one of a cross-functional nature. The cross-functional view requires sharing information, information systems and integrated processes (Amrani, Rowe et al. 2006). For an organization to be more efficient, it needs to improve its way of doing business. The way of doing business is in effect, the business processes. So there needs to be an emphasis on improving the business processes in an organization to maintain or improve efficiency (Harmon 2007). With ERP systems, business processes become standardized, information flows across functional lines (Barua, Ravindran et al. 2007), and companies become more efficient and competitive.

1.1.2 Business Process Education

Business process comprehension is essential for today's business student preparation for future employment. Hammer and Champy (2001) reiterate the necessity for business processes within an organization arguing that *"It is not products but processes that create products that bring companies long-term success"* (p.27). It is often found that company problems originate in poor processes, not that employees are incompetent or that technology is flawed (McDonald 2010). If employees develop a process perspective, and search for ways to improve those processes identified, then the company will more likely satisfy their customers fully, become more efficient, eliminate or decrease errors, and increase their profits (ibid). No longer can higher education teach in silos of separate information functional areas, but professors need to impress upon the students the business process view.

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University business majors are indeed now beginning to study business processes. In the past, businesses were organized around functional jobs and subsequently, business schools were organized around functions, with classes in separate functional areas (Monk, Wagner 2013). Business higher education has lagged behind in teaching business processes and business schools have been criticized for teaching in silos. By teaching in silos of information, students are not prepared to work with cross-functional problems in today's fast-paced environment (Cannon, Klein et al. 2004). In addition, "*because of the discipline-based structure of business schools, coursework promotes specialization rather than integration*" (Michaelsen 1999, p. 9). Businesses hiring new graduates are looking for those with cross functional skills (Aurand, DeMoranville et al. 2001), so as a result, business schools are rethinking their curriculum's functional orientation (Becerra-Fernandez, Murphy et al. 2000).

In the mid-1990s, only MBA curriculum taught cross-functionality (Corsini, Crittenden et al. 2000, Crittenden 2005) and by 2000, an AACSB survey of undergraduate business programs showed a result of 90% of classes at the senior level had a capstone class with business integration, but only 5% had a fully integrated program (DeMoranville, Aurand et al. 2000). The current AACSB standards emphasize integration of business areas and cross-functional education (Aurand, DeMoranville et al. 2001). Business schools are moving their coursework towards a process-oriented approach, which fits in with these standards and places importance on cross-functionality. As previously mentioned, capstone strategy classes are one way to fulfill this accreditation requirement. In some Business Schools, business process modeling is being taught in separate classes (Recker, Rosemann 2009). Enterprise Resource Planning systems software is also used to experientially teach integrated business processes over the last 10 or so years (Wagner, Najdawi et al. 2000, Wang 2009, Rienzo, Han 2010).

The importance of understanding business processes is evident in the literature and in practice. Students need to go beyond understanding individual functional areas and be able to comprehend business processes that stretch across functional lines (Jeyaraj 2010). Higher education should be confident that the students are actually learning business processes. However, assessing that learning of business processes is challenging. This research is attempting to meet that challenge and measure business process learning from experiencing ERP systems.

1.1.3 Assessment

An extensive review of past studies attempting to measure business process learning with ERP systems resulted in surprisingly little conclusive research on the effectiveness of teaching ERP systems in a university setting (Monk, Lycett 2011). Understanding whether a student gains in knowledge of business processes after learning ERP therefore remains a challenge. Out of the 9 studies reported, only 4 gave an objective exam for testing students' business process knowledge, and only one study from those 4 showed significant results in validating the business process education with ERP systems. 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 substantial research (either quantitative and/or qualitative) that has been addressed with any rigor. The challenge is to understand whether a student acquires knowledge of business processes after learning ERP systems. Testing a student 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 past studies, the researcher compiled results from questionnaires that probed feelings on the learning experience and/or gave an objective exam to a student. To measure the students' understanding of a business process and how functional departments are linked through information systems by an objective exam may not be accurate. Some experts feel that standard exams are no longer able to assess all the knowledge students gain using today's technology (Kozma 2009). While most of the research reviewed stresses positive feelings for using ERP, there is little statistically significant quantitative data to validate the effectiveness; much of the data are based on studies of self-efficacy. Students need to be confident about their own abilities and understanding, however self-efficacy may not translate to better decision making in an organization. Students should feel positive about their learning environment, but their own perceptions do not measure their true understanding of business processes. In summary, a more concrete measurement of knowledge is required for conclusive evidence. In this research, it is argued that business simulation is a more appropriate measure of business process understanding that stretches to the higher levels of Bloom's cognitive taxonomy (Bloom, Engelhart et al. 1956).

1.1.4 Computer simulation as assessment

Computer simulation of business is common in higher education and experiential learning theory accelerated the use of simulation games in business education (Keys, Wolfe 1990). The benefits of teaching with simulators are attractive. *“The simulation’s value [is] as a learning methodology, a research tool, and a classroom decision-making exercise that models the real world of business”* (Washbush, Gosen 2001, p. 292). Kolb’s experiential learning theory is based on his philosophy that *“learning is the process whereby knowledge is created through the transformation of experience”* (Kolb 1984, p. 28). Experience is a fundamental aspect of education and in particular, information systems education which often includes hands-on computer work. Kolb postulated that educators lead the student around the experiential learning cycle, through the various modes of concrete experience, reflective observation, abstract conceptualization, and active experimentation.

Experiential learning theory proposes that a learner can understand more with experience. This happens, for example, during an information systems class when hands-on computer exercises are used for instruction. A computer simulation of business can also take the learner through the experiential learning modes of active experimentation, concrete experience, reflective observation, and abstract conceptualization, as problems are posed and solved. Regardless of the student’s achievement or GPA, it has been demonstrated that students are overwhelmingly in favor of business simulations for education (Anderson, Lawton 2009).

One attribute of a simulation game is its fidelity or *“level of realism”* (Feinstein, Cannon 2002, p. 426). Simulations are models of reality and are not exact replicas. Even though they are not exact replicas 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). High fidelity is not (necessarily) linked with greater learning because game players can become over-stimulated and learning can be stalled (Feinstein, Cannon 2002).

An example of a business simulation game that is well-known is the MIT beer game. Originally developed at MIT in the 1960s, the game simulates a beer production and distribution system to promote learning about systems (Goodwin, Franklin 1994). Teaching outcomes from this simulation

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game are favorable; the game teaches students about the systems approach to problem solving (Goodwin, Franklin 1994). Another learning outcome from the Beer Game is that communication is essential to running a business. Students are surprised at the “*problems in communications for just one simple product*” (Jackson, Taylor 1998, p. 213).

Simulation games are used at universities to teach ERP concepts. Leger claims faculty have found that students struggle with the concepts that ERP systems introduce – integrated business processes – and yet also noted that today’s business student is very computer-literate (2006). The ERP educational simulation developed at HEC Montreal involves teams competing to run a cereal manufacturing business. Working with different time periods, the teams decide on production and sales and use an actual ERP system (SAP in this instance) to determine production runs. Results and statistics are generated in the form of reports and Excel files to give feedback to the teams so they can make adjustments. In this gaming classroom, students move from a silo-oriented approach running a company, to a process-oriented approach.

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 gradually find that reorganizing the task around a business process enables them to benefit from an integrated system (Léger 2006, p. 445).

In this ERP simulation game, students are evaluated on their use of the information that is presented to them from the ERP system, and in their final presentation to the “*boards of directors*” (Léger 2006 p. 445). Cronan et al speculate that teaching ERP via a simulation game is superior to that of hands-on ERP exercises because it allows the student to view the system as a whole and not get bogged down with step-by-step keystrokes on the ERP system (2009). This is an example of true experiential learning as the student observes the SAP results, plans strategies, and makes changes to win the game.

Past research testing the effectiveness of teaching with business computer simulations has mostly been in the realm of self-perception resulting in little research measured learning with concrete objective means (Anderson, Lawton 2009). However, a recent research project attempted to link the

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two. The researchers drew a strong correlation between self-perceived knowledge and actual objective measurement of knowledge using a simulation game to teach ERP concepts. After playing the ERP simulation game, students were asked a series of objective questions about enterprise systems, business processes, and SAP transaction skills. The easier questions on the Bloom's Taxonomy correlated more strongly with the positive self-perception than the more difficult questions (Cronan, Léger et al. 2010). Some researchers speculate that simulation games are good for teaching higher levels of learning on the cognitive scale of Bloom's Taxonomy and should not be used for teaching terminology, and basic concepts (Anderson, Lawton 2009). If that is the case, then perhaps simulation games are good at measuring the higher levels of learning as well, such as the complex understanding of business processes from ERP systems.

Computer business simulation games can do a good job of mimicking manager's decision making processes in a business situation. And these simulation games could also be used as an assessment to measure how well a student understands the various parts of a business and how they interact. Students should be asked to apply their knowledge as they would in a real life situation for assessment purposes (Weiss 1998); they should be able to solve new problems in unknown circumstances which will assess at a deep level (Biggs 1999). A computer simulation of a real business environment fits that requirement. Also mentioned previously, Kozma claims that the traditional assessment tools such as exams just allow students to regurgitate facts and do not test for today's requirements that graduates be technologically savvy, be able to solve complex business problems and communicate well (2009). Simulating a business environment as an assessment should be better.

Kolb's experiential learning cycle can be simplified as shown in Figure 1.1. It is argued here that the entire learning process can be categorized as Kolb's concrete experience, in a three-step cycle. Within that experience, the learner is reflecting, understanding, and acting. In the reflect phase, the learner is taking in all the information, identifying problems, and assessing the situation. From there, the learner moves to understand from the previous phase, builds up a strategy, and looks for a solution. Finally, the learner acts on that strategy and solution formulated in the previous phase. Those three steps together form the concrete learning experience; Kolb's concrete experience is not a separate part of the cycle, but encompasses the entire learning process.

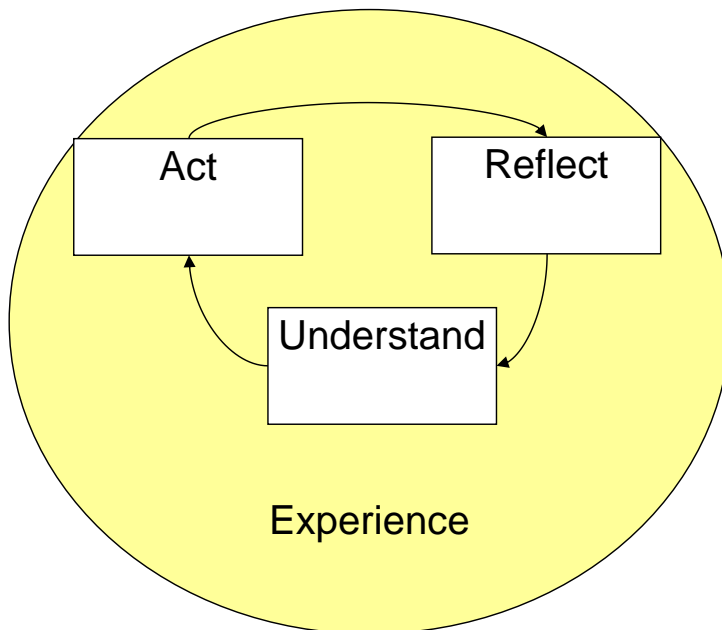


Figure 1-1 Simplified Kolbian experiential learning cycle

When playing a business simulation game, be it for learning or assessment, the player is following the simplified experiential learning cycle. First, the player must understand how to play the game and make some initial decisions. After the rules are determined and decisions on how to start are determined, the player can act on their choices. As the game unfolds, the player will reflect on feedback the game is giving, digest that feedback (e.g. understand it), and act on their decision. The circle continues around and around as the game is played. The entire act of playing the game is considered the experience. In this research the experiential simulation game cycle, passing through understand, act, and reflect, can be used as assessment for determining business process understanding after experiencing ERP in a classroom setting

1.2 Aims and Objectives

The aim of this research is to measure business process learning from experiential ERP. The objectives of this research are to:

1. Review the literature on assessing the value of experiencing ERP systems to learn business processes in order to benchmark the state-of-the-art

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2. Analyze the quantitative data from the change in simulation game outcome to see if there are differences between classes that experienced ERP and classes that did not experience ERP
3. Code and analyze the qualitative data to understand why the students played the game as they did and, along with the qualitative data, develop a mechanism for learning
4. Draw out the educational implications for theory and practice

In order to achieve those objectives, the intentions of the research are:

1. Find a commercially available business simulation game to measure students' understanding of business processes
2. Recruit students from information systems classes that do and do not use ERP systems to play a business simulation game before and after their classes in order to measure business process learning
3. Conduct focus groups and brief email interviews to identify students ideally suited for in-depth interviews
4. Conduct in-depth interviews with a variety of students to understand why they played the game as they did and to discuss business processes

1.3 Method of Study

The research philosophy pursued in this study follows critical realism, which attempts to understand the mechanisms beneath causal relationships (Danermark, Ekstrom et al. 2002). As an alternative to the traditional philosophies such as positivism or interpretivism, critical realism uses elements of both to explain the impact of "*sociotechnical phenomena*" (Wynn and Williams 2012, p. 787). Under this philosophy, empirical results alone are inadequate to determine theory. To complete a critical realist research study, mechanisms are hypothesized to explain the quantitative and qualitative data (Danermark, Ekstrom et al. 2002, Bygstad, Munkvold 2011). Within the context of the data, there are forces for (causal powers) and against (liabilities) the workings of these mechanisms by which

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the results occur; essentially the ways in which things actually act. Powers and liabilities each demonstrate potential mechanisms that may or may not happen in a given research situation (Sayer 1992). Bygstad and Munkvold summarize the goal of critical realism research as, not to come up with generalizations, but to uncover the mechanisms that cause the outcomes. Those mechanisms may not be evident from simple observations (Bygstad, Munkvold 2011).

Critical realism research, being diverse by nature and holistic in its view, demands multiple tactics (Bhaskar, Hartwig 2010). Mingers (2001) and Orlikowski and Baroudi (1991) present a set of cogent arguments in favor of using multiple research methods in a single research project.

- The world is complex, Mingers argues, and so one research method cannot explain all its complexities (2001).
- If only one research method is used, then the researcher may only be looking at one aspect of the project, and missing out on other facets, showing limited results (Orlikowski, Baroudi 1991).
- The triangulation of methods used in research will make it a stronger research project because the different methods can explain different aspects of the project and fill in any holes (Mingers 2001, Orlikowski, Baroudi 1991).
- The field of information systems has expanded to that of a social science therefore research within the field should employ a variety of research methods (Mingers 2001).
- Research projects run through various phases and each phase can use a different research approach (Mingers 2001).

In this research, data collection began with a quantitative approach in which the students played a business simulation game and were assessed by the outcomes of the game. This phase seeks to measure what the students have learned about business processes with or without ERP pedagogy. The second phase of the research is qualitative, where the students participated in focus groups and then in one-on-one interviews. The resulting data answers why the students played the game as they did, understanding the influence of ERP knowledge on using business processes to run a virtual company. Beginning with the proposition that students will learn more about business processes

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when experiencing ERP systems in the classroom, this multi-phase research tests and refines the proposition. To understand the students' thought processes while they played the simulation game and to understand why they did what they did in relation to business processes, this qualitative method is appropriate for the second phase. By interviewing students, this triangulated approach fills in the gaps left open and results in a refined and well-supported theory. Past research was lacking in that mostly quantitative data was collected, not allowing for a deep(er) understanding of how students learn. It is argued that critical realism is a more comprehensive research strategy that will produce definitive answers and recommendations for future work.

The steps in the research are outlined in the following Figure 1.2:

Measuring the Effectiveness of Enterprise Resource Planning Education on Business Process Comprehension

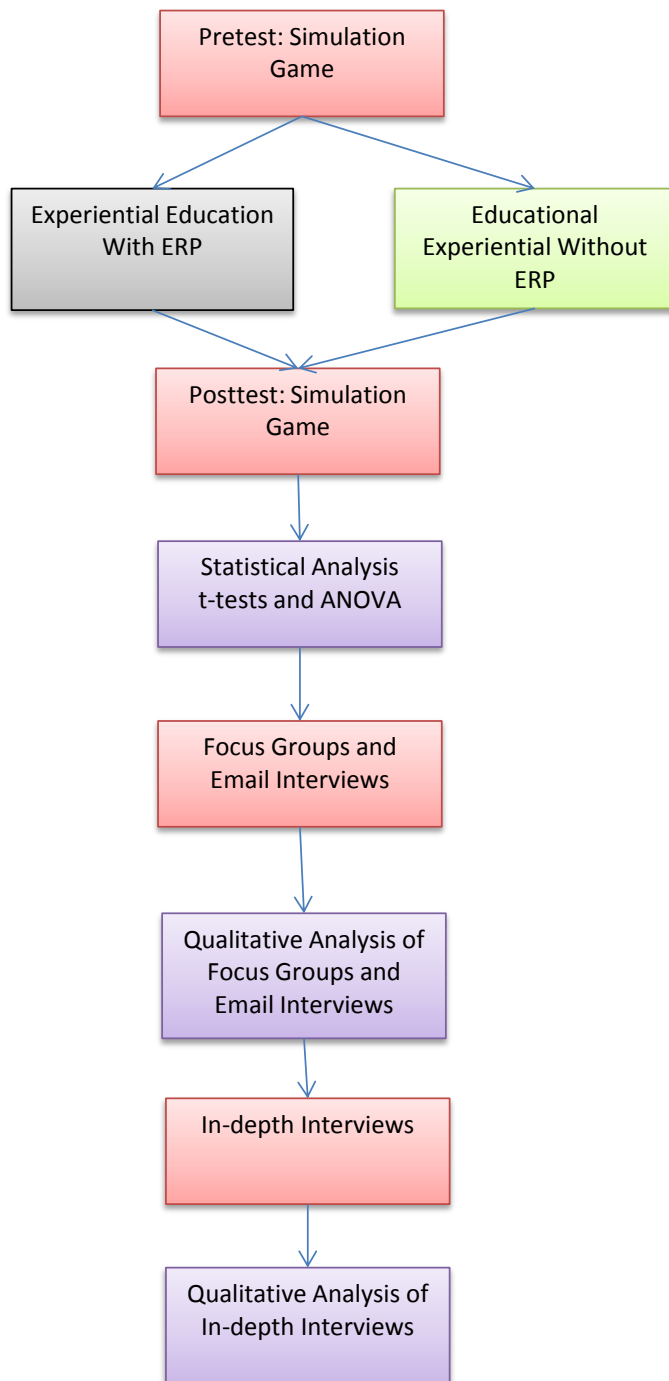


Figure 1-2 Research Steps

Students in each class were asked to play a business simulation game either before any education began or during the first week of their classes. The outcome of the game, net profit, was recorded

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for each student's game result. At the end of the semester (US undergraduates) or at the end of the coursework (UK postgraduates), students were again asked to play the business simulation game, with net income outcomes recorded. This quantitative data was analyzed statistically by t-tests between classes of the same university, and later by ANOVA for classes across both universities.

Focus groups and email interviews were then arranged and conducted with students from Delaware to briefly discuss strategies during the game. At Brunel, these were exclusively conducted by email since the researcher resided in another country. From these preliminary interviews, the qualitative data was analyzed and students who articulated unusual statements or who were voluble were selected for further in-depth interviews.

These selected students were interviewed to discuss the business simulation game and other topics surrounding business processes. Using content analysis, all interviews were transcribed and coded with the software NVivo. Categorical codes, previously identified in the literature, were used and new codes discovered when analyzing the interview transcriptions. A mechanism for learning was developed for each school.

Further delving into the data revealed specific objects or properties that have the power to trigger the learning mechanism or to inhibit the working of the learning mechanism. Those powers and liabilities were analyzed, discussed, and compared between the two universities. Implications for education were then concluded from the results.

1.5 Structure of Thesis

This thesis is structured in chapters. The chapters are outlined in Figure 1.3, and their descriptions follow.

Measuring the Effectiveness of Enterprise Resource Planning Education on Business Process Comprehension

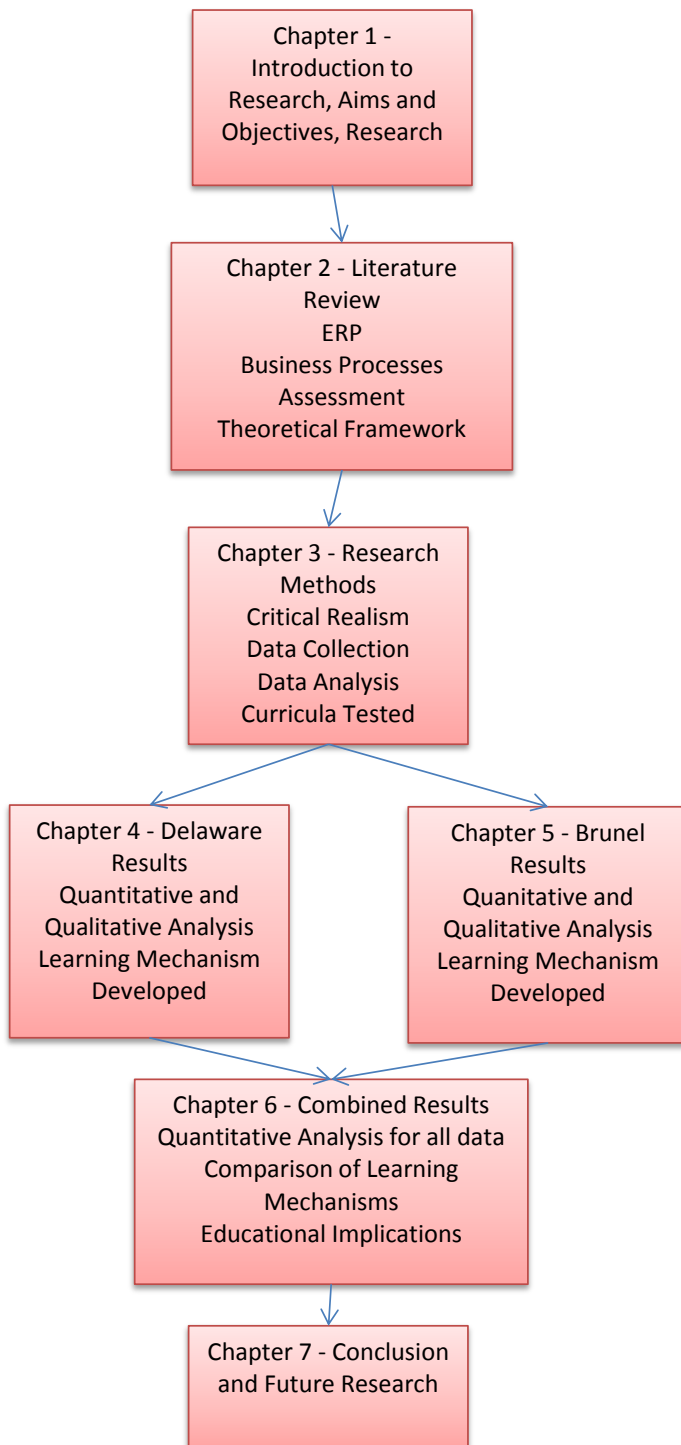


Figure 1-3 Chapter Organization

Chapter 2 provides an extensive literature review. The work begins with an in-depth look at ERP systems and how they promote efficient business processes. The importance of business processes

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is emphasized with a view towards higher education. Assessment and learning styles are then discussed with a focus on the experiential learning theory and ERP. Past research on the assessment of experiential ERP is thoroughly reviewed with simulation introduced as an improved assessment instrument. The chapter finishes with a theoretical framework for the research and issues and challenges arising.

Chapter 3 reviews the possible philosophical approaches to research: positivism, interpretivism, critical, and critical realism, with a focus on the latter. The philosophy of critical realism is then laid out in further detail. Possible research approaches, data collection techniques and data analysis techniques are explored, and the appropriate methodology for this research is justified. The curricula at both University of Delaware and Brunel University are highlighted for the classes and programs tested. The final experimental design is detailed.

Chapter 4 contains the comprehensive analysis of both the quantitative and the qualitative data collected at the University of Delaware. The work begins with the statistical outcomes of the quantitative data. Simulation game results are statistically compared from the classes experiencing ERP systems to the classes without ERP. Continuing from there, the qualitative data is analyzed using content analysis and a causal mechanism for learning developed. Triggers and suppressions to that mechanism are developed from the qualitative data.

Following the structure of Chapter 4, Chapter 5 covers the data analysis, both quantitative and qualitative for the Brunel data gathered at the postgraduate level. Again, two different postgraduate tracks are compared statistically. Next, from the qualitative data, a mechanism for learning is developed with forces for and against that mechanism.

All data collected from both schools are analyzed together in Chapter 6. Firstly, the quantitative data is analyzed by statistical means in different ways. Data between all classes at both universities are compared using ANOVA and data between the two universities are compared using a t-test. Secondly, the qualitative data and resulting learning mechanisms are compared and contrasted. Implications for educators are introduced as well.

The entire thesis is summarized in Chapter 7 along with significant conclusions. Limitations of the research are discussed and future research ideas suggested.

Chapter 2. Literature Review

Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand - Confucius

2.1 Overview

Experiential learning theory describes learning as a process that is constantly updating and changing, absorbing and reforming, stimulating thinking, unlike traditional memorization of the facts. In higher education, emphasis is increasingly placed on hands-on experience (Watters, 2012). Specifically in the area of Enterprise Resource Planning Systems, the largest of the information systems in a business, students experience what it's like to use a true business information system. This experiential learning leads to a deep understanding of the underlying purpose of an ERP system: more efficient business processes. Past research has attempted to measure the learning outcomes from using ERP in the classroom, but most research is focused on self-reporting, not true comprehension. Traditional exams are the most common way to measure comprehension, but traditional exams may not be accurate measurements. The best measurement of understanding business processes may be actual success in a working environment. To approach that working environment test, it is proposed that students play a business simulation game as a baseline to determine their success and to prompt them for later interviews on their understanding of business processes.

This chapter presents literature written on these topics beginning with large enterprise systems and how they promote efficient business processes in Section 2.2. Section 2.3 follows with an in-depth look at the process perspective from the vantage points of ERP, teaching, and key facets. Assessment and learning styles are addressed in Section 2.4 with emphasis on the Kolbian experiential learning theory. In Section 2.5, learning styles with regard to ERP Education and assessing the learning outcomes are explained. A simulation is presented as a cogent assessment instrument in that same section. The theoretical framework of the thesis is developed in Section 2.6, with issues and challenges noted in Section 2.7. The chapter is summarized in the last section, Section 2.8.

2.2 Enterprise Resource Planning Systems

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. Historically, companies have been divided by functional areas, such as marketing and sales or accounting and finance. However, in order to react to the demands of customers in a rapidly changing marketplace, work from must flow quickly and accurately between functional areas (Monk, Wagner 2013). 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. This cross-functionality promotes business integration with the ability to view real-time results (Ranganathan, Brown 2006).

ERP systems affect a company’s business processes, make them more efficient, and in effect, automate them (Themistocleous, Corbitt 2006). These large systems change the employees’ jobs and their way of thinking from a functional approach to one of a business process approach (Wieder, Booth et al. 2006). A classic example of a business process is order-to-cash, where a product is ordered, the product is either manufactured (or located in inventory), then shipped, an invoice sent and a bill paid. Whereas an example of a functional task is receiving and processing payments in Accounting. In a case study surveying 49 senior managers involved in ERP, more efficient business processes were claimed as a benefit (Chang 2006). There are numerous other benefits to using ERP systems that are widely touted throughout the literature, such as integrating all of a company’s systems on one network, with one software package giving the benefit of reduced duplication of systems and eliminating costly middleware (Segars, Catterjee 2010, Chang 2006, Ranganathan, Brown 2006). Many companies have duplicate systems not only from functional area departmental systems but also from mergers and acquisitions. By using a common database with a cross-functional approach, managers have a single view of the data (Umble, Haft et al. 2003), departments no longer own information and become more successful (McCombs 2007, Chang 2006). Different departments are linked, data is keyed in only once, avoiding typing errors, thus integrating the entire organization (Chang 2006). In reality, few large companies have only one enormous ERP system. The DuPont Company, for example, runs a separate SAP system for each of its business divisions (Monk, Wagner 2013). Compliance with Sarbanes-Oxley has enabled companies to cope more easily if they

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have implemented ERP (Winters 2004, Monk, Wagner 2013). In addition, the holistic view of an entire organization provided through an ERP system can give upper management much-needed control (Amrani, Rowe et al. 2006, Monk, Wagner 2013). Table 2.1 summarizes the major benefits to ERP systems.

Summary of Major Benefits to ERP
Efficient business process automation (Chang 2006, Themistocleous, Corbitt 2006, Wieder, Booth et al. 2006)
Cross-functional business integration (Ranganathan, Brown 2006)
Eliminates (or reduces) middleware, reduces duplicate systems (Ranganathan, Brown 2006, Segars, Catterjee 2010, Chang 2006)
Single view of the data, integrating entire organization, data keyed in once, i.e. more accurate (Chang 2006, Umble, Haft et al. 2003)
SOX compliance (Monk, Wagner 2013)
Upper management control (Monk, Wagner 2009, Amrani, Rowe et al. 2006)

Table 2-1 Benefits to ERP Systems

By the late 1990s, these benefits of ERP systems had convinced most Fortune 500 companies to install ERP (Monk, Wagner 2013). Mid-sized companies followed suit and today, many small companies are choosing small ERP packages over simple accounting software such as Peachtree, simply because the business outgrows the limited functionality of a small accounting software package (Ciecierski 2009). In addition, ERP vendors, having saturated the large organization market, are now going after the small and medium sized companies (Boyle 2007). The two largest vendors of ERP systems are SAP and Oracle. Microsoft is also a provider of ERP, along with many other software companies.

Although large, complex and in some ways all-encompassing, ERP systems have their limitations. Just as the single system allows for keying in data once, conversely, any mistake in entry of data into an ERP system can cause rippling problems throughout the organization (Davis, Comeau 2004). However, the main limitation lies in that ERP systems are challenging to implement, with some

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projects taking years to complete. ERP implementations have received a large amount of bad publicity, especially in the late 1990s when ERP was relatively new (Nicolaou 2004, Monk, Wagner 2013), and implementation problems still plague the industry. Implementation troubles often stem from people problems, specifically changing the way that employees do their job or changing the business processes (Murphy, Simon 2002). Those that fail tend to view ERP implementations as solely technical when, in fact, they are business changers with the ERP system imposing its own “logic” (Davenport 1998).

A recent study delving into the published research on ERP implementations paints a grim picture of a lack of success. More often than not, ERP implementations are deemed to be considered “unsuccessful” and large projects have a greater probability for failure than smaller projects (Momoh, Roy et al. 2010). Certain identified causes lead to these disappointing implementations. For example, lapses in change management, training, and top management commitment are some failure factors. Those companies that reprogram the ERP system to a great extent run the risk of poor implementations. And those that don’t understand the way the business must change to fit the software, and how they need to change the status quo also run the risk of poor implementation outcomes. In addition, poor data quality can stymie the effort of ERP implementations (Momoh, Roy et al. 2010).

Despite these challenges in implementations, demand for ERP systems remains strong (Momoh, Roy et al. 2010, Rees 2011). Usage of ERP systems for experiential learning in higher education also remains strong, as evidenced by the SAP University Alliance now having over 1,000 members (SAP University Alliances Educating Future Corporate Leaders, 2011). With this large number of universities using ERP software in the classroom, this thesis is attempting to measure whether experiencing ERP systems aids in business process comprehension, perhaps validating this educational effort.

2.3 The Process Perspective

ERP systems promote efficient business processes and universities are using ERP systems in an experiential manner in the classroom to teach business processes. Understanding of business processes involve comprehension of a number of key facets surrounding those business processes which will be outlined in this section of the literature review.

2.3.1 ERP and The Process Perspective

With ERP systems, business processes become standardized, information flows across functional lines (Barua, Ravindran et al. 2007), and companies become more efficient and competitive. Unsurprisingly, business organizations are emphasizing business processes. From global competition to the speed of today's transactions, organizations are changing the way they think from a functional one to one of a cross-functional nature. The cross-functional view requires sharing information, information systems and integrated processes (Amrani, Rowe et al. 2006). For an organization to be more efficient, it needs to improve its way of doing business. The way of doing business is in effect, the business processes. So there needs to be an emphasis on improving the business processes in an organization to maintain or improve efficiency (Harmon 2007).

The benefits speak for themselves. Cross functional teams contribute to the success of new product development (Valle, Avella 2003). An organization is more competitive when each employee understands and appreciates each other's skills and jobs (Huang, Newell 2003, Hutt, Walker et al. 1995). Better decisions are made with organizations operating in a cross-functional way (Pinsonneault, Kraemer 2002). If a company wants "*greater control over their corporate performance*" they most likely will be involved in integration and business processes (Amrani, Rowe et al. 2006, p. 81).

Widener University did a study of 20 companies from differing industries and found that most emphasized their business processes (Antonucci 2008) and the Gartner Group found that the top priority for CIOs in 2009 was business process "capability" (Recker, Rosemann 2009). In fact, according to Network World, the top tech job for IT professionals is Business Process Modeling. College graduates with business process knowledge are attractive to future employers (Lee 2008) as evidenced by a study of IT jobs and pay scales showing that business process modeling was indeed a valuable skill. In the fourth quarter of 2008, that job specialty experienced gains in pay, over most that did not. Kevin Faughnan, the director of IBM's Academic Initiative, feels that business majors should be studying business processes, and even considers that knowledge critical before companies can tackle any problems in business they need to solve (Marsan 2009).

2.3.2 Teaching from a Process Perspective

University business majors are indeed now beginning to study business processes. In the past, businesses were organized around functional jobs and subsequently, business schools were organized around functions, with classes in separate functional areas (Monk, Wagner 2013). Business higher education has lagged behind in teaching business processes and business schools have been criticized for teaching in silos. A traditional silo is a high, vertical structure for holding grain; the idea of an information silo is that it also is a high vertical structure holding information without any linkage to the other structures that hold information. By teaching in silos of information, students are not prepared to work with cross-functional problems in today's fast-paced environment (Cannon, Klein et al. 2004). In addition, *"because of the discipline-based structure of business schools, coursework promotes specialization rather than integration"* (Michaelsen 1999 p.9). Businesses hiring new graduates are looking for those with cross functional skills (Aurand, DeMoranville et al. 2001). As a result, business schools are rethinking their curriculum's functional orientation (Becerra-Fernandez, Murphy et al. 2000). In the mid-1990s, only MBA curriculum taught cross-functionality (Corsini, Crittenden et al. 2000, Crittenden 2005). By 2000, an AACSB survey of undergraduate business programs showed a result of 90% of classes at the senior level had a capstone class with business integration, but only 5% had a fully integrated program (DeMoranville, Aurand et al. 2000). The current AACSB standards emphasize integration of business areas and cross-functional education (Aurand, DeMoranville et al. 2001). Business schools are moving their coursework towards a process-oriented approach, which fits in with these standards and places importance on cross-functionality. Capstone strategy classes are one way to fulfill this accreditation requirement and separate classes in business process modeling (Recker, Rosemann 2009) are an alternate way. Moreover within the last 10 or so year Enterprise Resource Planning systems software has also been used to teach integrated business processes (Wagner, Najdawi et al. 2000, Wang 2009, Rienzo, Han 2010).

2.3.3 Key Business Process Facets

Business process comprehension is essential for today's business student preparation for future employment. In their seminal book, *Reengineering the Corporation*, Hammer and Champy reiterate the necessity for business processes within an organization:

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It is not products but processes that create products that bring companies long-term success. Good products don't make winners; winners make good products (Hammer, Champy 2001, p. 27).

It is often found that company problems originate in poor processes, not that employees are incompetent or that technology is flawed (McDonald 2010). If employees develop a process perspective, and search for ways to improve those processes identified, then the company will more likely satisfy their customers fully, become more efficient, eliminate or decrease errors, and increase their profits (ibid). No longer can higher education teach in silos of separate information functional areas, but professors need to impress upon the students the business process view. In order to understand how various higher education curricula deliver a business process experience, the key facets of business process understanding must be identified and comprehended.

A business process is a series of activities a company does, that have some specific inputs and outputs, and involve people, technology, and information (McDonald 2010, Davenport 1998). A business process cuts horizontally across functional lines resulting in the organization of functional departments that contain silos of information diminishing. Information technology allows companies to focus on and improve their business processes (Davenport 1998), with focuses on the customer and creation of value for that customer. (Davenport 1998).

Table 2-2 lists the key facets of business processes. Students who understand business processes should understand this list.

1.	Group of related tasks
2.	Enables information sharing
3.	Promotes integration between departments and/or processes
4.	Creates value for the customer (either internal or external)
5.	Cross functional
6.	Could involve multiple people

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7.	Involves key business activities; uses business terminology
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Table 2-2 Key Facets of Business Processes (Amrani, Rowe, & Geffroy-Maronnat, 2006; Chang, 2006; Cronan, Léger, Charland, Robert, & Babin, 2010; Harmon, 2007; Rienzo, 2007)

Business processes envelop a number of tasks for a particular purpose in an organization. For example, take the classic case of the order-to-cash cycle. Each step in this cycle, such as taking an order, sourcing the inventory, picking, packing, shipping, billing, and collecting the remuneration are related to a particular purpose – completing a sales order. This order process is the company’s contact with the customer; if the order is processed successfully then the relationship with the customer is successful; if the order is processed poorly, then the relationship with the customer will suffer. Those companies that put a priority on their customer order process are competitively superior to those that do not (Shapiro, Rangan et al. 2001).

Throughout that process, information must be shared between functional departments. For example, when the order is taken, the warehouse must be checked to see if the item can be shipped by the appointed date. The information flows from the marketing and sales department to the Accounting department and onto Production and Logistics. The process moves horizontally and cuts across those functional lines. Whenever the process steps across a function, it could fall into a “crack” and get lost (Shapiro, Rangan et al. 2001) or could simply slow down. Since the customer’s view of the organization hinges on this business process, any orders that fall through the “cracks” could have disastrous effects.

In most organizations the sales order process involves multiple people in filling the order. As different departments are used for fulfilling the order, different personnel in each department are working together for that purpose. Throughout this cycle, business terminology is being used and key activities such as taking the order and packing/shipping the order are involved. These are outlined in the following table.

Key Activities	Sample Business Terminology
1. Presales Activity	Pricing information, Inquiry, Quotation, Binding document, Guarantee pricing, Sales calls, Mailings

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2. Taking order	Quotation, Inquiry, Selling price, Quantity, Discounted pricing, Pricing configuration, Accounts Receivable, Available credit, Credit balance
3. Source inventory	Inventory records, Production planning, Availability, Expected shipping date, Shortfall, Open orders
4. Create delivery	Releasing documents, Picking, Packing, Shipping, Materials management, Warehouse
5. Billing customer	Invoice, Sales order, Printing document, Mailing document, Faxing document, Debit Accounts Receivable, Credit Sales, Updating accounting records
6. Collect payment	Debiting Cash, Crediting customer's account, Credit checks, Blocking orders, Granting credit

Table 2-3 Key Activities of the Order to Cash Cycle with Sample Business Terminology (Monk & Wagner, 2013)

The importance of understanding business processes is evident in the literature and in practice. Students need to go beyond understanding individual functional areas and be able to comprehend business processes that stretch across functional lines (Jeyaraj 2010). Higher education should be confident that the students are actually learning business processes. However, assessing that learning of business processes is challenging. This thesis is attempting to meet that challenge and measure business process learning from experiencing ERP systems.

2.4 Assessment and Learning Styles

Assessment is measuring what students have learned. Studying business processes and experiencing ERP systems are complex subject matters and assessment of that learning is challenging. This section of the literature review deals with general assessment, and how that assessment needs to match the complexity of the subject matter via Bloom's taxonomy. It also introduces the Kolbian experiential learning theory which is at the heart of teaching business processes with ERP systems. Although learning styles are not profiled in this research, the area is discussed and elimination of that categorization for this research is argued.

2.4.1 The Role and Value of Assessment

In this thesis, assessment is to understand the students' learning of business processes by experiencing ERP systems.

In general, teaching and assessment go hand-in-hand with grading exams and assignments as traditional assessments. Weiss (1998) gives a formal definition of evaluating students:

The systematic assessment of the operation and /or the outcomes of a program or policy, compared to a set of explicit or implicit standards, as a means of contributing to the improvement of the program or policy (1998, p. 4).

This definition can be broken down and analyzed. In Weiss's words, a systematic assessment is one that is conducted with "*formality and rigor*" (Weiss 1998, p. 4). The operation or outcomes of a program or policy form the heart of the assessment; this is what the assessment is centered around. The outcomes of this assessment are often compared to some standards or expectations, or in some instances, the outcomes are simply presented. The reason for assessment is often to improve upon some program or give a student feedback in order to help them improve. Assessment can be supported by reviewing Bloom's Taxonomy. One of the oldest set of learning objectives still in use today, Bloom's taxonomy was published in 1956. 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 highest interest for educators today as it deals with understanding, knowledge, and problem solving. Bloom's cognitive domain taxonomy is meant to be a "*classification of the student behaviors which represent the intended outcomes of the educational process*" (Bloom, Engelhart et al. 1956, p. 18). The cognitive domain and its levels have been updated to add more relevant information and to address the fact that Bloom and his colleagues were "ahead of their time" in 1956 creating this classification (Anderson, Krathwohl 2001), see Table 2.4. Today assessment is a big focus in all levels of education and the revised taxonomy supposedly can aid in this challenging process. For example, Bloom's Taxonomy is used to develop standardized tests in the US state of Florida. Students are tested at the lower level of knowledge, comprehension, and application, and then are tested at the higher level of application, analysis, synthesis, and evaluation (University of South Florida, n.d.). In

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higher education, multiple choice exams are said to test at the lower levels of Bloom's Taxonomy, whereas case-based exams might test at the upper end of the taxonomy (Anderson, Lawton 2009).

Higher level Thinking Skills	Evaluation
	Synthesis
	Analysis
	Application
	Comprehension
Lower Level Thinking Skills	Knowledge

Table 2-4 Bloom's Cognitive Domain Taxonomy

In the area of ERP education, introductory courses only go as far as knowledge, comprehension, and application (Draijer, Schenk 2004), whereas more advanced courses might utilize Bloom's Cognitive Taxonomy towards the higher level thinking skills. Assessment should match the appropriate level of thinking skills.

Atherton (2011) argues that a perfect assessment instrument is impossible to create. Some group of students will always pass when they shouldn't have, and some will fail when they shouldn't have. To truly assess properly, there needs to be a variety of instruments used with different student's learning preferences (discussed in later section), some students do well with certain types of assessments, whereas others do well with different assessments. Assessment should be made to be valid, reliable, and fair (Atherton 2011) - assessing what it was meant to assess, and nothing else extraneous. A reliable assessment measurement is repeatable on the same group of students or on a similar group of students with fairness coming into play when the assessment is evaluated or graded. Anonymity is essential for fairness of grading (Atherton 2011). The creation of the assessment instrument should focus on the goals of the course or program (Weiss 1998, Gronlund 1998). Weiss (1998) argues that students should be asked to apply their knowledge as they would in a real life situation. This line of thinking is explored further by Wiggins (2006), who suggests using the arts or sports as examples of how assessment should be created. In arts and sports, feedback is frequent and the players or artists can make adjustments as they progress.

Some argue that today's assessment is all wrong and that it doesn't serve today's goals of education (Kozma 2009). Society has changed; most students will eventually work in jobs with knowledge and

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information. Kozma argues they are not being taught the tools that they need to succeed in this new workplace environment. Assessment drives the old-fashioned way of teaching in that students are simply taught facts to be regurgitated. In today's work environment, employees must be technologically savvy, solve complex problems, and communicate well. Assessment is critical to advancement in education. Teachers' own assessments often lie in how well their students do on standardized tests. That causes teachers to teach to the test, not teach what is really necessary for today's complex world. *"Traditional assessments also fail to measure all the skills that are believed to be enabled and acquired by the regular use of new tech-based environment"* (Kozma 2009, p. 7).

So a non-traditional assessment, something other than a written exam, may be a better measure of understanding the integrative functionality in a business after learning about ERP systems, highly technical software. In addition, mimicking a real-life situation, where students can experience business processes in action, may be the key to calibrating knowledge acquisition at a higher level of Bloom's cognitive taxonomy, such as the application level.

2.4.2 Experiential Learning Theory

In order to properly assess students' learning about business processes, any research must be grounded in a theoretical foundation. Kolb's experiential learning theory fits well with hands-on information systems higher education and it also stands out as the one most-often cited learning theory in the academic literature.

David Kolb wrote a seminal book in 1984 titled, *Experiential Learning*. Based on past work by Piaget, Dewey, and Lewin, Kolb set out to describe the cycle of experiential learning. His over-riding idea is that to fully learn, students must experience, not just absorb book-learning (Kolb 1984). Experiential learning arguably fits well with information systems education, specifically the teaching of ERP systems. When a student uses an ERP system in a hands-on fashion, they are experiencing what it is like to work in that very business environment. Every experience changes a person, they learn from each experience with learning being fluid, constantly changing and reshaping the mind.

The difference between experiential learning and traditional learning relates back to the ideas of Kozma that assessment doesn't match up with today's educational goals. Kolb states that traditional

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learning involves lecture and memorization promoting regurgitation, and not original thoughts. Whereas knowledge includes the creation of new ideas and thoughts. This creation is omitted with traditional lecturing. Gen Y students (those of today) learn more through experience and controlling their learning environment (Lippincott, Pergola 2009) .

Experiential learning consists of 4 modes according to Kolb (1984):

Concrete Experience	Feeling
Reflective Observation	Watching
Abstract Conceptualization	Thinking
Active Experimentation	Doing

Table 2-5 Kolb's 4 Modes of Experiential Learning

When one learns, they use all 4 of these modes at different times to fully comprehend, some happening quickly and some over longer periods of time (Atherton 2011). In addition, good teachers should encourage students to go from mode to mode and question their knowledge to gain maximum benefit (Atherton 2011). These 4 modes of experiential learning can be related directly to management and hence business education. Kayes (2002) describes 4 modes that are how managers learn experientially and these 4 can be juxtaposed onto the 4 Kolb modes. In the Action mode, managers are executing their goals by way of managing information and people, and dealing with problems. In the Cognition mode, managers learn to solve problems. The Reflection mode allows the manager to think in a complex way about problems and question them, seeing often the big picture. Finally, in the Experience mode, managers use feedback for themselves to improve their managerial expertise (Kayes 2002).

The 4 Kolb modes of experiential learning can be graphically noted as in the following Figure 2-2, with the 4 Kayes modes of managers noted on the appropriate areas:

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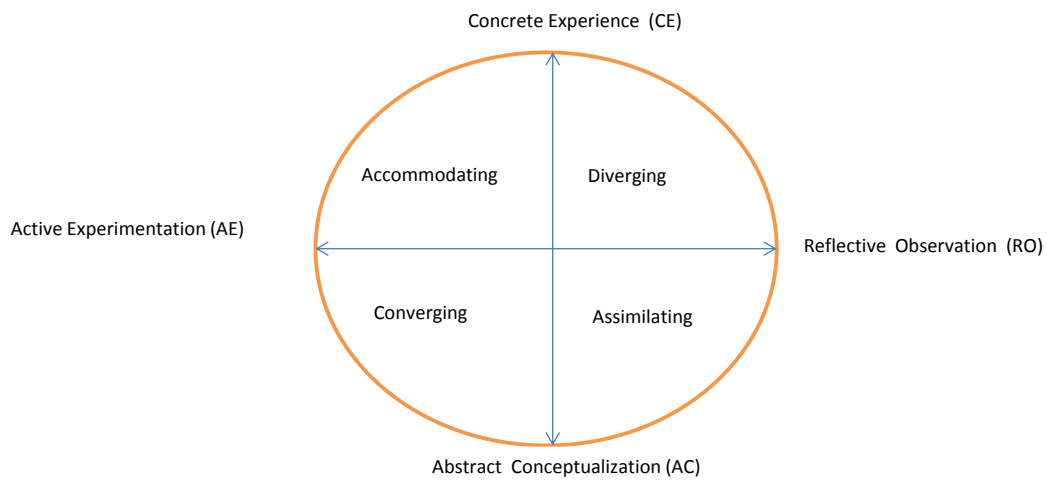


Figure 2-1 The Kolb Experiential Learning Theory with the Kayes Modes of Managerial Experiential Learning

A good manager can learn from experiences and make decisions based on what has been learned. Those managers that do learn from the past experiences are usually better at their jobs than those who do not learn (Kolb 1984). Therefore, it is unsurprising that the Kolbian Experiential Learning Theory has heavily influenced the area of management (aka business) education (Kayes 2002, Vince 1998). The theory helps managers understand how experiences shape their learning (Vince 1998), with unstructured experimentation and structured time for reflection (Neill 2006).

Experiential learning theory is important for the education of business students in business processes. As the student experiences and learns by using ERP systems through Kolb’s experiential learning cycle, they are also learning about business processes.

This experiential learning theory, referred to in this thesis as ELT, rests on the 6 assumptions listed in Table 2.6.

1.	Learning is a process, not an outcome
2.	Learning derives from experience
3.	Learning requires an individual to resolve dialectically opposed demands
4.	Learning is holistic and integrative
5.	Learning requires interplay between a person and the environment

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6.	Learning results in knowledge creation
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Table 2-6 Six assumptions of Kolb's Experiential Learning Theory (Kayes, 2002)

These 6 assumptions of ELT play out in a higher education classroom environment teaching ERP systems. One can imagine that the entire semester's class progresses through the material and experiences these complicated systems, not for a goal of just passing an exam, but understanding the systems in preparation for using them in industry. The actual hands-on work with a real ERP system allows the student to immerse themselves into the business environment and experience the way a business process works for the whole company. By moving around the experiential learning theory cycle, and resolving issues with the system, the student is not simply memorizing the facts, but creating long-lasting knowledge for themselves.

In the management literature, the main criticism of the experiential learning theory is that it is too limited (Kayes 2002) and focuses solely on the individual, ignoring other aspects and influences on learning (Race 2011). Social pressures, power-plays, and historical experiences can significantly affect how a manager learns from experience. These factors are omitted from Kolb's experiential learning theory. Discussions, arguments, and debates all could change one's experience and hence change one's learning or capacity for learning (Holman, Pavlica et al. 1997). In addition, some experiences are best not experienced, but simply learned from others (Vince 1998). Other factors also can play a part in the learning experience and affect it greatly such as doubt, anxiety, and fear. These factors are not taken into account in the Kolbian Experiential Learning Theory (Vince 1998).

To address some of these limitations and augment the ELT for today's student, Mughal and Zafar (2011) present additions to the Kolbian experiential learning theory. This is diagrammatically shown in the following Figure 2-3:

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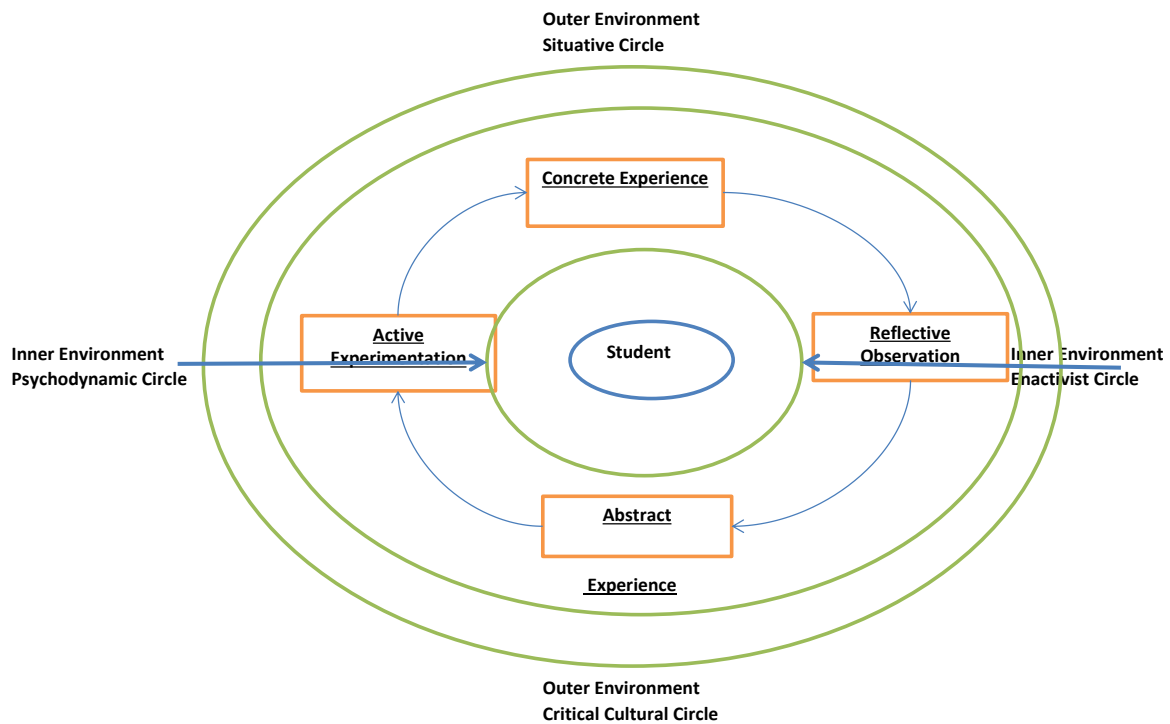


Figure 2-2 Augmented Kolbian Experiential Learning Theory

The authors discuss these augmentations as further routes to learning originating with literature work done by Fenwick (2001). Their summary of the inner and outer circles imposing on the Kolbian experiential learning theory is outlined in the following Table 2-7.

Alternative Circle	Deficiencies in Kolb's Experiential Learning
Psychodynamic	Emotions such as anxiety, desire
Situative	Participation of student, judgment, perception
Critical Cultural	Cultural aspects, power influence and relations
Enactivist	Interaction with environment

Table 2-7 Augmented Kolbian Experiential Learning (Mughal and Zafar, 2011, p.6)

They address some of the concerns voiced at Kolb's lack of certain pressures on learning. Although these criticisms of the Kolbian experiential learning theory center on its limitation, it continues to be a useful educational theory.

2.4.3 Accounting for Learning Styles

Building on, but separate from, his experiential learning theory of experience, observation, conceptualization, and experimentation, Kolb postulated that people all learn in different ways, some emphasizing one mode over another and people who use a variety of learning modes learn more fully. Carl Jung claimed that while a person might emphasize one mode over another one, the other modes are still available to be used in other circumstances; almost as if they were dormant. A person's learning experiences will shape the preferences they have for a particular learning mode, which contributes to the "evolution" of people. In order to test his experiential learning theory Kolb devised a set of learning preferences while admitting the challenges of categorizing styles that fit people since each are unique (Kolb 1984).

Kolb's preferences translate into quadrants between the ELT modes as 4 basic learning-styles are summarized in the following Table 2.8. Kolb's impetus for these preferences is that if one understands their preference, or others' preferences, education, work, communication, and conflict resolution will all be improved.

<u>Learning Style</u>	<u>Attributes</u>
Converging (AC and AE)	Good problem solvers; do well on standard tests; like technical work
Diverging (CE and RO)	Good imagination; good at new ideas
Assimilating (AE and CE)	Good at reasoning; good at new theoretical models
Accommodating (AE and CE)	Learn from hands-on work; like trial and error; adaptive

Table 2-8 Kolbian Learning Style Inventory (LSI)

Kolb's work has made a huge impact on the research and teaching community. The Kolbian Learning Styles Inventory prompted the creation of many other learning style models. In a comprehensive review of learning styles, Coffield et al (2004) identified 71 different models for learning styles, many of which are adaptations of each other. These are outlined and compared to the Kolbian LSI in the following table to illustrate the diversity of opinions in this field.

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<u>Learning Style – Honey and Mumford</u>	<u>Attributes</u>	<u>Like Kolbian LSI?</u>
Activist	Likes hands-on work	Accommodating
Reflector	Observes and reflects	
Theorist	Attempts to comprehend	
Pragmatist	Tries things out	Converging
<u>Learning Style - Gregorc</u>	<u>Attributes</u>	<u>Like Kolbian LSI?</u>
Concrete Sequential	Ordered; practical; thorough	Accommodating
Abstract Sequential	Logical; analytical	
Abstract Random	Sensitive; emotional; spontaneous	
Concrete Random	Intuitive; independent; original	Converging
<u>Learning Style - VARK</u>	<u>Attributes</u>	<u>Like Kolbian LSI?</u>
Visual	Prefers descriptions and demonstrations	
Aural	Prefers to listen	
Read/write	Prefers to take lecture notes	
Kinesthetic	Prefers hands-on and experiences	Accommodating
<u>Learning Style – Felder-Silverman</u>	<u>Attributes</u>	<u>Like Kolbian LSI?</u>
Sensing or Intuitive	Learn facts; solve concrete problems OR grasp underlying meanings; creative	Converging OR Diverging
Visual or verbal	Likes to learn from pictures and diagrams OR listen	
Active or reflective	Apply material; try things out; work in groups OR think and reflect; work alone	Accommodating OR Assimilating
Sequential or global	Step wise OR holistic	

Table 2-9 Competing Learning Styles (Atherton, 2011; Coffield, Moseley, Hall, & Ecclestone, 2004; Fleming & Mills, 1992; Graf, Viola, Leo, & Kinshuk, 2007; Gregorc, 2010)

Each of these and the many other learning styles exist to enable good education with learning style categorization being used by many secondary schools and even some universities. This categorization has spawned an entire money-making industry from selling tests and booklets for use in the classroom. Educational psychology textbooks also embrace these learning styles (Pashler,

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McDaniel et al. 2008). Much research has been performed in the field to understand how these learning styles can translate into the classroom and improve learning outcomes. To date, the research is still conflicting.

In order to improve educational outcomes by using learning styles, researchers and educators have devised a method for improving pedagogy called the meshing hypothesis, which states that the learning style of the student should match the teaching style for optimum learning (Pashler, McDaniel et al. 2008). Although schools and teachers often use learning styles to categorize their students, in all valid studies none proved this meshing hypothesis (Cavanagh, Coffin 1994, Coffield, Moseley et al. 2004, Pashler, McDaniel et al. 2008). With the surplus of learning style theories today attempting to capture the differing human traits (Coffield, Moseley et al. 2004), it is unsurprising that skepticism of the meshing hypothesis of learning styles exists. Atherton (2011) argues that all students are different and it's impossible to cater to every different learning style in a classroom environment. Some claim that there is evidence that people assess their own abilities or preferences incorrectly, and feel that they learn more in certain ways when it is just the opposite. For example, if performance improves quickly during a teaching session, then the student feels like they are learning well. In fact, a slower learning process enables longer term retention (Pashler, McDaniel et al. 2008). This leads one to conclude a similar technique to that recommended by Hawk and Shah (2007): use a variety of teaching techniques geared to a variety of learning styles in the classroom. The idea of using a variety of methods in the classroom supports the experiential learning theory. In an ideal situation using ELT, the teacher is leading the student around the modes of the theory. As this is done, a variety of teaching methods geared towards the different learning styles are being utilized. Specifically, in teaching ERP systems, Scott recommends using a variety of learning models to deal with the complexity of the software (1999).

A tremendous amount of academic literature is devoted to that of learning styles and a large amount of educational budgets are also spent on categorizing students. Considering the lack of rigorous evidence that using these categories to pinpoint educational practice is valid, it is suggested that limited educational budgets should be spent elsewhere (Pashler, McDaniel et al. 2008). It is true that people have a propensity to learn in certain ways, but whether catering to that type of learning in the classroom is effective remains doubtful. It appears that addressing all types of learning styles in the classroom and adopting experiential learning which steps through different phases of learning

is the best way to deliver educational material. There are some specific studies which looked at ERP and learning styles. Those will be discussed next.

2.5 Learning Styles and Assessment in ERP Education

It has been argued that learning styles should not be profiled in this thesis measuring ERP educational outcomes. However, past research has attempted to measure comprehension with a view towards learning styles. Those studies are discussed in this section. In addition, a comprehensive review of all studies that have tried to measure learning outcomes with ERP systems is presented. A preferable method of assessment, the business simulation game, is then presented.

2.5.1 Learning Styles and ERP

In the area of assessing ERP educational outcomes research, there are three studies that looked at the Kolbian Learning Style Index for students receiving some sort of an ERP treatment, none of which conclusively supported the theory that teaching with a particular learning style helped pedagogy.

Rienzo's dissertation research delved into the area of Kolb's original four learning styles, and whether those students exhibiting a specific learning style have an effect on how a student learns with ERP systems. In terms of ascertaining whether certain preferences for learning styles catalyzed learning from ERP systems, the data are inconclusive (Rienzo 2007). Noguera and Watson tested students' performance, self-efficacy, and user satisfaction for three types of classes: one with traditional readings and exercises, one with simulated ERP exercises, and one with live ERP exercises (all three were treated after 2 ERP lectures). In each of the three cases, the learning style of the student had no effect on the performance, self-efficacy, or user satisfaction (Noguera, Watson 2004). This outcome demonstrates again the lack of evidence that learning styles play a part in learning outcomes. An earlier research group reported on using different learning styles to formulate the curriculum, in effect, experimenting with the meshing theory. Desmarais and Ritchie (2001) designed their ERP curriculum to address two learning styles: sequential and holistic, similar to the dual learning style analysis of Rienzo. The results collected from this carefully crafted curriculum were scant. The students were not tested prior to the class as to what learning style they favored. No data was collected after the class in terms of learning style preference. The only data collected was a survey of the entire class on satisfaction, which was mostly positive (Desmarais,

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Richie 2001). Again, no conclusions about learning styles affecting learning outcomes can be made from this early research.

In the specific area of ERP education, there is a lack of compelling data pointing to a clear and overwhelming case for categorizing students under specific learning styles. Heavy criticism of learning styles from Atherton(2011), Coffield et al (2004), and Pashler et al (2008) reaffirm that for general education as well. Learning styles of students may simply be a preference and not affect the outcome of learning. However, experiential learning and assessing students' learning is at the heart of this research. Past studies of this type are now presented.

2.5.2 Assessment and ERP

The assessment of teaching ERP in higher education has been researched by academics and presented in the literature. Ten key studies have been identified and are now presented and critically discussed. The following table summarizes the research into the assessment of the effectiveness of teaching with ERP systems.

Author/ Publication Date	Method of Assessment	Delivery of ERP	Results
Seethamraju 2011	Questionnaire, self-assessment	SIM Game	Good business process knowledge and SAP skills; challenging game
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

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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 et al 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

Table 2-10 Past Research Summary

Past research studies have attempted to ascertain how much and what type of learning happened when students are exposed to ERP systems. Experiential learning theory tells us that doing or experiencing something is the best way to learn. In each of these studies, students experienced ERP systems mostly through hands-on exercises. The majority of the studies were not conducted over an extended period of time, such as a whole semester or year, but tested students after the ERP experience. As they are highly complex, ERP systems may arguably be better experienced over a long period of time, rather than just for a lesson or two.

The outcomes of many of the studies were based on self-efficacy feelings or self-reported knowledge rather than concrete measures of learning outcomes. Interestingly, the outcomes of the self-efficacy studies were all positive. Although students should feel good about their learning, their own assessment may be an inaccurate measurement of the actual learning. Assessing learning outcomes is challenging, but should go beyond feelings and measure (concrete) learning objectives.

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Only 3 of the studies, Rienzo (2007), Johnson et al (2006), and Noguera and Watson (2004) deviated from self-efficacy alone and used a traditional exam to test the students' knowledge after experiencing ERP. Out of those 3, only the Noguera and Watson (2004) study showed improved outcomes of business process learning; the other studies were inconclusive.

None of the studies collected data from different countries and only one study, the (Winkelmann and Leyh 2010) collected data from multiple universities. Cronan et al admits to a deficiency in their study in that the data was only from a mid-sized university in the United States (2009). In addition, only one study, (Winkelmann and Leyh(2010) collected data from undergraduates and postgraduate students. All other studies were on one level of higher education only. Confirmation of learning across cultures, universities and levels of study will add to the strength of teaching ERP experientially. The results are listed in table 2.7.

Author/ Date	Post ERP Treatment	Pre ERP Treatment	Alternate class without ERP
Seethamraju 2011	X	X	
Winkelmann and Leyh 2010	X		
Cronan et al 2009	X	X	
Rienzo 2007	X	X	
Seethamraju 2007	X		
Johnson et al 2006	X	X	X
Noguera and Watson 2004	X		X
Davis et al 2004	X		
Nelson and Millet 2001	X	X	
Wagner et al 2000	X		X

Table 2-11 Summary of Past Studies on Measuring ERP Educational Outcomes

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Surprisingly, only 3 of the 10 studies used a control group for comparison. Including a control group in future research may delineate the benefits of using an ERP system experientially in higher education. In addition, the evaluation of the results of each study was accomplished by quantitative statistical methods. All data collected was questionnaire, self-efficacy survey, or exam. No interviewing was conducted in any of the studies, although a qualitative (content) analysis was performed on the open-ended written questions in the Seethamraju study (2011).

The reviewed research did lead to a positive conclusion concerning using a simulated environment. Noguera and Watson (2004) demonstrated that there was no difference in delivering a live ERP system to the class, as opposed to a simulated ERP system. Consequently, simulations of environments, such as computer business simulations, may be considered as fruitful forms of delivering exercises or assessing the students.

Overall, the 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 substantial research (either quantitative and/or qualitative) that has been addressed with any particular rigor. Understanding whether a student gains in knowledge of business processes after learning ERP systems therefore remains a challenge.

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. To measure the students' understanding of a business process and how functional departments are linked through information systems by an objective exam may not be accurate. Some experts feel that standard exams are no longer able to assess all the knowledge students gain using today's technology (Kozma 2009). While most of the research reviewed stress positive feelings, there is little statistically significant quantitative data to validate the effectiveness; much of the data are based on studies of self-efficacy. While students need to be confident about their own abilities and understanding, self-efficacy may not translate to better decision making in an organization. In summary, a more concrete measurement of knowledge is required for conclusive evidence. In this

thesis, it is argued that a more appropriate measure of business process understanding that stretches to the higher levels of Bloom's cognitive taxonomy is a business simulation game.

2.5.3. Simulation as an Assessment Instrument

Computer simulation of business is common in higher education and experiential learning theory accelerated the use of simulation games in business education (Keys, Wolfe 1990). The benefits of teaching with simulators are attractive. *"The simulation's value [is] as a learning methodology, a research tool, and a classroom decision-making exercise that models the real world of business"* (Washbush, Gosen 2001 p. 292). In experiential learning theory we know that a learner can understand more with experiencing. Learning becomes a process whereby the learner is absorbing and reabsorbing information through their experiences. This happens, for example, during an information systems class when hands-on computer exercises are used for instruction. A computer simulation of business can also take the learner through the experiential learning modes of active experimentation, concrete experience, reflective observation, and abstract conceptualization, as problems are posed and solved. Despite the student's achievement or GPA, it has been demonstrated that students are overwhelmingly in favor of business simulations for education (Anderson, Lawton 2009).

Interestingly, Herz and Merz proposed that the structure of a simulation game is similar to that of the Kolbian experiential learning cycle (1998). Simulation games can propel the gamer through all stages of Kolb's ELT, and result in a richer pedagogical treatment over traditional teaching methods. If pedagogy is better via a simulation game, then perhaps assessment will also be better via a simulation game. In Herz and Merz' research, they map the structure to the Kolbian ELT, as shown in Figure 2.4.

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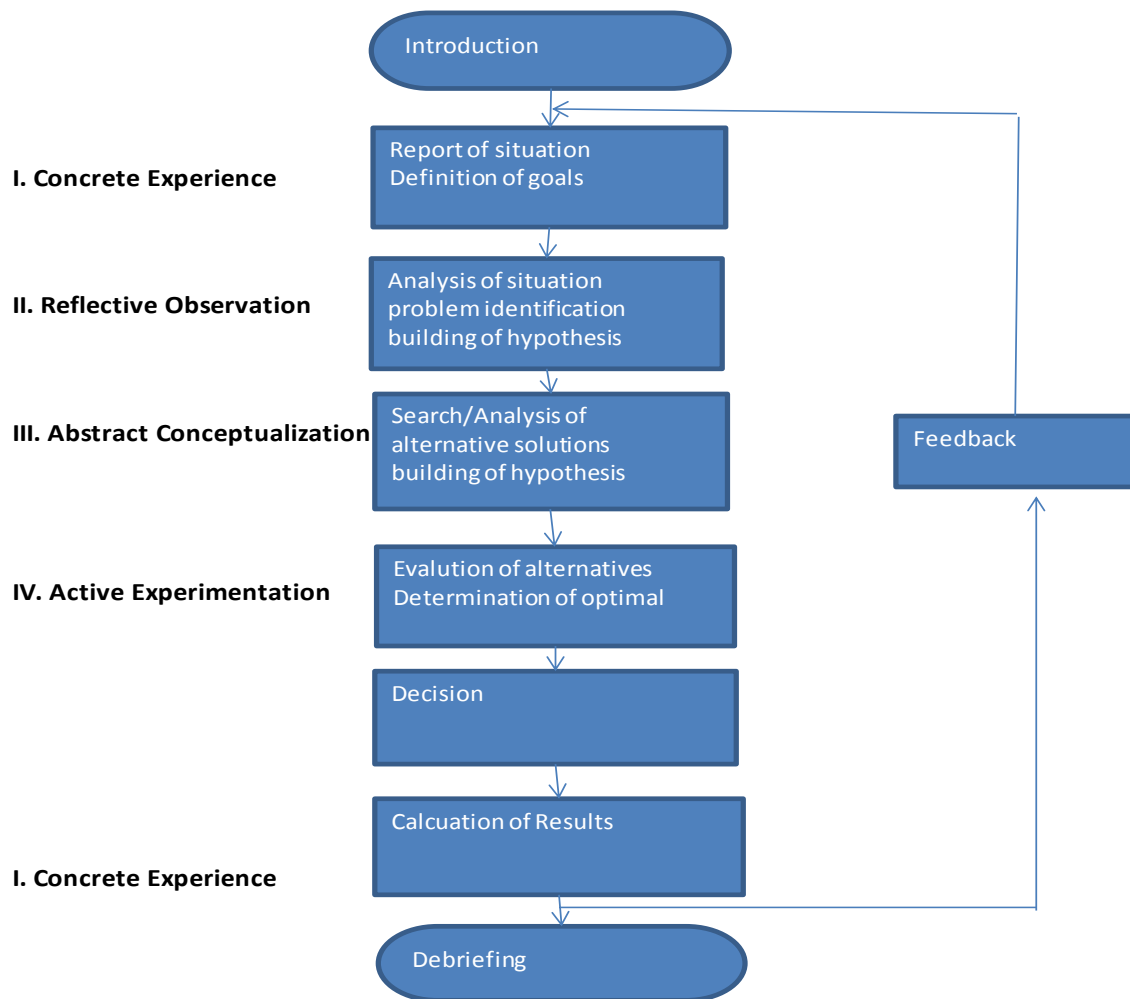


Figure 2-3 Simulation Game in the Kolbian ELT (Herz & Merz, 1998)

One attribute of a simulation game is its fidelity or “*level of realism*” (Feinstein, Cannon 2002, p. 426). Simulations are models of reality and are not exact replicas. Even though they are not exact replicas 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). High fidelity is not linked with greater learning because game players can become over-stimulated and learning can be stalled (Feinstein, Cannon 2002).

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An example of a business simulation game that is well-known is the MIT beer game. Originally developed at MIT in the 1960s, the game simulates a beer production and distribution system to promote learning about systems (Goodwin, Franklin 1994). Students work in teams and are given customer orders to fulfill with one product. The customer orders are not revealed to the team ahead of time. Orders are held constant for 4 periods and then increased but held at the increased level in period 5 until the game is over. Retailers end up over-ordering cases of beer to satisfy the demand, and ultimately have too much to sell (Goodwin, Franklin 1994). Teaching outcomes from this simulation game are favorable; the game teaches students about the systems approach to problem solving (Goodwin, Franklin 1994). Another learning outcome from the Beer Game is that communication is essential to running a business. Students are surprised at the “*problems in communications for just one simple product*” (Jackson, Taylor 1998, p. 213).

Simulation games are used at universities to teach ERP concepts. Leger claims faculty have found that students struggle with the concepts that ERP systems introduce – integrated business processes and yet also noted that today’s business student is very computer-literate (2006). The ERP educational simulation developed at HEC Montreal involves teams competing to run a cereal manufacturing business. Working with different time periods, the teams decide on production and sales and use an actual ERP system (SAP in this instance) to determine production runs. Results and statistics are generated in the form of reports and Excel files to give feedback to the teams so they can make adjustments. In this gaming classroom, students move from a silo-oriented approach to running a company, to a process-oriented approach.

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 gradually find that reorganizing the task around a business process enables them to benefit from an integrated system (Léger 2006, p. 446).

In this ERP simulation game, students are evaluated on their use of the information that is presented to them from the ERP system, and in their final presentation to the “*boards of directors*” (Léger 2006, p. 445). Cronan et al speculate that teaching ERP via a simulation game is superior to that of

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hands-on ERP exercises because it allows the student to view the system as a whole and not get bogged down with step-by-step keystrokes on the ERP system (2009). This is an example of true experiential learning as the student observes the SAP results, plans strategies, and makes changes to win the game.

Most research testing the effectiveness of teaching with business computer simulations has been in the realm of self-perception. Little or no research has measured learning with concrete objective means (Anderson, Lawton 2009). However, a recent research project drew a strong correlation between self-perceived knowledge and actual objective measurement of knowledge using a simulation game to teach ERP concepts. After playing the ERP simulation game, students were asked a series of objective questions about enterprise systems, business processes, and SAP transaction skills. The easier questions on the Bloom's Taxonomy correlated more strongly with the positive self-perception than the more difficult questions (Cronan, Léger et al. 2010).

Much has been written about using a simulation game to teach but little written on using a simulation to assess a student's performance or to understand their knowledge retention. Aldrich claims that simulation games "*can lower tension (so using a game... for assessment might actually be more accurate than using a written test)*" (Saulnier 2009). In some instances, the simulation game results are used for assessment along with more qualitative means, such as explanation of results of the game (Léger 2006). Jones argues that simulations as assessment are used extensively in industry, but not in education (1998). Simulation games as assessment have also been used heavily in the military. In the early 1900s, the Prussian Army used a simulation to ascertain potential soldiers' behavior, since the written exam was not recruiting properly. The British Army utilizes simulation methods to assess their recruits. In the Second World War, the Americans followed suit when they had problems recruiting spies. In the 1950s, simulations began to be used to assess potential managers (Jones 1998).

In order for a simulation game to be used for assessment, it must measure the educational objectives of the curriculum (Anderson, Cannon et al. 1998). Andersen and Lawton argue with the example that classes often write practice essays and then take essay exams. Therefore students should be able to learn on simulations and then take an exam on a simulator. Experts claim that a computer game is simply problem solving (Corbett 2010).

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Many educational simulation games are multi-player. Criticism has been levied about multi-player games. Aldrich states *“Batting cages and tennis backboards come before a good scrimmage... [multi-player games] prevent the repeatability and practice that is essential to most learning...A good sim needs a stand-alone, single-player (albeit with coaching) mode up front”* (Saulnier 2009). Thavikulwat and Pillutia confirmed the single-player preference in their research (2004). Prior to this study, many studies have disproved a relationship between general academic performance, such as GPA and simulation performance (Gosenpud 1989). Washbush and Gosen claimed that simulations promoted learning but did not correlate that to any level of grade outcomes (2001). The aforementioned studies were when students played simulation games in teams. In two papers, however, Anderson and Lawton found that there was a correlation between single-player simulation results and major course GPA (1995, 1997). In Thavikulwat and Pillutia’s work, there was a positive correlation between general GPA and simulation game performance and a positive correlation between major course GPA and simulation game performance when the game was played by a single person as opposed to a team. The team’s scores do not correlate due to the *“free ride”* factor, where some or one team member just hangs on and doesn’t contribute to the team score (Thavikulwat, Pillutia 2004, p. 11).

Some researchers speculate that simulation games are good for teaching higher levels of learning on the cognitive scale of Bloom’s Taxonomy and should not be used for teaching terminology, and basic concepts (Anderson, Lawton 2009). If that is the case, then perhaps simulation games are good at measuring the higher levels of learning as well, such as the complex understanding of business processes from ERP systems.

Computer business simulation games do a good job of mimicking manager’s decision making processes in a business situation. And these simulation games could also be used as an assessment to measure how well a student understands the various parts of a business and how they interact. Aforementioned, students should be asked to apply their knowledge as they would in a real life situation for assessment purposes (Weiss 1998); they should be able to solve new problems in unknown circumstances which will assess at a deep level (Biggs 1999). A computer simulation of a real business environment fits that requirement. Also mentioned previously, Kozma claims that the traditional assessment tools such as exams just allow students to regurgitate facts and do not test for today’s requirements that graduates be technologically savvy, be able to solve complex business

problems and communicate well (2009). Simulating a business environment as an assessment may be a more perfect test.

2.6 Theoretical Framework of this Research

A business simulation game allows for experiential assessment and/or experiential learning. Kolb's experiential learning theory is based on his philosophy that "learning is the process whereby knowledge is created through the transformation of experience" (Kolb 1984, p. 28). Experience is a fundamental aspect of education and in particular, information systems education which often includes hands-on computer work. Kolb postulated that educators lead the student around the experiential learning cycle, as shown in Figure 2-5, through the various modes of concrete experience, reflective observation, abstract conceptualization, and active experimentation.

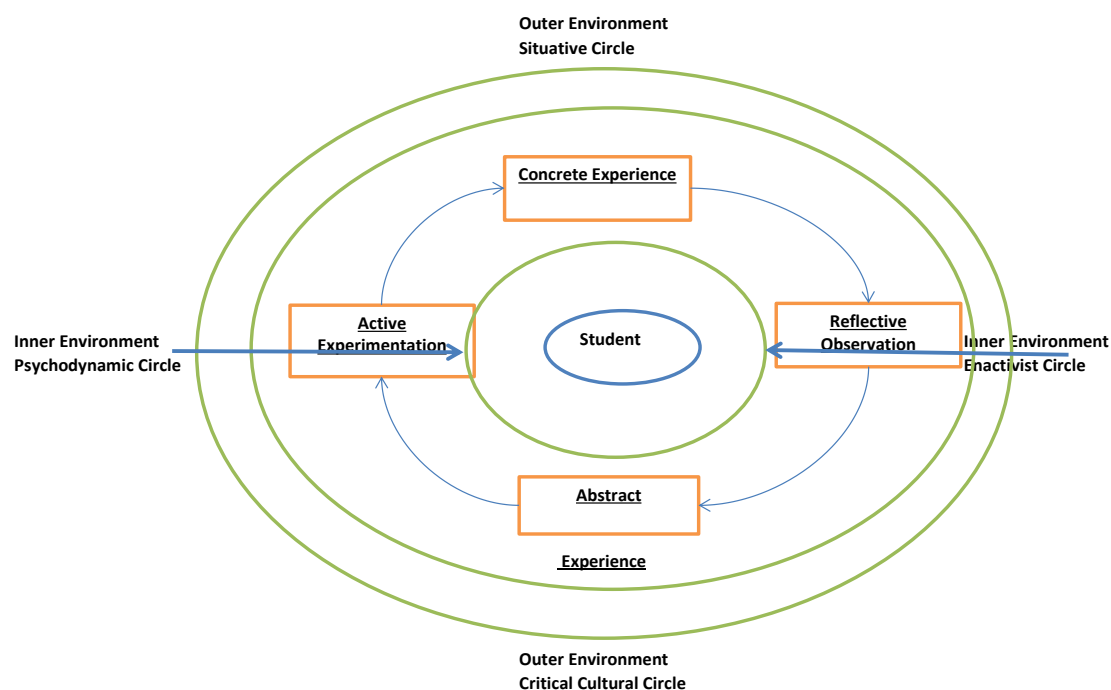


Figure 2-4 Kolb's Experiential Learning Cycle (Modified)

These 4 Kolbian modes can be abridged to be called experience, reflect, understand, and act. In hands-on information systems education, the experience is intertwined with the education. It is therefore argued here that the Kolbian Experiential Learning Cycle can be further refined by the learning process being the entire experience, thereby simplifying Kolb's experiential learning cycle as shown in Figure 2.6.

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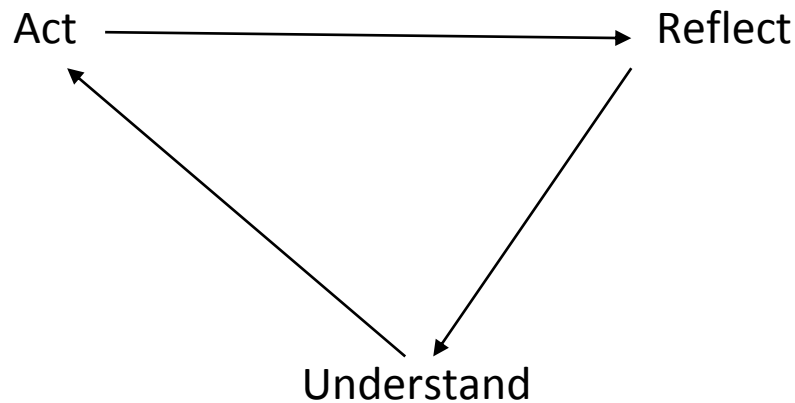


Figure 2-5 Simplified experiential learning cycle

The entire learning process can be categorized as Kolb's concrete experience, in a three-step cycle. Within that experience, the learner is reflecting, understanding, and acting. In the Reflect phase, the learner is taking in all the information, identifying problems, and assessing the situation. From there, the learner moves to understand from the previous phase, builds up a strategy, and looks for a solution. Finally, the learner acts on that strategy and solution formulated in the previous phase. Those three steps together form the concrete learning experience; the Kolb's concrete experience is not a separate part of the cycle, but encompasses the entire learning process.

When playing a business simulation game, be it for learning or assessment, the player is following the simplified experiential learning cycle. Firstly, the player must understand how to play the game and make some initial decisions. After the rules are determined and decisions on how to start are determined, the player can act on their choices. As the game unfolds, the player will reflect on feedback the game is giving, digest that feedback (e.g. understand it), and act on their decision. The circle continues around and around as the game is played. The entire act of playing the game is considered the experience.

It is argued in this thesis that this experiential simulation game cycle, passing through understand, act, and reflect, can be used as assessment for determining business process understanding after experiencing ERP in a classroom setting.

2.7 Issues and Challenges Arising

ERP systems, massive software packages that run all aspects of businesses, are used by most organizations and inherent in these important systems, are efficient business processes. In today's competitive and fast-paced work environment, businesses are looking to make every business process as efficient as possible by taking a business process view. In order for the employees to enable this efficiency, they must understand the business processes within an organization. Therefore a challenge to higher educators is how to teach business processes. A few universities have courses specifically on business processes but many others use a course on ERP systems to teach business processes. The issue at hand is whether or not using ERP systems does in fact enable retention of business processes. This research is attempting to measure that classroom outcome.

ERP systems promote efficient business processes. ERP-based higher education uses ERP systems to reinforce the concept of business processes. Students who understand business processes should be able to apply the main concepts of the subject. Any assessment of the students on their knowledge of business processes should assess the main facets of business processes.

However, assessing students' learning is difficult in today's technological world. Many have dismissed the old-fashioned exams, saying they don't really test a student's understanding of the complexities of the business world. Ten past studies have been identified that attempt to measure students' learning after an ERP experiential class or classes with using either written exams or self-efficacy surveys and most have measured after only a few sessions with an ERP system. An issue arising is whether those measures accurately assess the students' knowledge of business processes and whether sufficient learning time is given.

Simulated environments are popular today on computer games. Computer simulation games are being used more and more in the classroom, and even for assessment. Measuring how well a student does in running a small company on a computer simulation should give a more accurate assessment of how well that student understands business processes. From that game play, students should be able to articulate their thought processes during interviews, in order to understand how students learn.

It is proposed that a business simulation game be a good way of assessing students, in that it approaches the idea of success in a real job. If a student does well on a business simulation game,

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then it is argued that they understand business processes. This is because a business simulation game lets them experience business processes, performing activities in a virtual company that has inputs and outputs and create value for internal and external customers.

A business simulation game will propel the player through the modified Kolbian ELT stages, tracing the manager's approach to problem solving. The business simulation game stages of a commercially available game by Pixelearning (being used for this research) are show in the modified Kolbian experiential learning cycle with the managerial stages in the following Figure 2-7:

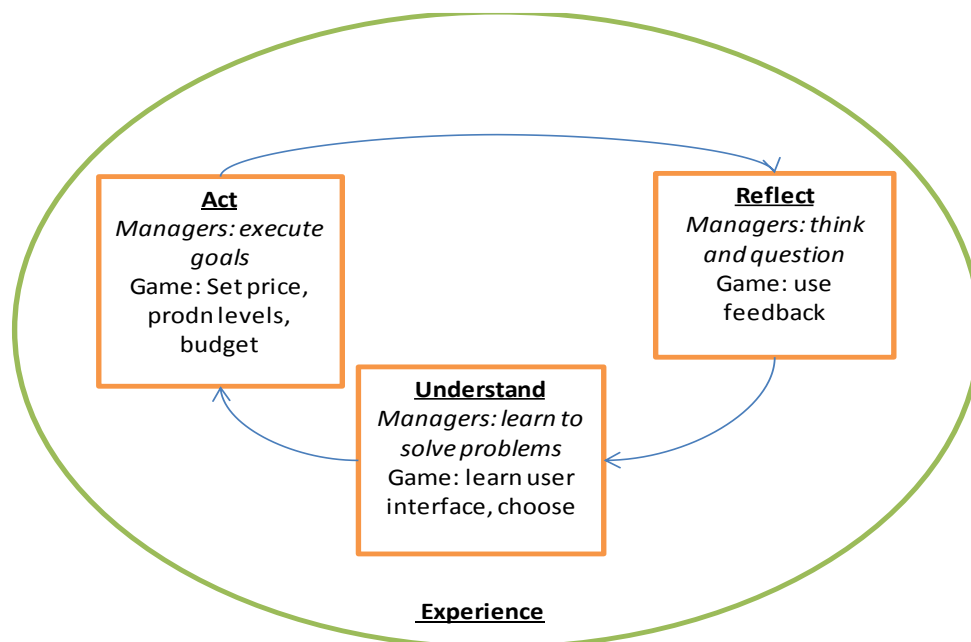


Figure 2-6 Simplified Experiential Learning Cycle with Commercial Simulation Game

Those universities that choose to teach business processes with ERP systems are implicitly endorsing Kolb's experiential learning theory. In that theory, learning is enhanced through experience, not simply listening to lectures. Using ERP systems as examples of efficient business processes enables the student to experience the efficient business processes and more fully understand and remember. This experiential learning brings students further up Bloom's cognitive taxonomy, leaving behind simple memorization and propelling them to true understanding. For today's challenging work environment, educators that use experiential learning strive to move students to higher levels on Bloom's taxonomy, challenging them to solve complex problems in new and unknown circumstances. If, therefore, students are learning at a higher level on Bloom's taxonomy,

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assessment of students needs to also be at a higher level. Simple multiple choice exams assess at a lower level; simulation games, where students are playing in unknown scenes, deliver a higher level of assessment, which is required for this higher level of learning.

The business simulation game that will be used for this research requires a student to run a small company by choosing a product to sell, setting its price and marketing that product, then setting production levels and selling to make a profit, can assess students' understanding of a business process. In the following Table 2-12, the key concepts of a business process are correlated with the steps in the business simulation game.

	<u>Business Process Facet</u>	<u>Simulation Game Experience</u>
1	Group of related tasks	Selling, producing, and marketing all happening during game
2	Enables information sharing	Use information from one department to direct another
3	Promotes integration between departments and/or processes	Marketing affects selling; selling affects production; production affects pricing
4	Creates value for the customer (either internal or external)	Starting a business; attempting to make a profit in 3 years; selling; advertising; producing
5	Cross functional	Covers marketing, sales, production, finance
6	Could involve multiple people	Different people from different departments give advice and information
7	Involves key business activities; uses business terminology	Key activities: sales, production, finance. Business terms used throughout the game

Table 2-12 Business Process Facets and Simulation Game Experience

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It is important for the future of business education, to fully understand how ERP systems affect the outcomes of the students' business process knowledge. The results of this thesis should play an important role in shaping future business process pedagogy.

2.8 Summary

Enterprise Resource Planning Systems (ERP) are used in higher education as a vehicle for teaching business processes. ERP systems are large software programs which coordinate and control many aspects of a company and often form the backbone of most large organization's information systems. They integrate all functional areas in an organization and promote a business process perspective. Students who use an ERP system experience what it's like to use 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. ERP systems have been used at universities for over the last 10 years, but little research exists that assesses the effectiveness of using ERP to further comprehension of business processes.

Assessing knowledge gained after educational treatment is challenging. Traditional examinations such as multiple choice tests often examine at lower levels of thinking skills but assessment should match the appropriate level of thinking skills. ERP and business processes are more difficult and abstract topics, therefore, assessing that educational retention should reside at a higher level of thinking skills. It is argued that using a business simulation game to assess students' knowledge will reflect true understanding of business processes because the game will mimic a real business work environment. The level of realism, or fidelity, of a business simulation game should be an accurate estimate of comprehension of business processes.

With today's fast-paced business environment, university students need to be well equipped to meet the challenges of working in the 21st century. Assessing the value of having students experience ERP systems to teach the concepts of business processes should be an important contribution for higher education today.

Chapter 3. Research Methods

Knowledge is experience. Everything else is just information - Albert Einstein

3.1 Introduction

To investigate the transfer of knowledge from experiencing an ERP system to learning business processes, students were asked to play a business simulation game as an initial test of their understanding of business processes. It has been argued that a business simulation game is a superior measure to that of a traditional exam in that it measures the understanding of how organizations operate in a cross-functional manner. The business simulation game results showed trends of whether the key facets of business processes were comprehended and, moreover, the simulation game was a stimulus to feed into and direct the second phase of the research. In that second phase, students were queried to understand why some performed in certain ways on the simulation game with relation to business processes. Further in-depth discussions were conducted with select students, in order to obtain a complete view into experiential learning outcomes. As this chapter will describe, the philosophical approach adopted to ensure the most thorough research possible was critical realism. Multiple methods of quantitative and qualitative data collection and statistical and content analysis were used to uncover a mechanism for learning.

This chapter begins with a general overview of potential philosophical approaches to research in Section 3.2, with a focus on the philosophy chosen for this dissertation, critical realism. Sections 3.4 and 3.5 discuss techniques for data collection and data analysis. The actual experimental design used in this study is detailed in Section 3.6, with specific steps in each phase thoroughly explained. The chapter concludes in Section 3.7.

3.2 Philosophical Approaches to Information Systems Research

This thesis adopts critical realism as the basis for investigating the following proposition: Teaching ERP experientially in an information systems class improves the students' understanding of the integrative nature of business. Students completed a business simulation game twice, both before and after their coursework, and then participated in either a focus group or email interview. Selected students further participated in in-depth interviews, discussing their thought processes and

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strategies during the simulation game play. As a first step, the research philosophy of this thesis will now be discussed. This step in the layout of the chapter is highlighted in Figure 3.1

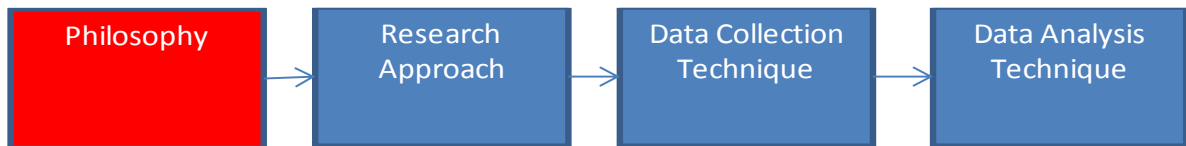


Figure 3-1 Stages in Research

In recent years, information systems research has moved from emphasis on the technological aspects of systems to one of a more social type, with a focus on managerial issues (Myers 2011). When early research in the field was mostly based on technical topics such as computers, the philosophical approach to research was highly quantitative. The advent of social research brought changes in the ways researchers conduct their exploration and interpret their data. In the following paragraphs, descriptions of the research philosophies will be discussed, along with their applications to this thesis, beginning with a summary table that outlines the various philosophies.

Philosophical Approach	Main Premise	Typical Methods Used
Positivist	Formal propositions, hypothesis testing	Quantitative statistics
Interpretivist	Focuses on social aspects, context	Qualitative evaluation of occurrences
Critical	Focuses on conflict in situations and relationships	Social critique over time, influence and enact changes
Critical Realism	Attempts to understand mechanisms and causal relationships	Assortment of methods from other approaches

Table 3-1 Philosophy Summary

3.2.1 Positivism

Broadly speaking, if research is approached with a scientific view towards epistemology, the study of knowledge (Lehrer, 2000) it is said to be positivist, where concrete values are assigned to research outcomes and statistical methods are applied to analyze the data. In this philosophy, the researcher is detached from the situation, interviews (if needed) may be conducted in a structured manner, and data are assigned numerical values. The positivist sees the world in a concrete manner, with predetermined questions and calibrated answers, analogous to an objective exam, using causal models with fixed relationships that are understood and proven (Baroudi 2009, Myers 2011).

Orlikowski and Baroudi claim research philosophy to be positivist if it fulfills these parameters:

“evidence of formal propositions, quantifiable measures of variables, hypotheses testing, and the drawing of inferences about a phenomenon from the sample to a stated population” (1991, p. 5).

Twenty years ago, positivism was very popular in information systems research, as evidenced by 96.8% of all information systems research in 1991 being positivist (Orlikowski, Baroudi 1991). Even 75% reported with a positivist approach less than 10 years ago (Mingers 2003).

Some in information systems research have criticized the positivist philosophy. Although the stance promotes the researcher as the objective observer, it's impossible for a researcher to come into a project without some bias or to be a real outsider (Orlikowski, Baroudi 1991). The positivist researcher asks questions of their audience and those questions are the only ones that the surveyed audience can answer; the bias of the study is embedded within the selection of questions of the survey. Therefore the outcome of this type of research can be to omit certain key aspects of a study by not asking the correct questions (Orlikowski, Baroudi 1991). Even though positivist research is the dominant type of research, it focuses on causal relationships to the exclusion of other aspect of the surrounding world such as the social aspects, linguistics, and human feelings (Orlikowski, Baroudi 1991, Mingers 2006).

In positivistic research, hypotheses are deduced to be wrong; nothing can be proven to be true. As a result, positivist research is to reject the null hypothesis (Myers 1997). Null hypothesis significance testing, although used extensively in positivist research analysis, has been heavily criticized.

Statistical significance is often reported without regard to whether or not the research results have practical significance with data driving the models instead of theory (Mingers 2006). Large sample sizes are utilized to gain significant results; small changes can become statistically significant with

large sample sizes, even if these results are not actually important (Ibid). In addition, there exists pressure to publish positive results in research, which encourages only those projects which reject the null hypothesis as being accepted and published (Mingers 2006).

3.2.2 Interpretivism

In recent years, information systems research has migrated away from a technical perspective toward a more social one and social interactions in information systems are now being analyzed via the interpretivist philosophy. This philosophy began in cultural anthropology, with work such as that of Margaret Mead (Mead 2011, Baroudi 2009). Unlike the positivist approach, where outcomes are measured in an objective way, the interpretivist researcher focuses on the social aspect of the data collected and looks to social relationships for meaning. Social surroundings and language play a large role in interpretive research (Myers 1997). By focusing on the context of situations, researchers do not impose their pre-existing biases on the research (however, a good interpretivist always acknowledges some bias) (Baroudi 2009). Proponents of the interpretivist approach argue that one cannot attach a number to a feeling or cultural attribute.

In the research literature, criticisms have been voiced. Orlikowski and Baroudi (1991) outline them:

First, the interpretive perspective does not examine the conditions, often external, which give rise to certain meanings and experiences. Second, research in this perspective omits to explain the unintended consequences of action... These unintended consequences of action are often a significant force in shaping social reality... Third, the interpretive perspective does not address structural conflicts within society and organizations... Finally, the interpretive perspective neglects to explain historical change (1991, p.18).

For example, if an interpretivist conducted a case study in a business and came to some conclusions about the data, a positivist would claim that this is just a rich case study and say that the research is not complete because only one business was analyzed and that many businesses would have to be studied in order to draw some statistically reliable conclusions. No causal relationships can be proven in an interpretivist's mind (Baroudi 2009).

3.2.3 Critical Philosophy

Another epistemological approach to information systems research is critical philosophy, addressing some of the concerns voiced above. Critical philosophy assumes that humans are shaped by their social surroundings and historical experiences and, by nature, there will be conflict within relationships. In critical philosophy, the researcher is not just an observer who comes up with results but the researcher is involved and attempts to influence or make changes to the research setting (Ngwenyama, Lee 1997, Myers 1997, Orlikowski, Baroudi 1991). These settings, for example work places, have conflicts and fairness issues. Humans in these settings can work to change those conflicts and fairness issues, but often are constrained. A critical researcher, not only collects data, but works to change and eradicate those inequities not looking at any single point in time, but instead, gathering data over history, compiling what is known as ethnography, for example. (Orlikowski, Baroudi 1991).

As with all philosophical approaches, there is skepticism of the critical approach. Some authors claim that the approach overall is too vague, its evaluation techniques also vague and that those who use the critical approach do not admit its limitations. This approach to research focuses exclusively on the socio-economic aspect of a workplace setting, without regard for other factors of influence such as gender or race (Orlikowski, Baroudi 1991). In addition, it is written that the critical approach looks excessively on societal structure.

3.2.4 Critical Realism

In this thesis, critical realism was chosen as an alternative to the traditional positivist and interpretivist philosophies used in information systems research because it allows for identification of in-depth causal mechanisms (Danermark, Ekstrom et al. 2002), a feature lacking in past research attempting to link business process learning with ERP. Wynn and Williams (2012) claim that critical realism research fits well with information systems because along with mechanism identification, it fills in any holes between traditional philosophical approaches, and joins information systems to results. The purpose of research using this philosophical approach is *“to provide clear, concise, and empirically supported statements about causation, specifically how and why a phenomenon occurred”* (Wynn and Williams 2012, p. 789).

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Critical realism contains a layered ontology of reality and objects (Mingers 2004), as illustrated in Figure 3.2. Ontology can be defined as a grouping of things that exist in reality. The outside shell is the “real” where certain objects exist independently without any regard for knowledge including the mechanisms that produce these objects. This reality may not be fully understood or observed by humans (Wynn and Williams 2012). Within this shell is the “actual” where events may happen whether or not they have been experienced. Finally, lastly in the center is the “empirical” where reality and objects are experienced and seen by people. This middle includes experiences, theories, data and facts (Bhaskar 1975, Danermark, Ekstrom et al. 2002). A critical realist believes that reality exists even if nothing is happening – this is considered the real; the actual exists if something happens and it is not observed – this is considered the actual (Mingers 2006); therefore the world would be present without humans thinking of it (Sayer 1992). Bhaskar calls this intransitive; that is, there are intransitive objects that would occur in the world even if mankind were gone; events are independent of experiences (Bhaskar 1975).

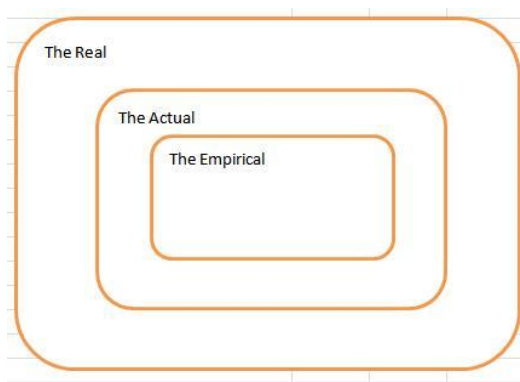


Figure 3-2 Minger’s Critical Realism World (Mingers, 2004b)

Lyubimov relates this critical realist world to research and experimentation. A researcher will form an experiment which is classified under the Empirical – observable experience, as shown in Figure 3.3. That experiment generates actual events. In critical realism, the researcher strives to understand the mechanisms that generate those observable experiences. These mechanisms fall under the sphere of the Real (Figure 3.3), and are considered “unobservable” (Lyubimov 2009). It is challenging to interpret the world through our own perceptions, and those perceptions and understandings must be constantly revised and improved (Wynn and Williams 2012).

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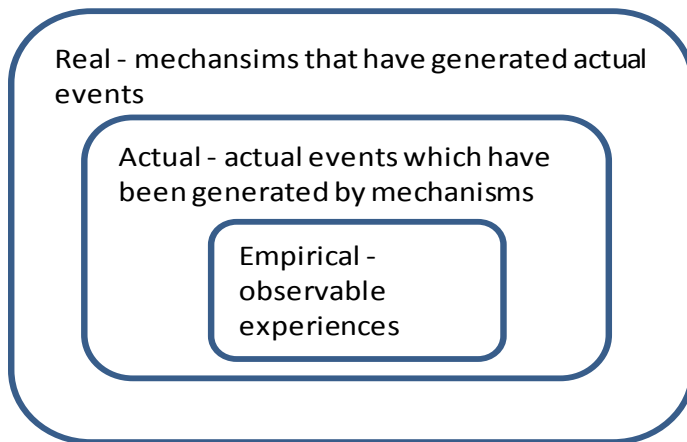


Figure 3-3 Lyubimov's Critical Realism Research World (Lyubimov, 2009)

All entities, physical or intellectual, can influence the world around us, and should be considered with an equal view. For example, language is vital in our existing world – without it, research could not be conducted. Hence, language must be taken into account during the research process (Danermark, Ekstrom et al. 2002). Social mechanisms, deep-seated in our existence, must also be taken into account in the research process (Danermark, Ekstrom et al. 2002). In order to comprehend and utilize all these entities, multiple research methods may be required to result in a complete view and to refute any incorrect theories. Consequently, critical realists approach problems in a holistic way, and the choice of methods is not limited by historical philosophical associations – rather, they should be appropriate to the investigation in hand (Bhaskar, Hartwig 2010).

The relation between epistemology, what is known and changing, and ontology, what is real and unchanging, needs to be mindful of the epistemic fallacy (Varaki and Earl 2005). Science is based on previous work or knowledge that can be considered transitive (Bhaskar 1975). The epistemic fallacy represents a theory based solely on empirical observations, and assumes that the world must conform to that theory, when in fact the world is much more complex (Mingers 2001). Critical realism looks for differences between epistemology (definite knowledge - transitive) and ontology (reality concepts about the world - intransitive) and attempts to explain the mechanisms beyond simple observation (Lyubimov 2009, Bhaskar 1975).

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For the critical realist, knowledge is created by retrodution. Retrodution is the process of asking questions and in Sayer's view, explaining events by finding mechanisms (Sayer, 1992). So in essence, the critical realist begins research with a theory that is viewed in a critical manner (Sayer 1992), conducts the research to some abstract means, and then returns to create a new theory (Danermark, Ekstrom et al. 2002), hopefully improving on what has been done in the past. Statistics may suggest relationships in causal social research (Mingers 2004), but may not be the definitive conclusion. In order to prove a contributory link, underlying mechanisms must be understood (Goldthorpe 2001) ; these are the mechanisms which cause certain outcomes to happen.

In order to identify the constituent parts of these mechanisms, existing literature-based knowledge is initially referenced. New mechanisms must also be identified for the given research situation from the data, emanating from perhaps a person's "*reasons and beliefs*" (Wynn and Williams 2012 p. 800). These mechanisms can be identified as either necessary or contingent. The necessary informs understanding of the relationship between objects. These necessary relations are actualized in the context of contingent relations possibly producing different outcomes depending on the situation. Smith (2010) called this the contingent causality, where a mechanism may change with varying contexts.

Once the mechanisms are identified, the interaction between those mechanisms and how the outcomes of the research were generated must be identified as well (Wynn and Williams 2012). Known as causal powers and liabilities, they trigger or inhibit the mechanisms by which the results occur; the causal powers encouraging; the liabilities being what opposite pressures may be working against the mechanism. Each demonstrates potential pressures that may or may not happen in a given research situation (Sayer 1992). In effect, this stage corroborates the mechanisms identified in the previous step. Using the suggestion gathered in the research, events are drilled down into further detail, uncovering what activates or suppresses the mechanism.

Although critical realism is becoming a more prevalent philosophical approach in information systems research, there are few firsthand studies to follow as guidelines (Bygstad and Munkvold, 2011; Wynn and Williams 2013). Additionally, Klein has critiqued Minger's description of critical realism and called for more clarification but he argues that finding a common philosophy for IS research would strengthen the field. In the past, information systems researchers have used almost

polar opposite philosophies, hence there were few commonalities and sharing of research was very difficult (Klein 2004). Critical realism is an improvement, focusing on understanding rather than prediction (Mingers 2006).

In order to thoroughly describe and understand the mechanism behind students' experiential learning with ERP systems, a critical realism philosophical approach has been used in this research. Most higher education information system professors believe is that experiencing ERP in an information systems class will contribute to greater learning of business processes, although the comprehensive review of past research attempting to prove this theory has shown past research lacking. To fully understand this educational linkage, it is imperative to move beyond empirical results and look to qualitative analysis in order to understand the mechanisms of causality and the powers and liabilities that determine the workings of that pedagogical mechanism.

3.2.5 Critical Realism with Multi-method Research

Critical realism research, being diverse by nature and holistic in its view, demands multiple tactics to research. Mingers (2001) and Orlikowski and Baroudi (1991) present a set of cogent arguments in favor of using multiple research methods in a single research project.

The world is complex, Mingers argues, and so one research method cannot explain all its complexities (2001). If only one research method is used, then the researcher may only be looking at one aspect of the project, and missing out on other facets, showing limited results (Orlikowski, Baroudi 1991). In this dissertation, understanding students' learning is a very complex problem, as evidenced by many trying to measure that learning in past studies. Therefore, the nature of the subject requires more than one research method to attempt to understand this learning. In addition, adopting a critical realist philosophy allows the usage of other methods traditionally associated with different philosophical traditions. For this research, a quantitative approach was used but not in isolation since it alone would be too shallow. To dig deeper and understand the knowledge gained, a qualitative approach has also been included. The triangulation of methods used in research makes it a stronger research project because the different methods can explain different aspects of the project and fill in any holes (Mingers 2001, Orlikowski, Baroudi 1991).

3.3 Research Approach

This research was approached with multiple methods. For the primary stage, the research approach was an experimental simulation followed by a modified group feedback analysis for the second phase. This step in the chapter is highlighted in Figure 3.4.

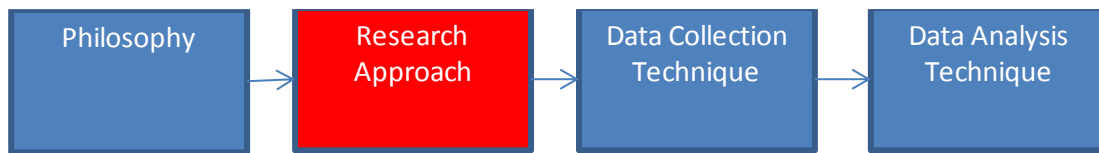


Figure 3-4 Stages in Research

A variety of research approaches were identified and assessed for suitability for this thesis (Jenkins 1985, Baskerville 1999, Benbasat, Goldstein et al. 1987, Myers 1997), with two approaches chosen as appropriate. The first phase used was an Experimental Simulation where a simulation model represents the real world and the results of students introduced to the model were analyzed. Students were asked to play a commercially available business simulation game, which mimics running an actual business. After playing the game, results were gathered and analyzed. The game not only provides quantitative data, but prompts discussion from the students in the next phase.

After this initial experimental simulation approach, the thesis assumed a qualitative tack in the second phase, by following an approach similar to the Group Feedback Analysis. In the Group Feedback Analysis approach, Jenkins (1985) describes the method:

Employing this methodology, groups of human subjects complete an objective instrument for testing of the researcher's initial hypothesis. Following the statistical analysis of the collected data, the data and the analysis are discussed with the subject group to obtain their subjective evaluation. The intent is to achieve a deeper analysis than that afforded by the statistical analysis alone. This methodology allows a re-evaluation of the original hypothesis (1985, p. 105).

Here, after the simulation exercise was complete and the data collected and analyzed, the students formed focus groups or answered brief email interviews to discuss the outcome of their exercise. The focus groups or brief email interviews got the students talking in a non-threatening, casual

atmosphere which revealed their thought processes. Others' comments during the focus group prompted some students that forgot parts of their logical approach to remember them and discuss them. The simulation game play provided a good starting point to probe the students' thoughts on business processes and perhaps remind them of concepts learned and applied. The outcomes of these focus group sessions were interpreted to understand why students acted as they did during the game. After identifying students particularly willing to discuss their game play, or exhibiting unusual results, in-depth interviews were conducted to probe further into the reasoning behind the simulation game play. The resulting qualitative data was used to uncover a new theory, following a critical realism philosophy. This was a similar approach to that of grounded theory, with the exception that a framework is used at the beginning of the interpretive data collection and that framework is then developed and refined from analysis into a theory, as opposed to beginning without a theory and building it up from the data. Grounded theory research does not begin with any hypothesis or proposition, but develops the proposition during the data analysis, thereby grounding it in the empirical work. Critical realism begins with a proposition and refines that through data analysis.

The research approach is the vehicle that links the philosophy to the actual design of the research and the data collection (Myers 2011). This approach drives the way the research is conducted. In essence, the critical realism philosophy aforementioned is adhered to: begin with a proposition, analyze the quantitative data to suggest a starting point, collect and analyze qualitative data, and further refine the proposition. In effect, the quantitative results from the students' playing the simulation game served as the framework to set the scene for further work, now of a qualitative nature, to understand why students might learn more about business processes when learning with ERP systems.

3.4 Data Collection Techniques

There exists a variety of data collection techniques available to today's researcher. Quantitative data collection techniques could be surveys or questionnaires, interviews, archival data, or some objective measure such as an exam (Straub, Gefen et al. 2005), whereas qualitatively, researchers may gather data through observation, texts, interviews, and transcripts (Myers 1997, Silverman 1993). This step in the chapter is highlighted in Figure 3.5.

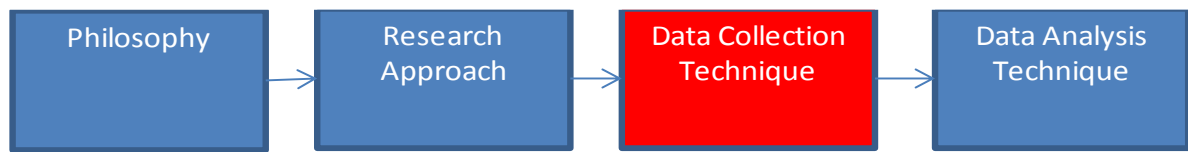


Figure 3-5 Stages in Research

Interviewing as a data collection technique, can be either quantitative or qualitative. In the area of quantitative data collection, researchers are asking specific pre-ordained questions to find out facts (Silverman 1993), whereas qualitative interviewing research may be more open-ended.

Interpretation and understanding are the goals of interviewing under the qualitative track, with the researcher guiding the conversation (Kvale 1996). The second phase of this research employed this method of data collection to qualitatively understand why the students make certain decisions while playing the simulation game.

3.5 Data Analysis Techniques

This dissertation approached research both quantitatively and qualitatively. The different approaches require different types of data collection, as discussed in section 3.4, and hence require varying data analysis techniques. This step in the chapter is highlighted in Figure 3.6.

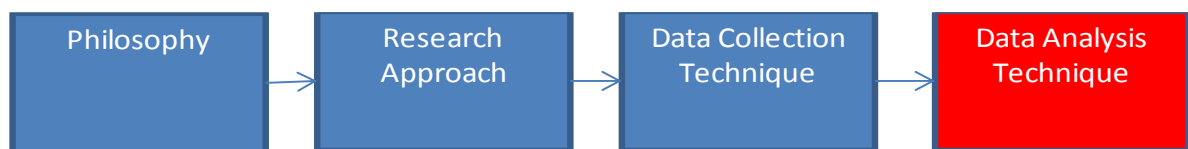


Figure 3-6 Stages in Research

3.5.1 Data Analysis Techniques for Part 1: Business Simulation

Students played the business simulation game both before and after the educational treatment and outcomes were measured to assess whether or not teaching ERP in an information systems class helps the students' understanding of business processes

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Since the same students played the simulation game twice (before and after the educational experience), and there are only two types of classes (with and without ERP), the strongest method to analyze the data is using a t-test. This type of analysis is used for measuring the mean scores of two groups with only one independent variable (with or without experiential ERP) (Hair, Black et al. 2006). In this experiment, data was collected by the same measures (the outcomes of the simulation game) from the same group of students, 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 was statistically analyzed. Once the pre and post data were compared between the classes with and without ERP, the results of the simulation game were also compared across countries (US and UK), which is also across level of curriculum (undergraduate and graduate). This comparison of means then became a test with 2 independent variables: with and without ERP, and US and UK. To statistically analyze this data, a multifactorial ANOVA was used, the best procedure for two independent concurrent variables.

In this study, there was a control group (those classes without ERP) which helps alleviate internal validity threats (Cook, Campbell 1979). To have external validity, the outcomes of the study should yield generalizations for other groups, usually requiring random samples (Cook, Campbell 1979). Since the outcomes of this study are applicable in higher education, at the undergraduate and postgraduate levels only, and the subjects being used for this study were undergraduates and postgraduate students in higher education, external validity should be acceptable. Students at each school should be representative of other university students.

An additional type of validity is construct validity, which sets out to ensure that there are no other constructs in the experiment which are causing the effect; in other words confounding (Cook, Campbell 1979). Two confounding variables in this study are the content of the different courses and the different professors teaching the different courses. Since this is, in some ways, like a field experiment, so both the content and the professor cannot be held constant, these confounding variables cannot be eliminated, but will be discussed in the data analysis.

It is concluded, therefore, that the research instrument of the simulation game is well-validated, both internally and externally. Surprisingly, in the research field of Information Systems, there has

been criticism that researchers do not validate their research instruments well. According to Straub (1989), researchers must validate their instruments for the following reasons. Firstly, validation of an instrument goes hand in hand with rigor of research. Secondly, well validated instruments can be used again by other researchers in other studies. Thirdly, validation allows a researcher to rethink and refine their basic research questions. Fourthly, if an instrument cannot be validated, then the entire research study could be questionable.

3.5.2 Data Analysis Techniques for Part 2: Group Feedback Analysis

The focus group, email interview, and in-depth interview qualitative data were gathered after the students played the simulation game at the end of semester or academic year. The resulting qualitative data was then analyzed.

One approach to analyzing interpretive data is to use content analysis, which is a method that allows the researcher to look through large amounts of data such as text, pictures, or videos, to find repeating arrangements of data. This pattern matching system uses codes to find repetitions, by not simply counting words, but looking for synonyms and also looking at the context in which the repeating word might have been used. Inferences and conclusions can be drawn from the results. For example, an old anonymous writing was credited to a deceased author by using content analysis on his previously authored work and the anonymous writing (Stemler 2001).

To analyze the qualitative data from this research, the constant comparative method, a type of content analysis, was used. Overall, this method allows for coding of the 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 was 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 new codes 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, Strauss 1967). This constant comparative

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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.

In summary, the t-test/ANOVA design and the constant comparative method for data analysis fit well with the critical realist approach in this dissertation. The research began with a proposition which was tested and criticized quantitatively with the business simulation game. As the qualitative data was collected, understanding of the students' knowledge of business processes was abstracted, and a new theory built up successively. Through a critical realist approach, the initial stage used an experimental simulation which, as an objective measure of students' knowledge, analyzed by a t-test/ANOVA. For the second stage, a modified group feedback analysis was employed with data being collected by interviews and analyzed by content analysis and the constant comparative method. From both of these analyses, quantitative and qualitative, a mechanism for learning was developed. The mechanism was further refined by retroduction with the qualitative analysis to identify the causal powers and liabilities that underlie this educational process.

3.6 Experimental Design

The basic research design follows that of the flowchart shown in Figure 3.7.

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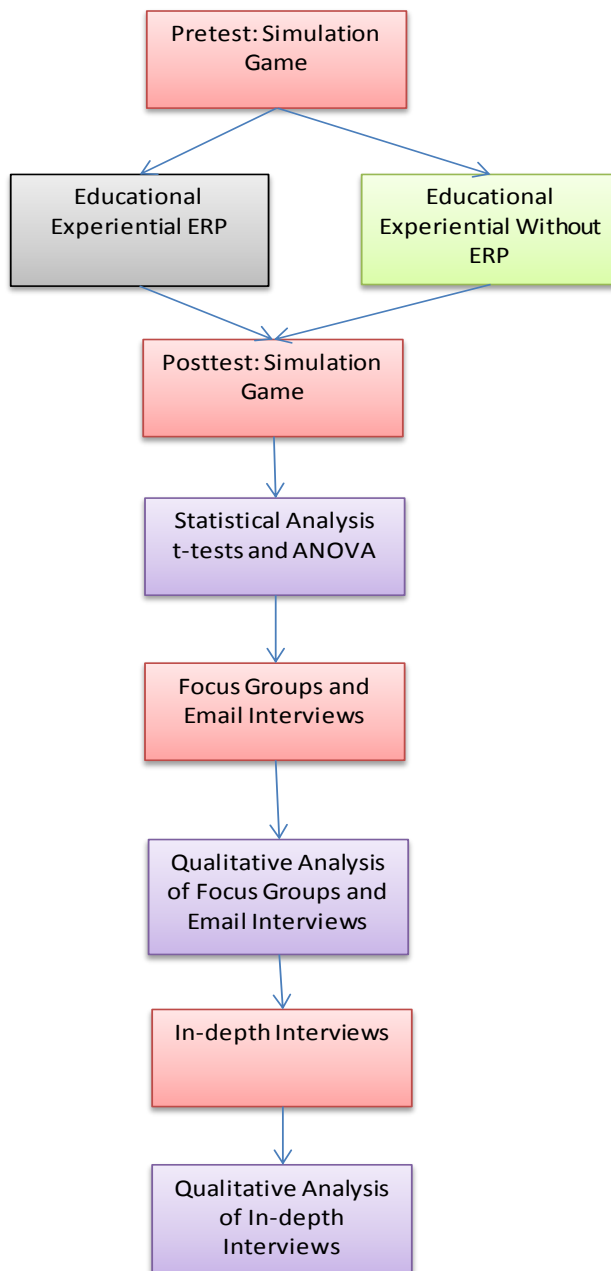


Figure 3-7 Research Design Flowchart

Each process in the research design flowchart will now be explained.

3.6.1 Pretest Phase

Students in each program initially played the simulation game before any classwork commenced.

This pretest allowed a baseline to be formed from which improvements in game performance were

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measured after the pedagogy. Printouts or electronic screenshots from the results of the simulation game were collected.

After the pretest, education commenced. Students received different educational treatments and these educational treatments were considered the *independent variables*. The test of the business process knowledge after the educational experience was considered the *dependent variable*.

3.6.2 Educational Treatment: Curriculum Tested

The educational treatment occurred in two different countries, the United States and the United Kingdom, and occurred at two different higher educational levels, the undergraduate level and the postgraduate level.

In the United States, students from 3 distinct classes at the University of Delaware were tested. The classes ran for 14 weeks, beginning in late August 2011 and finishing in December 2011. A summary of those classes and their students are listed in Table 3.2.

Class	Description	Number of Students	Using ERP experientially?
ACCT302 – Accounting Information Systems	Database design and usage for AIS	75 undergraduates	NO
MISY225 – Programming Business Applications	Database design and usage, Decision support, VB programming	80 undergraduates	NO
MISY261 – Business Information Systems	Database design and usage, Decision support, ERP	150 undergraduates	YES

Table 3-2 United States undergraduate classes

The source of students for each of these 3 classes is the Lerner College of Business and Economics at the University of Delaware. Before entering any of these classes, students must first successfully complete an introductory class, Business Computing: Tools and Concepts. It can therefore be assumed that each type of class begins with a similarly-prepared group of students. In addition, any

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one of these classes can count towards an undergraduate degree in an equivalent fashion. In other words, if a student takes one of these 3 classes, they do not have to take either of the other two to graduate.

In the United Kingdom at Brunel University, MSc (Masters) students were assessed after they completed their entire course of study (1 year). Beginning in October 2011, these students completed their coursework by March 2012, when they were evaluated by the simulation game instrument. There were two MSc programs that were evaluated, as listed in Table 3.3.

Program	Description	Number of Students	Using ERP experientially?
Information Systems Management	Strategic IS, IS development, IS management	70 graduate students	NO
Business Systems Integration (with SAP)	Enterprise systems, Service oriented architecture, ERP	70 graduate students	YES

Table 3-3 United Kingdom graduate programs

Both MSc programs have some common courses. Business modeling, Data management and Business Intelligence, Professional development and research, and Systems project management are taken in both tracks. In addition, students in either track need to write a dissertation after completing their coursework.

3.6.2.1 Curriculum Discussion – University of Delaware

Accounting Information Systems (ACCT302) is a 3rd year undergraduate course (undergraduate education at University of Delaware is 4 years) taken by Accounting majors in the College of Business and Economics. Students entering this class have had the same prerequisite as all others in this research. The course centers on designing and using enterprise-wide databases for accounting systems. Although the term “enterprise” is used in this course description, ERP systems are not used in this class. The software used to illustrate the databases in accounting systems is Microsoft Access.

Within this class, the concepts of REA Enterprise Ontology are studied, a database design approach for a shared database in the Accounting field of study (McCarthy 1982). A number of Accounting

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business processes are also studied, along with risks and controls. Although ERP systems are not experienced in this class, extensive work into business processes and enterprise systems may manifest itself into students with good understanding of concepts being tested by the simulation game. In terms of credits accepted at the University of Delaware, this course is somewhat equivalent to the other two courses tested. The students are at the same level as the other two classes tested, but are mostly Accounting majors. Accounting majors traditionally have a higher grade point average than the other students in the College of Business and Economics. The curriculum is rigorous and attracts a higher calibre student. That difference in student ability was addressed when analyzing the data. During the semester that the data was being collected, this class was taught by one professor only, so there wasn't any difference between the classes in terms of pedagogical experience. Discussions with this professor took place after the semester was over, to find out any differences between what the syllabus proposed to cover and what was actually covered in the classroom.

Introduction to Programming Business Applications (MISY225) is a 2nd year undergraduate course at the University of Delaware taken by any major in the College of Business and Economics. It is the first course in the sequence of the MIS minor, which is a program of 6 classes that grant the student a minor of study in MIS upon graduation. This class is equivalent in level to the other 2nd year course (MISY261) that uses ERP systems, and students can take this as a substitute for MISY261. Although the content is quite different, it was decided to collect data on this class because it was available and might prove to show some interesting results.

The course (MISY225) teaches the fundamentals of the visual basic programming language running under the Windows operating system, and visual basic for applications running under Excel. Programming topics such as subroutines, functions, decisions, loops, and arrays are covered with hands-on computer lab work. The students taking this class have opted in because they are choosing to include a minor of study in the field of Management Information Systems. Again, like in the Accounting course (ACCT302), the grade point average of these students could be higher than those taking the experiential ERP class (MISY261). Students who are interested in the field of MIS and in computers are usually the ones who decide to take this MIS minor. These differences were taken into account when analyzing the resulting data. For the semester of the data collection, there was only one professor teaching all 3 sections of the class, so there wasn't any variation in the

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pedagogical experience between those 3 classes. Discussions post-teaching ensued to find out if the course deviated at all from the original plans on the syllabus.

Business Information Systems (MISY261) is also a 2nd year class, taken at the undergraduate level by any major except for accounting majors in the College of Business and Economics at University of Delaware. Again, students entering this class have the same prerequisite as for the other two classes, ACCT302 and MISY225. In general, the students taking this class do not work in the Information Technology field when they graduate.

The course content includes database design and implementation with Microsoft Access, decision support building with Microsoft Excel, and the study of Enterprise Resource Planning Systems. Experiential hands-on work with the live SAP system is covered through the SAP University Alliance. Specifically, the students get to run a Sales and Distribution Exercise in SAP which enables them to experience the order-to-cash business process. They also run a number of exercises on the BEX analyzer, which is a business intelligence tool within SAP. In addition, they get some extra practice with business processes by creating process maps using the flowcharting tools in Microsoft Excel. During the data collection semester, there were 3 classes being taught by one professor, and one class taught by another professor. The two professors work closely to share syllabi, course content, and exams. Therefore it was assumed that students in the two classes had similar experiences. Also, discussions around the exact material covered compared to the original syllabus occurred, to see if there were any differences in the educational experience.

3.6.2.2 Curriculum Discussion – Brunel University

In the Masters of Science programme at Brunel University, the Information Systems Management track is a course of study emphasizing enterprise-wide information systems. Special attention in this curriculum is paid to aligning the enterprise system with the strategic direction of the organization. One of the courses taken is Business Integration, which exposes the student to business processes through different aspects of integrating business such as technological challenges and inter-organizational issues. In addition, a course, Business Modeling also promotes a business process approach with conceptual and practical modeling techniques. A course in Data Management and Business Intelligence contains a module of using a BI tool through an SAP system, although the rest of the programme does not utilize an ERP system.

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In contrast, the Business Systems Integration (with SAP technology) track does use SAP's ERP in an experiential fashion. The goals of the programme are to promote an integrated approach to organization's information system through ERP and web services. Some courses that are in the ISM programme are also available to the BSI students, such as Business Modeling and Data Management and Business Intelligence. In addition, courses such as ERP Systems Theory and Practice and ERP Systems Deployment and Configuration give the student a highly experiential approach to learning with ERP.

The following Table 3.4 summarizes the business process approach for each curriculum studied.

Course	Level	Business Process Approach
ACCT302	Undergrad	Accounting business processes, REA Enterprise Model
MISY225	Undergrad	Visual Basic Programming examples
MISY261	Undergrad	Experiential ERP, business process mapping
IS Management	Postgrad	Business modeling and integration
Business Systems Integration	Postgrad	Experiential ERP, business modeling

Table 3-4 Business Process Approach by Curriculum Studied

3.6.3 Posttest: Simulation Game

After the educational treatment (*independent variable*) was complete, students played the business simulation game and printed out their results or electronically emailed them. The resulting printouts or screenshots displayed key information of game decision making, marketing, and financial aspects. In addition to playing the simulation game, students completed a brief questionnaire that recorded any prior knowledge that might affect the outcomes. For example, if a student has had work experience, their knowledge of business processes may be much greater than that of a student who has never been exposed to industrial work.

To understand the results from the game, the stages of game play must first be explained. The simulation game is broken into 5 stages, as shown in Table 3.5.

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Stage	Game Segment
1	Introduction – Here the player learns the user interface and how to access the various pieces of information important for play.
2	Market Research – Here the player reviews market research on the various products to sell and chooses one.
3	Select Sales Strategy – Here the player decides on how to sell the product: by sales agent, by distributor, or directly.
4	Prepare to Trade – Here the player decides on the selling price, sales and marketing budget, and the product quality.
5	Complete 3 Years of Trading – During this time of trading, production, selling price, sales and marketing budget, and product quality can be changed to reflect what is happening re the company financials.

Table 3-5 The 5 stages of the Simulation Game

The business simulation game mimics a real life managerial job, where the player is in charge of choosing a product to market, produce and sell. The intention is that students draw on their knowledge of how businesses work and, perhaps, business processes to play the manager’s role for a positive game outcome. Students who understand more about the business processes of an organization may perform better on the simulation game, as they would perform better in a real life organizational situation. The simulation game assesses each facet of business process understanding. Shown in Table 3.10, each important business process facet (as identified in Chapter 2) is played out during the game.

	Business Process Facet	Simulation Game Experience
1	Group of related tasks	Selling, producing, and marketing all happening during game
2	Enables information sharing	Use information from one department

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		to direct another
3	Promotes integration between departments and/or processes	Marketing affects selling; selling affects production; production affects pricing
4	Creates value for the customer (either internal or external)	Starting a business; attempting to make a profit in 3 years; selling; advertising; producing
5	Cross functional	Covers marketing, sales, production, finance
6	Could involve multiple people	Different people from different departments give advice and information
7	Involves key business activities; uses business terminology	Key activities: sales, production, finance. Business terms used throughout the game

Table 3-6 Key Facets of Business Processes during the Simulation Game

This simulation game has been used as a measurement of the students' knowledge of business processes. Measurement of educational outcomes, or student assessment, aligns well with the goals of an educational program and the teaching methods. Consistency is important because assessment then does what it is supposed to do: test what is learned (Biggs 1999). In this research, students experienced an ERP system in some of the curriculum studied. Through the hands-on work with ERP, the teaching method used is based on the Kolbian experiential learning theory. So in essence, the education was experiential. To align the educational experience with that of the assessment experience, the measurement of that learning also was experiential, as it is with a computer simulation game.

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). Bigg's term performative is defined as a high level of comprehension alters the learner's view so that he/she performs differently. If students

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fully understand a concept, then they will be able to use those concepts to solve new problems in unknown circumstances. This type of assessment, which is similar to that of a simulation game, is superior to verbal assessment because it gets at a deep level of comprehension (Biggs 1999), striving for the higher end of Bloom's Cognitive Taxonomy. 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, on the lower end of Bloom's Cognitive Taxonomy, one that is not sufficient to show the true pedagogical 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 simulation game, the assessment of the students' knowledge, can be theoretically based on the modified Kolbian experiential learning theory, as is the actual learning of business processes through the experience of an ERP system. As shown in Figure 3.8, the stages of the game can be juxtaposed over the modified experiential learning cycle.

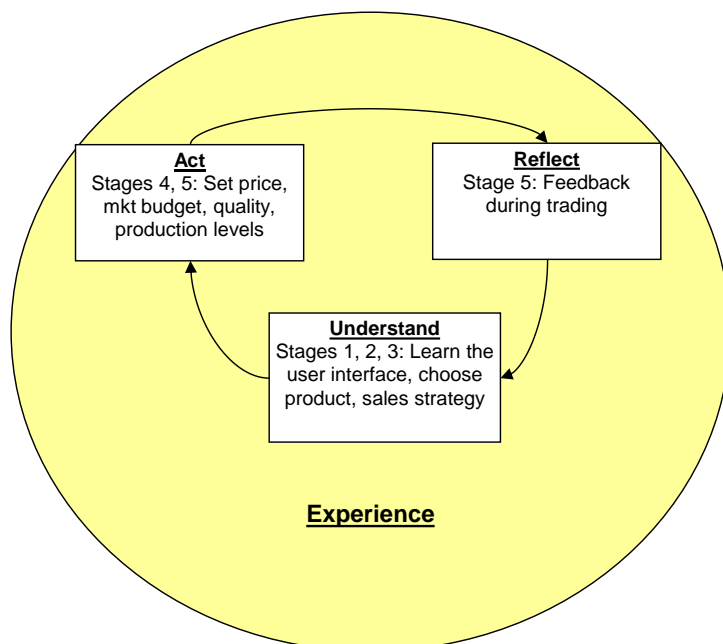


Figure 3-8 Simulation Game Stages under the modified ELT

Key decisions made in the game were recorded by the game software. During the game, the player must choose a product to sell and a sales channel to sell that product in (stage 2 and stage 3). Both

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of those decisions are recorded and displayed at the end of the game, along with the reasons why those decisions are made (PIXELearning, 2011). The final product quality and final product price, which are initially set in Stage 4, and can be changed in Stage 5, were printed out at the end of the game. Outcomes of the game were also recorded and financial results are displayed at the end of the game. Gross and net profit, with some sample numbers, were calculated and printed as shown in Figure 3.9.

Full year accounts	
Sales revenues (gross):	9,675,380.00
Sales Commission:	1,935,076.00
Sales revenues (net):	7,740,304.00
Total Production costs:	5,172,603.00
Gross Profit:	2,567,701.00
Transport & Shipping:	504,306.00
Office Administration:	639,000.00
Sales & Marketing Spend:	634,500.00
After Sales & Support Costs:	351,000.00
One Off Costs	-
Net Profit:	

Figure 3-9 Financial Performance at the end of the Simulation Game

3.6.4 Statistical Analysis of Simulation Game Results

Through a t-test and ANOVA, Minitab was used to analyze the results of the simulation game for the two groups: the education with ERP systems and the education without ERP systems, comparing the before and after results of the educational treatment. Group comparisons were made between countries (UK and US) and between levels of education (undergraduate and postgraduate). The independent variables were the type of class and the country (or level of education). The dependent variable was the outcome of the simulation game.

The key outcome of the simulation game used for analysis was net profit (see Figure 3.10). The net profit number was chosen as the key outcome because it summarizes all aspects of playing the game. Revenue (sales) comprise part of net profit, as do expenses which test whether students were able to operate their manufacturing facilities efficiently and keep their marketing budgets within the boundaries of revenue produced. This key outcome measured understanding of business processes in an abstract way.

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Once the educational experience was finished and the students played the simulation game at the end of the semester/year, the data was once again collected. The individual differences between the outcome of the game before and after education were calculated and run in Minitab. The means of the two groups, classes with ERP and classes without ERP, were compared by using a t-test.

After all data was collected and analyzed with the t-tests, comparisons were then be made across countries and across level of curriculum. In the US, the classes tested were undergraduate classes. That data was compared with that of the UK, which are classes of postgraduate degree students. Comparing the data between the countries, therefore between the levels of education, was also be performed by using Minitab via a t-test. To inspect all classes together, an ANOVA was used since there are more than two groups to compare: with or without ERP, and US undergraduate (3 classes or UK (postgraduate) (2 classes).

Once this statistical analysis was complete, further analysis turned to the qualitative data. By analyzing the qualitative data, refinement of understanding how students learn experientially with ERP systems was discovered.

3.6.5 Focus Groups and Email Interviews

In the first phase of the qualitative data collection, after playing the simulation game, focus groups of students were formed or individuals contacted in person or via email to discuss their thought processes while playing the simulation game. Those discussions were centered on business processes and whether students thought of the integrative functionality in an organization while strategizing in the game. For those participating in the focus groups, akin to group feedback analysis, students were able to discuss their strategies in the game in a non-threatening setting (Jenkins 1985). Issues brought up by the other students in the focus group prompted some forgotten thoughts of others and allowed them to share their strategies.

Transcriptions of the focus group results and email interviews were created. Although there were many focus groups and interview sessions, the format of each was similar with similar questions so that the pertinent phrases were identified.

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Through an interpretive lens employing retrodution, students' thought processes were analyzed to find out their approach to playing the simulation game. Of particular interest was whether they thought of the "big picture", as managers do when they reflect, that is, thought about problems in a complex way and questioned them (Kayes 2002). Did the students consider the business process when reflecting on the information that is being presented during the game play? Did they take into account how information is being shared cross-functionally in an organization when financial results such as cash flow are being rapidly thrown at them? Some sample questions are listed in Table 3.7.

1.	What were you thinking when you were playing the game?
2.	What strategies did you use to play the game?
3.	How did you attempt to make a profit during the trading time?
4.	Were you able to reverse any loss in profits during the trading time?
5.	What information was relevant to ensuring a profitable outcome?
6.	Did that information originate in different areas of the company?
7.	Did you think as a manager might, about the overall picture of the company and what problems were affecting the outcomes?

Table 3-7 Sample Focus Group Questions

This interpretive data collection examined what was happening in the Reflect Phase of the modified experiential learning theory and the Kayes Experience Modes (see Chapter 2), as shown in Figure 3.10.

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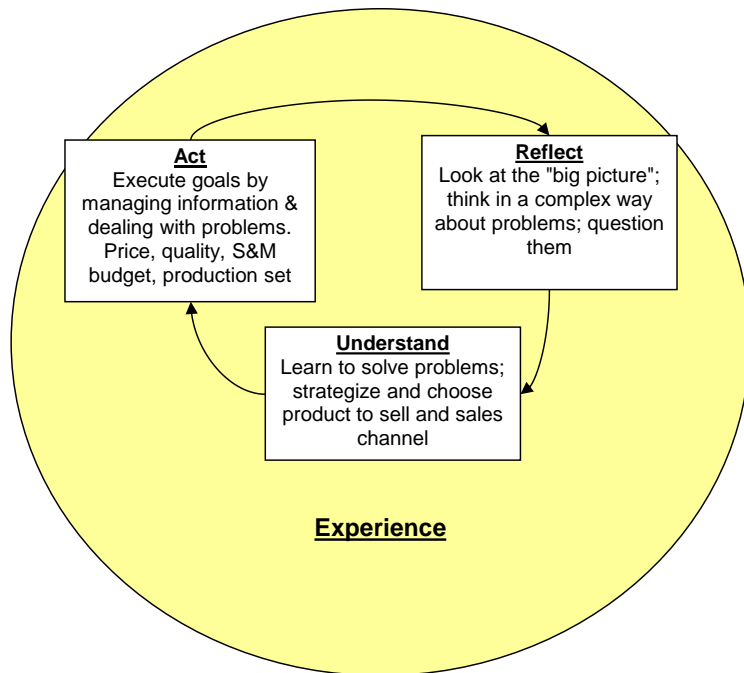


Figure 3-10 Key Simulation Game Decisions and Outcomes under Kayes and Kolbian ELT

3.6.6 Analysis of the Interpretive Data

The focus groups, individual interviews and email interviews resulted in interpretive data that was analyzed by content analysis and the constant comparative method at times using the software NVivo. The name of the software, NVivo, originates from the Latin phrase, “in vivo”, which means “within the living”. For qualitative analysis, in vivo meant generating concepts from the subjects of the experiment and from its situation (Gibbs 2010). Prior to collecting the data, categorical codes were developed and are listed below. These categories originated in the literature search from Chapter 2 and have been codified to represent parts (Myers 2011) of text that were verbalized in the focus group interview process.

Categorical Code	Explanation
1. Business Processes	
a. Connections	Group of connected tasks, e.g. order to cash
b. Integration	Integration between departments and/or

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	processes
c. Communication	Sharing information outside sphere of work; communication
d. Value	Creates value – either internally or externally
e. Collaboration	Cross-functional tasks
f. Involvement	Multiple people involved
g. Terminology	Involves key business activities; uses business terminology
2. Enterprise systems – ERP	
a. ERP integration	Business integration
b. Info view	Single view of information with central database
c. Efficiency	More efficient business processes
d. Performance control	Great control over corporate performance
e. Communication	Better communication
f. Empathy	Understand perspective of other functions
g. Management control	Management control
3. Experiential learning	
4. Business Knowledge	
a. Financial	Financial outcomes of the game
b. Marketing	Marketing of product
c. Pricing	Pricing of product

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d. Manufacturing	Manufacturing of product
e. Quality	Quality of product
f. Choice	Choice of product
5. Broad view	
6. Complexity	

Table 3-8 Categorical Codes from Literature Review

New nodes were discovered in the data, and added to the list of existing objects. A frequency count of times that these objects have been mentioned was conducted. Anderson et al (Anderson, Blatt et al. 2006) suggest guidelines for using and discounting mechanisms known under the heading “the Stopping Rule” (p. 107). Researchers can know when to stop looking for mechanisms from hints originating in the literature; they can look at different organizational planes above and below the current research topic and finally they can rely on their own talents. It is argued here that a good rule for uncovering mechanisms is the following: Gaps in the frequencies were examined as natural cut-offs for uncovering a learning mechanism.

After this frequency analysis, it was determined that the focus group and email data was too shallow to create the mechanism for learning. The next section outlines how the mechanism for learning was formed from the in-depth interview data.

3.6.7 In-Depth Interviews

A handful of students who showed unusual results in playing the games or were particularly voluble were called in for further discussions. Those unusual students were interviewed separately and in-depth, for a longer period, from the main groups of students.

Based on expert interviewer’s advice (Vicker 2012), the following questions were used as a beginning framework for discussion during the in-depth interviews:

1. What was your general approach to playing the business simulation game?
2. What was the difference between playing the game the first time versus the second time?
3. How did your coursework inform how you played the game or your thinking towards the

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game?

4. How did your knowledge of business processes help you play the game?
5. What sort of information did you access when you played the game?
6. Do you think the game simulated what a manager might do?

The order of these questions varied, along with further questioning based on answers to these questions. The data was then analyzed in a similar fashion to that of the focus groups.

The in-depth interview data was coded and a frequency count conducted. Necessary mechanisms were first identified from the literature-based objects, using an appropriate stopping rule of a large gap in the frequency of identified phrases. New objects were then identified in this qualitative data, and again using a stopping rule of a gap in frequency, contingent mechanisms were also identified. The two types of mechanisms, necessary and contingent, formed the overall learning mechanism.

Further scrutiny of the actual in-depth interview text completed the analysis. This drilling down into the interview transcripts confirmed the learning mechanism and identified forces that enabled or inhibited the workings of that mechanism. Those forces, be they positive or negative, were labeled as powers and liabilities.

This method was driving into the detail of the in-depth interviews creating a well-developed mechanism for learning. Analysis of the data was consistent beginning with the focus groups, individual interviews and Email interviews and carrying on through the in-depth interviews between both universities, University of Delaware and Brunel University, at the two levels of education, undergraduate and postgraduate.

3.7 Summary

Universities throughout the world are using ERP systems in the classroom to teach business processes. This method of teaching is an affirmation of the Kolbian Experiential Learning Theory, which states that experiencing is an essential part of learning. This thesis is attempting to support the proposition that indeed using an ERP system will aid in business process understanding.

The past research results cited in Chapter 2 surrounding the effects of teaching ERP in higher education have been mixed and somewhat inconclusive. Those attempting to prove a causal relationship between ERP teaching and more business process knowledge conducted positivist-type

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studies or self-efficacy questionnaires. Since none of these were definitive in their results, it was time to rethink the approach to understanding how this experiential pedagogy plays into students' learning. It was not sufficient just to do another causal study, but it was important to move beyond the positivist/quantitative-only study where differing experiments can lead to differing results (Newton, Deetz et al. 2011).

In order to not only measure students' learning, but also to understand the mechanisms underlying that learning, a critical realist philosophical approach to this research was taken. Beginning with an initial proposition that teaching ERP experientially in a higher education information systems curriculum results in better business process learning, an improved theory was created.

Retroduction was employed in the qualitative analysis to identify the causal powers and liabilities that underlie this educational process.

Through a critical realist lens, it was argued that using multiple methods in research results in a more complete study. Beginning with a simulation game as a quantitative measure of students' learning, the experiential educational treatment with ERP took place in the US at the undergraduate level for a one semester class, and in the UK at the masters' level for a year's curriculum. Control groups of classes without ERP were tested and analyzed alongside the classes with ERP. After the educational treatment, the simulation game was played again and focus groups were formed or interviews conducted to discuss how the students played the simulation game. By playing the simulation game prior to the focus group interviews, students were more readily be able to articulate their thought processes. Further in-depth interviews occurred with selected students from each class. Data analysis consisted of quantitative t-tests and ANOVA, and qualitative content analysis with the constant comparative method.

The results of this research are significant. With the large number of universities using ERP software for experiential learning, the improved theory sheds new light and is a direction for future educational endeavors.

Chapter 4. University of Delaware Results

Nothing ever becomes real till it is experienced – John Keats

4.1 Introduction

This chapter presents the quantitative and qualitative results from the business simulation game for all undergraduate classes tested at University of Delaware. Specifically, undergraduates were recruited from 3 distinct classes to play a business simulation game before and after the semester's coursework. One of the classes experienced ERP systems during the semester, and the other two did not. The outcomes of the game were statistically analyzed and the results are presented as the quantitative portion of the research. After the second business simulation game play, students from the 3 classes participated a variety of interviews. In this chapter, the qualitative results from the focus groups, individual interviews and the in-depth interviews are presented and a model for learning is introduced. Triggers and suppressions to that model are subsequently developed and explained.

In discussing the University of Delaware results, this chapter begins with the quantitative data analysis using a t-test of the 3 different classes tested in Section 4.2. Following that analysis, in Section 4.3 the qualitative analysis is developed through coding with the preliminary focus groups and interview data. In the proceeding Section 4.4, the in-depth interview data is described in detail both conceptually and causally, resulting in a learning model with powers and liabilities identified. Finally, the summary concludes the entire chapter in Section 4.5.

4.2 Quantitative Data Analysis

In order to obtain the quantitative data for this research, students were asked to play a business simulation game at the beginning of the semester and also asked to play the same game at the end of the semester. The score of Net Profit, an outcome of the game, was recorded for each game play. The difference between Net Profit scores from the beginning of the semester to the end of the semester was calculated. This difference was used for analysis in the statistical program, Minitab.

A t-test analysis was performed on the Net Profit difference for 3 different classes (previously described in Section 3.6.2):

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- MISY261 – Business Information Systems (With ERP)
- ACCT302 – Accounting Information Systems (Without ERP)
- MISY225 – Programming Business Applications (Without ERP)

The difference of the net profit score of the class with ERP is compared to those without ERP.

Results of the statistical data analysis follow.

4.2.1 Results of MISY261 versus ACCT302 and MISY225

Before the classes without ERP are compared with the ERP class, the separate classes must be examined for normality. The difference in Net Profit from the simulation game results for the two game plays was computed and the results for all three classes have a normal distribution as shown in Figures 4.1-4.3:

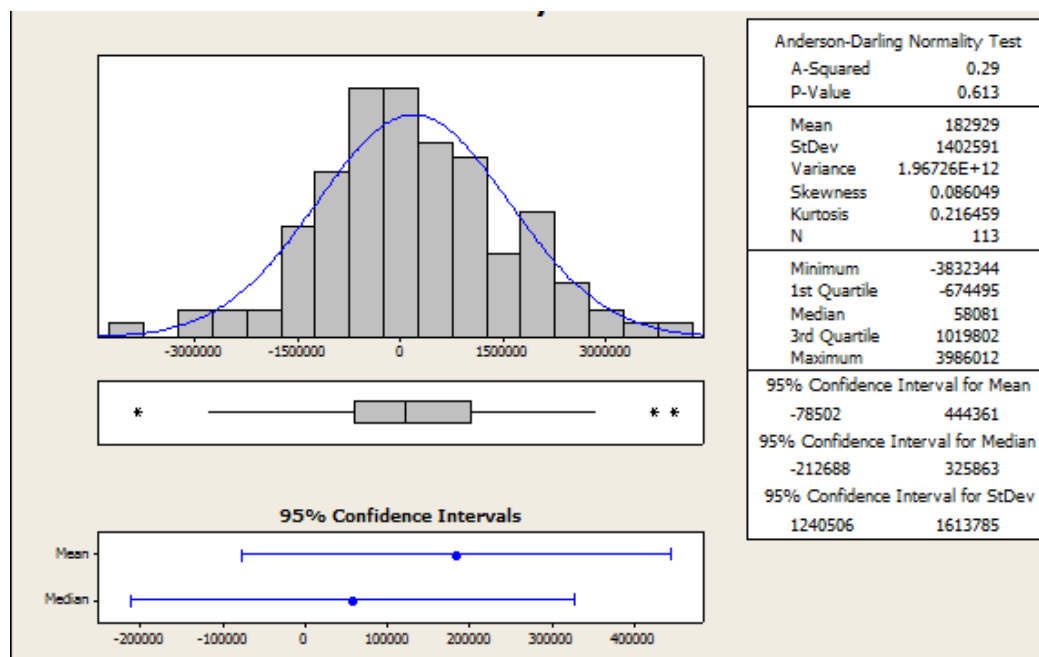


Figure 4-1 Distribution of Net Profit Difference for MISY261 (with ERP)

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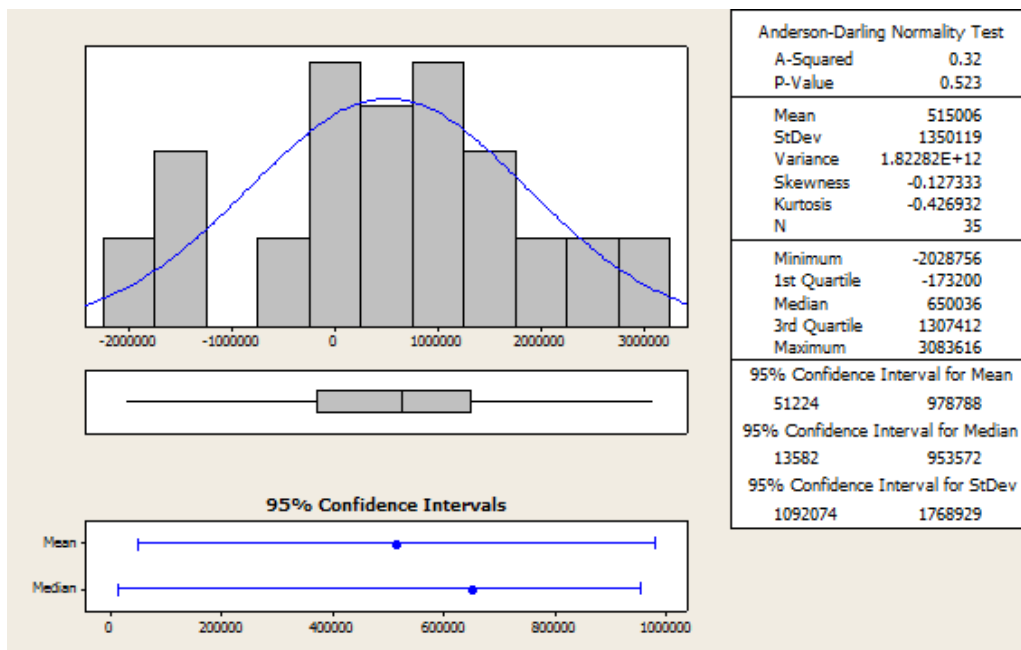


Figure 4-2 Distribution of Net Profit Difference for ACCT302 (without ERP)

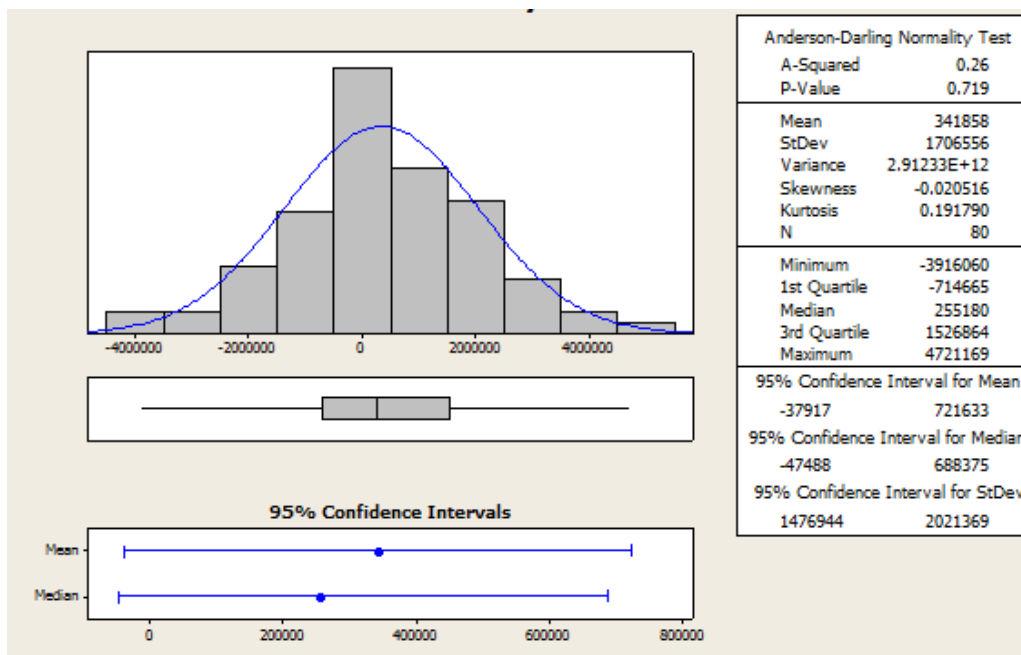


Figure 4-3 Distribution of Net Profit Difference for MISY225 (without ERP)

Notice that all scores are clustered around a bell-shaped curve with p-values greater than 0.05, indicating that the data is normal for all three classes. This distribution confirms the use of t-tests as

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an appropriate method to compare the outcomes from the different classes. Without a normal data distribution, alternative tests would be needed.

T-tests were run twice: once for the comparison of MISY261 (with ERP) to that of ACCT302 (without ERP) and once for the comparison of MISY261 (with ERP) to that of MISY225 (without ERP). The results follow in Tables 4.1 and 4.2:

Class	Number of Students	Mean Difference in net profit between 2 instances of game play	St Dev	SE Mean
MISY261 (ERP)	113	182929	1402591	131945
ACCT302 (no ERP)	35	515006	1350119	225212
T-value=-1.26	P-value=0.213	DF=58		

Table 4-1 Comparison Results between MISY261 and ACCT302

Class	Number	Mean Difference in net profit between 2 instances of game play	St Dev	SE Mean
MISY261 (ERP)	113	182929	1402591	131945
MISY225 (no ERP)	80	341858	1706556	190799
T-value=-0.69	P-value=0.494	DF=148		

Table 4-2 Comparison Results between MISY261 and MISY225

The t-test compares each set of two groups, by testing the null hypothesis that both means are equal. For both comparisons, the p-value is 0.213 and 0.494 respectively, which are both above the 0.05 significance level. Therefore, the analysis failed to reject the null hypothesis and it can be assumed that there is no difference between the outcomes of the classes without ERP compared to

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those with ERP. In other words, the difference in Net Profit for MISY261, Business Information Systems (With ERP) is the same as the difference in Net Profit for ACCT302 Accounting Information Systems (Without ERP) or MISY225 (Without ERP) for all the students in the classes tested.

However, for the group of students that were later interviewed in-depth, those students who took the ERP class (MISY261) were largely successful during the second time they played the business simulation game as opposed to the first time they played. All increased their score after the semester's class. However, for the non-ERP classes, two thirds of the ACCT302 class interviewed students decreased their score the second time they played and one third of the MISY225 interviewed students also did worse the second time they played the game. The overwhelming success of the ERP class of students playing the game the second time points to a difference between this class versus the other classes. Details on that difference can only be described with the qualitative data analysis, as indicated when following a critical realist view.

Along with the game play, students were asked to record their grade point average, known as GPA, to compare the different sets of classes to ensure the students were similar. The first step was to check the normality of the GPA data. The results of the three classes are as follows:

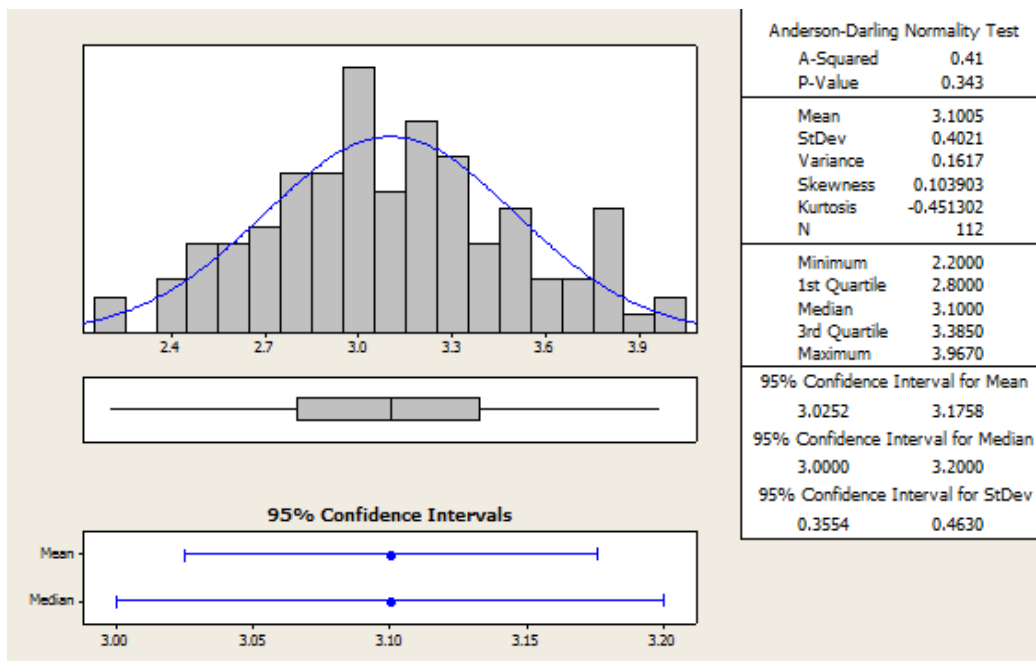


Figure 4-4 Grade Point Average Distribution for MISY261 (with ERP)

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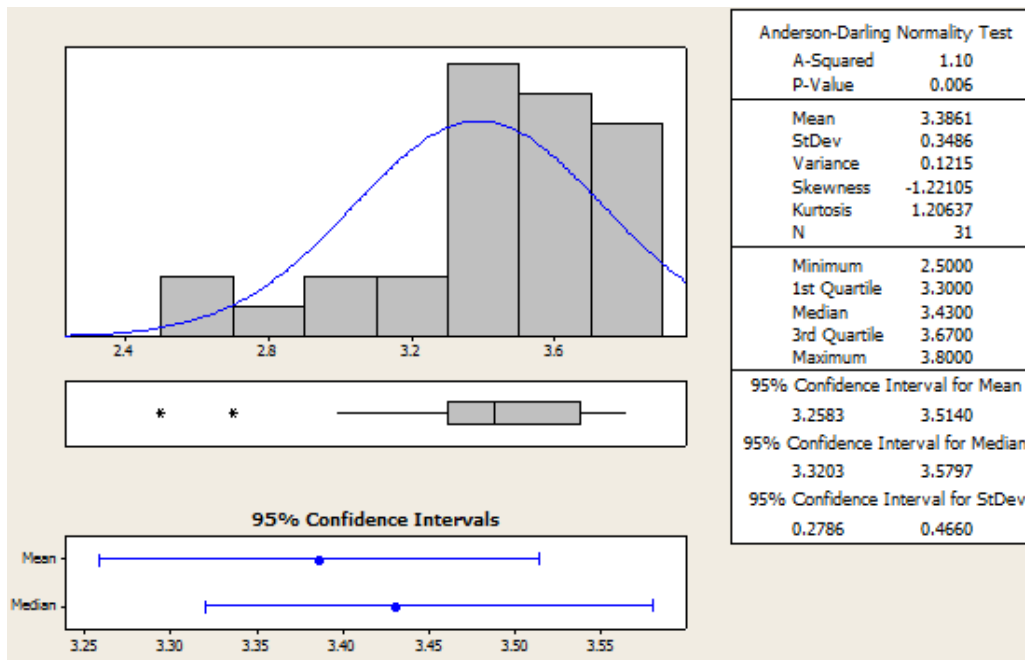


Figure 4-5 Grade Point Average Distribution for ACCT302 (without ERP)

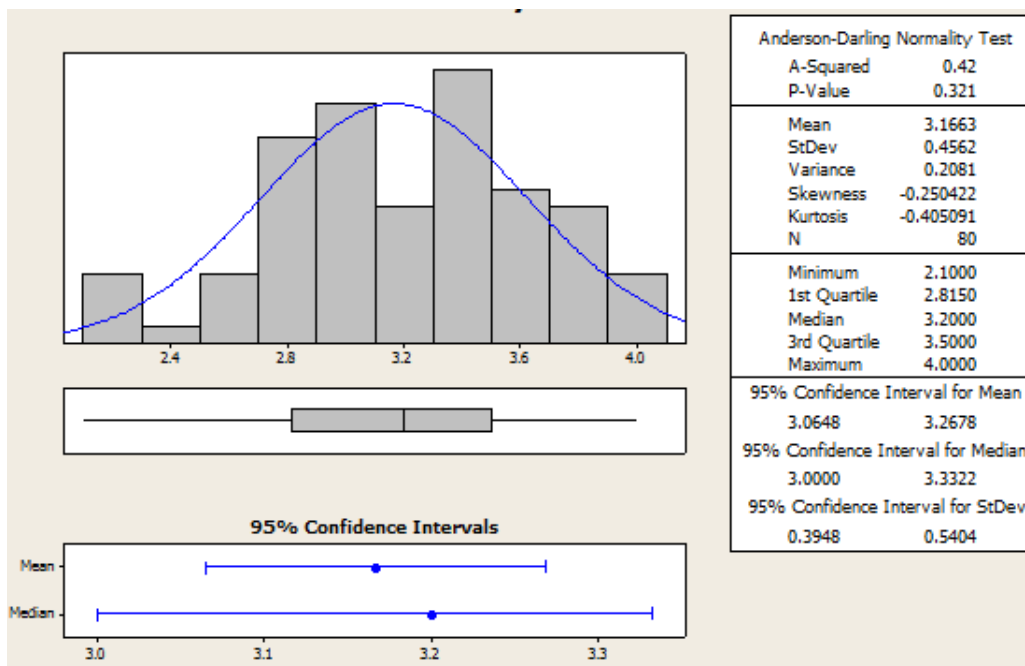


Figure 4-6 Grade Point Average Distribution for MISY225 (without ERP)

The distribution of the grade point averages of the MISY261 (with ERP) class and the MISY225 (without ERP) class are normal. On the other hand, the GPA of the ACCT302 students is not normal

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and according to the test the normality of GPA is unlikely. The p-value of the test statistic is 0.006.

The t-test results for the grade point average comparisons are as follows:

Class	Number of Students	Mean of GPA	St Dev	SE Mean
MISY261 (ERP)	112	3.101	0.402	0.038
ACCT302 (no ERP)	31	3.386	0.349	0.063
T-value=-3.90	P-value=0.000	DF=54		

Table 4-3 GPA Comparison Results between MISY261 and ACCT302

Class	Number	Mean of GPA	St Dev	SE Mean
MISY261 (ERP)	112	3.101	0.402	0.038
MISY225 (no ERP)	80	3.166	0.456	0.051
T-value=-1.03	P-value=0.303	DF=156		

Table 4-4 GPA Comparison Results between MISY261 and MISY225

In the results shown in Table 4.3, for MISY261 (with ERP) compared with ACCT302 (without ERP) the p-value is 0.000 which indicates that the GPAs of the two classes are different. Since the data is not normal, a Mann-Whitney test was additionally run on the data. The results, showing the p value at 0.0002, confirm the difference between the two classes' GPAs. Surprisingly, the GPA difference between the two classes does not appear to make a difference in the outcomes of the delta between the simulation game plays, but every student from the high GPA class (ACCT302) had a positive net profit the first time they played the game (bar one student). This is an indication that there are differences between the groups, which can only be discovered by analyzing the qualitative data. In the results shown in Table 4.4 for MISY261 (with ERP) compared with MISY225 (without ERP), the p-value is 0.303 which indicates that the GPAs of the two classes are not different.

The demographic data from all three classes was reviewed to ensure that some students weren't basing their simulation game play or interviews on past work experience. None of the students had

significant work experience that would affect their results. (Note: any jobs had by these students were part-time or short-term jobs such as waiters, cashiers, financial analysts, clothing store employees, phone store employees, or accounting firm summer internships.)

We now turn to the qualitative analysis to explore differences between the classes.

4.3 Qualitative Data Analysis - Focus Groups and Individual Interviews

The second phase of this research is qualitative, beginning with focus group discussions and individual interviews. These were conducted with 53 students after the final playing of the simulation game, with 24 of them from MISY261 (with ERP), 16 from ACCT302 (without ERP) and 13 from MISY225 (without ERP). Some of these interviews were conducted via email because students had left campus for the holiday break and were unavailable in person. All discussions and interviews were imported into the software NVivo and then transcribed within NVivo.

The initial coding phase then commenced. The categorical objects and their properties that were used for this research project, introduced and explained in Chapter 3 (section 3.66), are initially prescribed and originate from the theoretical framework developed from the literature as suggested by Danermark (Danermark et al 2002). They are as follows:

1. Business Processes
 - a. Connections
 - b. Integration
 - c. Communication
 - d. Value
 - e. Collaboration
 - f. Involvement
 - g. Terminology
2. Enterprise systems – ERP
 - a. ERP integration
 - b. Info view
 - c. Efficiency
 - d. Performance control
 - e. Communication

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- f. Empathy
- g. Management control
- 3. Experiential learning
- 4. Business Knowledge
 - a. Financial
 - b. Marketing
 - c. Pricing
 - d. Manufacturing
 - e. Quality
 - f. Choice
- 5. Broad view
- 6. Complexity

Once the focus group and individual interview data was coded with the aforementioned objects, new objects were added to the categorization of the data. The new objects are as (1) Level of Interest, (2) Competition, (3) Strategy, (4) Environment, (5) User Interface, (6) Timing, and (7) Product and Market Knowledge.

To fully understand the impact of the data, a frequency count was undertaken to find out which categorical objects and their properties, both predetermined and new, are most important, as shown in the following Table 4.5.

<u>PREDETERMINED OBJECTS</u>	MISY261	ACCT302	MISY225
1. Business Processes			
a. Connections	4%	0%	0%
b. Integration	29%	19%	8%
c. Communication	29%	25%	8%
d. Valuable			
e. Collaboration	13%	19%	8%

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f. Involvement	17%	6%	0%
g. Terminology	46%	44%	31%
2. Enterprise systems – ERP – company-wide information systems			
a. ERP Integration			
b. Info View			
c. Efficiency			
d. Performance Control	4%	0%	8%
e. Communication			
f. Empathy			
g. Management control			
3. Experiential learning	29%	0%	8%
4. Business Knowledge			
a. Financial	33%	13%	23%
b. Marketing	75%	75%	46%
c. Pricing	75%	75%	85%
d. Manufacturing	42%	69%	46%
e. Quality	58%	63%	46%
f. Choice	17%	25%	31%
5. Broad, overall view	0%	6%	0%
6. Approach problems in a complex way	63%	38%	15%
<u>NEW OBJECTS</u>			
Level of Interest	0%	19%	0%
Competition	67%	50%	31%
Strategy	8%	13%	0%

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Environment	13%	31%	0%
User Interface	8%	0%	0%
Timing	38%	6%	0%
Product and Market Knowledge	0%	13%	8%

Table 4-5 Frequency Count of Focus Group and Individual Interview Data

The data are not rich enough to draw any conclusions, or to develop the learning mechanism, but were used to identify students that would be ideal candidates for the in-depth interviews. Some observations may be drawn from this data:

- Business knowledge is summarized from specific discussion of the simulation game. Every property of business knowledge was discussed by at least one class's focus groups and/or individual interview. It is obvious that students are articulating their understanding of business when demonstrating their decision-making skills during the simulation game play.
- Very little, if any, objects were discussed surrounding ERP systems. Less than 10% of students in any class brought up any properties within ERP. This is not surprising for students in ACCT302 and MISY225 since they didn't study with the software during the semester. But it is odd that the group using ERP didn't mention it much in the focus groups or individual interviews.
- In the area of business process objects, 30-50% of all groups touched on the property that a business process involves terminology. In other properties in this area, MISY261 students and ACCT302 students were more likely to discuss business processes than were the students in MISY225.
- There were a number of new objects discovered in the focus groups and individual interviews. Those that are most prevalent are highlighted in Table 4-5. All groups discussed competition in the business simulation game. At the end of the game, the player is awarded a company car. Depending on the level of net income, the award possibilities are a sports car, a family sedan, or an old three-wheeled car. Students got excited about the reward of a car and discussed it after they played the game. This excitement translated to discussion of the competition during the focus groups and individual interviews.
- At least 30% of the students in the ACCT302 class mentioned the environment and how the

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economy wasn't part of the game. They also mentioned other external factors that were missing from the business simulation. Perhaps students in that curriculum are more attuned to economic factors affecting financial outcomes. Students in MISY261 spoke of the timing of the game as an issue, either good or bad.

Since the data was deemed too shallow, other means were used to identify candidates for the next round of interviews. The criteria used for selecting the students to participate in these interviews were those students who exhibited the following in the focus group and individual brief interviews: (1) User interface problems; (b) drew on information learned in curriculum; (c) complained about aspects of the game; (d) focused on varied information; (e) expressed interest in helping further research; (f) were voluble; (g) drew parallels between game and real life; (h) were bored by game. These criteria were identified because they suggested that the students thought deeply about the simulation game, or had problems with the game, and could articulate those deep thoughts in an interview format.

4.4 Qualitative Data Analysis – In-Depth Interviews

In-depth interviews were then conducted with 19 students. Seven of those students experienced ERP systems within their classes the past semester (MISY261 Business Information Systems). Twelve of the students did not learn ERP (MISY225 – Programming Business Applications and ACCT302 Accounting Information Systems).

4.4.1 Conceptual Analysis

All interviews were transcribed and selected statements were coded using the categorical objects and their properties predetermined in the literature review. The objects were tallied up in a frequency count and those objects that met the threshold of being contained in overall at least 50% of all interviews (the next lower frequency was less than 20% overall) were considered objects of a necessary structure with ERP Learning only for the class of students who had used ERP in their coursework, as highlighted in Table 4.6. The “*Stopping Rule*” (Anderson et al, 2011, p. 107) for developing mechanisms from identified categorical objects suggests this cutoff method as acceptable. Those particular objects were identified as being necessary because they must be present for the business process learning to take place, that is, causing certain outcomes to happen.

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Necessary objects are dependent on another (Sayer 1992). For example, business process understanding is dependent on business knowledge and in some cases ERP learning, in this research setting, as defined by Sayer as the “*structure of a system of interest*” (Sayer 1992, p. 62). Because the research cannot only be restricted to what exists in the literature, additional objects were identified and added for new objects, some becoming contingent aspects, meaning that they may produce a different outcome depending on the situation. Known as the contingent causality (Smith 2008), these objects result in mechanisms that interact and produce outcomes varying by context (Smith 2006, Bystad and Munkvold 2011). These are new objects emanating from the in-depth interviews, not carried over from the focus group and individual initial interviews. Contingent aspects are those that influence a mechanism positively or negatively. They can exist independently (Sayer 1992) and define the boundaries of the mechanism. In the data they were identified as being prevalent in at least 25% of the interviews. The frequency count for each object is:

	MISY261	ACCT302	MISY225
<u>PREDETERMINED OBJECT</u>			
1. Business Processes	Overall 100%	Overall 50%	Overall 67%
a. Connections	14%		
b. Integration	71%	17%	
c. Communication	14%	17%	
d. Valuable			
e. Collaboration			
f. Involvement		8%	17%
g. Terminology		33%	50%
2. Enterprise systems – ERP –	Overall 57%	Overall 17%	

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company-wide information systems			
a. ERP Integration			
b. Info View	29%		
c. Efficiency			
d. Performance Control	14%		
e. Communication			
f. Empathy	14%	17%	
g. Management Control			
3. Educational assessment			
4. Experiential learning			
5. Learning styles			
6. Business Knowledge	Overall 100%	Overall 100%	Overall 100%
a. Financial	57%	83%	100%
b. Marketing	57%	100%	100%
c. Pricing	71%	100%	67%
d. Manufacturing	71%	83%	83%
e. Quality	43%	100%	50%
f. Choice	14%	50%	33%

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7. Broad, overall view			
7. Approach problems in a complex way			
<u>NEW OBJECTS</u>			
Market Understanding	71%	67%	
Intuition	14%	17%	33%
Classes	71%	83%	100%

Table 4-6 Frequency Count for In-depth Interviews

From that frequency count, the SELECT model is developed. The model, at its simplest, is as follows:

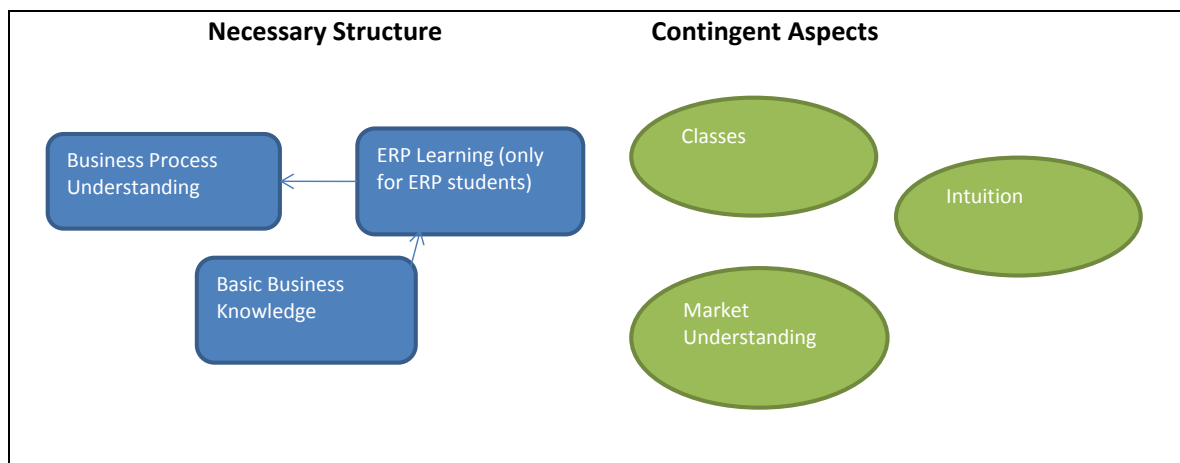


Figure 4-7 The Undergraduate SELECT Model

The model is labelled as Undergraduate SELECT, an acronym for Source of Experiential Learning Educational Causal Theory. The model contends that in order for students to have success in experiential learning, they must begin with business knowledge, reinforced by experiencing ERP systems in order to learn business processes. There are positive and negative pressures exerted on that learning. Some of their classes impact that classroom learning in a positive way, in that some students were excited to discuss what they had learned and how they applied it to the business simulation game. Market Understanding can aid or detract from university learning and supersede

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concepts taught in the classroom as evidenced by some students not analysing the products they chose to sell from marketing or cost basis, but just picking what they liked or what was popular with their friends. In a similar fashion, some students relied on their intuition to play the game successfully, but some had poor results and spoke of “*common sense*” and “*second nature*”, showing their neglecting important game information and just playing on gut feel.

As in the focus groups and individual initial interviews, during the in-depth interviews students freely and easily spoke about all properties under the object business knowledge. It is therefore reasonable to assume that all students begin with a basis of business knowledge, as indicated as the starting concept in the necessary structure of the SELECT model. This is evidenced by every single student interviewed discussing business knowledge, as shown in the frequency count of Table 4.6, in both the ERP class and the non-ERP classes. Students spoke about their first time in playing the game, indicating business knowledge to start with, as indicated by this quote: “*The first time I made the mistake by trying to stay in front of everyone as far as the amount of technology in the product, the quality and the price. And the problem with that was that the other firms I guess in the game would start lowering the prices and kind of put me as an outlier, so I would be caught in there and would have to struggle to get back in the middle and then they will shift again and by the time I eventually caught up to them I was too in debt.*”

For ERP Learning, only the class that learned about ERP actually discussed frequently the properties within that category. Interestingly, 100% of all students who experienced ERP systems were able to relay their thoughts on business processes while playing the game, often claiming that their class material was ingrained. This indicates the Kolbian experiential learning theory at work. For those that did not study ERP, their knowledge of business processes came more naturally and they focused more on the financial and accounting processes.

The necessary structure is supported by these sample statements by the student interviews:

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<u>Basic Business Knowledge: Students with ERP</u>	<u>Students without ERP</u>
<i>I had just too many costs going on so that would really hurt my profit so then I focused more just on like having one solid production line to meet demands.</i>	<i>You can have losses at first because of all the groundwork that you are putting into it eventually you have your customer base and then you have profits.</i>
<u>ERP Learning: Students with ERP</u>	<u>Students without ERP</u>
<i>The ability to see what the competition was doing and to be able to change what I did more quickly I could clearly see that was helping and that would allow me to make more money and so just the flow of information I say was definitely key.</i>	
<u>Business Process Understanding: Students with ERP</u>	<u>Students without ERP</u>
<i>Definitely just knowing how marketing flows and the production you have to be able to do. You have to have sales in order to, if you do not have sales like production doesn't really matter and knowing the importance of all different parts you need to be able to meet demand and all that.</i>	<i>Well when you manufacture a good product then you know that you want to promote it really well so I think that's how I thought about upping my marketing expenses when I was thinking it was really a good product here, it's a little bit expensive so I want to make my money's worth and make people know that and even though it is quite expensive make sure that I want to exude the fact through marketing that the quality was really good and it was worth the price.</i>
<i>Ya because you could like if you changed your price and then nothing really happened to your revenue. Then you will also have to change how many factories you had opened, you'd</i>	<i>It definitely played a role because when you are creating the factories and the over timers, the amount of employees you have, you had to find a balance. I think you could hire more</i>

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<i>also have to change the level of quality. You have to get a good mix across the board in order to maximize revenues.</i>	<i>construction facilities. You don't want anything sitting idle but still you want to meet demand.</i>
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Table 4-7 Sample Necessary Structure Statements

4.4.2 Qualitative Results - Causal Analysis

The contingent aspects in the SELECT model positively or negatively affect business process learning. For example, students who had learned with ERP systems cited a number of different classes as being helpful in forming this knowledge: Operations Management, Marketing, Accounting and Finance, Economics, and basic core business classes. That Delaware group with ERP discussed specific topics within those classes such as marketing a product, determining the number of factories, and generally feeling armed with *"enough foundation so you weren't guessing in the game."* The students who had not learned with ERP systems focused also on those classes, with more emphasis on the financial and accounting areas, with topics highlighted such as cost/benefit ratio, cash flow analysis, and income statements. This is unsurprising, since many of the students in that cohort were Accounting or Finance majors. Both groups also cited the market understanding or the current market as a source of business decision-making. It may be argued that undergraduate students in the US are great consumers, so it would be only natural for them to think of today's current market during the business simulation game.

Interestingly, 100% of students in the class MISY225, Programming Business Applications, discussed their classes as influencing how they made decisions in the business simulation game. The content of this class includes database design and usage, as in the other two classes. It also includes visual basic programming, which normally attracts a more technical type of student.

An obvious and very surprising difference between the two groups manifested itself in the contingent aspect of intuition specifically in the area of how students initially played the business simulation game. The non-ERP groups were confident of their ability to play the game the first time. They admitted to using similar strategies for playing the game both times and exuded confidence in their abilities. For example one student, who had a positive net profit for both game plays, claimed *"People that didn't have business background that I had wouldn't be able to do it as well as I did. They might have been able to do well, but may not be able to do as well as I did throughout the*

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process.” The ERP group was much more tentative the first time they played the game, and they used words such as “*overwhelmed*” and “*multitasking too much*” displaying their lack of confidence or understanding. It is argued that at times this tentativeness is a power for learning, since the transformation from being overwhelmed the first time to being successful the subsequent time was dramatic. Every student who learned with ERP systems improved the second time they played the business simulation game. One experiential ERP student who felt they were out of control during the first time they played the game, discussed concepts such as marketing and classes such as Operations Management that helped them during the second game play so it wasn’t simply a game of guessing. For those who did not learn with ERP, half of that group actually did worse the second time they played the game. The confidence exuded by this cohort may have overshadowed their absorbing full information to make better decisions the second time they played the game.

The contingent aspects are supported by these sample in-depth interview responses:

<u>Classes: Students with ERP</u>	<u>Classes: Students Without ERP</u>
<i>I learned about ... just in time production...in accounting just kind of having the right amount of product...different information that was provided to me...market research</i>	<i>Well certainly I think everything I learnt definitely contributed. I know that’s a general answer probably not you are looking for but I mean it’s kind of how I felt like obviously going through it step by step you know you see things from like cost accounting. So you see what all the timings, what opening up new factories means. I could relate it back to my classes.</i> <i>As far as obviously as I said the benefit to cost ratio that obviously another thing I learnt in class.</i>
<u>Market Understanding: Students with ERP</u>	<u>Market Understanding: Students Without ERP</u>

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<i>Because the products you know are possibly used in real life. Something I took it seriously that I feel is real life what do I think you know current trends everything like music thing and that's real big. So it just kind of made real sense.</i>	<i>I was thinking about what was more popular now so I think at one point I chose the iPod because that was like 'oh technology is getting bigger and so this could be making me money'.</i>
<u>Intuition: Students with ERP</u>	<u>Intuition: Students Without ERP</u>
<i>The first time was overwhelming and there was stuff everywhere</i>	<i>I kind of used commonsense...came naturally...a little bit of commonsense to do my best and make the best outcomes</i>

Table 4-8 Sample Contingent Aspects Statements

The next step in the qualitative data analysis is to determine why and how a particular mechanism is being fired (or not). In essence, this step is retroducting the theory, refining it and explaining how the contingent aspects trigger or suppress the causal powers of certain properties. Within each property, the interviews were combed for statements that might identify a causal power or liability that would trigger the mechanism that was the level above. These powers and liabilities are listed in the following Table 4.9, with a plus sign (+) indicating a power and a minus sign (-) indicating a liability. The two different types of classes were separated into groups of “With ERP” and “Without ERP”, with sample quotes from the in-depth interviews supporting these concepts.

<u>Concept</u>	<u>Power/Liability</u>	<u>With ERP</u>	<u>Without ERP</u>
<i>Business Knowledge</i>	Choice	+	-
		<i>I think it is the most interesting one for me...technology is definitely the future so cell phones was a</i>	<i>It was just the product that I could associate myself with and I knew what kind of needs I wanted and figured the</i>

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		<i>pretty good choice</i>	<i>needs in the game would be similar</i>
	Financial/Marketing/Manufacturing	+	+
		<i>I think from your core business classes you have enough foundation to where you weren't just guessing in the game</i>	<i>Last semester I took finance xxx course and found this really useful...to look at the cash flow and the production, the quantity and difference between my product and competitors</i>
ERP Learning	Efficiency	+	
		<i>Maintaining whatever that the customers were demanding so I wasn't under producing or over producing the product</i>	
	Info View	+	
		<i>I was constantly looking at what the competition was doing... then also at the production levels</i>	
Business Processes	Connections	+	+

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		<i>So if my product at one time was the most ideal than all the others I'd up manufacturing a lot then I would get larger sales during that period</i>	<i>Based on everything... like the financial and the cash flow and sales. I looked at the competitor stuff before the pricing ... figure out production</i>
	Integration	+	
		<i>The process flow seemed like what steps ... connect ... it seemed I guess where information was going</i>	

Table 4-9 Powers and Liabilities

Under the concept of Business Knowledge, all the students who learned with ERP systems discussed choice or product influences; that is, how outside influences affected their choice of product during the business simulation game. All of these students did better the second time playing the business simulation game, so for them market influences enhanced their learning. Only 40% of the non-ERP students mentioned product influences and most of them did poorly on their second try at the business simulation game. For this group, choice of product leading to the contingent aspect of market understanding was suppression on the necessary structure of the mechanism, thereby inhibiting learning. This is taken as a liability since it affects how the student thinks through business processes and may detract from their using university or work-gained knowledge. At first glance, it might be said that using outside influences such as current events or popularity of products would be considered a power for decision-making. However, the data indicated that in this case, it would be a liability in that students ignored data presented to them in the game and solely were influenced by preconceived information. It is thought that today's market is a powerful force for the undergraduates and that force may dominate their decision-making.

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Both groups definitely used their pedagogical foundation as a basis for their business knowledge of financial, marketing, and manufacturing. For all three classes, more than 70% of respondents spoke of it, as exemplified by this one student's comments *"I think in the beginning of the semester I hadn't learnt much in the classes yet, towards the end I had gotten through most of the course so I was taking marketing at the same time so I learnt how to market a product and all the things you need to take into account in doing that; And then I was taking operations management so I kind of knew how things were made and how you have to market your products in the different factories I guess like how many factories you need to do so much production."* Students had a tendency to discuss past courses in mostly general business subjects. It was refreshing to hear that the undergraduates at Delaware had remembered what they learned and applied the principles to playing the business simulation game, demonstrating a positive influence on learning.

Unsurprisingly, the ERP learning categories were discussed almost exclusively by the students in the classes that had experienced ERP systems. For that group efficiency, which was expressed as equalizing supply and demand, was a common theme in their interviews and more than 70% of the students mentioned it. Statements like [I] *"focused a lot on production and that was my main thing because I wanted to meet the demands of my customers"* and *"To make sure that was meeting the demand...keep your demand and production equal"* demonstrate that those students were thinking about how the functional areas of a business fit together, in effect, a power for learning business processes. In addition, more than 50% of the students in that group spoke around the idea that info view or information flow was vital in decision making. One interviewee remarked *"Using the email and like the graphs that were on the system where you could flow between different interfaces and just see how you were doing that month,"* demonstrating info view as a trigger for learning. Every one of these students improved their score the second time they played the business simulation game, indicating some change in their ability to make business decisions. However, none of these students spoke directly of the course that used ERP experientially, nor did any even mention Enterprise Resource Planning software.

The focus of this research is to understand how students learn business processes. Under that concept, all properties highlighted had the power to stimulate the SELECT mechanism. Specifically, students focused on connections within the organization in the business simulation game. For

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example, a typical student said *“Accounting helps a lot because I have to know the over-time and the factory. Should I expand or not and things like the income statement that report. That helps a lot and also the per unit cost and things like that also.”* Only the majority of the students that learned with ERP systems discussed integration with the usefulness of flowcharts and how functional areas within a company are connected, as evidenced by this quote *“Definitely just knowing how marketing flows and the production. You have to have sales. If you do not have sales, production doesn’t really matter and knowing the importance of all different parts you need to be able to meet demand.”* These ERP students who had spoken of learning with the system all did better on the business simulation game after their coursework had ended. Again, this result points to a change in their ability to understand and use business processes. Overall, it’s interesting to note that at least 50% of students in all three different classes discussed business processes. This prevalence of discussion, for both experiential ERP students and those not experiencing ERP, leads to the idea that teaching business processes can be accomplished in different ways. More than half of the non-ERP students study accounting or finance. From the in-depth interviews with these students, it is thought that the accounting curriculum inherently teaches business processes, most likely through various accounting cycles. . A graphical summary of the powers and liabilities superimposed on the necessary mechanism is displayed in the following Figure 4-8.

Necessary Structure

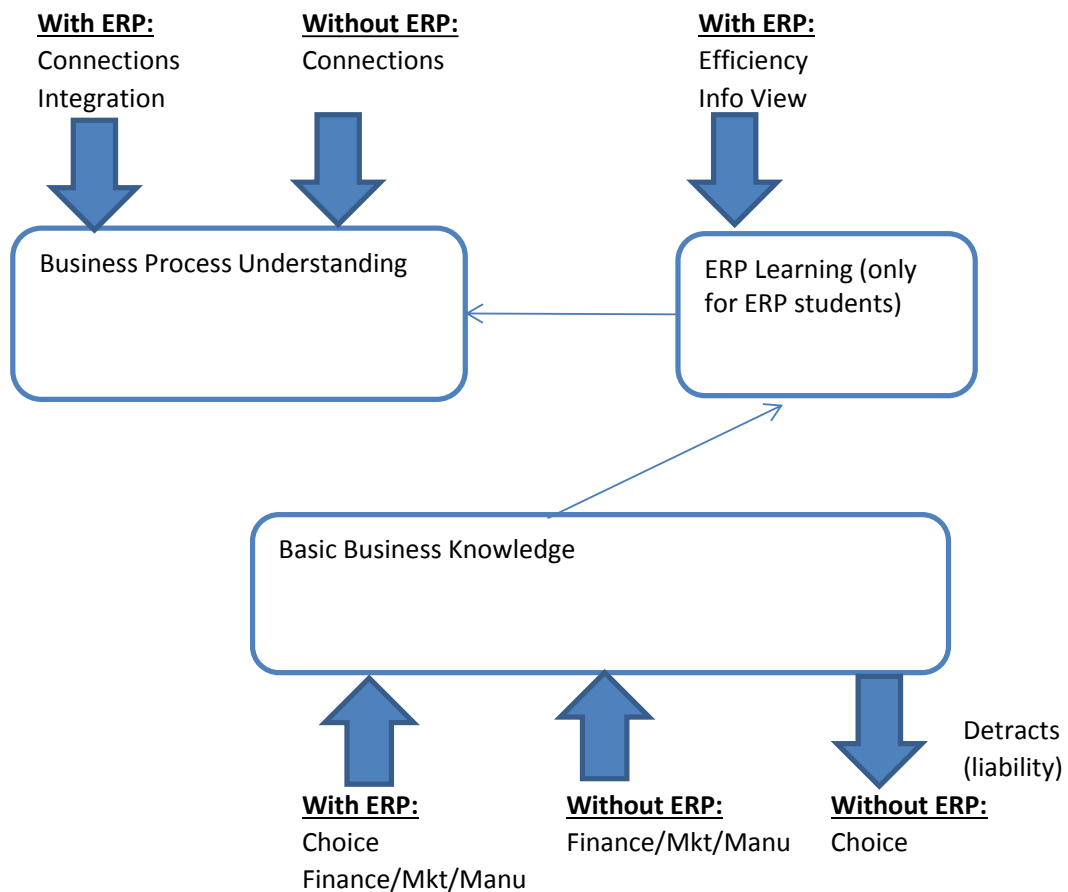


Figure 4-8 Necessary Mechanism with Powers and Liabilities

4.5 Summary

Data collected on Net Profit from the simulation game results at University of Delaware has been analyzed and discussed in this chapter. Three different classes, one using experiential ERP and two not experiencing ERP were analyzed, using a critical realist view both quantitatively and qualitatively.

Quantitatively, there were no statistical differences in the average change in net profit from one game play to another for all 3 classes: all three classes performed similarly on the business simulation game. Interestingly for the interviewed students, the majority of the class with ERP improved their game results the second time they played and the accounting information systems class (without ERP) registered a higher average GPA than the ERP class, but their net profit change

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was similar to that of the class with ERP. This is a clue to differences in the data, which can only be answered by looking at the qualitative results, following a critical realist view.

Preliminary focus group and individual brief interviews were conducted, recorded, and analyzed using the software, NVivo. Results from this analysis were too brief and shallow to draw any conclusions, but were used to identify students for the in-depth interviews which followed. Those in-depth interviews were rigorously analyzed by coding the transcribed data with the objects beforehand discovered in the literature, and with new objects found in the actual data. From that coding, the undergraduate SELECT model for learning was developed. The SELECT model, an acronym for Source of Experiential Learning Educational Causal Theory, postulates that students begin with business knowledge in order to learn about business processes. Experiencing ERP systems can aid in that learning of business processes. When this learning occurs, contingent aspects may influence its success. Certain classes taken by students can affect learning positively. Students rely on their understanding of the market and at times, rely solely on intuition to make decisions which could affect learning either positively or negatively.

Important properties of the categorical objects were identified as being either positively and negatively affected by the contingent aspects. These are considered causal powers and liabilities that work for or against learning. Under business knowledge, for some students the choice of the product was negatively influenced by market understanding since students disregarded important information in choosing a project to sell but simply used today's current market popularity to make that decision. For other students, the choice of the product was positively affected by today's current market in that it helped the student's game improvement. Financial, marketing, and manufacturing were all influenced positively by classes taken during the semester in that they helped students make good business decisions. For those students who learned with ERP systems, there were positive effects to learning from those classes in efficiency of business processes and in the info view, or using of the single view of information while playing the business simulation game. For all classes, the property of connections between various organizational tasks was seen as a trigger for the learning mechanism, whereas the ERP students also saw integration between different departments as a power for learning.

Chapter 5. Brunel University Results

One thorn of experience is worth a whole wilderness full of warning. – James Russell Lowell

5.1 Introduction

This chapter reports on students from two postgraduate programs at Brunel University in the UK that were tested for business process knowledge. Students in the two classes played the simulation game before any coursework began, the results were recorded and after the entire program's coursework, the students played the game a second time. The difference between the two games was calculated and used as a basis for statistical analysis. After the second playing of the game, students were briefly questioned initially via email, and then latterly participated in face-to-face or Skype in-depth interviews. The resulting data from the in-depth interviews facilitated the development of a mechanism for this experiential learning. Through a critical realist lens, business process learning with experiential ERP is demonstrated.

This chapter begins with a thorough analysis of the quantitative data collected, reported in Section 5.2. Following that work, qualitative data is analyzed, firstly with coding the preliminary email interviews (Section 5.3) and secondly with coding the in-depth interviews (Section 5.4). A conceptual model is developed with causal powers and liabilities identified. Finally the chapter ends with a summary in Section 5.5.

5.2 Quantitative Data Analysis

In order to obtain the quantitative data for this research, students were asked to play a business simulation game at the beginning of their coursework and also asked to play the same game at the end of their coursework, as described in Chapter 3. The score of Net Profit, as an outcome of the game, was recorded for each game play. The difference between Net Profit scores from the beginning of the course to the end was calculated. This difference was used for statistical analysis.

The quantitative data was collected from two classes of postgraduate students at Brunel University, West London, United Kingdom. The two classes: Information Systems Management (ISM) and Business Systems Integration (BSI) are at the same postgraduate level but BSI uses an ERP system

(SAP) integrated into its curriculum. The outcome of the class with ERP is compared to those without ERP. Results of the statistical data analysis follow.

5.2.1 Results of BSI versus ISM

Due to technical difficulties in running the simulation game in the computer lab at Brunel, there is a smaller amount of data that has been collected from the two classes. Before the two classes are compared, the data is checked for normality across both sets. Shown in Figure 5.1, the data is close to a normal distribution.

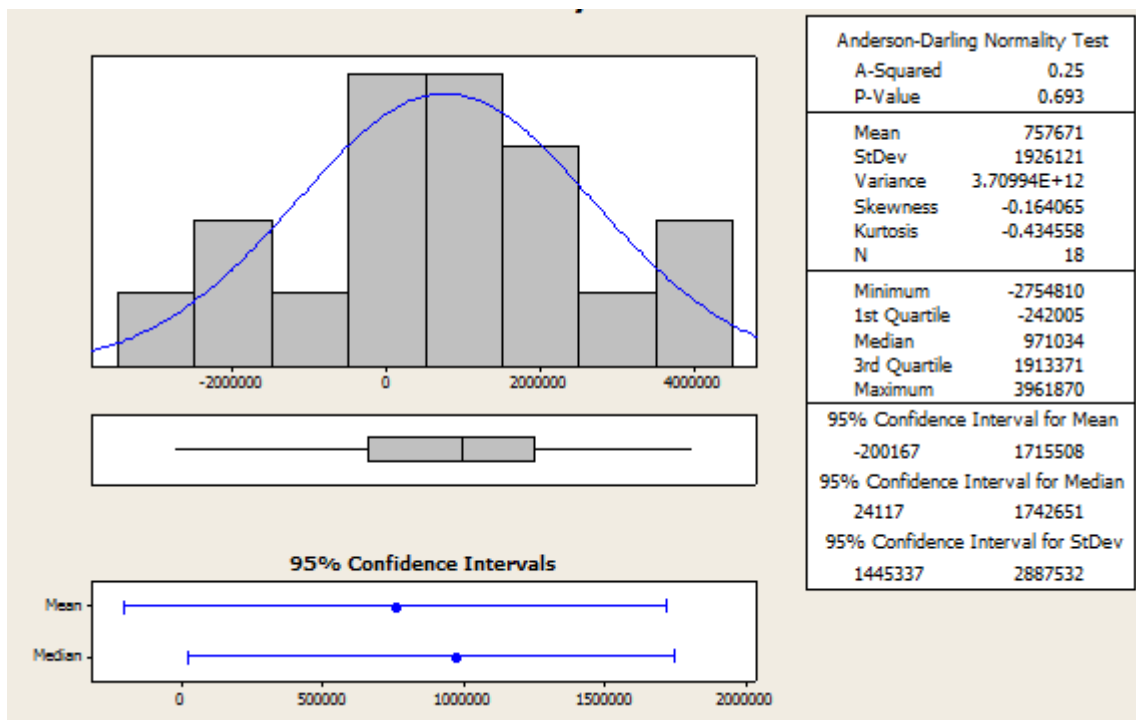


Figure 5-1 Data Distribution for Net Profit Difference across both groups

Being normal, the data has a bell-shaped curve and a p-value of >0.05 and therefore a t-test is an acceptable method for analysis. This test was performed to test the null hypothesis that the means of the two classes are equal. The results are shown in the following Table 5.1:

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Class	Number of Students	Mean Difference in net profit between 2 instances of game play	St Dev	SE Mean
BSI (with ERP)	16	892548	1800109	450027
ISM (no ERP)	2	-321349	3441434	2433461
T-value=0.49	P-value=0.710	DF=1		

Table 5-1 T-test results for the difference in Net Profit

Since the dataset is small, the non-parametric significance Mann-Whitney test was used to rank the data and compare it in addition to the t-test.

The results are as follows:

Course	Number	Median
BSI (with SAP)	16	971034
ISM (without SAP)	2	-321349
Test Stat W=155	P-value=0.7254	

Table 5-2 Mann-Whitney test results for the difference in Net Profit

The results of both the T-test and the Mann-Whitney test show that the difference between the means of the two classes is not significant, with p-values of 0.710 and 0.7254 respectively thereby not rejecting the null hypothesis. Those who took the course of study with ERP systems did not score significantly higher than those that took the course of study without ERP.

Three quarters of the 16 students from the BSI (with SAP) pool did better the second time they played the business simulation game. The remaining quarter did poorly playing the game after their coursework. For the two ISM students (without SAP), one student performed better the second time and one performed worse the second time. So it can be said that the majority of all students improved in their playing of the game after they completed their coursework, which indicates some influence from the curriculum. With a critical realist view, this empirical result is not sufficient to understand that influence. Later in this chapter, the qualitative data analysis will be explained and

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used with the quantitative data to develop a learning model.

The demographic data from the two UK course track participants was reviewed to identify any bias in the results from past work experience. Most of the students, being of the postgraduate level, had some work experience. Only one had ERP implementation experience and another ran a small company. The rest of the students involved in the research had IT-related experience. All students that participated in the research were included in the analysis, that is, no data collected was rejected. Grade point average data was also collected from the majority of the group and analyzed. Using a chi-square test, the GPA data was determined to be of a normal distribution and the average GPA of the two groups was determined to be similar by running a t-test, as shown in table 5.3.

Class	Number of Students	Mean Difference in net profit between 2 instances of game play	St Dev	SE Mean
BSI (with ERP)	13	2.57692	0.70993	0.1969
ISM (no ERP)	2	2.50000	1.41421	1.0000
T-value=-0.12871	P-value=0.8996	DF=13		

Table 5-3 T-test results for the difference in GPA

The p-value is 0.8996, greater than the 0.05 confidence level; therefore the null hypothesis cannot be rejected, indicating a similarity between the means of the two sets of data. Next the qualitative data is analyzed to highlight how experiential ERP affects business process learning.

5.3 Qualitative Data Analysis Part 1 – Email Interviews

Initial email interviews were conducted with the students in lieu of focus groups since the researcher was located in another country and the students had left campus for the Easter break. Again, the data collected was rather scant, having only 11 email interviews, one of which is from a student in the ISM (without ERP) program and 10 of which are in the BSI (with ERP) program. The email interviews were imported into the software NVivo.

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The initial coding phase then commenced. The categorical objects that were used for this research project, introduced in Chapter 3 (Section 3.66), originate from the theoretical framework developed in the literature review (following Danermark et al 2002). They are as follows:

1. Business Processes
 - a. Connections
 - b. Integration
 - c. Communication
 - d. Valuable
 - e. Collaboration
 - f. Involvement
 - g. Terminology
2. Enterprise systems – ERP
 - a. ERP integration
 - b. Info View
 - c. Efficiency
 - d. Performance Control
 - e. Communication
 - f. Empathy
 - g. Management control
3. Experiential learning
4. Business Knowledge
 - a. Financial
 - b. Marketing
 - c. Pricing
 - d. Manufacturing
 - e. Quality
 - f. Choice
5. Broad view
6. Complexity

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Additional categorical objects were realized in the data from the email interviews as it was coded. Those new objects not identified in the literature review and different from those discovered in Chapter 4 from the Delaware data are:

- Branding
- Coursework
- Fun
- Realism
- Training
- MIS tool
- Experience
- Scepticism

The interview emails were then analyzed and coded with these categorical codes. The frequency of discussion of the predetermined concepts and the new concepts were tallied and a percentage shown in Table 5.4. The results are as follows:

PREDETERMINED OBJECTS	BSI	ISM	Both
1. Business Processes			
a. Connections			
b. Integration			
c. Communication			
d. Valuable			
e. Collaboration			
f. Involvement			
g. Terminology	40%	100%	45%
2. Enterprise systems – ERP – company-wide IS			
a. ERP Integration			
b. Info View			
c. Efficiency			
d. Performance Control			
e. Communication			
f. Empathy			

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g. Management Control	40%	0%	36%
3. Educational assessment			
4. Experiential learning			
5. Learning styles			
6. Business Knowledge			
a. Financial			
b. Marketing	90%	0%	82%
c. Pricing	80%	100%	82%
d. Manufacturing	80%	0%	73%
e. Quality	90%	100%	91%
f. Choice	20%	0%	18%
7. Broad View			
8. Complexity			
<u>NEW OBJECTS</u>			
Coursework	0%	100%	9%
Fun	10%	0%	9%
Realism	10%	100%	18%
Training	10%	0%	9%
MIS tool	10%	0%	9%
Experience	0%	100%	9%
Skepticism	30%	0%	27%

Table 5-4 Frequency distribution of concepts

Only one of the students in the ISM program was able to do the email interview. This sample size is too small to compare with 10 students' interviews in the BSI (with ERP) program. The decision was therefore taken to analyze this data as a whole. This is shown in Table 5-4 as column labeled "both".

For the entire group, close to half of the students wrote about their experiences using business terminology and discussed business activities indicating their thinking about business processes. In these email interviews, the responses were very brief, so little conclusions can be reached from this data. About 1/3 of the students brought up the property of management control, which falls under the object of Enterprise Resource Planning Systems. Since most of the students studied ERP during their coursework, it seems fitting that they would bring up this concept while answering the email

discussion. Almost all students thoroughly discussed aspects of the simulation game in the email messages. This indicates their familiarity and even comfort level with basic business knowledge. The new objects were raised only by individual students except for one which was skepticism of the availability of data. About 25% of the students expressed skeptical feelings that it would be highly unlikely that a company would have so much data available to make decisions.

As shown, this preliminary email interview data was analyzed with qualitative data coding to see if any models could be developed. However the data is very brief and not robust enough to draw any conclusions. To uncover and comprehend the real learning mechanism, in-depth interviews must be analyzed in a similar fashion. That analysis is presented in the next section.

5.4 Qualitative Data Analysis Part 2 - In-depth interviews

Qualitative data in the form of the in-depth interviews was collected from 15 postgraduate students, including 2 students in the non-ERP track. (The interviews were conducted either face-to-face or via Skype.) Since the sample size of the two cohorts is so different and that of the non-ERP group is small, it's difficult to distinguish between those who took the masters' course experientially with ERP and those that did not have an ERP component. Therefore, for analysis purposes, they have been grouped with those students who did experience ERP systems in their masters' coursework.

5.4.1 Conceptual Analysis

The in-depth interviews were transcribed and selected statements were coded using the predetermined categorical objects (the literature-identified concepts.) The objects were counted and those objects that met the threshold of being contained overall in at least 50% of all interviews were considered objects of a necessary structure; that is, these concepts must be present for learning to take place and are dependent on one another (Sayer, 1992). (50% was deemed a good cut-off since it would indicate a majority). Additional objects, over those found in the literature, were identified and added for new objects, some of which becoming contingent aspects. As stated in Chapter 4, contingent aspects drive the workings of a mechanism and rely on the context of the situation to work, existing independently and defining the boundaries of the mechanism. In the data, they were identified as being prevalent in at least 25% of all interviews.

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The frequency count for these in-depth interviews is as follows:

PREDETERMINED OBJECT	
1. Business Processes	<u>Overall 67%</u>
a. Connections	7%
b. Integration	47%
c. Communication	13%
d. Valuable	0%
e. Collaboration	7%
f. Involvement	20%
g. Terminology	13%
2. Enterprise systems – ERP – company-wide IS	<u>Overall 100%</u>
a. ERP Integration	13%
b. Info View	60%
c. Efficiency	7%
d. Performance Control	40%
e. Communication	0%
f. Empathy	60%
g. Management Control	40%
3. Educational assessment	
4. Experiential learning	<u>60%</u>
5. Learning styles	
6. Business Knowledge	<u>Overall 100%</u>
a. Financial	67%
b. Marketing	100%
c. Pricing	80%
d. Manufacturing	73%
e. Quality	67%
f. Choice	67%
7. Broad, overall view	
7. Approach problems in a complex way	
NEW OBJECTS	

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Technical Background	6%
Age	6%
Classes	88%
Experience	29%
Advice	6%

Table 5-5 Frequency count for in-depth interviews

The model, at its simplest, is as follows:

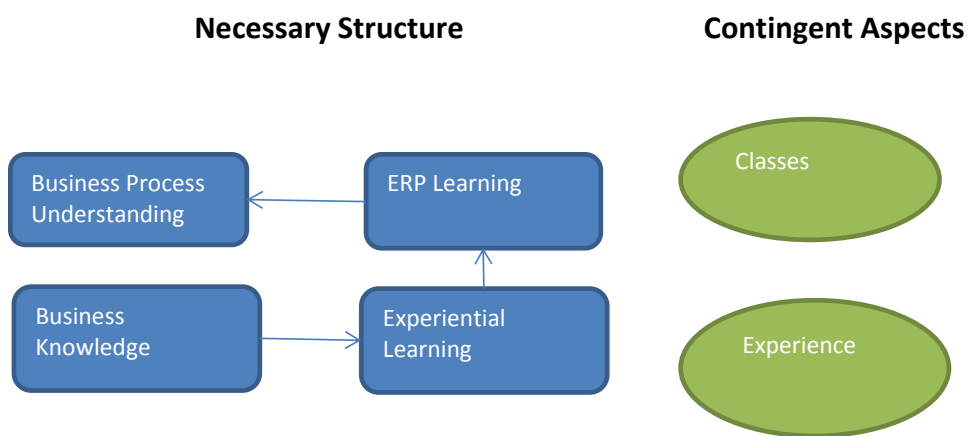


Figure 5-2 The Postgraduate SELECT Model

The model is labeled as Postgraduate SELECT, an acronym for Source of Experiential Learning Educational Causal Theory. Students must have some basic business knowledge before they can learn about business processes. Experiential learning coupled with learning ERP systems reinforce that business process learning, again, after students have a foundation of basic business knowledge. Some of their classes impact that learning in a positive way. Work experience can, in some cases, diminish the value of that classroom experience. This model is different than that of the undergraduate model. Experiential learning plays a larger role in this learning mechanism, and contingently, experience replaces intuition and market understanding.

In the preliminary email interview data and in the in-depth interviews, all students discussed business knowledge in some form. In Table 5-4, the email interview data shows most students

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discussing business knowledge. For the in-depth interviews, 100% of all students also noted their overall knowledge of business when discussing their game play. This overwhelming majority validates the start of the SELECT mechanism: business knowledge is essential to understand and learn about business processes. Certain statements from the interviews also point to the foundational precedence of business knowledge. Most students began talking about the first time they played the game (before any coursework began) with that business knowledge in place. For example, *“My first and foremost strategy was to select a product which would be economical and used by most of the people. Also tried to maintain the quality and the price at the same level...so that the profits could be earned but that didn’t work out well”* and *“Basically first time round I didn’t want to become bankrupt and I wanted to at least breakeven, I didn’t take many risks. Basically you could have made extra plants; I didn’t decide to go with that. It would cost too much”* show that students did indeed begin with a basic understanding of how businesses work.

More than half of the students expressed ideas surrounding experiential learning and over three quarters of all students at Brunel articulated their ideas about ERP systems during the in-depth interviews. This large proportion clearly demonstrates that students experiencing ERP systems use the concepts to make business decisions. Over half of all students talked about business processes when discussing their playing of the business simulation game. These students are thinking about business processes and putting the concepts into action.

Each of the concepts of the necessary structure objects in the model is supported by numerous quotes in the in-depth interviews. A representative sample is displayed in the following Table 5.6:

Basic Business Knowledge: <i>“we were taught that initially when I was doing my undergraduate degree. Although I didn’t do it from [this grad school] I can relate it.”</i>
Experiential Learning: <i>“Indeed there was a module in the first term and that’s ‘Business Modelling’ that really helped because it’s basically about how a business works and how process in a business work and you know that’s related to our courses so that kind of came into my mind”</i>
ERP Learning: <i>“I guess when we were learning during our ERP course, learning business processes, how sales work and how marketing works or even production works. It gave me a deeper thought process into</i>

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the game”

Business Process Understanding: *“My knowledge of business processes helped me from the sales and production part. So I was able to understand especially when I needed to because the first time I just thought Oh I am not getting enough market share and I went and increased production and that was disastrous because there wasn’t enough demand. [At end of term] I was able to ... merge the sales and production in together to use it to know when to do that. Also know when to do a stop using two production lines.”*

Table 5-6 Supporting quotes for the Necessary Structure of the SELECT Model

5.4.2 Causal Analysis

The contingent aspects in the SELECT model, Classes and Experience, have the capacity to encourage the mechanism to work, or to inhibit the mechanism’s working. Various classes that students mentioned as being helpful were dissected to uncover details. An often- mentioned class in the program was one that dealt with business intelligence and data management. Students found the subjects of business analytics, data modeling, and hands-on business intelligence very useful in playing the business simulation game. For example, one student remarked *“We are doing the business intelligence thing and so this stuff I already know. The first time I didn’t know, I didn’t understand it.”* Another said *“I am sure that the strategy was influenced by a course I did in BI”* and another student commented: *“After my program ... I gained more confidence, gained expertise in BI, and also in analytics of information and so I applied all of that.”* Experiential ERP systems are used in the Business Intelligence class in the form of the SAP Business Warehouse. This practice in the system made a large positive impact on the learning of business processes, as modeled in Postgraduate SELECT. Other useful classes were the business modeling class and an ERP configuration class. Discussing the configuration class influence, one remarked *“I saw the connection between sales and marketing in that course.”* Like the Business Intelligence class, the configuration class also gave the students experience in a live SAP system and the business modeling class did that subject in the context of ERP.

Students’ experience often worked against the mechanism in that they may have ignored important concepts from coursework. For example, one remarked *“I used my previous experience, my own*

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experience, or from some other experience I have in my life. Not anything from my course.” Further sample statements supporting the contingent aspects of the SELECT model are displayed in the following Table 5-7. Interestingly, these two students cited for their experience working against learning business processes. Both did very poorly on the business simulation game. One student improved, but never made a profit in either game and the other student lost two million pounds the second time he played the game. Both students had high GPAs. It could be argued that these two students were so confident of their abilities gained from industrial experience that they didn’t take the game playing seriously.

Classes: <i>“I guess I was influenced pretty much by what I have learnt because I come from a technical background”</i>
Work Experience: <i>“I have worked for 28 years ... [decisions made during the game were] not from anything I have learned here at uni”</i>

Table 5-7 Supporting quotes for the Contingent Aspects of the SELECT Model

The next step in this qualitative data analysis is retroduction. Here the theory is being refined and causal powers and liabilities are discovered as keys to how the SELECT mechanism works. In this research, the causal powers are enabling the students to learn business processes; the liabilities are what opposite pressures may be working against this learning. Each demonstrates potential mechanisms that may or may not happen in a given situation (Sayer 1992).

Within each property of the objects, the interviews were combed for statements that might identify a causal power or liability that would trigger the mechanism that was the level above. These powers and liabilities are listed in the following table, with a + plus sign indicating a power and a – minus sign indicating a liability. Supporting quotes from the in-depth interviews are included.

<u>Necessary Concept</u>	<u>Causality/Liability</u>	<u>Power Liability</u>
Business Knowledge	Financial	+
<i>“I know that dashboard is just an interface but it is based on a lot of accounting work for warehousing”</i>		

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	Financial/Marketing/Manufacturing	+
	<p><i>"I didn't want to become bankrupt and I wanted to at least break even... concentrate on the profit margin." "I was looking at the market trying to understand what my competitors were pricing their products at; trying to understand what was driving the sales...maybe changing the product, the price, changing something that would make me more competitive."</i></p>	
Experiential Learning		+
	<p><i>"I guess when we were learning during our ERP course, learning business processes, how sales works and how marketing works or even production works. It obviously gave me a deeper thought process into the game"</i></p>	
ERP Learning	Performance Control	+
	<p><i>"because business intelligence is ... about having the advantage over my competitors actually; gaining insight into the business."</i></p>	
	ERP Integration	+
	<p><i>"I think everything had to be integrated together to have a full/big picture of the whole process of everything that is going on inside the company"</i></p>	
Business Process Understanding	Communication	+
	<p><i>"[From] data consolidation ... you know lots of information coming in real time"</i></p>	
	Terminology	-

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"I think if you have been in business and you are coming with the knowledge of how business works you don't apply the knowledge you gain at the university, you just apply your general knowledge to it"

Table 5-8 Powers and Liabilities of SELECT

Certain properties of business knowledge have the power to trigger the learning mechanism through the contingent aspect of classes. The financial outcome of the simulation game is one example of that power. A student remarked *"Business intelligence wasn't all about the practical but we had to reflect what are the key factors that the company must consider to be strategic and to be competitive"* with the financial being an obvious key factor. In that remark, the Business Intelligence class positively influenced the learning. Other properties of business knowledge in addition to financial, such as marketing and manufacturing were supported as triggering the SELECT mechanism as well, as exclaimed by this student, *"I really pushed on sales a lot because I think that was the whole point, at the same time trying to reduce my production costs so I could have bigger margin in terms of profit."* From the interview, it was unclear as to where that business knowledge originated, but it assumed that it was either a positive influence for learning through classes or through work experience.

Classes have the power to trigger learning through the object of experiential learning. Three quarters of all students interviewed mentioned experiential learning, specifically how their class experiences helped them make business decisions in the simulation game. For instance, one student remarked *"The first time I had no clue but this time I had a strategy and I am sure that the strategy was influenced by a course I did in BI basically."* From this and other proclamations, it is clear that experiencing in a university setting is helping students learn about business processes. Another student was able to explain this further *"In particular the Business Intelligence course/module because in this module we took a look about dashboards and this kind of business intelligence tool that gives the decision maker quick information about the current status now for the company in comparison with the other competitors. So I was able to witness my situation, market share for me and with all these parameters, I was able to make decisions according to these parameters and to increase production or decrease the production or to increase the budget for marketing or so on."* As previously stated, the business intelligence class contains hands-on exercises in the live SAP system

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and these quotes demonstrate the experiential power of an ERP system. This result definitively validates the Kolbian experiential learning theory: using a live ERP in the classroom facilitates learning. In each of the interviews cited for this object, students again and again returned to classes that used SAP. There wasn't a mention of any specific lectures, but only those experiential lessons.

So the ERP Learning object was also seen as a power for learning business processes. Having performance control or in other words, greater control over corporate performance encourages the firing of the SELECT mechanism as validated by this sample statement *"Basically business intelligence is all about decision making. Since BI is based on decision making then all of the data, like the sales and everything, we can link that to SAP."* And ERP Integration helps students learn about business processes and apply that knowledge to their business decision making. Another remark confirms this idea, *"There is a course we did last semester, I think it was configuration. [From] that course [Configuration] I saw the connection between sales and manufacturing in that course."* In that configuration class, students work on business processes and workflow. That quote is a satisfying confirmation of the course content. All students discussed ERP in some way during the in-depth interviews and all of those but one discussed it as a positive influence for business process learning. Two thirds of this group brought up information they learned in their classes as being important for making decisions in the business simulation game. In addition, although everyone except one student improved in the game results, three quarters of the students improved significantly on the game's net profit the second time they played. These results show that classes indeed have a positive effect for learning business processes, as triggered by certain properties of ERP learning, another affirmation of the Kolbian experiential learning theory.

The absorption of business process knowledge is aided by the property of communication, or sharing information, as exemplified by these students' comments, *"IT could help a lot because when you have all the data you need, then you can make the decisions you need to make"* *"Understanding the power of information; you might have so much information but you should know how to utilize it, then it is as good as nothing."* However, within the confines of this data, terminology or key business activities and business terminology can be considered a liability or a deterrent to learning. For example, one student remarked *"I reckon I used complete commonsense and my industrial experience. It was my own thing, my own self, no disrespect to the course, no effect to the way I played the game"* *"[used my] daily life experience in business."* And another one said *"You have to*

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contend with a lot of politics and you have to contend with a lot of other issues that the game can never simulate." These statements show that for some students, their experience is inhibiting learning through the SELECT mechanism. Drilling down deeper into this data, the group of students who articulated their lack of learning of business processes all referenced their work experience as a source of knowledge for them when making business decisions. They emphatically discounted any information gained from their coursework. This type of response brings to the forefront a concern for educators: will students with work experience take their educationally gained knowledge seriously and apply it to their future jobs?

Under the same object of business process knowledge, the group that felt that sharing information outside of work or communication highlighting business processes never brought up the subject of their work experience as helping them play the business simulation game. This group relied on knowledge gained in their coursework to make business decisions. This line of distinction between the two groups discussing business process learning is validating the contingent aspect of experience. Properties of business process learning have the power to either trigger the learning mechanism in the case without relying on significant work experience or inhibit the learning by relying on that work experience.

All students who discussed business process knowledge improved in their business simulation game net profit score from the first time they played to the second time they played the game, including those who discounted their coursework. As an aside, GPA didn't seem to correlate with other factors in the analysis. For all groups identified in the previous paragraphs, students had mixed grade point averages.

The necessary mechanism with its powers and liabilities superimposed is summarized in the following Figure 5-3.

Necessary Structure

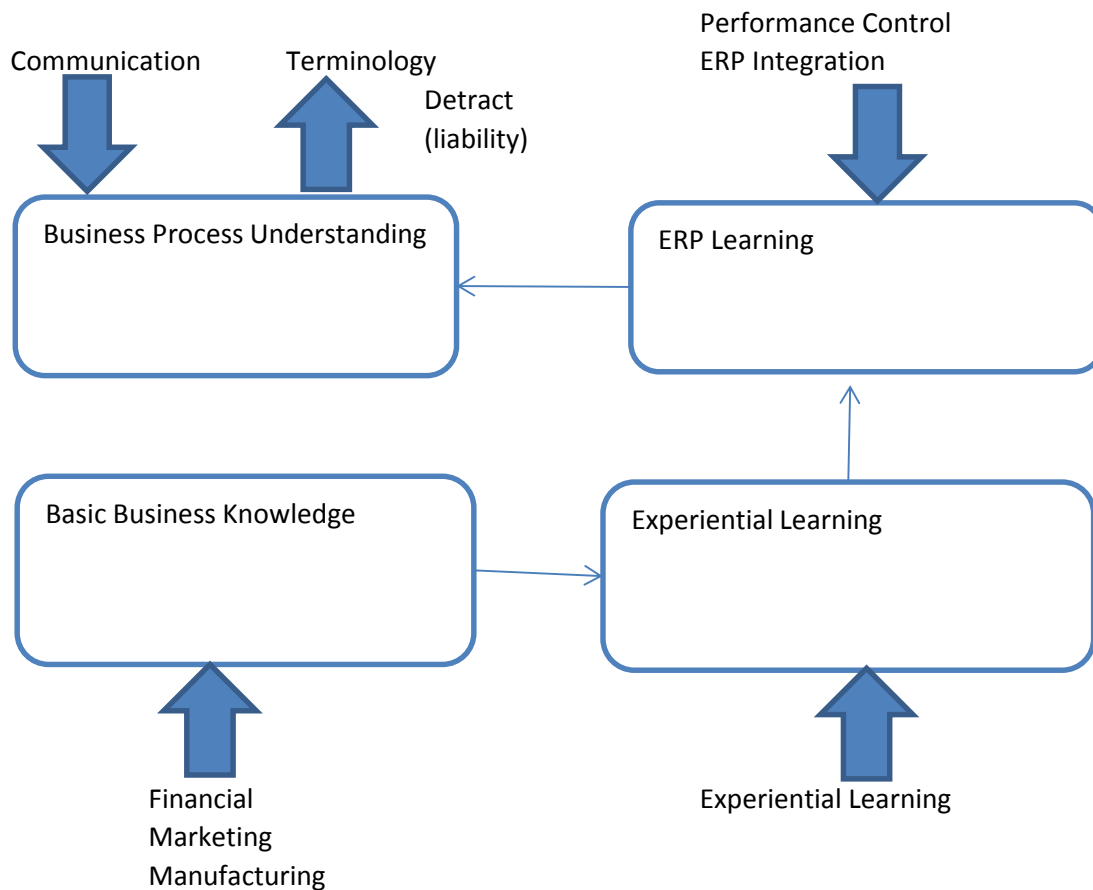


Figure 5-3 Necessary Mechanism with Powers and Liabilities

5.5 Summary

Although higher education is extensively using enterprise resource planning systems to experientially teach business processes, research proving ERP's beneficial effect on learning has not been conclusively demonstrated until now. From data collected in two postgraduate information systems programs at Brunel University, with experiential ERP and without ERP, the SELECT model has been developed which is a mechanism by which students learn business processes through hands-on work with ERP systems.

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The first part of the research required the students to play a business simulation game, a proxy for business process understanding, before and after coursework. Students in two tracks were compared statistically, and those who experienced ERP systems performed no better on average on the game. However, the majority of all students improved the second time they played the game. This result indicates some sort of change in decision-making ability from the beginning of the coursework to the end of that course. To comprehend that change and create a model for learning, the qualitative data was explored.

The second part of the research involved analyzing email interviews and subsequently in-depth interviews from those game-playing students. The mechanism for learning business processes was developed and it showed that the source of the experiential learning was very important. For many students, experiential learning in certain classes such as hands-on work with ERP in business intelligence had a big impact on their understanding business processes, thereby validating the Kolbian experiential learning theory. For others with extensive work experience, only their past knowledge through the real-world impacted their understanding of business processes to the exclusion of classroom-gained information.

Causal powers and liabilities were identified in the in-depth interviews as triggers to the SELECT learning mechanism. Financial, marketing, and manufacturing all have the power to encourage business process learning through the contingent aspect of classes. Specific classes were cited as being particularly helpful in learning, with business intelligence being the most cited. Particular classes were also a positive influence for learning in the object of experiential learning and ERP learning. Those classes all included modules with experiential ERP, which confirms the Kolbian experiential learning theory. On the other hand, business process knowledge absorption was inhibited by those with extensive work experience. That group of students relied on past on-the-job knowledge to make business decisions, rather than call on their university-gained knowledge.

Chapter 6. Discussion of Results

Experience is the teacher of all things – Julius Caesar

6.1 Introduction

In this chapter, the data from the two different universities are compared. Firstly, the quantitative data from each class is compared. Five different classes are analyzed statistically by ANOVA, and then the two school's data are compared to each other by means of a t-test. The scores of those students who participated in the in-depth interviews are also analyzed separately. The qualitative data previously analyzed is compared between the two schools. The two mechanisms for learning are juxtaposed, and similarities and differences highlighted. A thorough discussion of results for both schools is presented individually and then collectively, with educational implications being noted.

This chapter is organized as follows: In Section 6.2, the quantitative data analysis is presented, initially comparing all five classes and latterly comparing the two universities, both for the whole group and for the in-depth interviewees. The qualitative data is compared in Section 6.3, contrasting the two mechanisms and their individual contingent powers and liabilities. Discussions of the data are then explained, for the Delaware undergraduates in Section 6.4 and for the Brunel postgraduates in Section 6.5. Educational implications are presented in Section 6.6 with enumerated points and recommendations for educators.

6.2 Quantitative Data Analysis

Data has been collected from each student playing the business simulation game twice: once before the educational experience and once afterwards. This quantitative data analysis is answering the question, 'are there significant differences between any of the groups of students, experiencing or not experiencing ERP and/or undergraduate or postgraduate that would then validate the benefits of experiential learning?' The key result of Net Profit for each game's outcome was recorded and the difference from the first to the second game was calculated. This difference in net profit has been statistically analyzed by ANOVA to ascertain any difference in the means between the various classes thus testing the null hypothesis that the means of the classes are equal.

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The 5 classes compared are as follows:

<u>Class/Program</u>		<u>Description</u>	<u>Number of Students</u>	<u>Using ERP experientially?</u>
ACCT302 – Accounting Information Systems	US Undergrad	Database design and usage for AIS	35 undergraduates	NO
MISY225 – Programming Business Applications	US Undergrad	Database design and usage, Decision support, VB programming	80 undergraduates	NO
MISY261 – Business Information Systems	US Undergrad	Database design and usage, Decision support, ERP	113 undergraduates	YES
Information Systems Management	UK Postgraduate	Strategic IS, IS development, IS management	2 postgraduate students	NO
Business Systems Integration (with SAP)	UK Postgraduate	Enterprise systems, Service oriented architecture, ERP	16 postgraduate students	YES

Table 6-1 Description of All Classes

The results of the one way ANOVA are as follows in Table 6.2:

	Sum of Squares	DF	Mean Square	F	P
Between Groups	9.55614E+12	4	2.38903E+12	1.01	0.405
Within Groups	5.72833E+14	241	2.37690E+12		
Total	5.82389E+14	245			

Table 6-2 One-way ANOVA results for all 5 classes

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The p-value at 0.405 is greater than 0.05 significance level, which indicates the null hypothesis cannot be rejected and that the means of the 5 classes are not significantly different. A further mean separation test, the Tukey's test, which compares every mean with the other means, also shows that the means are not significantly different.

The next statistical analysis performed was to see if there were differences in the means of the 2 different universities, and therefore in the different levels of study. Recall that University of Delaware students were undergraduates and Brunel University students were postgraduate students. First both sets of data were checked for normality, as shown in the following Figures 6.1 and 6.2:

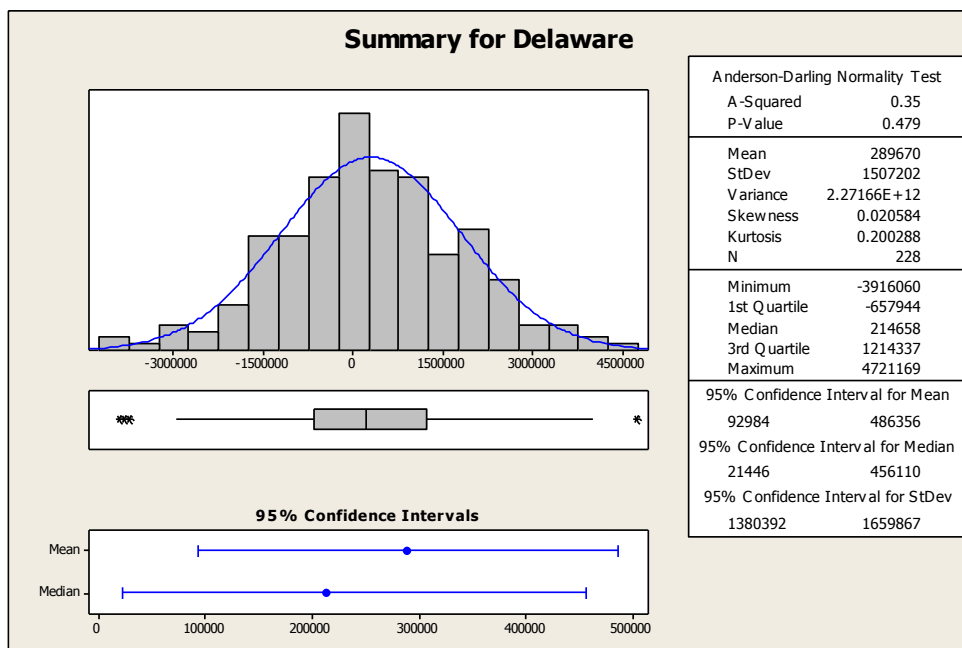


Figure 6-1 All Delaware Data

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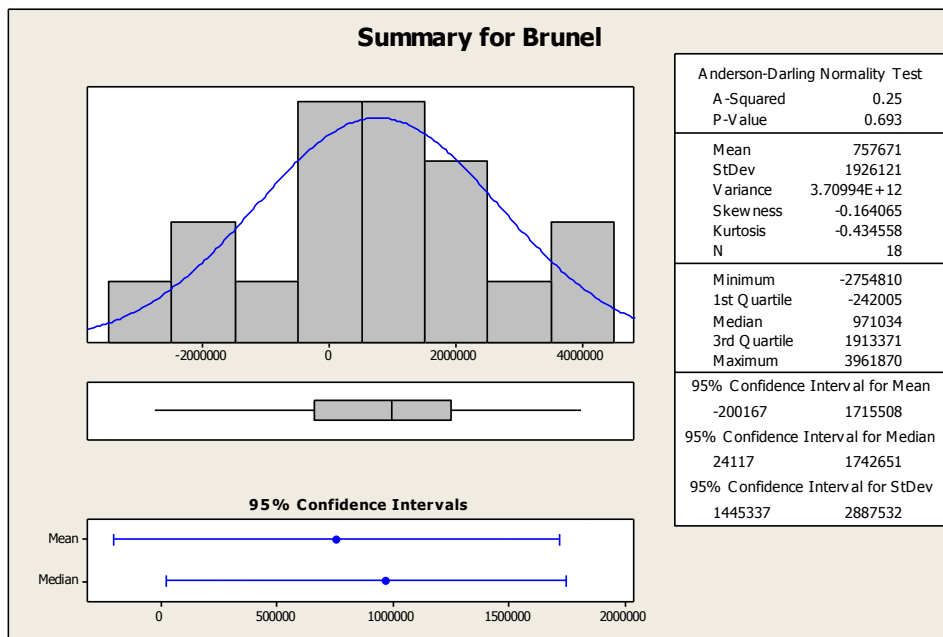


Figure 6-2 All Brunel Data

Since both sets of data appear normal, a t-test can be performed to test the null hypothesis that the means of each set are not different. The results of the t-test are as follows:

Class	Number	Mean Difference in net profit between 2 instances of game play	St Dev	SE Mean
Brunel	18	757671	1926121	453991
Delaware	228	289670	1507202	99817
T-value=1.01	P-value=0.327	DF=18		

Table 6-3 T-test results for all classes

The p-value is 0.327 which is above the 0.05 confidence level, so the null hypothesis cannot be rejected. Therefore the means of the two universities are not significantly different.

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The aforementioned data analysis was performed on all students' results from the business simulation game, reporting a broad view of all classes. To delve deeper into possible differences, data from the selected group of students who completed the in-depth interviews have been analyzed in a similar fashion. This additional statistical analysis helps hone in on differences in this group of interviewees from which learning mechanisms have been developed.

The results of the one way ANOVA for only the interviewed students are as follows in Table 6.4:

	Sum of Squares	DF	Mean Square	F	P
Between Groups	1.26001E+13	4	3.15004E+12	1.49	0.231
Within Groups	5.90721E+13	28	2.10972E+12		
Total	7.16723E+13	32			

Table 6-4 One-way ANOVA results for all 5 classes

The p-value at 0.231 is greater than 0.05 significance level, which indicates the null hypothesis stands and that the means of the 5 classes are not different. A further mean separation test, the Tukey's test, shows in its grouping information that the means are not significantly different, as similar to the data as a whole.

The data looks different, however, when figuring which students increased their score during the second time they played the simulation game. All students who experienced ERP from the University of Delaware increased their score after the ERP class, as shown in the following Figure 6-3.

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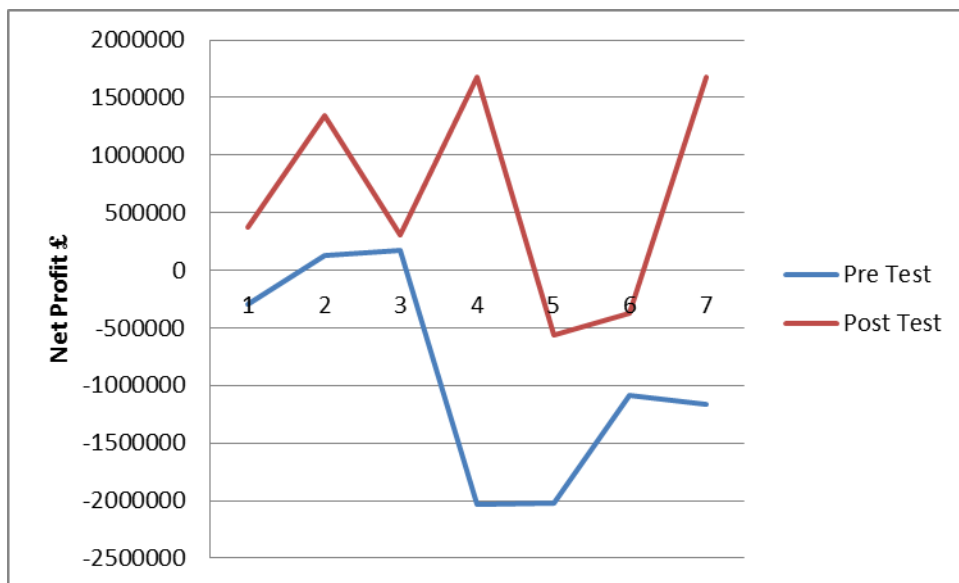


Figure 6-3 Delaware interviewed students who experienced ERP

In addition, if the undergraduate students from Delaware who learned with ERP (MISY261) are compared with the Accounting Information Systems students who did not learn with ERP (ACCT302), the difference in means for the students who participated in the in-depth interviews is significant. These results are displayed in Table 6-5.

Class	Number	Mean Difference in net profit between 2 instances of game play	St Dev	SE Mean
MISY261 (with ERP)	7	1535862	1288610	487049
ACCT302 (without ERP)	6	-179085	1303493	532149
T-value=2.38	P-value=0.039	DF=10		

Table 6-5 MISY261 (with ERP) versus ACCT302 (without ERP) for those who were interviewed

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The p-value is 0.039 which is below the 0.05 confidence level, so the null hypothesis can be rejected and it is shown that there is a significant difference in the means between MISY261 and ACCT302 for those who participated in the in-depth interviews. For those students interviewed in MISY225 (business programming without ERP), the p-value was above the 0.05 confidence level so the null hypothesis could not be rejected for that group compared with MISY261.

For the experiential ERP students at Brunel, all but two students increased their score on the business simulation game after their course work, as shown in Figure 6-4.

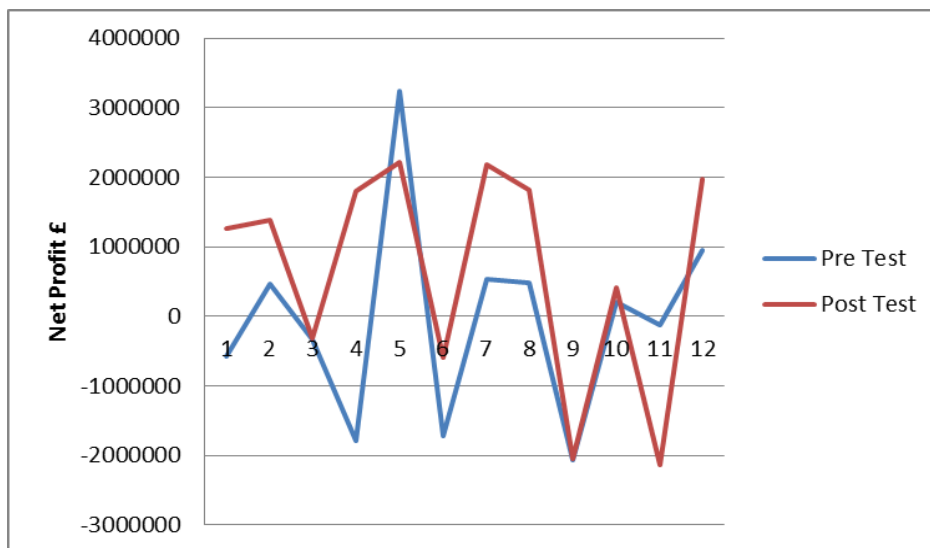


Figure 6-4 Brunel interviewed students who experienced ERP

To statistically analyze this group of experiential learners, a pairwise t-test was chosen to compare the same group of students before and after playing the game. The null hypothesis could not be rejected at the 0.05 confidence level, although the results are trending to be marginally significant. Given the small sample size, it's difficult to differentiate the improvements other than by chance. Those results are displayed in the following Table 6-6.

Class	Number	Mean	St Dev	SE Mean
After Classes	12	662655	1587247	458199
Before Classes	12	-62046	1447862	417962

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Difference	12	724702	1435842	414492
T-value=1.75	P-value=0.108			

Table 6-6 Brunel ERP Interviewed Students' Paired T for After – Before Classes

Although the difference in means between all classes was found to be not significant, there are hints of differences in some classes for the interviewed group of students. This result indicates a clue to the power of experiential ERP and a validation to the modified Kolbian experiential learning theory. However, under the critical realist view, the empirical data is not sufficient to determine any models for learning. The qualitative data needs to be analyzed as well to gain a more complete picture.

6.3 Qualitative Comparative Data Analysis

In-depth interview data was collected from both universities and conceptual models were developed, as described in Chapters 4 and 5. For the University of Delaware students, the undergraduate SELECT model was that show in Figure 6.5.

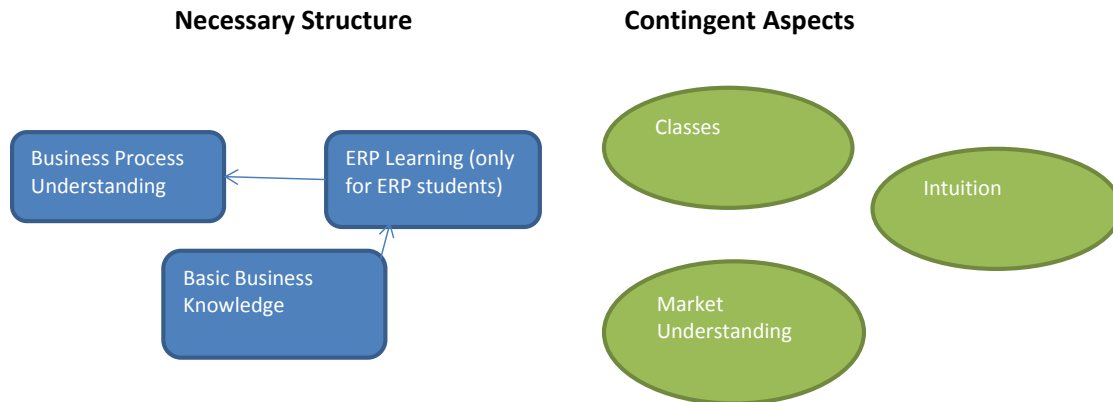


Figure 6-5 Delaware undergraduate SELECT model

To compare, the Brunel qualitative data, generated this variation on the undergraduate SELECT model, as shown in Figure 6.6.

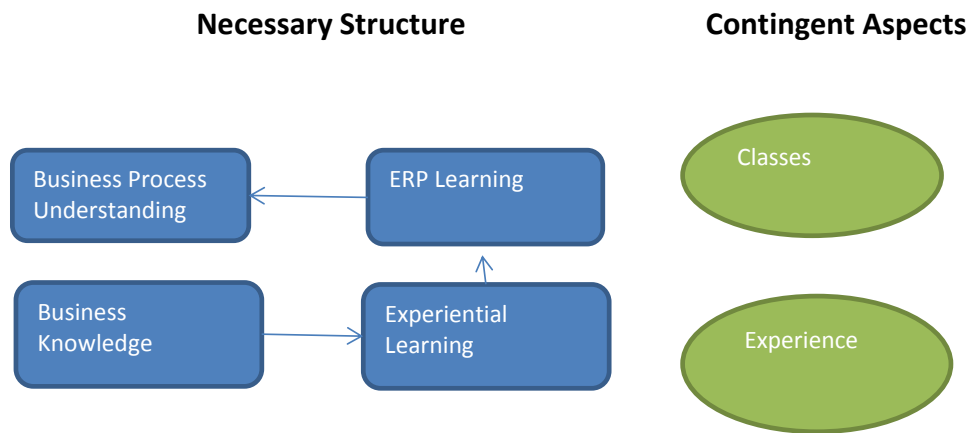


Figure 6-6 Brunel postgraduate SELECT model

The necessary structure of the SELECT model for the universities has mostly commonalities with a slight difference. Initially, students begin with some understanding of business knowledge before they proceed to study ERP systems to enhance their learning about business processes. The postgraduates at Brunel were more demonstrative in their experiential learning, hence the inclusion of the object Experiential Learning in the model. Contingently, for both groups, classes have the capacity to encourage the learning mechanism to occur, or to inhibit its working. The other contingent aspects identified, differed between the two groups. Undergraduates at University of Delaware more clearly used their intuition and their understanding of the current market to make business process decisions, whereas some postgraduates at Brunel were influenced by their past work experience.

6.3.1 Necessary Aspects

With all students interviewed, it is evident that knowledge of business is a prerequisite for this learning mechanism. Comparative quotes among the two universities at the two levels: undergraduate and postgraduate, demonstrate this contingent aspect. For example, an undergraduate Delaware student who experienced ERP said *"I had just too many costs going on so that would really hurt my profit so then I focused more just on like having one solid production line to meet demands."* This indicates an understanding of business during the game, similar to this student's statement (a non-ERP undergraduate) *"You can have losses at first because of all the groundwork that you are putting into it eventually you have your customer base and then you have profits."* One Brunel student drew on his business knowledge gained from previous education as he

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says “we were taught that initially when I was doing my undergraduate degree. Although I didn’t do it from [this grad school] I can relate it.” Another postgraduate explained their business knowledge in this statement “I was looking at the market trying to understand what my competitors were pricing their products at; trying to understand what was driving the sales...maybe changing the product, the price, changing something that would make me more competitive.” Both schools and therefore both levels of higher education exhibit a necessary understanding of business knowledge. Surprisingly, there seems to be no difference between either school, the different levels, nor between the ERP class and the non-ERP class. In examining the interview data in detail, there was no correlation in level of business knowledge and grade point average. For all students, no matter what level of education, business knowledge is required prior to learning and therefore using business processes in decision making, as this one Delaware student stated, “I think from your core business classes you have enough foundation.” This outcome is an important reminder for educators who teach business processes.

As a variation on the model, the Brunel postgraduates discussed experiential learning in their in-depth interviews. For over half of them, the benefits of learning with a live SAP system was articulated in ideas such as this: “I guess when we were learning during our ERP course, learning business processes, how sales works and how marketing works or even production works. It obviously gave me a deeper thought process into the game.” Brunel postgraduate students’ deep thinking and their discussions of classes that contained an SAP component differs from those undergraduates at Delaware. Although experiential ERP concepts were alluded to during the Delaware interviews, no undergraduate student at Delaware specifically mentioned those classes that contained hands-on work with SAP as they did at Brunel. Again, the depth of knowledge more pronounced in the postgraduate Brunel data.

In order to determine why the depth of knowledge for experiential learning with ERP is greater for those students studying at Brunel University, an overview of course content is outlined in the following Table 6-7.

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University of Delaware – MISY261 – Sole ERP Class	Brunel University – ERP Courses
Database design and implementation	ERP Systems Theory and Practice
Decision support, systems development	ERP Systems Deployment and Configuration
ERP, practical and theoretical using SAP	BI - Business analytics, BI via data marts and warehouses using SAP

Table 6-7 Curriculum Comparison for ERP Courses

There may be a number of explanations as to why postgraduate students are able to articulate experiential ERP more freely than those undergraduate students. Firstly, the curriculum content at Brunel is cohesive and uses SAP in a number of courses. It was even noted by one interviewee that the last 3 classes in that BI course were the most beneficial. This made a lasting impression on the students and they were able to recall the experience easily. For the Delaware undergraduates MISY261 covers ERP with experiential SAP for about 1/3 of the class, along with other topics. The thoughts from Delaware students on ERP were not engrained as they were for the postgraduates in the BI class. Another plausible explanation may be that postgraduates, with some work and life experiences, can understand the importance of ERP more readily than those undergraduates who have not had any substantial work experience and only know business from university-driven pedagogy. Postgraduates are more mature and can put ERP systems more enthusiastically into perspective. These explanations are evidenced by the Delaware undergraduates alluding to ERP systems, whereas a few of the Brunel postgraduates called the ERP software, SAP, by name. Only one of the Delaware undergraduates mentioned a part-time job, conversely, a number of Brunel postgraduates mentioned their past work experience. Most likely, the reason why the two different groups of students are discussing at different levels is a combination of the two explanations. The curriculum is different and the experience and maturity levels are also different.

Using ERP in the classroom aids in the comprehension of business processes for both cohorts, as evidenced by at least 70% of all students who studied ERP discussing its properties during the in-depth interviews. However, if the data is delved into deeply, it appears that the Delaware undergraduates barely scratched the surface of ERP learning, whereas the Brunel postgraduates discussed ERP in depth, covering more properties of ERP. For example, the undergraduates at UD

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who experienced ERP systems discussed only one property of ERP during their in-depth interviews. This undergraduate student described the info view property by stating, *“The ability to see what the competition was doing and to be able to change what I did more quickly I could clearly see that was helping and that would allow me to make more money and so just the flow of information I say was definitely key”*. However, at Brunel, the majority of the postgraduate students discussed multiple properties within ERP learning. The depth of understanding is indicative in this comment by a Brunel student, *“I would have had a passion for BI but this time...the passion initially was towards the technical part of it; SAP, but I know now realized that at the latter part of the class kind of featuring a lot of things the whole thing is how do you apply BI to the business scenarios to me the bottom line is how do you gain in the organization.”* This difference gives a clue to how and when to best experience ERP systems for business process learning. As one might expect, the undergraduate experience was shallower than that of the postgraduate experience.

However, in comparing this research to past research attempting to measure business process learning, the undergraduate data collected in this work was after an entire semester’s work. In the past research, data was collected after one or two classes experiencing ERP, which resulted in a lack of conclusive evidence of the efficacy of using the software in the classroom. It is clear from the results that collecting data after a prolonged exposure to ERP is the preferred method of research. This also affirms the thought that ERP systems, being complex in nature, requires a higher level of Bloom’s taxonomy for comprehension and hence a longer time to absorb this knowledge and apply it to business processes.

The in-depth interviews indicated that the majority of students did learn business processes with over half of the Brunel students and the non-ERP Delaware discussing the object, and all of the Delaware students who experienced ERP talking about this necessary aspect. These students are indeed using their knowledge of business processes for decision making in the business environment, displayed by this statement from a Brunel postgraduate student,

“My knowledge of business processes helped me from the sales and production part. So I was able to understand especially when I needed to because the first time I just thought Oh I am not getting enough market share and I went and increased production and that was disastrous because there wasn’t enough demand. [At end of term] I was able to ...

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merge the sales and production in together to use it to know when to do that. Also know when to do a stop using two production lines.”

The undergraduates at Delaware had a similar take on business processes and how they apply to making decisions, for example, this ERP student mentioned *“Definitely just knowing how marketing flows and the production you have to be able to do. You have to have sales in order to, if you do not have sales like production doesn’t really matter and knowing the importance of all different parts you need to be able to meet demand and all that.”* The predominance of business process discussion among the ERP students at the undergraduate level is a further validation of the usefulness of experiential ERP in teaching business processes.

6.3.2 Contingent Aspects

Enough cannot be written about the positive effect that classes have on learning business processes. This contingent aspect is strong for both cohorts, as indicated by discussions surrounding Table 6.6, the curriculum comparison.

The remainder of the SELECT model’s contingent aspects differs between the two universities. For Delaware, it was much more apparent that the undergraduate students used their market understanding and intuition to make business decisions when playing the simulation game. Within this research project, these two objects may or may not work against the learning mechanism however. For those students where market understanding enhanced the learning mechanism, each was able to discuss ideas of business processes stressing connectivity and information being essential for the business to run smoothly. For example, one student who used market understanding to choose the product to sell, *“Basically, you know it was just the product that I could associate myself with”*, indicated her understanding of business processes by saying

I think it was the subconscious thing. I mean I don’t think I was like was gonna figure out the cause and it was kind of like what are the cause, what are the benefits like how can I improve the product you know how can I lower cost of demand make sure that demands set at a proper rate make sure I am using things. Make sure I am using overtime effectively. Make sure I don’t need to open up a new factory whatever it is like you know like consider all those things you understand the importance of each of those entities individually. So I think that just made it an easier and easier transition to figure out, like why something was working

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something was not working. I wasn't sitting there with a calculator doing it like in my head I guess I was like that was kind of my thought process throughout the game.

For the group of students where market understanding affected their game playing negatively, none of them mentioned connectivity or information being important, and the majority didn't touch on business processes. This group of students spoke of using their knowledge of current market trends to play the game, rather than reading and understanding all the parameters required to make good, sound business decisions.

Some Delaware undergraduates relied on their intuition to play the game, calling it commonsense or business sense. This contingent aspect was a positive influence for the learning mechanism for some students, and for others it was a detraction from learning. The group that used their commonsense and business sense to enable learning was solidly voluble surrounding the topic of business processes. For example, one of the students in this group claimed:

I mean I would obviously say [business processes] helped a lot. I meant to the extent the game kind of is like an introduction to the business because it gives you so much like knowledge and I think it's just more how you apply it. That being said I mean I guess you know I am a business student so I guess it is kind of second nature focus of college but yeah I definitely think it helps you know because you are going to apply things like you learn within in the classroom as far as you know how you manage, how to market what you are looking for, you know how cost to benefit ratios and stuff like that and obviously I didn't do cost to benefit ratio. But in your head you can kind of like balance that out so I think it definitely helps from that standpoint.

The group of students whose score was negatively affected by using their commonsense or business sense didn't stress the use of business processes when playing the business simulation game. When queried, one student from this group said the following, indicative of not really understanding business processes:

I guess it's a tough question in general. This is like the only thing I know it's not like I am comparing like a history class versus a business class I am comparing like it's just I only have a business mind; I am accounting and finance double major. It's just like I can't compare to a

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history major taking that because I am not a history major. I think it might help me because I know like I was able to read the financial course a little bit easier but I can't compare it to myself as a history major just because I am not a history. I don't know how I will be if I was a philosophy major or nursing major.

This can be compared to the Brunel postgraduate students' SELECT model contingent aspect of experience. Some students in the group relied on their work experience to the exclusion of university-gained knowledge for decision-making, as displayed by this student's proclamation, "*I have worked for 28 years ... [decisions made during the game were] not from anything I have learned here at uni.*" In comparing both groups, it is reasonable to assume that some of the undergraduates at University of Delaware, without any prior work experience, decided to rely on their market understanding and intuition to make decisions rather than think through the problem thoroughly by exploring all aspects of the game. For the postgraduate students at Brunel, armed with some work experience, used that experience-gained knowledge to play the game. The difference between these groups makes sense: postgraduates coming into the Brunel program have had work experience and they can easily fall back on that for decision-making. The undergraduates at Delaware have minimal, if any, work experience. Their fallback position is to look at what they know about today's market and/or simply rely on their own innate sense. Further discussions of these contingent aspects follow in Section 6.3.3.

6.3.3 Powers and Liabilities

The contingent aspects in the SELECT model have the capability of triggering the learning model or suppressing its working. In effect, there are properties of an object that are positive or negative influences for learning business processes. The previous chapters outlined the categorical objects and properties as follows:

1. Business Processes
 - a. Connections
 - b. Integration
 - c. Communication
 - d. Value
 - e. Collaboration

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- f. Involvement
- g. Terminology
- 2. Enterprise systems – ERP
 - a. ERP integration
 - b. Info view
 - c. Efficiency
 - d. Performance control
 - e. Communication
 - f. Empathy
 - g. Management control
- 3. Experiential learning
- 4. Business Knowledge
 - a. Financial
 - b. Marketing
 - c. Pricing
 - d. Manufacturing
 - e. Quality
 - f. Choice
- 5. Broad view
- 6. Complexity

Selected properties from this list were identified in the in-depth interviews as being triggers or suppressions to the learning model. Table 6.8 summarizes the comparison of these powers and liabilities for both schools, listed under the necessary structure objects, with a plus sign (+) indicating a power and a minus sign (-) indicated a liability.

	University of Delaware	Brunel
Business Knowledge	Choice (- for non-ERP, + for ERP)	Financial only(+)
	Combination of Financial/Marketing/Manufacturing (+)	Combination of Financial/Marketing/Manufacturing (+)

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Experiential Learning		(+)
ERP Learning	Efficiency (+)	Performance Control (+)
	Info View (+)	ERP Integration (+)
Business Processes	Connections (+)	Communication (+)
	Integration (+)	Terminology (-)

Table 6-8 Powers and Liabilities for Both Cohorts

For the University of Delaware students, business knowledge was influenced negatively and positively by different groups of students' market understanding when it came to the choice of the product they were going to sell. A group of students did not discuss business processes in their in-depth interviews. Instead, that group relied on their market understanding for their business knowledge in choosing a product to sell and they ended up doing poorly the second time on the business simulation game. It appears that this group of students ignored the basic game information available to them to make their decisions. For the students who discussed business processes, by contrast, using market knowledge enhanced their business knowledge to choose a product to sell had a positive effect on their game play results. For the group of Delaware undergraduates who relied on their intuition to choose a product to sell, those who improved on the game appeared to analyze the product's features more deeply than those who did poorly on the business game, and also had a tendency to discuss business processes. In either case, this illustrates a common phenomenon that educators should be cognizant of: students in this undergraduate age, transitioning from childhood to adulthood, are highly influenced by experiences in their current lives. Educators must work to ensure students look beyond their current world knowledge for problem solving (Mughal and Zafar 2011).

Business knowledge was enhanced by all students at both universities from classes taken. These properties, financial, as well as marketing and manufacturing, are seen as powers for triggering good learning outcomes, as evidenced by this statement from a Brunel Postgraduate: *"I know that dashboard is just an interface but it is based on a lot of accounting work for warehousing"* Students

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further articulated their knowledge of these specific properties, thereby enabling the learning mechanism, as indicated by these statements at the postgraduate level:

"I didn't want to become bankrupt and I wanted to at least break even... concentrate on the profit margin." "I was looking at the market trying to understand what my competitors were pricing their products at; trying to understand what was driving the sales...maybe changing the product, the price, changing something that would make me more competitive."

Digging deeper into the data to further corroborate the aspect of the mechanism dealing with experiential learning (Wynn and Williams 2012), one Brunel postgraduate answered the question 'Did anything come to mind when you were playing the game from your coursework?'

Yes, I think in my business intelligence for making forecasts and then you're looking at historical sales. I think that can be related to this as well. Because when you've got your historical sales you can plan your next year's product planning... Business Intelligence class... Basically business intelligence is all about decision making. And again since business intelligence is based on decision making then all of the data, like the sales and everything, we can link that to SAP as well because in business intelligence you're getting all the data through ECC4.0. So from those from those forums you use the sales, you use all these figures. I mean that is the main database which we analyze it to report in BI. I mean those reports, the market share, those graphs, they're all reporting and that's how it's related to BI.

This student is proceeding through the phases in the experiential cycle, as outline in Figure 6-8. In the simplified Kolbian experiential learning theory for the business simulation game, developed in Chapter 2, the experience encompasses understanding, acting, and reflecting. At first, he understands how the experience of using an ERP system is beneficial to a business intelligence component. Next, he plays the game, which is the Act phase. Finally, there is great reflection on all the information the business simulation game provides. For example, he refers to the reports, market share, and graphs which are all an integral part of the game to provide feedback to the player.

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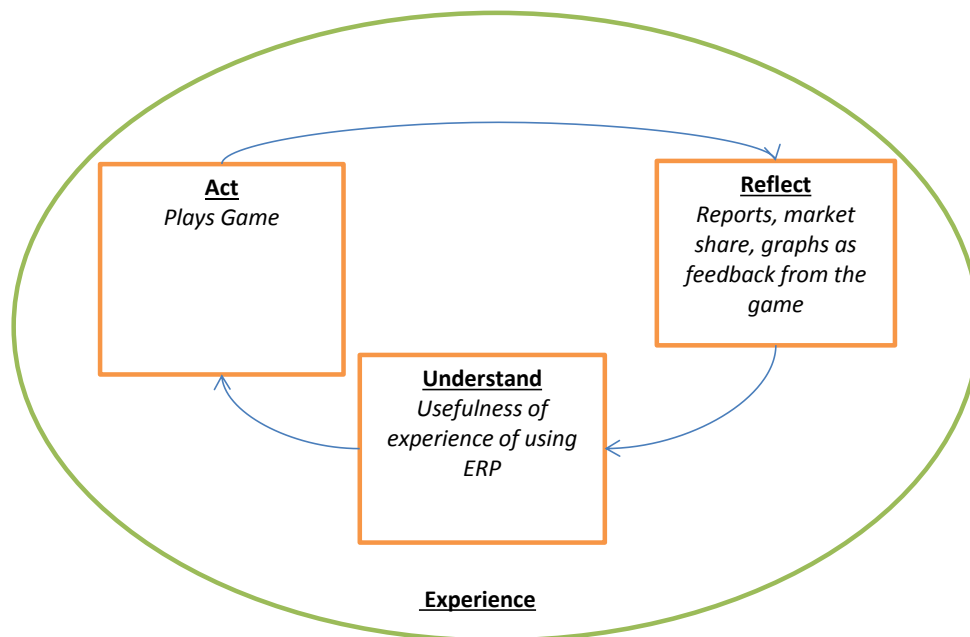


Figure 6-7 Simplified Experiential Learning Cycle with Typical Brunel Postgraduate Game Play

For ERP Learning, all properties highlighted in the in-depth interviews had the power to trigger the learning mechanism positively. The two groups of students, undergraduates at Delaware and postgraduate students at Brunel differed in the properties they discussed most. For the undergraduates, it seems as though efficiency or more efficient business processes played out as a power, as stated by this student, *"Maintaining whatever that the customers were demanding so I wasn't under producing or over producing the product."* Also this group focused on the info view, or single view of information with statements such as *"I was constantly looking at what the competition was doing... then also at the production levels."* Whereas the postgraduate students focused on performance control, or greater control over corporate performance, shown in this statement *"because business intelligence is ... about having the advantage over my competitors actually; gaining insight into the business"* and on ERP integration *"I think everything had to be integrated together to have a full/big picture of the whole process of everything that is going on inside the company."* The focus from the two cohorts is on different properties of the ERP learning object. It appears as though the undergraduate students at Delaware are focusing on the basics of ERP: efficiency of the business process and the single view of information. Comparatively, the postgraduates are focusing on more complex outcomes of ERP systems: greater control over corporate performance and integration of functional lines of business. This distinction between the

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two groups suggests that postgraduates are learning on a higher level of Bloom’s taxonomy, which assures the professors teaching this program that they are indeed holding the students up to a greater plane than that of an undergraduate program, as shown in the following table.

Higher level Thinking Skills	Evaluation	Brunel Postgraduates
	Synthesis	
	Analysis	
	Application	Delaware Undergraduates
	Comprehension	
Lower Level Thinking Skills	Knowledge	

Table 6-9 Bloom’s Taxonomy mapped with Student Subjects

However, no matter what level of study, undergraduate or postgraduate, the overriding outcome is the same: classes that experience ERP have a significant impact on students’ ability to make business process decisions.

The goal of this research is to determine the effect of learning business processes with experiential ERP. For that necessary structure object, undergraduate classes at Delaware were a positive influence for learning business processes under the properties of connections and integration. The students seemed to think about connections between tasks and integration between departments. This claim is supported by

I remember there was one almost a graph that kind of show you, level of the product you like like what quality it was versus the price of the product and its place my product along with everyone else’s all the competition so I could see you know who had the best product, who had the cheapest product who was kind of right in the middle.

I used that a lot to place my product right around you know so it stood out there wasn’t the same price and the same something else and it was the same quality or something else but ten dollars cheaper so that you know I could get all the sales. So you know I was constantly looking at what the other competition were doing.

I’d say primarily that and then also the production levels I would look at that occasionally because that would be changing there was a chart that would tell me you know how many

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different factories you wanted to open and how many over-time hours you would really pay for and things like that.

So if my product you know at one time was the most ideal and better than all the other products you know if I'd up manufacturing a lot then I would get larger sales during that period.

These type of statements indicate students understanding the power of integration with business processes.

For the Brunel postgraduate students, coursework also positively affected their capacity to learn business processes mostly in the property of communication or sharing of information, as evidenced by this comment “[From] data consolidation ... you know lots of information coming in real time.” However, experience hindered that business process learning under the property of terminology or involving key business activities. One student mentioned this “I think if you have been in business and you are coming with the knowledge of how business works you don’t apply the knowledge you gain at the university, you just apply your general knowledge to it.” From this statement, it’s evident that this particular student fell back on the knowledge learned on the job or perhaps they favored the on-the-job knowledge. This particular deterrent to learning is only seen at the postgraduate level, indicating the more-experienced group of students.

6.4 Discussion for Delaware Undergraduates

Past research attempting to measure the difference between classes experientially using ERP systems and those not experiencing the systems has been somewhat inconclusive and lacking in rigor. In measuring those differences and probing the basic question: what components enable a student to learn business processes, this research is attempting to unlock the relationship between the courses and determine which relations are necessary and which are contingent in a critical realist view for student learning (Sayer 1992, Easton 2010). In doing so, the learning mechanism is uncovered and properties that promote or inhibit that mechanism are realized. The quantitative results from the undergraduate courses as a whole at a large university show no statistical difference in means between understandings of business processes, as measured by playing a business simulation game, between classes that have experienced ERP systems as opposed to classes that

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have not used ERP. These results are similar to the pattern of past research in that they are inconclusive. However, there are some quantitative differences gleaned from the in-depth interview data which give clues to business process learning.

All students who experienced ERP systems performed better on the business simulation game the second time they played it, after their class was completed. For the students in classes that didn't study with ERP, their results the second game play were mixed. Half of that group of students did worse the second time they played the game. In addition, GPAs were significantly higher in the one non-ERP class. Consequently, it may be inferred that there is something in the ERP curriculum that allowed these lower GPA students to absorb more from their class to enable them to improve on the business simulation game. This work has sought to answer this question using a critical realist philosophy. By performing a second phase of the research, understanding of the mechanisms and causality behind students' learning in the two distinct classes was achieved. Under this view of critical realism, it is inadequate to determine any theory from empirical observations solely. The qualitative research portion sheds light on the differences between the two classes and validates the modified Kolbian experiential learning theory of understand, act, and reflect, described as follows:

1. Fundamentally, business process learning begins with a basic understanding of business in general, as shown in the start of the SELECT learning model. Students from all groups clearly demonstrated their understanding of business in the focus groups, individual interviews, and in the in-depth interviews. This is considered the Understand phase of the theory, where problem-solving is learned.
2. Students that were interviewed in-depth frequently mentioned that today's market influenced their decision making process. This conclusion is impactful for educators of business undergraduate students. If our students are relying on their knowledge of current markets to make decisions, we need to be cognizant of that and work to eradicate any misconceptions and ensure their knowledge of current markets is correct. In this phase, students are acting to execute the goals of the organization, the business simulation game company.
3. Similarly, some students used only their intuition to make business decisions in the simulation game. Acumen is a trait valued in business. However, it should be impressed

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upon students to incorporate appropriate information before making decisions. Again, this occurs in the Act phase when the students are running the game.

4. Students interviewed overwhelmingly mentioned their coursework as a source for their knowledge of business. In addition, coursework was mentioned again and again from all groups within the interviews when discussing business process usage during the game, validating the educators' efforts in imparting and instilling not only facts, but knowledge that is able to be applied. These students' interviews are indicating that learning is taking place on the higher level cognitive scale of Bloom's taxonomy at the application level, not simply rote memorization. This completes the loop of the modified experiential learning theory. In this the reflect phase, the students are thinking and questioning their decisions in light of the knowledge they've gained in coursework.
5. Once students have a basic knowledge of business they can experience ERP systems to solidify their understanding of business processes. For the group of students who did learn with these large computer programs, the concepts of equalizing supply and demand in an organization and the idea that information is essential for decision making were firmly entrenched in their minds when discussing business processes. Students in this group also thought more often about the power of information and how parts of an organization were connected together. From a pedagogical point of view, these ideas articulated in the interviews and used to play the business simulation game show that students are digesting their experiences with ERP systems and applying that knowledge in business decision-making situations. This conclusion validates the experiential learning theory: experiencing is crucial to learning. Within the confines of the experiment here, students who experienced ERP systems in their curriculum will be able to use that experiential knowledge for future success in the business world. With regard to the modified Kolbian experiential learning theory, students who experienced ERP systems reflected on the connectivity of business and on how information was key to decision making. These reflections indicate an understanding of business processes. The non-ERP group, being mostly finance and accounting majors, reflected greatly on the financial aspects of the game.
6. Unsurprisingly, students in the group without experiential ERP focused on financial

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statements when discussing the subject of business processes. Since the majority of those students are accounting or finance majors, it is only natural that they would focus on the financial aspect. This raises an interesting implication for future educators. Another route to learning business processes may be through the traditional accounting classes. From the quantitative data, the large classes of students statistically did just as well as the ERP students in mastering the business simulation game. However, out of this group of accounting and finance majors, more than half of those that participated in the in-depth interviews did poorly on the second time they played the business simulation game. In contrast, in their qualitative interviews, they were able to discuss business processes and how it impacted their decision making in the game as were the ERP students. Timing of classwork may be an issue here. Most of this group of students brought up ideas from past year's accounting classes; only 2 mentioned finance classes they had just finished. Students who took those classes in prior semesters are already beginning with a basic knowledge of business processes to play the game the first time. Another explanation is that this group of students, most of which exhibit a high level of confidence, used that confidence to play the game well the first time. It is thought that these students came into playing the game the first time with business process knowledge. This is validated by the quantitative data: for the ERP students who were interviewed, all first game play results were negative, bar two. For the Accounting students, all first game play results were positive, bar one, confirming their entry into the game playing with preacquired business process knowledge.

7. Yet another surprising result is that this same group of students appear to be very confident about their business process knowledge and relied on their business sense or even common sense to articulate their thoughts on business processes. As mentioned in the quantitative data analysis, the GPAs of the non-ERP group from the Accounting classes were higher than those of the ERP group. Perhaps the higher GPA students are more confident of their abilities and feel that their business sense and commonsense is sufficient for decision making. At the university where the research took place, the accounting program is the most rigorous within the college and it attracts the higher achieving students. With this rigor and achievement, confidence exudes. On the flip side, the group of students who learned with ERP was quite tentative and overwhelmed when they played the business simulation game

the first time with all improving the second game play, as they gained confidence in business process decision-making. Again, this is most likely due to lower average GPA translating into a lack of self-confidence, but a greater capacity for learning.

6.5 Discussion for Brunel Postgraduates

The quantitative research results from the 2 postgraduate tracks at Brunel University display means that are not statistically significantly different. The postgraduate students in the track experiencing ERP systems for their year's course did not perform significantly better on the business simulation game than those who did not experience ERP systems in the classroom. These results are identical to those of the undergraduate classes at University of Delaware and they are also similar to the past research highlighted in Chapter 2 in that they are statistically inconclusive, on their own. On the other hand, almost all students improved their scores on the second playing of business simulation game after their coursework. This result, although not statistically significant but trending towards marginal significance, indicates a change from doing the course curriculum. However, only the qualitative data alone or the quantitative data with the qualitative data can address in detail how students learn with ERP systems, under the critical realist view. None of the past research used qualitative analysis except for self-efficacy studies.

The results of the data analysis and subsequent learning model development trace the steps in the modified Kolbian experiential learning theory. These are now discussed:

1. In the Understand phase of the modified Kolbian experiential learning theory applied to learning business processes, students cannot begin to understand or learn business processes without a basic knowledge of how a business works. Problem solving is learned in this Understand phase and a requirement for learning how to solve business process problems is a knowledge of business.
2. Using the quantitative experience of playing the business simulation game as a talking point, in-depth interviews were conducted with the students and the qualitative results, rigorously analyzed, produced the SELECT model, where the source of the experience was important for learning outcomes. Students were divided. Many relied on classroom experiences to demonstrate their knowledge of business processes through the simulation game. Some others, however, solely relied on their past work experience to guide them through the

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decision-making in the game. This finding, that students may be using their past experience to guide them through business process decision making, is important to educators of the subject. In the Kolbian modified experiential learning cycle, students at this point are understanding the problems presented and recalling knowledge to solve those problems.

3. Drilling down further into the interview data from those students articulating classroom experience, specific courses were highlighted as important in the students' learning which played out in the second simulation game; in the first game prior to any coursework, one student claimed *"I just went with instincts"*. Overwhelmingly, students mentioned the Business Intelligence and Data Management class as important in decision-making during the game the second time around. This is unsurprising, since the content of the class includes topics such as information integration approaches and experiential work with a live SAP system. In these classes, students claimed that they learned how a business works *"there was a module in the first term, and that's 'Business Modeling' that really helped because it's basically how a business works"*, how decisions impact a firm strategically *"I remember business intelligence it wasn't all about the practical but we had to reflect what are the key factors that the company must consider to be strategic and competitive"*, how complicated a business is *"During our ERP course, learning business processes, how sales works and how marketing works or even production works"*, and how all parts of a business fit together *"business intelligence is based on decision making then all of the data, like the sales and everything, we can link that to SAP."* Others remarked on the business modeling class and the ERP configuration class, as being useful for playing the game. Again, these remarks make sense since the business modeling class includes conceptual modeling paradigms and the ERP configuration class works with business process improvement. These classes prepared the student to change the simulation game from simply a play-thing to understanding how a serious business works. Remarkably, there was a clear division for most of the students in their game playing before and after their coursework. For the large number that cited information in their classes as helpful in the game, all but one student improved in the game outcome. Qualitatively, in the second game play, they were making good use of the information from the MIS and able to make sense of the business scenario. They were clearly more aware of how business decisions made would affect the outcome of

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the game and felt that information was vital to the success or failure, again understanding what needed to be done to complete the game – that is in the understand phase of the learning cycle.

4. By using their background knowledge of basic business understanding, these courses which utilize ERP systems are enabling the students to articulate their superior comprehension of business processes and to apply that knowledge gained in a decision-making situation, in the Act phase of the learning cycle, as illustrated by this representative statements: Past research never detailed specific classes that were critical to learning.

From a broader perspective understanding the business processes, I can actually say that I would see that the entire organization had different sections, departments... I had people in the sales department, R&D, IT. Each of them have their own various tasks and objective so they have a series of business processes they actually do... Understanding what their business processes were I could actually know where to get this if I go this specific information related to sales then obviously I need to ask this sales person and then it helped me, giving me an understanding.. of how the company actually functions to that I can effectively make my decisions."

5. Analysis revealing causal powers highlighted topics within the classes that were important to the students' learning experience. It was clear that some classes made a big impact on the student and they expressed common themes throughout all necessary structure objects in the SELECT mechanism. All topics from classes mentioned had a positive effect on the mechanism for learning. For example, a student said *"The first time I thought this is just a game and I played it while the second time when I was playing I got some idea from the module I learnt and then applied"*. On the other hand, students who relied solely on their work experience to help them play the business simulation game inhibited the SELECT mechanism. Their industrial experience was working as a confirmation bias resulting in ignoring classroom teaching. Hence, they looked towards their work exposure to play the game and then discuss business processes, as stated by one student *"To be honest, I didn't*

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take anything from my course or from my modules to help myself." Past research on this subject never delved as deeply into the subject to identify what might be a deterrent to learning. This discussion of class contents and its importance or lack thereof, completes the modified Kolbian experiential learning theory where the students are reflecting on how they played the game and its outcomes.

The modified Kolbian experiential learning theory is confirmed in its cycle of understanding, acting, and reflecting for students playing the business simulation game, in overall terms. However in light of this research, the theory lacks additional aspects which may be helpful in distinguishing differences between the two subject universities, such as influences, social pressures and anxiety which were highlighted in Chapter 2. Mughal and Zafar (2011) present an augmentation to the Kolbian experiential learning theory which may be applied to the modified theory used in this research. This is diagrammatically shown in the following figure:

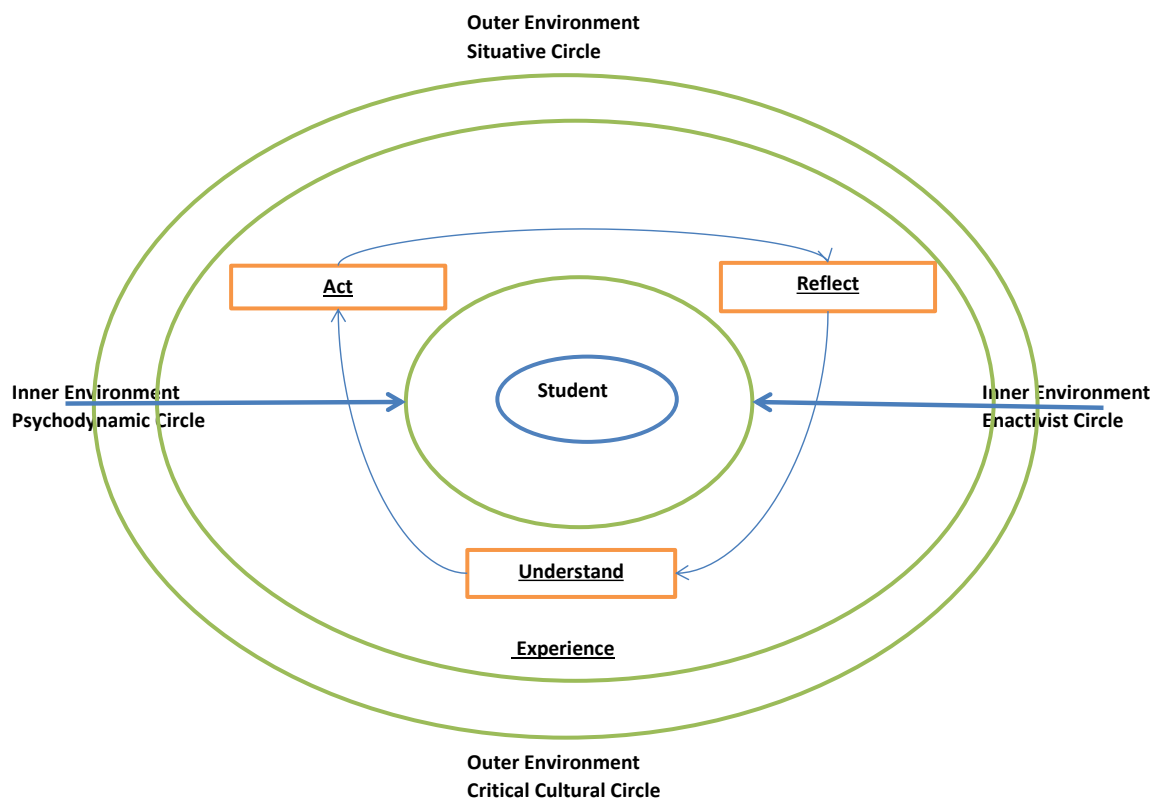


Figure 6-8 Augmented Modified Kolbian Experiential Learning Theory

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The additions either affect the inner environment, or the outer environment. The psychodynamic refers to the interplay between the conscious and the unconscious mind. For this category, self-confidence and tentativeness were identified in the in-depth interviews with the undergraduates at Delaware. Students who experienced ERP systems exhibited more tentativeness, yet seemed to improve more on the business simulation game. Some students in the group that did not learn with ERP were more confident in their ability to play the game. Surprisingly, this confident group of students did not all improve the second time they played; half of the group did poorly. The difference in tentativeness and confidence is thought to be attributed to the difference in GPA. The students (ERP) who were more tentative had lower GPAs on average compared to the confident students. Did this affect their capacity for learning? Most of the tentative students improved consistently with their game outcomes, whereas half of the confident group did not. It is thought that the psychodynamic subconscious confidence may pose a barrier to learning, since the student feels they already know it all, but the tentativeness is actually enhancing learning as the student gains experience in ERP.

The authors argue that Kolb ignores the environment's impact on learning, which is articulated in the situative circle. For some postgraduate students at Brunel, their past or current work environment had a significant impact on their capacity to learn. Some of the students interviewed used only their work experience to make business decisions during the game, showing that their environment affected their capacity for learning and its application in business decision making.

Culture also may have an impact on learning, as defined in the critical cultural circle where learning can be affected by cultural norms. The learning mechanisms did vary between the two cultures on the contingent aspects of work experience (UK) and market understanding and intuition (US). It is thought that these differences are attributed to maturity of the student, since the UK educational level is that of postgraduate. It may, however, also be attributed to a cultural difference especially in the aspect of market understanding. The US is a dominating consumer culture and that influence could very well cloud the student's learning capacity.

The final circle in the extended learning model is that of the enactivist circle which involves the merging of learning and the environment. In this research project, the environment of being in an

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undergraduate class or in a postgraduate curriculum is thought to have an effect on the level of learning occurring. Postgraduate students, interacting with mature peers with a variety of work experience, achieve a higher level of learning on Bloom's taxonomy not only from their coursework but also from this rich and diversified environment. Undergraduate students, being in classes with students of similar age groups lacking a wealth of experiences, are denied that rich learning experience and varied environment.

6.6 Educational Implications

There are implications for education that have arisen from this research. These implications have been juxtaposed over the augmented modified Kolbian experiential learning theory and are presented in Figure 6-9.

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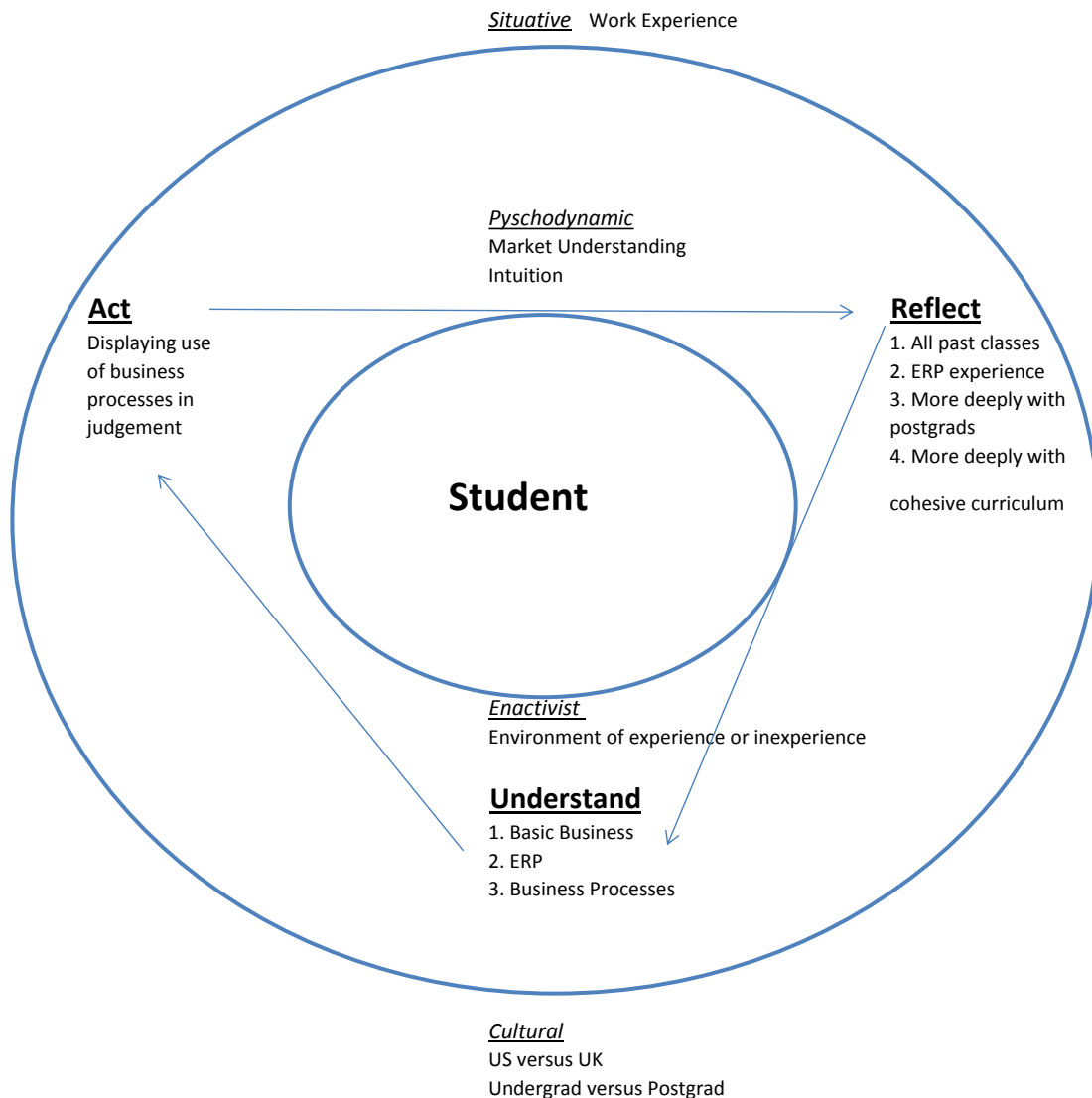


Figure 6-9 Implications Juxtaposed on Augmented Modified ELT

Firstly, beginning in the Understand phase of the augmented modified ELT, students need to have a basic understanding of business before attempting to learn business processes from experiencing ERP systems. This point was validated by the qualitative data analysis of the in-depth interviews after students played the business simulation game; basic business knowledge enables students to learn from ERP systems. This point makes sense: how can a student understand the complexities of business processes in ERP without understanding the basics of a business? The outcome of this conclusion for educators is to make sure that students understand those business basics before moving to complex software with business processes. The other part of that equation is that

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educators need to be clear in what those basics are. At the postgraduate level, students are entering with a vast array of different experiences (unlike undergraduates who are entering directly from high school). Some of those students could be lacking in basic business knowledge even if they have work experience. For example, one student mentioned during his in-depth interview that he was heavily influenced by his coursework when playing the game because he came from a very technical background with limited industrial experience. Another mentioned he relied on conversations with his brother who works with ERP systems. The implication for educators is clear: before embarking on a curriculum teaching business processes or using experiential ERP, students must know about basic business.

This research study confirms the original proposition that experiencing ERP aids in students' learning of business processes. By validating this proposition, the modified Kolbian experiential learning theory is also validated. The emphasis by organizations on business processes is compelling. Students from either the undergraduate level or the postgraduate level need to understand and make decisions based on business processes. ERP systems have been used for over 10 years to teach this important topic. Universities should continue to do so, confident in the result that learning with a live ERP system indeed facilitates business process learning. Continuing through the Act phase to the Reflect phase in the augmented modified ELT, for both universities, it was evident from the in-depth interviews that overwhelming majority of students relied on their classes to help them make business decisions. This is a gratifying result and one that should be emphasized to flaunt educational success.

The research results showed that learning at the different levels of education does appear to differ. For the undergraduates at Delaware, their discussion of ERP learning was more superficial than that of the postgraduates at Brunel. This group of undergraduates never specifically stated the usefulness of their ERP classes when making business decisions, but only alluded to their usefulness, whereas, in the area of classes with hands-on ERP, the postgraduates at Brunel were voluble. They freely discussed this experiential learning and its benefits when making business decisions. It is thought that the maturity and the experience not the culture that the postgraduates have are enabling them to synthesize the knowledge gained from the experience of ERP into a better business process perspective.

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In comparing undergraduate education and postgraduate education, the latter reaches a higher level in Bloom's taxonomy, reflecting the content of a postgraduate degree. In addition, the curriculum of the ERP classes at Delaware and Brunel differ. The Brunel curriculum is more cohesive, partnering a technical experience with a strong conceptual understanding. For Delaware, the curriculum is a portion of an information systems class. The educational recommendation is that a cohesive curriculum working towards a solid hands-on experience with an ERP package helps experiential learning more than simply a module of ERP embedded within a course. For the augmentation to the modified ELT, there are forces that can work for or against students' using their knowledge gained in classes to make business decisions. They exist at both the undergraduate level and at the postgraduate level, and they are different for the two. For the undergraduates, some students have a tendency to rely on their intuition to make business decisions. While it is commendable to have a "business sense", it is highly unlikely that inexperienced undergraduates can make business decisions based on their innate commonsense alone. In addition, some students appear to use what they know about today's popular market to make business decisions, i.e. the environmental impact. These students use their information gleaned from products and popular culture at times to the exclusion of other information provided. These two sources of information have a significant educational implication: any curriculum taught should encourage use of full information and not simply falling back on intuition or market knowledge. Educators should also ensure that any intuition or market knowledge used is accurate and not misunderstood. These are forces in the situative circle, being a lack of work experience; the psychodynamic circle, relying on intuition and market understanding; the enactivist circle, having experience or inexperience in the case of the undergraduates; and finally the cultural circle, being an undergraduate involves interacting with relatively inexperienced peers.

In a similar way, postgraduates can use their own work experience to the exclusion of knowledge gained in the classroom to make business decisions. A group of postgraduate students interviewed at Brunel relied solely on past work experiences when playing the business simulation game. They emphatically stated that they didn't use anything from their coursework. At times, work experience can appear to work against the students' knowledge gained in the classroom, and dominate their decision-making. Those who teach at the postgraduate level should be cognizant of the fact that some students may not apply classroom knowledge in their future employment and may wish to

alter their pedagogical approach to accommodate these learners. Those professors should encourage the marriage of extensive work experience with experiential learning at the postgraduate level to achieve the highest level on Bloom's taxonomy.

6.5 Summary

Students in five different classes, across two universities and two levels of study, played the business simulation game before and after their coursework to indicate their knowledge of business processes. The difference between the outcome of the game played before the coursework and that played after the course was calculated and used for statistical analysis. Using ANOVA as a statistical test of means, there wasn't any difference in the means of all five different classes. In addition, the classes from each school were grouped together and their means compared using a statistical t-test. Again, the results from the test indicated that the means of the two universities' groups were not different. However, when looking at the improvement of the game score from the beginning of the coursework to the end of the class, all the interviewed students who studied with experiential ERP increased their score over that learning time, except for two in the Brunel group. Of the interviewed students at both schools who did not study with ERP, half of that group did worse the second time they played the game, with one set of comparisons being statistically significant. These results indicate differences between students who experience ERP and those that do not. Under the critical realist view, the qualitative data must also be analyzed to create a model for learning. Empirical results alone are insufficient.

The qualitative data from each school was analyzed and the SELECT mechanism for learning business processes developed. That mechanism has been compared for the two schools. The necessary structure of the mechanism, with the objects of business knowledge leading into ERP learning and resulting in business process understanding is similar for both schools. Students must have an understanding of basic business before they can embark on learning the complex subject of business processes. ERP experienced in the curriculum aids in that learning. Experiential learning plays a larger role in the education of the postgraduates, and is included in the Brunel SELECT mechanism.

Contingently, the two schools had similarities and differences. In both Delaware and Brunel, classes contributed greatly to the comprehension of business processes. From the in-depth interviews, many statements were produced that supported that claim. At Delaware, some students relied on

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their understanding of current market conditions or simply their intuition to express their understanding of business processes. On the other hand, some Brunel students used their past work experience to the exclusion of other available information to show their business process understanding. These contingent aspects were influenced by certain properties to make the mechanism work or inhibit its working, hence encourage learning or discourage learning.

The takeaways for educators are as follows. First, in order to study the complex subject of business processes, all students must begin with a basic knowledge of business. Experiential ERP indeed aids in learning business processes, both at the undergraduate and postgraduate level, with the latter benefiting more deeply from the experience. Another tactic that encourages the success of experiential learning with ERP is a more cohesive curriculum. Refreshingly, courses taught in universities are making an impact on their students as evidenced by them using concepts taught in those classes to make business decisions. On the other hand, some students turn to other sources for decision-making help, such as intuition, market knowledge, and work experience. Those students should be encouraged to use all information available, including knowledge learned in classes, to make business decisions. Those teaching postgraduates should be particularly aware that their students may rely solely on their work experience and those teaching may wish to alter their teaching techniques to encourage integration of work experience, experiential learning, and conceptual understanding.

Chapter 7. Summary and Conclusions

People never learn anything by being told, they have to find out for themselves. Paulo Coelho

7.1 Summary

Enterprise Resource Planning Systems (ERP) are used in higher education as a vehicle for teaching business processes. ERP systems are large software programs which coordinate and control many aspects of a company and often form the backbone of most large organization's information systems. They integrate all functional areas in an organization and promote a business process perspective. Students who use an ERP system experience what it's like to use 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. ERP systems have been used at universities for at least 10 years, but little research exists that assesses the effectiveness of using ERP to further comprehension of business processes. Using ERP in the classroom as a method of teaching is an affirmation of the Kolbian Experiential Learning Theory, which states that experiencing is an essential part of learning. In that light, this thesis has explored the proposition that using an ERP system will aid in business process understanding. Measuring the value of having students experience ERP systems to teach the concepts of business processes is an important contribution for higher education today.

Assessing knowledge gained after an educational treatment is challenging. Traditional examinations such as multiple choice tests often examine at lower levels of thinking skills but assessment should match the appropriate level of thinking skills. ERP and business processes are more difficult and abstract topics, therefore, assessing educational retention should reside at a higher level of thinking skills. It is argued that using a business simulation game to assess students' knowledge will reflect true understanding of business processes because the game will mimic a real business work environment. The level of realism, or fidelity, of a business simulation game should be an accurate estimate of comprehension of business processes.

The past research results on the effects of teaching ERP in higher education have been mixed and inconclusive. Those attempting to show a causal relationship between ERP teaching and better

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business process knowledge conducted positivist-type studies or self-efficacy questionnaires. Since none of these were definitive in their results, it was time to rethink the approach to understanding how this experiential pedagogy plays into students' learning. It was not sufficient to do another causal study, even if it seemed to be an improvement on the past studies. It was important to move beyond the positivist/quantitative-only study where differing experiments can lead to differing results (Newton, Deetz et al. 2011). To truly understand any knowledge gains, a study should move beyond quantitative work, critically examine the initial proposition, and collect a variety of data to create a better theory.

In order to not only measure students' learning, but also to understand the mechanisms underlying that learning, a critical realist philosophical approach to this research was taken. Using an initial proposition that teaching ERP experientially in a higher education information systems curriculum results in better business process learning, an improved theory was created. Retroduction was employed in the qualitative analysis to identify the causal powers and liabilities that underlie this educational process.

Through the lens of critical realism, it was argued that using multiple methods in research results in a more complete study. The research proposition was examined and refined by (1) a quantitative measure of students' learning with a business simulation game and (2) a qualitative measure of learning with a group feedback analysis of focus groups and interviews. Data analysis consisted of quantitatively t-tests and ANOVA, and qualitatively, content analysis with the constant comparative method. Students were pretested before any educational treatment by playing the business simulation game and recording their results. The experiential educational treatment with ERP took place in the US at the undergraduate level for a one-semester class, and in the UK at the Masters' level for a year's curriculum. Control groups of classes without ERP were tested and analyzed alongside the classes with ERP. After the educational treatment, the simulation game was played again. The results of the game were analyzed with the software, Minitab. After the statistical analysis, focus groups were formed and interviews conducted to discuss how the students played the simulation game with the intention that, by playing the simulation game prior to the focus group interviews, students would be readily able to articulate their thought processes. The qualitative data from the focus group interviews was analyzed with the help of the software NVivo.

7.1.1 Data Analysis

Data collected on Net Profit from the simulation game results at University of Delaware has been examined. Three different classes, one using experiential ERP and two not experiencing ERP were analyzed, using a critical realist view both quantitatively and qualitatively. Quantitatively, there were no statistical differences in the average change in net profit from one game play to another for all 3 classes: The means of the net profit change were not significantly difference. Interestingly, in those students who were interviewed, the entire class with ERP improved their game results the second time they played in contrast to the classes without ERP which evenly either increased or decreased their scores, with comparisons between 2 classes being statistically significant. This is a clue to differences in the data, which can only be answered by looking at the qualitative results, following a critical realist view.

Preliminary focus group and individual brief interviews were conducted, recorded, and analyzed. Results from this analysis were used to identify students for the in-depth interviews which followed. Those in-depth interviews were analyzed by coding the transcribed data with the objects previously discovered in the literature, and with new objects found in the actual data. From that coding, the undergraduate SELECT model for learning was developed. The SELECT model, an acronym for Source of Experiential Learning Educational Causal Theory, postulates that students begin with business knowledge in order to learn about business processes. Experiencing ERP systems can aid in that learning of business processes. When this learning occurs, contingent aspects may influence its success. Certain classes taken by students can affect learning positively. Students rely on their understanding of the market and at times, rely solely on intuition to make decisions which could affect learning positively or negatively.

Important properties of the categorical objects were identified as being either positively or negatively affected by the contingent aspects. These are considered causal powers and liabilities that work for or against learning. Under business knowledge, choice of the product was negatively influenced at times by market understanding since students disregarded important information in choosing a project to sell but simply used today's current market popularity to make that decision. Financial, marketing, and manufacturing were all influenced positively by classes taken during the semester in that they helped students make good business decisions. For those students who learned with ERP systems, there were positive effects while playing the business simulation game

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from topics such as the efficiency of business processes, having a single view of information in ERP, and integration between departments. From the university classes, students articulated the ideas of connections between various organizational tasks to enable them to play the game successfully.

At Brunel, as in Delaware, the first part of the research required the students to play a business simulation game, a proxy for business process understanding, before and after coursework. Students in two tracks were compared statistically, and those who experienced ERP systems performed no better on average on the game. However, the majority of all students improved the second time they played the game. This result indicates some sort of change in decision-making ability from the beginning of the coursework to the end of that course. To comprehend that change and create a model for learning, the qualitative data was explored.

The second part of the research involved analyzing email interviews and subsequently in-depth interviews from those game-playing students. The SELECT mechanism for learning business processes was developed and it showed that the source of the experiential learning was very important. For many students, experiential learning in certain classes such as hands-on work with ERP in business intelligence had a big impact on their understanding business processes, positively correlating with the Kolbian experiential learning theory. For others with extensive work experience, only their past knowledge through the real-world impacted their understanding of business processes to the exclusion of classroom-gained information.

Causal powers and liabilities were identified in the in-depth interviews as triggers to the SELECT learning mechanism. Business process learning was enhanced by coursework with experiential learning and ERP systems, affirming the Kolbian experiential learning theory. On the other hand, business process knowledge absorption was inhibited by those with extensive work experience. That group of students relied on past on-the-job knowledge to make business decisions, rather than call on their university-gained knowledge.

Data from both schools was then analyzed and compared. Students in five different classes, across two universities and two levels of study, played the business simulation game before and after their coursework to indicate their knowledge of business processes. The difference between the outcome of the game played before the coursework and that played after the course was calculated and used for statistical analysis. Using ANOVA as a statistical test of means, there was no difference in the

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means of all five different classes. In addition, the classes from each school were grouped together and their means compared using a t-test. Again, the results from the test indicated that the means of the two universities' groups were not different. However, when looking at the improvement of the game score from the beginning of the coursework to the end of the class for those students participating in the interviews, all students who studied with experiential ERP increased their score over that learning time, except for one from Brunel. Of the students at both schools who did not study with ERP, the results were evenly spread with half of that group doing worse the second time they played the game. These results indicate differences between students who experience ERP and those that do not. Any correlation or lack of correlation does not imply causation, however. The link between correlation and causation needs to be investigated further under the view of critical realism; empirical results alone are insufficient

The qualitative data from each school was analyzed and the SELECT mechanism for learning business processes developed. That mechanism has been compared for the two schools. The necessary structure of the mechanism, with the objects of business knowledge leading into ERP learning and resulting in business process understanding is similar for both schools. Students must have an understanding of basic business before they can embark on learning the complex subject of business processes. ERP experienced in the curriculum aids in that learning. Experiential learning plays a larger role in the education of the postgraduates, and is included in the Brunel SELECT mechanism.

Contingently, the two schools had similarities and differences. In both Delaware and Brunel, classes contributed greatly to the comprehension of business processes as evidenced by the in-depth interviews where many statements were produced that supported that claim. At Delaware, some students relied on their understanding of current market conditions or simply their intuition to express their understanding of business processes. On the other hand, some Brunel students used their past work experience to the exclusion of other available information to show their business process understanding. These contingent aspects were influenced by certain properties to make the mechanism work or inhibit its working, hence encourage learning or discourage learning.

7.2 Research Conclusions

From the study of the in-depth interviews from both universities, it is apparent that students must first understand general business knowledge before endeavoring to learn business processes. All

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students interviewed demonstrated their knowledge of general business topics when discussing their strategies in playing the business simulation game. This is an important educational implication. University professors must be aware of the students' prior knowledge or lack of knowledge before embarking on complex business process pedagogy. In an undergraduate curriculum, this may be a relatively easy task with students required to take prerequisite classes before moving to more complex subjects. However, in a postgraduate curriculum, students are coming into the program with varied degrees and backgrounds. Educators must be cognizant of that varied knowledge and ensure a proper foundation of business understanding before teaching business processes. These recommendations make sense, but were never verbalized from past research.

This research study indeed confirmed the proposition that experiencing ERP helps students learn business processes, validating the Kolbian experiential learning theory. Students who learned with ERP were able to articulate business process concepts when discussing their decision-making during the business simulation game. Past research attempting to prove this linkage has been inconclusive. It also appears that the postgraduate experience of ERP makes a greater impression upon the students than that of the undergraduate ERP experience. It is thought that the more mature students in the postgraduate curriculum are better able to synthesize the knowledge gained from using ERP and apply that to decision making in business. In addition, a more cohesive curriculum integrating experiential ERP into its classes makes a greater impression upon the students than that of a class containing a portion on ERP. Past research has never made comparisons such as these and never tested students after a prolonged educational experience. For future educators using ERP to teach business processes, a good suggestion would be to teach a class with a unified approach to ERP than simply a single module of ERP to facilitate extensive learning.

It was evident from the in-depth interviews that experiencing ERP systems either in the undergraduate classes or at the postgraduate level contributed to a student's understanding of business processes, within the confines of this study. It also appeared that an alternative route to learning about business processes is through the subject of Accounting. A number of Delaware undergraduates were able to demonstrate their knowledge of business processes while discussing the subjects of Accounting and Finance. It is thought that the embedded cycles within Accounting, such as order to cash, enable students to learn business processes. This surprising result adds to the

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list of educational implications for teaching business processes: studying the subject of Accounting is an alternative method for learning business processes.

Past research examining a link between experiential ERP and learning business processes has not addressed how business classes affect a student's decision making. From the critical realist view, it was seen from this thesis that students indeed use much of what they have learned in business classes to make business decisions. Those teaching in higher education can be assured that their pedagogical endeavors are making a tremendous impact on their students.

Surprisingly, some students discussed objects that diminished their learning business processes. For the undergraduates at University of Delaware, many students relied on their understanding of today's current market to make their business decisions. Showing their naïve approach and their lack of a deep understanding, they ignored certain parameters in the business simulation game and simply thought about the popularity of certain aspects of today's market. This should serve as a reminder for college professors. Students may ignore pieces of information and in a naïve way, fall back on just what they know to make business decisions. Naive assumptions should not be used solely for decision making. Educators must reinforce the idea of using all types of information before making decisions.

Similarly, some undergraduate students at the University of Delaware based their decisions on their intuition, commonly thought of as "gut feel". Again, while having business acumen is a positive trait, an inexperienced student should not rely only on their intuition to make decisions. Those who teach at universities should encourage students to make sure to use complete information available before making decisions, and not rely solely on their commonsense.

At Brunel University, the postgraduate students interviewed didn't frequently speak of the market understanding or of using their intuition. What some did discuss, though, was using their work experience to make their business decisions. Again, it can be good to incorporate past business experience in decision-making, but this should not be to the exclusion of all other important information. Those who educate at the postgraduate level should be cognizant of the fact that students enter the program with experience that might dominate their decision making. Curriculum may need to be adjusted for that group of students to integrate their work experience into experiential learning to enable them to receive a worthwhile education.

7.3 Meeting Objectives of this Thesis

The objective of this thesis was to approve or disprove the proposition that using ERP systems experientially aids in business process comprehension. To do so, different classes either using ERP or not using ERP were recruited to play a business simulation game as a proxy for business process understanding. Two universities were used as subjects: University of Delaware at the undergraduate level and Brunel University at the postgraduate level. The objectives of the thesis were met and some unanticipated results occurred.

The objectives of this research and how they were met are:

1. Review the literature on assessing the value of experiencing ERP systems to learn business processes in order to benchmark the state-of-the-art: Accomplished through a rigorous literature review which uncovered inconclusive research relating experiencing ERP systems to learning business processes.
2. Analyze the quantitative data from the change in simulation game outcome to see if there are differences between classes that experienced ERP and classes that did not experience ERP: The average of the change in game score from the first game play to the second was similar for all types of students, those who experienced ERP and those who did not, from undergraduates and postgraduates. However, all interviewed students who experienced ERP improved the second time they played the game, bar one.
3. Code and analyze the qualitative data to understand why the students played the game as they did and, along with the quantitative data, develop a mechanism for learning: The in-depth interview data was rigorously coded for both universities and separate mechanisms for learning were developed. Triggers and suppressions to that learning mechanism were also identified for both schools.
4. Draw out the educational implications for theory and practice: Educational implications were found and suggested. The Kolbian experiential learning theory was validated by the results.

In order to achieve those objectives, the research accomplished the following:

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1. Find a commercially available business simulation game to measure students' understanding of business processes: Pixelearning was able to provide an online business simulation game free of charge for this research.
2. Recruit students from information systems classes that do and do not use ERP systems to play a business simulation game before and after their classes in order to measure business process learning: Students from three different undergraduate classes at University of Delaware were used as subjects. One of those classes experienced ERP and the other two did not. Students from two separate tracks in a postgraduate program at Brunel University were also used as subjects. One track includes work with SAP (the ERP system) and the other track does not use the ERP software. All of these students played the business simulation game before and after their course experience.
3. Conduct focus groups and brief email interviews to identify students ideally suited for in-depth interviews: 53 undergraduate students from University of Delaware participated in the focus groups or brief email interviews, whereas 11 of the Brunel postgraduates answered the brief email interviews. The data was used to identify further recruits for the in-depth interviews.
4. Conduct in-depth interviews with a variety of students to understand why they played the game as they did and to discuss business processes: 19 undergraduates from Delaware and 15 postgraduates from Brunel participated in the in-depth interviews (4 additional Brunel students were recruited to participate).

7.4 Research Limitations

As with any research, there exist some limitations which are difficult to control for and in some ways unavoidable. At University of Delaware, it was not possible to randomize the subjects of the study. The three different classes were taught by different faculty, students in one class had a higher average GPA, and the curriculum in the three classes was slightly different. For the quantitative data, all classes except for the Accounting class had 100% participation. Although specific students were targeted, the in-depth interviews were conducted with students willing to discuss the business simulation game. At Brunel, the amount of data collected was much less than initially anticipated, and most of the data came from volunteers in the two information systems tracks. In addition, the

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Brunel postgraduates readily discussed the business intelligence class. That was the last class they took in their curriculum, so they may have been remembering that class clearly. Mark Lycett was the professor for the class and he was emailing students to participate in the in-depth interviews, so again the students may have thought of the business intelligence class more readily since it was associated with Professor Lycett.

In this thesis, it was argued that a business simulation game is a superior measurement of business process knowledge than a simple exam in that it would measure tangential capability such as business decision making which would indicate a greater knowledge of business processes. The simulation game was a good measurement of business process knowledge for the group of students who were interviewed, but it lacked a significant outcome for all the students as a whole. The data collected from the business simulation game was the Net Profit recorded at the end of the game. It was thought that Net Profit would be a good arbiter for improvement since it encompassed not only revenue but also costs. However, other results might have been a better judge of students' business process understanding. Examining the sales revenue directly or analyzing the specific costs incurred may have been better indicators. Digging further into the aspects of the game, the selection of product sold may have presented clues for understanding learning.

Although this research was conducted at varying levels of study and in two separate countries, both of those universities were native English-speaking. Therefore the results of this research may be limited to only those countries where English is spoken. It may be the case that, for example, Asian students learn in a different way to those of the United States and England.

The philosophical approach to this research is based on that of critical realism. Critical realism, although gaining popularity in the field of information systems research, is relatively new. Although there has been a substantial amount written on the philosophy, there are few guidelines as to how to conduct a critical realist study. This lack of guidance allowed the researcher latitude in developing a methodology for analyzing the data.

7.5 Recommendations for Future Research

Future research studies could improve upon that of this thesis. Those recommendations are:

1. A suggestion for future research would be, in addition to the post-curriculum interviews, to

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interview students before they played the business simulation game and before they had any educational experience. Each set of interviews could be coded and the results compared.

2. Acting on this research outcome of the necessity of general business knowledge before learning business processes, students could be pretested on their general business knowledge before the coursework commenced. That result combined with the quantitative simulation game results and the qualitative interview analysis could contribute to refining the learning mechanism.
3. Experiential Enterprise Resource Planning pedagogy differs in delivery and exercises at different universities. Repeating the research at additional schools or at the postgraduate level in the United States and at the undergraduate level in the United Kingdom may further validate the SELECT learning mechanism.
4. The mechanism by which students learn in non-English speaking countries, such as Asian countries, could be different to the learning mechanisms uncovered in this research. An expanded study should include some non-English speaking countries to fully understand experiential ERP's impact on business process retention.
5. Different measurements of success from the business simulation game could be tracked in future research. Not only numerical outcomes, such as revenue and specific costs, but non-numeric data such as product choice could be analyzed to see if patterns emerge for those students who experienced ERP.
6. In order to further causal understanding, additional aids could be explored, for example, causal loop modeling (Spector, Christensen et al. 2001).
7. As more and more researchers use critical realism as a philosophical foundation for their research, methodologies will become more established and tested. Future research can take advantage of what the pioneers in this social science paradigm have accomplished and improve upon their efforts.

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Appendix A: Game Directions

(Pre-test)

Simulation Game Instructions

STEP 1

- Go to www.pixelearning.com
- On the left hand side of the screen, under “Off the Shelf Products”, Click on “Game Login”
- Use the following Access Code and start a new game:
ba4-410f-9bbb
- Use your number as the company name

STEP 2

Stage 1 – Introduction – learn the user interface – Follow the verbal directions to learn how to navigate the screen. When you have completed this investigation, go to the plasma screen (you may have to choose Stage 1) and click the Start Stage 2 button in the lower right hand corner, to begin playing, as shown below.



Stage 2 – Carry out the market research – review the market research (in the folders) on each product and select the one you want to sell. There is no one correct choice.

Stage 3 – Select your sales strategy – You can choose a sales agent, a distributor, or sell your product directly. Again, there is no one correct choice. Investigate each option before choosing your strategy (information in the folders).

Stage 4 – Prepare to trade – Choose your selling price, set your sales and marketing budget, and choose your product quality. To do so, use the laptop, click on the MIS icon, and then the Marketing drop down menu. Set your product price, your sales and marketing budget, and your product quality.

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Stage 5 – Complete 3 years of trading – You produce and sell your product here. If you access the MIS screen, you'll be able to see the Marketing, Financials (Sales Charts, Cash Flow, Financial Statement – after 1 month of trading), and Production. You can adjust production capacity by adding or subtracting production lines and adding or eliminating overtime and you can change your marketing strategy (product price, sales and marketing budget, and product quality) at any time. Access emails from your PDA and advice from your video phone. Adjust the speed of the game at the bottom of the screen.

STEP 3

When the game is finished, please print the Business Record of Achievement, sign this sheet and return both to your professor.

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This research is being conducted by Ellen Monk, a part-time PhD student at Brunel University and an Instructor of Information Systems at the University of Delaware

- This research is attempting to understand how students learn in an Information Systems curriculum. Since the researcher has been teaching in the area for over 20 years, she is interested in measuring learning outcomes.
- You will be asked to play a computer business simulation game at the beginning of the semester and at the end of the semester during class time. Each time you play the game, it should take 30-45 minutes.
- If you choose not to participate in the computer simulation game, an alternative assignment will be provided.
- You will be also asked to participate in a focus group interview at the end of the semester. This will be conducted outside of class time and should take less than 30 minutes.
- This participation is not compulsory and you may withdraw at any time without consequence. No compensation will be given for your participation. If you do participate in both simulation game exercises and in the focus group discussions, the total time dedicated is 1 ½-2 hours. The total number of participants in this study is approximately 305.
- All your personal details will be kept anonymous.
- Please direct any questions concerning this research to Ellen Monk, 302-831-1794, monke@udel.edu or to Chair, Institutional Review Board, University of Delaware, 302-831-2137, as the contact for questions or concerns regarding the rights of individuals who agree to participate in research.

CONSENT FORM

Please tick the appropriate box

	YES	NO	
Have you read description of the research listed above?	<input type="checkbox"/>	<input type="checkbox"/>	
Have you had an opportunity to ask questions and discuss this study?	<input type="checkbox"/>	<input type="checkbox"/>	
Do you understand that you will not be referred to by name in any report concerning the study?	<input type="checkbox"/>	<input type="checkbox"/>	
Do you understand that you are free to withdraw from the study:			
• at any time	<input type="checkbox"/>	<input type="checkbox"/>	
• Without having to give a reason for withdrawing?	<input type="checkbox"/>	<input type="checkbox"/>	
(Where relevant) I agree to my interview being recorded.	<input type="checkbox"/>	<input type="checkbox"/>	
(Where relevant) I agree to the use of non-attributable direct quotes when the study is written up or published.	<input type="checkbox"/>	<input type="checkbox"/>	
Do you agree to take part in this study?	<input type="checkbox"/>	<input type="checkbox"/>	

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Signature of Research Participant:

Name in capitals:

Date:

(Post-test)

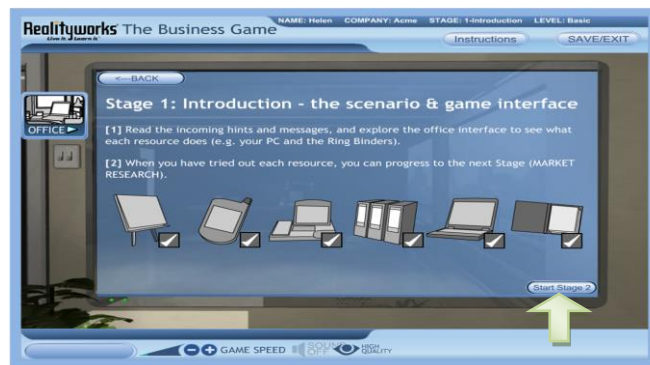
Simulation Game Instructions

STEP 1

- **USE INTERNET EXPLORER.** Go to www.pixelearning.com
- On the left hand side of the screen, under “Off the Shelf Products”, Click on “Game Login”
- Use the following Access Code and start a new game:
- Ba4-410f-9bbb
- Use your number as the entrepreneur and company name

STEP 2

Stage 1 – Introduction – learn the user interface – Follow the verbal directions to learn how to navigate the screen. When you have completed this investigation, go to the plasma screen (you may have to choose Stage 1) and click the Start Stage 2 button in the lower right hand corner, to begin playing, as shown below.



Measuring the Effectiveness of Enterprise Resource Planning Education on Business Process Comprehension

Stage 2 – Carry out the market research – review the market research (in the folders) on each product and select the one you want to sell. There is no one correct choice.

Stage 3 – Select your sales strategy – You can choose a sales agent, a distributor, or sell your product directly. Again, there is no one correct choice. Investigate each option before choosing your strategy (information in the folders).

Stage 4 – Prepare to trade – Choose your selling price, set your sales and marketing budget, and choose your product quality. To do so, use the laptop, click on the MIS icon, and then the Marketing drop down menu. Set your product price, your sales and marketing budget, and your product quality.

Stage 5 – Complete 3 years of trading – You produce and sell your product here. If you access the MIS screen, you'll be able to see the Marketing, Financials (Sales Charts, Cash Flow, Financial Statement – after 1 month of trading), and Production. You can adjust production capacity by adding or subtracting production lines and adding or eliminating overtime and you can change your marketing strategy (product price, sales and marketing budget, and product quality) at any time. Access emails from your PDA and advice from your video phone. Adjust the speed of the game at the bottom of the screen.

STEP 3

When the game is finished, please print the Business Record of Achievement, fill out the back of this sheet and return to your professor.

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Number: «Number»

Note: Do not put your name on this sheet. Your pre-printed number is listed. All information is gathered only by this assigned number.

Please answer the following questions:

1. What is your GPA (estimate):

2. Have you ever been employed by a company?
 - a. Yes
 - b. No

3. If so, how long did you work there?
 - a. Less than 1 year
 - b. 1-2 years
 - c. 3-5 years
 - d. More than 5 years

4. Briefly describe your job(s):

Note: Brunel Questions did not include GPA.

Appendix B: Protocol Amendment Form (IRB)

HUMAN SUBJECTS PROTOCOL AMENDMENT

University of Delaware

Protocol title: Using a Computer Business Simulation to Measure Effectiveness of Enterprise
Resource Planning Education on Business Process
Comprehension

Principal Investigator: **Ellen F Monk**

Advisor (if student): Mark Lycett (Brunel University, West London, England)

Other investigators:

Investigator Assurance:

By submitting this protocol, I acknowledge that this project will be conducted in strict accordance with the procedures described. I will not make any modifications to this protocol without prior approval by the IRB. Should any unanticipated problems involving risk to subjects, including breaches of guaranteed confidentiality occur during this project, I will report such events to the Chair, Institutional Review Board immediately.

PROPOSED AMENDMENT Please provide a brief description in LAY language (understandable to an 8th grade student) of the purpose of the proposed amendment and the rationale behind the change(s).

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From the original data collection, I have developed a model for how using ERP systems in the classroom affects students' learning of business processes. I would like to further refine and test this model by doing some in-depth interviews with selected individual students.

1. New Project Staff

Please list any additional personnel, including students, who will be working with human subjects on this protocol who are not on original protocol (insert additional rows as needed):

NAME	ROLE	HS TRAINING COMPLETE?

2. PROCEDURES

Describe **all changes** to procedures involving human subjects for this amendment.

A selected group of students (12-20) will be called back for a further discussion of how they played the business simulation game. The interview should take approximately 15 minutes.

The students will be contacted via Email to arrange for an interview time and date. The Email text will state the following:

Thank you for your valuable participation in playing the business simulation game and answering questions concerning the game last semester. I appreciate your help with my research. I would like to spend an additional 15 minutes discussing the business simulation game with you. In appreciation, I plan to offer you a \$5 gift card to a local coffee shop.

Please indicate if you are willing to participate one more time, and if so, let me know when you are available so we can schedule a meeting time.

Thank you once again and Best Regards,

3. STUDY POPULATION AND RECRUITMENT

Describe **any additional** subjects who will be invited to participate. Include age, gender and other pertinent information.

Same subject pool.

Describe what exclusionary criteria, if any will be applied.

The criteria used for selecting the students to participate in the in-depth interviews are those students who exhibited the following in the original focus group interviews:

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- a. User interface problems
- b. Used product life cycle and other information from classes
- c. Complained about the timing of the game
- d. Focused on lots of different information
- e. Expressed interest in helping research further
- f. Voluble
- g. Drew parallels between game and real life
- h. Wasn't entertained by the game or was bored

Describe what (if any) conditions will result in PI termination of subject participation.

None

4. RISKS AND BENEFITS

Describe **any new risks** to participants resulting from the procedures requested in this amendment

(risks listed here should be included in the consent document).
If risk is more than minimal, please justify.

No risks.

What steps will be taken to minimize risks?

Describe any direct benefits to participants.

None.

Describe any future benefits to this class of participants.

None.

5. COMPENSATION

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Will participants **receive additional compensation** for participation due to this amendment?

Yes.

If so, please include details.

A \$5 gift card to a local coffee shop will be offered as appreciation for their further time.

6. DATA

Are there **any changes to data** management as a result of this amendment?

No

7. CONFIDENTIALITY

Will participants be audiotaped, photographed or videotaped as part of the procedures requested by this amendment?

Audiotaped.

How will subject identity be protected?

The subject will simply be identified by their assigned number which was initially randomly allocated.

Is there a Certificate of Confidentiality in place for this project? (If so, please provide a copy).

No

8. CONSENT and ASSENT

____ Consent form revisions are required and are attached for review.

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Additionally, child assent forms will be changed and are attached.

No consent form revisions are required.

Consent forms will not be used (Justify request for waiver).

9. REVISED STUDY MATERIALS

Please list all supporting materials uploaded to IRBNet in support of this application. **Include one tracked-changed/highlighted copy and one clean copy of each revised document.**

Appendix C: Personal Motivation

My motivation for this research and thesis comes from my own personal experience. I have been teaching information systems for 23 years at the University of Delaware in the USA. All of my students are traditional American college students, beginning their university education immediately after high school without any gap years or work experience. Over the years, I have noticed a lack of general business comprehension. Students, although studying the subjects in business, really didn't understand how businesses operated. Moreover, students did not understand that many businesses were terribly dysfunctional when it comes to integrated information systems.

When I began teaching the concepts of enterprise resource planning systems about 10 years ago, I witnessed a change in the students' comprehension. They seemed to be more interested in these systems because I felt that they actually began to understand how a business operates. My hope is that this thesis can prove that students truly do learn more about business through ERP systems. If this is proven then perhaps more universities will take up the challenge to teach these complex systems.

It is very challenging teaching this complex software. Many universities shy away from integrating ERP into their curriculum because the software is inherently intricate. Because the nature of the software is so rich with data and information, it has to be very complex. Not even the highest paid consultant understands all modules to an ERP system. So one can imagine why a typical university professor, with research duties and a teaching load, would be loath to teach this commercial software. Understanding the system is challenging, and teaching it can be even more challenging. To top off the challenges, using the actual software in the classroom can be difficult at best.

When I began teaching these systems, I tried to make it understandable at the students' level, by generalizing the objectives of ERP: single database, integrated system, with management reporting. From that objective, I was able to see students' beginning to understand how a business functioned. By stressing the business process and showing them the order to cash cycle, they began to comprehend how a business operated. They began to see how all their discrete subjects fit together to form an organization to serve a customer, or the public, or whatever their market is. From a teacher's perspective, the students began to "get it", and that was exciting.