INTEGRATING THE SAP SOFTWARE INTO THE MANUFACTURING ENGINEERING CURRICULUM

A Thesis

Submitted to the Faculty

of

Purdue University

by

Lin Qian

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science

May 2013

Purdue University

West Lafayette, Indiana

Graduate School ETD Form 9
(Revised 12/07)

PURDUE UNIVERSITY
GRADUATE SCHOOL
Thesis/Dissertation Acceptance

This is to certify that the thesis/dissertation prepared

By Lin Qian

Entitled
Integrating the SAP Software into the Manufacturing Engineering Curriculum

For the degree of Master of Science

Is approved by the final examining committee:

Dr. Edie Schmidt
Chair

Dr. Henry Kraebber

Dr. Regena Scott

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Approved by Major Professor(s): Dr. Edie Schmidt

Approved by: Dr. Katheryne Newton 04/25/2013
Head of the Graduate Program Date

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ABSTRACT

Qian, Lin, M.S., Purdue University, May 2013. Integrating the SAP Software into the Manufacturing Engineering Curriculum. Major Professor: Dr. Edie Schmidt.

The concept of Enterprise Resource Planning (ERP) was developed to integrate data efficiently and eliminate redundancy within organizations. Worldwide industries rely on ERP systems to keep a competitive advantage in world market place. Besides, cross-functional knowledge is required in industry. It is critical that schools integrate ERP concepts and methods in to academic curricula for Technology and Engineering School.

This thesis examined the effectiveness of a simulation game as a method for teaching for ERP systems in Technology and Engineering. The quasi-experimental design was used in this study to determine if the SAP simulation game had an impact on students' understanding of the ERP related concepts.

Technology students used a business simulation game that featured SAP-ERP transactions and reports to learn about business systems. Student leaning of business systems was tested before and after playing the simulation game. Student knowledge of specific terminology was higher following the simulation game.

CHAPTER 1. INTRODUCTION

This chapter covers the background information associated with the study, the significance of the study, and the research questions. Also, this chapter provides assumptions, limitations, and delimitations, as well as definitions of key terms and an overview of the study.

1.1 Background

In the early days of systematic computing, large-scale software systems were designed for internal function within organizations. After the 1970's, a majority of business system programs were developed in the United States. By the middle 1980's, with the rapid development of the PC, customized applications began to lose market share. Companies began to use packaged applications for support functions within their organizations (Kumar & Hillegersberg, 2000). The concept of Enterprise Resource Planning (ERP) was developed under this background. A goal of ERP is to integrate data efficiently and eliminate redundancy. The needs of data efficiency and the rapid development of PC and Internet, the use of the ERP concept grew rapidly. Even after the rapid growth of ERP methodology, industries all over the world have continued to rely on

ERP systems to keep the competitive advantage in world market place.

It is important that schools stay ahead of advances in enterprise systems and strive to integrate ERP concepts and methods into curricula. This objective is relatively a difficult one to achieve because generally Information Technology solutions tend to keep ahead of academia. Because the frequency of changes in the functionality and utility within the system, it is often difficult to stay ahead of these changes.

The implementation of the ERP systems curricula over the recent ten years in universities worldwide has been full of difficulties. It is clear that universities all over the world are in different stages of the ERP systems education deployment (Hawking, McCarthy, & Stein, 2004).

The traditional view of technology training concentrates on skill building, often centered on the procedural task operation of applications. However, the education of the ERP system needs to be cross-functional. Under the traditional view of technology training, it is difficult to provide the cross-functional knowledge within short terms (Sein et al., 1999).

Understanding the concepts of cross-functional business processes is a key requirement today in process-centric organization. In general, it is difficult to teach these concepts to students using traditional teaching and learning methods (Seethamraju, 2011). Furthermore, most of the ERP system curricula has been developed by business schools, which is more focused on the management and the business aspects. However, industrial

companies have started to implement ERP systems. It is critical to implement engineering and manufacturing aspects of the ERP system in curricula.

The ERP business simulation game helps in understanding business processes and enterprise integration for students. This research focuses on practical knowledge that the students gain from the course.

1.2 Problem Statement

It is difficult to teach the ERP system using traditional teaching and learning methods. In traditional approach for teaching ERP, students have almost no chance to operate the ERP system by themselves. They lean ERP system from books, presentations, and from network resource. However, ERP systems are very complicated. Even the students from business schools might struggle learning a company's ERP system when they step into industry.

Most of the ERP curricula were developed to emphasize sales, distribution, accounting, and procurement. However, very few curricula address the issues supporting manufacturing and engineering aspects of the business operations. It is hard to learn practical business processes and ERP in one class for Technology and Engineering major students.

With support from several powerful ERP software vendors, such as SAP, Oracle, Microsoft and others, some universities have successfully established ERP system use

into their business school curricula (Seethamraju, 2011). Typically the concepts of ERP systems and business process are taught using a lecture format. Business software operation skills may be taught during a lab session. Students repeat transaction steps that have been demonstrated by an instructor to learn ERP system concepts and SAP skills using traditional teaching methods. However, a deeper understanding of the business process and the ERP system concept is limited. In fact, the difficulties and limitations of teaching business process knowledge using the traditional teaching method was reported by Seethamraju (2007). The complexity of the ERP system makes it difficult for students to understand. The links between business processes are also hard to teach using the traditional teaching method.

Students easily focus too much attention on SAP software transaction codes, following every step in an instructors' demonstration, and memorizing the terms in textbooks. Seethamraju (2007) conducted a survey on students after the traditional teaching lab session; some students rated the experience as a "routine data entry exercise". Thus the traditional teaching method did not help students to have better understanding on ERP system and business process.

Purdue University seeks to incorporate the SAP software in a series of classes in the College of Technology to address this problem. SAP is one of the most powerful ERP system vendors. SAP ERP has been widely implemented by many companies and institutions. HEC Montréal, an SAP University Alliance Partner, has developed a series

of business simulation games that feature the SAP-ERP systems . Simulation games are one of the most powerful learning tools because of their ability to provide the real environment to students and promotion of getting students participate the real-world activity (Mortais et al, 2006). This research is to determine whether the SAP simulation game helped Technology and Engineering students gain a better understanding to ERP system and business process.

1.3 Significance

Implementing the SAP software in Technology and Engineering is very meaningful. The students from Technology/ Engineering are not required to take courses related to the business. Business system and ERP system knowledge is important in industry. Manufacturing can be the most important functions supporting an ERP system A person who has both engineering and ERP system knowledge becomes very valuable in industry.

For many universities, it has been a struggle to implement an ERP system even though ERP vendors have developed a number of methods to work on developing curricula. As companies' usage of the ERP system become more strategic and professional, ERP curricula need to support and reflect these changes. Although there has been rapid development in universities' curricula establish, evolvement in industry is much faster and complicated. Industry needs the people who have ability of skilled use of the ERP system.

"Industry now requires a broad range of knowledge that support the development, implementation and maintenance of ERP system solutions" (Hawing, McCarthy, & Stein, 2004). However, many of the existing ERP system curricula are based on the business school models. Therefore, this research to integrate ERP software in cross-discipline curricula for Technology/ Engineering students is meaningful. The lack of ERP curricula supporting Technology and Engineering education is the motivation for this research.

The curricula based on business school models are becoming mature. Many universities have different courses suited to three different stages of ERP system learning: Introduction to Management Information Systems, ERP systems, ERP systems configuration. Many of the ERP related concepts are familiar to students due to their usage in everyday life, such as marketing, logistics, supply chain, warehousing, and forecasting demand. According to the research to the existed study, few universities implement the ERP system related curricula needed for Technology and Engineering (Harking, McCarthy & Stein, 2004).

1.4 Statement of Purpose

The purpose of this research is to determine the impact of using a business simulation game on learning by Technology students at Purdue University.

The pretest and posttest analysis was used to determine the effectiveness of SAP simulation game on student learning. The pretest and posttest was used to determine

students' self-assessment of understanding to several ERP related terms.

1.5 Research Question

The main question central to this research project is:

- What is the impact on learning from integrating SAP software and a system simulation game into Manufacturing Technology curriculum?

1.6 Assumptions

The assumptions of this research includes:

- Students will be truthful in their responses.
- Students will not respond to those items they find unclear or unanswerable.
- An adequate amount of time will be spent contemplating and providing responses to questions included in the survey.
- Students will put forth their full effort when learning new material and being tested about the same material

1.7 Limitations

The limitations of this research includes:

- Sample size of students is limited because of the course size and access to the SAP simulation game.
- The SAP simulation game used in this study is limited to "distribution game".
- The pretest and posttest only conducted on IT442 Production Planning class.

1.8 Delimitations

The delimitations of this research includes:

- The study is limited to those Purdue University students enrolled in a technology or engineering major that are willing to volunteer for the project.
- Students included in the study will have no physical or learning disabilities that prohibit normal classroom learning.

1.9 Definition of Key Terms

ERP system – "information systems that help manage business processes such as sales, purchasing, logistics, human resources, customer relations, performance measurement and management" (Davenport, 1998).

ERPsim – a simulation game which is designed by anacademic teams at the HEC Montreal and implemented by business schools in the world (Seethamraju, 2011).

SAP – One of the top ERP vendors. “SAP Americas is the world’s largest business software company and the third largest software supplier overall” (Business-Software.com, 2013). SAP ERP provides an integrated software solution that incorporates the key business functions of the organization.

1.10 Summary

This chapter presented an overview of this research project, including the background, significance, and specific research question of this study. Also this chapter includes assumptions, limitations, delimitations, and definitions of key terms used within the study.

CHAPTER 2. REVIEW OF RELEVANT LITERATURE

This chapter provides a review of literature related to the research topic. Specifically, the chapter reviews studies related to the development of ERP systems, and the integration of the ERP software into curricula. The review establishes the reason to focus on integrated SAP software into Technology curriculum.

2.1 ERP

Enterprise resource planning (ERP) is a complex Information Technology package that meets the information management needs of an organization. ERP systems are often used to replace hard-to-manage legacy systems.

The survival of small and medium-sized companies has been challenged by increasing competition and poor economic conditions. As a result, companies have utilized ERP system to improved technology to help to manage these market changes more effectively. Razi and Tarn (2003) defined an ERP system as "an integrated set of application software modules such as accounting, distribution, sales and marketing, material management, human resources, logistics, and more."

Software systems are often designed to meet internal functional requirements of an

organization. By the early 1980's, with the development of the personal computer, system suppliers began to provide software application packages, and organizations began to implement these packaged applications (Kumar & Hillegersberg, 2000). The packaged applications were used to organize and manage the data and financial operations at the organization.

The concepts of ERP are still being used in many aspects of organizations (Fraser et al., 2002). The ERP Maturity Model described by Holland and Light (2001) has three stages. Stage 1 shows the implementation of an ERP system while still managing existing legacy systems. Stage 2 indicates the organization have applied the ERP system widely. Stage 3 indicates the organization is able to use the ERP system strategically.

Many companies have already achieved Stage 3. Furthermore, the scope of Stage 3 has extended in three directions. ERP covers advanced solutions such as Supplier Relationship Management (SRM), Customer Relationship Management (CRM), and Supplier Chain Management (SCM). Second, complexity-reduced versions of ERP systems start to target the market of small and medium-sized organizations. Third, the scope of ERP extends to the technical support (Klaus, Rosemann, & Gable, 2000).

SAP is one of the vendors providing ERP systems. Its large market share and cross-functionality makes SAP very important when talking about ERP systems (Rosemann & Maurizio, 2005). In this study, the ERP Simulation Game (ERPsim) was used as the teaching software for the ERP system. The ERPsim is an innovative approach

that allows the concept and function of ERP to be taught in a simulation game. It was developed by HEC Montréal in cooperation with the SAP University Alliance. This simulation game automates and simulates business processes. ERPsim documentation includes a job aid describing business processes and SAP transactions. Written documentation, and training videos that describes the operation of the game. Students can simulate the entire business process, allowing students to develop decision-making skills with simulated SAP software.

The ERPsim Lab created three levels of SAP simulation games: a distribution game, a logistics game, and a manufacturing game. The simulation games have different functions for students to play. In the distribution game, the game focuses on basic business process: change the product price, adjust the market expense, and look for market reports. Due to the students' limited knowledge of business processes and the SAP-ERP software complexity, the distribution game was selected for use in this study.

2.2 ERP Curricula

Recent studies investigating the development of ERP users, which indicates students in this research project, understanding suggests that the conceptual understanding of a system can have a significant impact on performance (Shayo & Olfman, 2000). More specifically, studies have indicated that students' experience with similar applications can significantly impact students' understanding (Igbaria, 1993). Learning is no longer

considered as an individual process, but knowledge and skill are discovered and built to students through interaction with instructor and other learners (Choi, Kim, & Kim, 2007).

Many universities are in varying stages of enterprise systems education deployment. Antonucci et al. (2004) indicate that industry identified maturity models can be applied to enterprise systems curriculum deployment. The comparison of the ERP Maturity Model (Holland & Light, 2001) with ERP system education considers the universities as staying in Stage 1 during the investigation of introducing ERP concepts or utilization in their curricula. Universities enter Stage 2 when they integrate curricula across disciplines. Stage 3 occurs when the universities maturity of ERP systems and the ability to extend curriculum to ERPII (Antonucci et al., 2004). Because of the frequency of changes in the functionality within the system, it is often difficult for academic professionals to stay abreast of these changes and to understand the implications of these changes to business practice, as well as research and education.

Most of the ERP curricula development is based on the business school model. Students in the business school have enough business knowledge to study the ERP system. Besides, many researchers have already developed relatively mature ERP curricula in Business Schools as shown in studies by Becerra-Fernandez, Murphy, and Simon (2000), Joseph and George (2002), Bradford, Chandra, and Vijayaraman (2002), Hajnal and Riordan (2004), and the study by Davis and Comeau (2004). There is, however a gap in integrating the ERP software into Technology/ Engineering curricula.

While business schools generally remain the curricula based on functionally object, the reality of business today requires a cross-functional process perspective for effective management decision-making. Information technology is no longer the only function in information systems.

There is a need to develop Technology/ Engineering students that have business knowledge (Stewart, Rosemann, & Hawking, 2008). Purdue University has already started to use the ERPsim Lab games, which are an innovative "learning-by-doing" approach to teaching SAP concepts. The ERPsim Lab uses a continuous-time simulation. Students are put in situations in which they have to run their business using a real-life SAP system. Student teams manage a company, interact with suppliers and customers, dealing with orders, raw materials, and products, and finish the entire circle of doing the business using the SAP software.

2.3 Simulation Learning

Attempts at incorporating SAP software skills in the curricula were previously tried in regular lectures and lab sessions. In lab sessions, although the students could take a look at SAP software screens, they are often not able to complete SAP transactions by themselves. Students typically follow transaction steps which were demonstrated by an instructor (Seethamraju, 2011). Students often have difficulty understanding the cross-functional perspective of business processes in SAP and the information flows

behind the transactions they using (Cannon et al., 2004).

Repeating the transactions demonstrated did not build a deep understanding of the business process and their significance. Learning SAP software skills with hands-on work using industry-standard software was considered a better learning experience than a traditional theoretical teaching of ERP system (Hawking et al., 2004). The installation of SAP software in industry often takes more than three years and carries a large cost. It is also very difficult for universities to implement SAP software for academic purposes due to the high cost and complexity of the system. The ERPsim Lab games provide a lower cost alternative to a full SAP-ERP implement.

Simulation games are one of the most powerful tools in learning because of their ability to provide a real-world business environment (Mortais et al., 2006). Students are trained to complete various activities in SAP simulation game and make business decisions. Students develop a deeper understanding of the business process in the ERP system. The games help create a controlled multitask environment.

2.4 SAP Universities Alliance

Purdue University has become a member of the SAP University Alliance and accessed the ERPsim game software. Most of the course materials and teaching methods come from the SAP University Alliance program and its members. The alliance provides key system support and collaboration connections between university leaders and

students, customers and partners, and SAP internal experts. SAP-ERP is provided to Purdue University through the University of Wisconsin – Milwaukee as a University Alliance member. Second, SAP simulation games are used by many of the universities within SAP University Alliance. The simulation games were developed by HEC Montréal ERPsim Lab with support from the SAP Company. The games provides a simulation of real-world environment of SAP software.

2.5 Quasi-experimental Designs

This study used pretest and posttest surveys to determine the effect of an SAP simulation game on student learning. The surveys enable the identification of the effect of a treatment by measuring the difference between the posttest and the pretest (Sekaran & Bougie, 2009). The treatment in this study is the use of the *ERPsim Distribution Game* and *SAP-ERP* software.

Pretest and posttest surveys are a quasi-experimental design, which is considered to have no scientific value in determining cause-and effect relationships. This is because there is no comparison between groups (Sekaran & Bougie, 2009). However, the objective of this study is to determine whether the SAP simulation game is able to help students better learn ERP systems and business processes. The pretest examines the students' self-assessment of how well they understand the ERP concepts before the treatment. The posttest was conducted after students completed a one-hour-long SAP

simulation game. Comparing the differences of self-assessment between pretest and posttest gives a measure of changes in knowledge and confidence with the formal system.

2.6 Technology Program

The Purdue University College of Technology (CoT), with nearly 50 years history, focuses on the practical improvements in business, industry and education. Research in the College of Technology focuses on practical problems in industry. Faculty members have strong backgrounds in industry. Courses in CoT combine theory and practical case studies. The college has seven academic departments: Aviation Technology, Building Construction Management, Computer Information Technology, Computer Graphics Technology, Electrical and Computer Engineering Technology, Mechanical Engineering Technology, and Technology Leadership and Innovation. (College of Technology, 2013)

Industrial Technology (IT) is one of the academic programs in Department of Technology Leadership and Innovation. This program focuses on the management, operation, and maintenance of complex technological systems. IT 442 Production Planning is an undergraduate course provided by Department of Technology Leadership and Innovation. This course studies the industrial organization and its management, production, and sales. IT 442 focuses on the process and management within organization.

The Department of Mechanical Engineering Technology, “Mechanical Engineering

Technology (MET) is an academic program that is uniquely qualified to meet the automation challenges experienced by today's industries. MET 546 Industrial Applications of Computer Integrated Manufacturing is also offered by the Department of Mechanical Engineering Technology. This course studies the development of Computer Integrated Manufacturing (CIM) from the application of basic automation to fully integrated systems for the operation of the business enterprise. MET 546 is a CIM introduction course for the students whose research areas are more technology and engineering base.

2.7 Summary

ERP is a developed concept in industry, and many universities have already developed a curriculum for ERP in their business schools. However, many companies are looking for the Technology/ Engineering students with the knowledge of ERP systems. The SAP simulation game provides students with realistic environment to learn ERP system functions and business processes. Purdue University has several courses that are related to ERP systems or business processes for students in technology. In this research, classes offered in IT and MET degree programs are included.

CHAPTER 3: FRAMEWORK AND METHODOLOGY

This chapter provides an overview of the framework and methodology that is associated to this research project. It divided into six steps to outlines the quantitative, quasi-experimental design and the intended hypotheses.

3.1 Framework

In Atonucci, Corbitt, Stewart and Harris (2004)'s study, the ERP Maturity Model (Holland & Light, 2001) was applied to enterprise systems curriculum deployment. The comparison of the ERP Maturity Model with enterprise systems education reveals universities are in Stage 1 during investigation of introducing ERP concepts or utilization in their curricula. Stage 2 indicates the integration of ERP curricula across disciplines. Stage 3 indicates the maturity of ERP systems and the ability to extend curricula to ERPII (Antonucci et al., 2004). ERPII is used by Antonucci to describe an upgraded stage of ERP systems. This indicates that the ERP Maturity Model is also able to reflect three stages of students' ERP knowledge levels.

This research studied the use of SAP software integrated into the Industrial Technology curriculum. SAP, as one piece of critical ERP software, supports

cross-disciplinary knowledge for College of Technology students. This research studied the use of Stage 2 ERP software integrated into the Industrial Technology Curriculum at Purdue University.

3.2 Methodology

This research followed seven steps to investigate the impact of SAP software into the Technology curriculum. This approach employed quantitative methods, making use of the quasi-experimental design.

Step 1: Obtain permission from the course instructors and the Institutional Review Board.

Step 2: Identify participants.

Step 3: Administer the experimental pretest to participants.

Step 4: The participants play first quarter of the SAP simulation game.

Step 5: Show SAP reports and training videos online. Provide time to discuss.

Step 6: Finish another two quarters of the game.

Step 7: Administer the experimental posttest to participants.

Step 1: Obtain permission from the course instructors and the Institutional Review Board.

Permission from the course instructor was needed to present students with the

opportunity to participate in the research study. The Institutional Review Board is a Purdue University committee that approves and monitors the research involving humans to protect research subjects from harm that might be caused by research. This research was submitted as Form Exempt 1 to the University's Institutional Review Board. The Form Exempt 1 was used for conducting research, which has no change of the course content. The students would have participated in the evaluation regardless of whether this research was being conducted. Human Subjects Approval from Purdue University's Institutional Review Board was requested and accepted (see Appendix D & E).

Step 2: Identify participants

Initially, the treatment was planned for the Mechanical Engineering Technology class. Time limitations in the MET 546 class led to the treatment only being completed on the IT 442 Production Planning class. IT 442 was using the SAP simulation game and was studied during the spring 2013 term. Ten students in the IT 442 class participated. The *ERPsim Distribution Simulation Game* was chosen for this study.

Step 3: Administer the experimental pretest to participants.

The experimental pretest tested students' self-assessment of understanding of business process and ERP systems. The purpose of the testing was to compare the results to identify any differences. In the pretest, the questionnaire included basic demographic

details such as gender, age, and year in school, major they are currently enrolled in. The pretest continued by asking whether they have experience/ basic knowledge on SAP and other business system. In the third section of the survey, using a five points scale (1 = Not at all, 5 = Expert Knowledge), students were asked to make a self-assessment on how they understand a list of ERP terms. The terms that are include in the pretest are: marketing, inventory management, logistic/ supply chain warehouse, material planning, procurement, fulfillment, production, bill of materials, company code, cost center, and forecast demand.

Some terms tested have common usage such as marketing, logistic/ supply chain warehouse, production, and forecast demand. The terms company code and cost center were not familiar to the students, but have specific meaning in *SAP-ERP*. The definitions of terms for this study were based on the *ERPsim Lab Distribution Game*. The meaning of the terms "inventory management" and "material planning" is considered similar meaning within the context of the distribution game.

Step 4: The participants play first quarter of the SAP simulation game.

SAP software contains numerical data and knowledge which can be difficult for undergraduate Technology students to understand. Student participants playing the game found themselves in situation in which they made business decisions as they run a company in the distribution game. Students were divided into three groups: three students

as Team A, another three students as Team B, and four students as Team C. Three teams represented three different companies in SAP simulation game. The ERPsim Lab uses a continuous-time simulation.

The figure 3.1 shows the job aid of the distribution simulation game. The job aid is a one-page document that graphically described the decisions to be made and shows the related transactions needed in SAP. A large version of the Job Aid for the *ERPsim Distribution Game* is shown in Apeentix A. The companies are bottled water distributors. The students interact with suppliers and customers by sending and receiving orders, changing the product price according to the market reports. The students were able to change the product price, modify the market expense, look for the market report, decide when and which product to buy from the suppliers. The objective is to maximize profits at the end of the game.

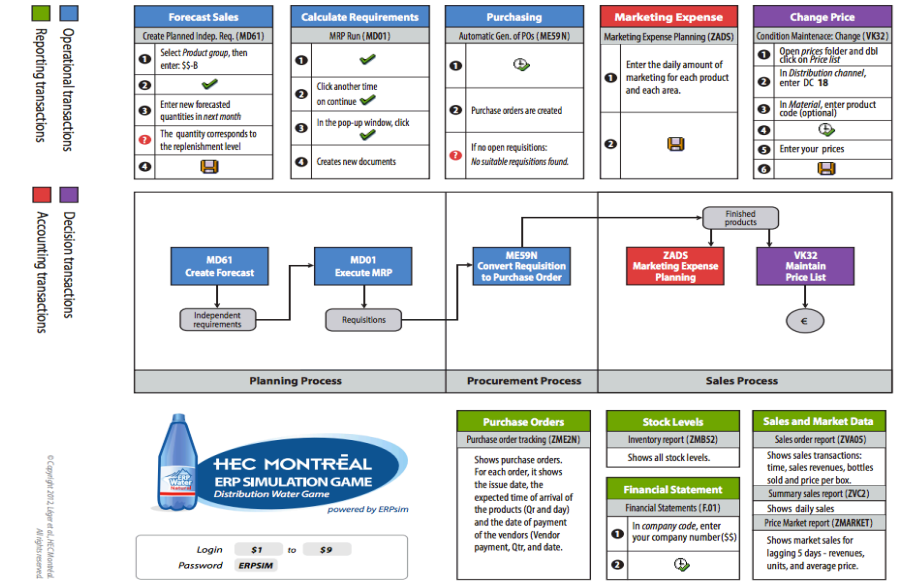

Figure 3.1 Job Aid of Distribution Simulation Game

The game consists three quarters, and each quarter has 20 days with one minute representing a day. In this step, students were provided with the job aid of this simulation game and the basic procedures needed to play the game. The students played the game by themselves without any further information about the SAP simulation game, or the required decisions.

Students entered a forecast of demand and calculated requirements by using the transaction codes MD61 and MD01. Using the transaction code ZADS students could change the marketing expenditure based on information found in the SAP market report. Additionally, the students were asked to change the product price to stimulate sales – using the VK32 transaction.

Step 5: Show SAP reports and training videos online. Provide time to discuss

After the first quarter, the overall business performance report and training videos were shown to the students. The students had many questions and issues following the first quarter, such as how to enter specific screens, and how to complete specific transactions. Most of the questions were related to basic software usage issues. ERPsim documentation includes a job aid describing business processes and SAP transactions. Written documentation, and training videos that describes the operation of the game. The overall report and the training videos helped them to understand the decisions needed to compete in the overall situation. And discussion time with team members and class was

provided. Asking question to instructors, and discuss strategy for following two quarters.

Step 6: Finish another two quarters of the game

Two addition quarters of the game were played following the . With a better understanding of SAP software operation, the students' behavior during the last two quarters was much better than in first quarter. They not only looked for the individual reports showing stock levels, financial statements, and sales and market data, but also used summary reports to make better business decisions. The amount of product sold and the money earned increased over the level of the first quarter.

Step 7: *Administer the experimental posttest to participants.*

The experimental posttest was administered in this step to allow corporations to the results of the pretest. Exactly the same questions from the pretest were asked in the posttest. Scores measuring student's self-assessment of level of comprehension after the course was compared to pretest, and the differences were measured.

The hypotheses was:

H_0: There is no effect in implementing SAP software into Manufacturing Technology Curriculum.

H_A: There is a positive effect in implementing SAP software into Manufacturing Technology Curriculum.

Due to the small class size, the data was analyzed using descriptive statistics and showing the “before” and “after” of students’ behavior evaluated by pretest and posttest.

CHAPTER 4. DATA ANALYSIS

This chapter covers the data collection procedure and data analysis. The detailed data collection procedure was very important to this study, because the students behavior during the treatment helps data analysis efficiency and clearly. Data analysis used mean and percentage changes to compare the difference between the pretest and the posttest.

4.1 Data Collection

This paper developed pretest and posttest to determine if the SAP simulation game had an impact on students' understanding of the ERP related concepts. In order to compare the differences between "before" and "after" the experience of SAP simulation game, the data was collected "before" and "after" the SAP simulation game. Both the pretest and the posttest were designed as a questionnaire, consisting of some basic demographic details such as gender, age, year in school, and major they are currently enrolled in. Second, the survey was continued as asking whether they have experience/ basic knowledge on SAP and other business system. In the third section of the survey, using a five points scale (1 = Not at all, 5 = Expert Knowledge), students were asked to make a self-assessment on how well they understand on some ERP concepts. See the

pretest and posttest instruments in Appendix B and C.

The terms that were included in the survey signify underlying concepts: marketing, inventory management, logistic/ supply chain warehouse, material planning, procurement, fulfillment, production, bill of materials, company code, cost center, and forecast demand. These ERP concepts are fundamental in business process and are relevant to the SAP simulation game. Students might have heard of some of the terms, such as marketing, logistic/ supply chain warehouse, production, bill of materials, and forecast demand. Some concepts have exactly the same meaning in the business process area. The reason for choosing those terms was to determine whether the SAP simulation game helps students understand those system specific terms. Terms such as company code and cost center, which are uncommon in real-life, were also included in the test. This was to determine, within the short duration of playing the game, if the SAP simulation game led to better understanding of material.

Originally, the researcher planned to conduct the pretest and the posttest in the MET 546 Industrial Application of Computer Integrated Manufacturing class. Unfortunately, this class ran out of time due to a class schedule conflict and IT 442 Production Planning participated instead. With the permission and help of the class instructor, the survey was conducted before and after the SAP simulation game in its scheduled lab session. A total of ten students in the class participated the study, they are divided into three groups: three students as Team A, another three students as Team B, and four students as Team C.

Three teams represented three different companies in SAP simulation game. The students were asked to work as teams to play the game.

The simulation game that was used in this class is the *ERPsim Lab Distribution Game.* The game was played in three quarters; each quarter has 20 days with one minute representing one day. At the first quarter, students played the game only after a brief description about how to enter transaction codes, and what transaction codes they will need during the first quarter. Without any further explanation about the SAP software except for basic procedures, the students are required to complete the detailed steps to play the simulation game with help of a job aid provided by the ERPsim Lab (see Appendix A.). Class instructors answered questions if asked by the students. After the first quarter, a report of team performance and three training videos were shown to the students. Moreover, the students were provided time to discuss problems they encountered and their strategies with their team members. There was one hour total of actual time playing the simulation game among two hours class duration. The posttest was conducted at the end of the class.

Only the pretest was conducted on the class MET 546 Industrial Application of Computer Integrated Manufacturing due to the class schedule. The class MET 546 is a graduate course from Department of Mechanical Engineering Technology. Eight students registered on this class in total, including the author of this study. Therefore, seven students in the class MET 546 participated in the pretest. The data from the MET 546

pretest can be compared with the pretest data from IT 442.

4.2 Student Feedback

The IT 442 class contained 10 students, nine from the Industrial Technology major, one from Manufacturing Engineering Technology. Eight students were seniors, one Junior, and one M.S student. Eight students were male and two female. Figures 4.1, 4.2, and 4.3 show the students' demographic information.

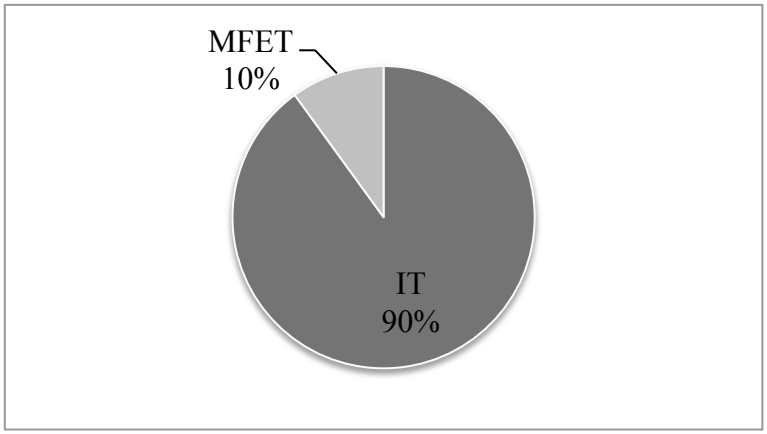

Figure 4.1 Students Demographic Information – Major

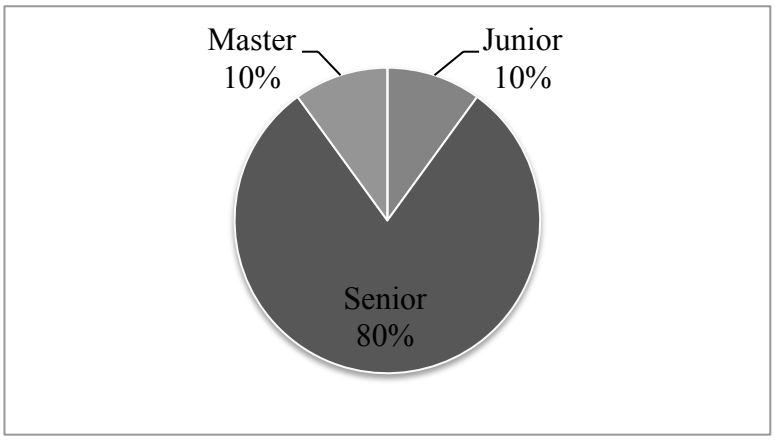

Figure 4.2 Students Demographic Information – Year in School

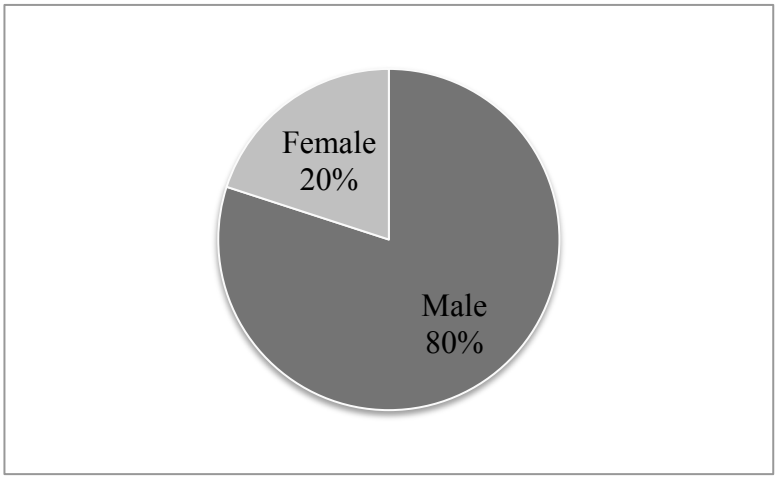

Figure 4.3 Students Demographic Information - Gender

Table 4.1 shows the self-assessment of students on how well they understand about ERP underlying concepts.

Table 4.1 Impact of SAP Simulation Game on Students

Concept	Pre-test Mean	Post-test Mean	Percentage Change ((Post - Pre)/ Pre)%
Company Code	1.8	3.2	77.78%
Material Planning	2.6	3.2	23.08%
Inventory Management	3.2	3.9	21.88%
Fulfillment (Sell)	2.7	3.2	18.52%
Procurement (Buy)	2.9	3.4	17.24%
Marketing	3.2	3.7	15.63%
Cost Center	1.9	2.1	10.53%
Forecast Demand	3.5	3.5	0.00%
Production (Make)	3.4	3.3	(2.94)%
Logistic/ Supply chain warehouse	3.5	3.3	(5.71)%
Bill of Materials	2.8	2.5	(10.71)%

4.2.1 Pretest Analysis of Students in IT 442 Class

As shown in Table 4.1, the concepts that have higher mean (above 3.0) in the pretest, are basically the term that are easily familiar with from normal content such as marketing, inventory management, logistic/ supply chain warehouse, production, and forecast demand. The others topics with means close to 3.0, such as material planning, procurement, fulfillment, and bill of materials, are not so familiar for the students. However, for company code and cost center, the mean is relatively low. The students were not familiar with those concepts before this semester. These terms are uncommon in real-life, but have specific meaning in ERP system. The posttest was conducted right after finish the simulation game was completed. Most of the ERP concept terms have higher means in the posttest.

4.2.2 Percentage Change Analysis of Students in IT 442 Class

4.2.2.1 More than 15% of Percentage Change

Table 4.2 More than15% of Percentage Change

Concept	Pre-test Mean	Post-test Mean	Percentage Change ((Post - Pre)/ Pre)%
Company Code	1.8	3.2	77.78%
Material Planning	2.6	3.2	23.08%
Inventory Management	3.2	3.9	21.88%
Fulfillment (Sell)	2.7	3.2	18.52%
Procurement (Buy)	2.9	3.4	17.24%
Marketing	3.2	3.7	15.63%

Table 4.1 shows that there were six ERP concept terms that had more than 15% of

increased mean percentage. Even all of them had high increased percentage, the different reasons can be considered.

From the overview of the Table 4.1, the results show that some of the concepts had a dramatically percentage increased, while some had a decreased mean. Here, on increase of more than 15% is defined as "dramatically". Following are the terms that have more than 15% of increased percentage.

"Company Code" (77.78%): As mentioned before, the students were separated into three teams, representing three different companies. They were asked to input their company code while playing the game.

"Inventory Management" (21.88%) and "Material Planning" (23.08%): In the SAP simulation game, basically the students need to navigate the game based on inventory management and material planning codes. Price changing and forecast demand was made all based on inventory management policies. The increased percentage of "Inventory Management" and "Material Planning" is a good example. However, these two ERP concepts have similar meanings in the SAP distribution simulation game.

"Procurement" (17.24%) and "Fulfillment" (18.52%): Based on the inventory report, the students are required to forecast demand, buy products from the supplier, and sell the products by changing the products' price and market expense.

"Marketing" (15.63%): The pre-test result indicates that the students already had some understanding about marketing before playing the simulation game. This makes

intuitive sense, as students are frequently exposed to marketing concepts throughout their lives. During the simulation game, the students were required to use specific transaction code to change expense on marketing.

4.2.2.2 Between 0% and 15% of Percentage Change

Table 4.3 Between 0% and 15% of Percentage Change

Concept	Pre-test Mean	Post-test Mean	Percentage Change ((Post - Pre)/ Pre)%
Cost Center	1.9	2.1	10.53%
Forecast Demand	3.5	3.5	0.00%

Nevertheless, some ERP concept terms have relatively low increased percentage, such as cost center and forecast demand. “Cost center” started with a low mean in pretest at 1.9, and only increased to 2.1. The term “cost center” is very unfamiliar to most of the students and the simulation game did not help them to learn its meaning. However, “cost center” is not included in the SAP distribution simulation game. Naturally, the simulation game does not help students understand the term “cost center”. “Forecast demand” did not change its mean from pretest to posttest. This can be assumed that the simulation game did not change the students’ understanding to the meaning of “forecast demand”. Although the simulation game required the students to input a forecast demand, the average mean did not change significantly. Looking at the individual means for students might help in this case. It is possible that only the students responsible for changing the

forecast during the simulation might have gained some insight into this term.

4.2.2.3 Negative Percentage Change

Table 4.4 Negative Percentage Change

Concept	Pre-test Mean	Post-test Mean	Percentage Change ((Post - Pre)/ Pre)%
Company Code	1.8	3.2	77.78%
Material Planning	2.6	3.2	23.08%
Inventory Management	3.2	3.9	21.88%

Obviously, some terms actually had a negative increase (decrease) in their mean score; such as logistic/ supply chain warehouse, production, and bill of materials. Especially, the term of "bill of materials" goes down 10.71% compared to the mean in pretest. The reason for the negative percentage change might be that students had different understanding before playing the game. The terms such as production and bill of materials are very common for students. However the meaning of these terms in business process may be different from typical usage. It could be considered as the students gained different aspects of understanding during playing the SAP simulation game. The simulation might help the students to rethink those terms, which is a good trigger for the students as a game. However, the module of "Production" is not included in the *ERPsim Distribution Game*. Hence, the outcome is not connected to the effect and is not applicable to this study.

4.2.3 Comparison between the class MET 546 and IT 442

Originally, the study had planned to conduct the research in class MET 546. Unfortunately, only the pretest was conducted on this class due to its class schedule conflict.

The following Figure 4.4, 4.5, and 4.6 shows the demographic differences between the students in IT 442 and MET 546. Seven students in class MET 546 participated in the pretest. It shows that the students come from variant age and major area. The students in MET 546 have a focus on manufacturing and production technology. Most of the students do not have a background in business processes. The limitation of students' focus area might contribute to the relatively low overall pretest result. This implies that the SAP manufacturing simulation game might be a good treatment for the students in MET 546. The manufacturing simulation game focuses more on the engineering process within the SAP software. Nonetheless, starting with an easier SAP simulation game, which is the distribution simulation game, is very necessary.

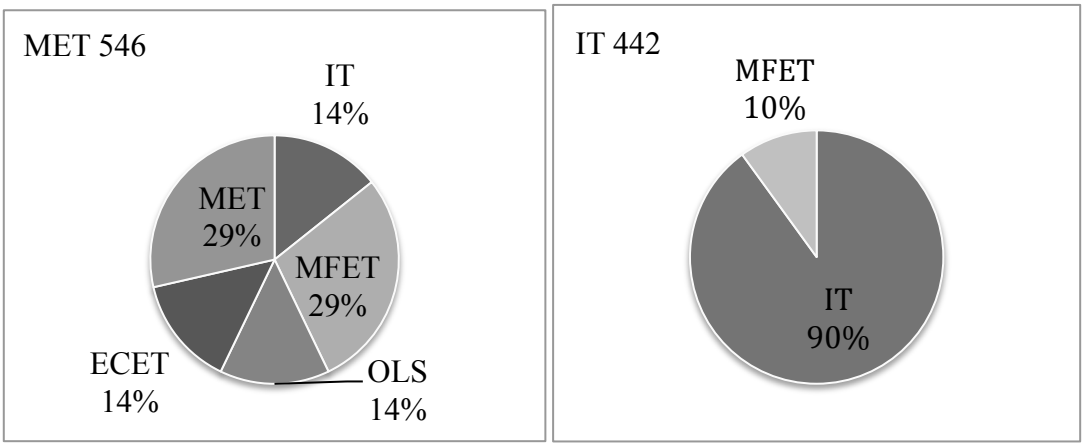

Figure 4.4 Students' Difference between MET 546 and IT 442 - Major

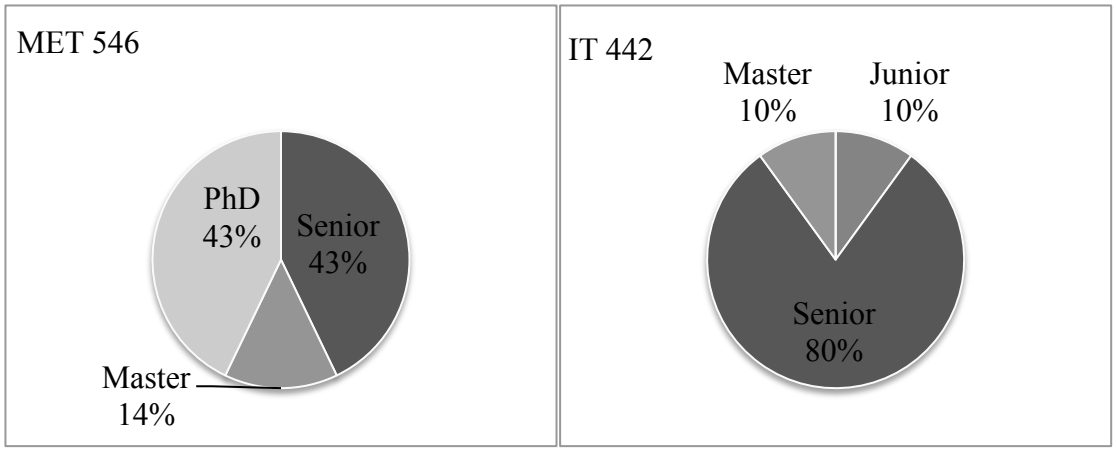

Figure 4.5 Students' Difference of MET 546 and IT 442 – Year in School

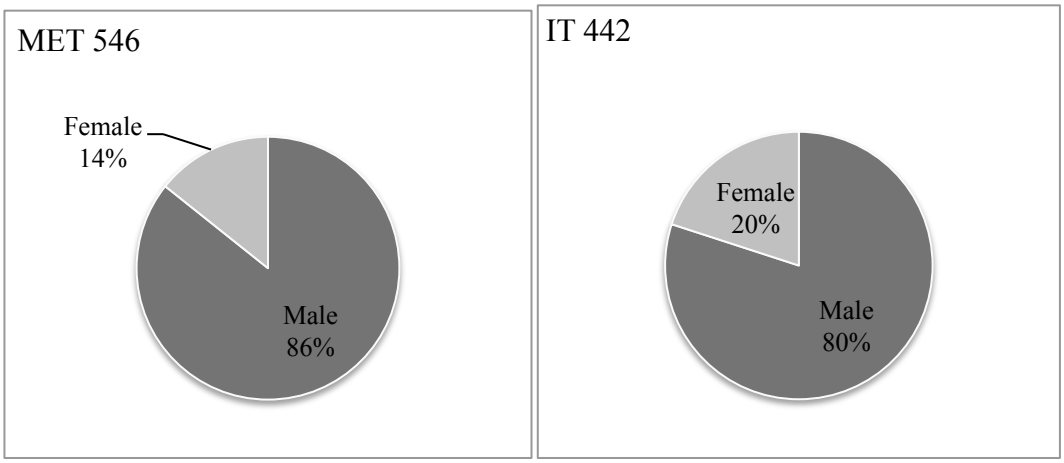

Figure 4.6 Students' Difference of MET 546 and IT 442 – Gender

Table 4.2 shows the pretest difference between the students in IT 442 and MET 546. Compared to the pretest from IT 442, the overall result from MET 546 is much lower. Variance of the major can be assumed as the reason. The students major in IT have more available courses than other major that provide exposure to the ERP system and business processes.

Table 4.5 Pretest Difference Between the Students in IT 442 and MET 546

Concept	Pretest	
	IT442 Mean	MET546 Mean
Marketing	3.2	1.5
Inventory Management	3.2	1.7
Logistic/ Supply chain warehouse	3.5	1.8
Material Planning	2.6	1.6
Procurement (Buy)	2.9	1.6
Fulfillment (Sell)	2.7	1.3
Production (Make)	3.4	2.5
Bill of Materials	2.8	2.8
Company Code	1.8	1.3
Cost Center	1.9	1.3
Forecast Demand	3.5	1.6

Looking at the MET 546 pretest results, only two terms have a relatively higher mean than others – Production and Bill of Materials. The students in MET 546 mainly study manufacturing processes. Accordingly, production and bill of materials are the most familiar terms for these students. The terms that are less relevant to the manufacturing process have lower means, such as marketing and fulfillment.

However, the limitation of this study is that the pretest and posttest result did not show how actually students understand those ERP concept terms. It would be meaningful if the students were asked to write down the definitions of those terms in the posttest.

CHAPTER 5. CONCLUSIONS

5.1 Study Conclusion

Implementing the SAP software into Technology's curricula, teaching complex ERP software skills, and ensuring students' understanding to SAP software, is always a challenge. The results suggest that the game had a positive effect on the students learning of ERP. The study was conducted on limited class population. The findings therefore might have limitations.

The ERP concept terms that have large increased means are marketing, inventory management, material planning, procurement, fulfillment, and company code. These terms are all directly relevant to the SAP distribution simulation game played in class. It indicates that, the SAP simulation game is able to help students gain ERP knowledge even within the short period. By practicing the ERP knowledge in the simulation game, the students tend to strengthen their understanding to the ERP system and business processes.

In contrast, the understanding of some ERP concepts show a decreased mean after the simulation game, such as logistic/ supply chain warehouse, production, bill of materials. This can be analyzed in several ways. First, the limited population size did not

provide an accurate result. Secondly, though these concepts are also included in the simulation game, they are not as directly related as other ERP concept terms. The students may have had difficulties on understanding after the game. However, the simulation game can trigger students to rethink the ERP concept terms and business processes.

However, the pretest and posttest results did not precisely show students' understanding to those ERP terms. The result did not show the students' learning effectiveness with the SAP software. The study only indicates the students' self-assessment change related to the ERP concept terms presented in the treatment. Additionally, the terms on the pretest and posttest did not reflect the SAP distribution simulation game thoroughly. For example, the term "Production" is not included in the distribution simulation game, but in the manufacturing simulation game. Therefore, the change of overall mean on the term "Production" may not indicate the effectiveness of the distribution simulation game on the students. The self-assessment may also fail to show the accuracy of students' understanding to SAP software. Asking the students to define those terms may be a better method to determine learning.

MET students need to understand ERP systems and their role in the operation of business systems. However, MET students had lower pretest mean scores than the IT students. The MET students may have a larger learning gap to close. Compared to the IT students, the pretest in the class MET 546 was relatively low. As the industry seeks

cross-functional knowledge from employees, it is meaningful to integrate the business simulation game into the MET curriculum. Overall, the students have increased opportunities to learn ERP systems and business processes through playing the *ERPsim Distribution Game* and other ERPsim games.

5.2 Further Research

In order to avoid limitations and researcher's bias to the study, repeatedly play the simulation game and increase population size are necessary. Playing a one-hour simulation game is not long enough to create learning changes on students understanding. Students benefit from playing the simulation game multiple times is better, digest the experience and knowledge inside the SAP simulation game.

Furthermore, the ERPsim Lab also provides a logistic simulation game and manufacturing simulation game in addition to the distribution simulation game. The other two simulation games provide different aspects of SAP functionality than distribution simulation game. These two simulation games can be expected to create more changes in students' self-assessment of understanding ERP systems. Students might focus too much attention to the business system learning used. Furthermore, due to the different business process functions achieved in the three different simulation games, the terms that had negative increased percentages might have different results after completion of the other simulation games. Additionally, due to the limitation of the pretest and posttest in this

study, a new test should be developed after deciding which simulation game classes will be used.

A larger sample also helps study result to become more reasonable. Due to the time shortage, this research did not include the students from Mechanical Technology curriculum. However the other learning activities and SAP software screenshots were provided to the students in the class MET 546. There are future opportunities to study the effects of the additional games and activities on students' learning.

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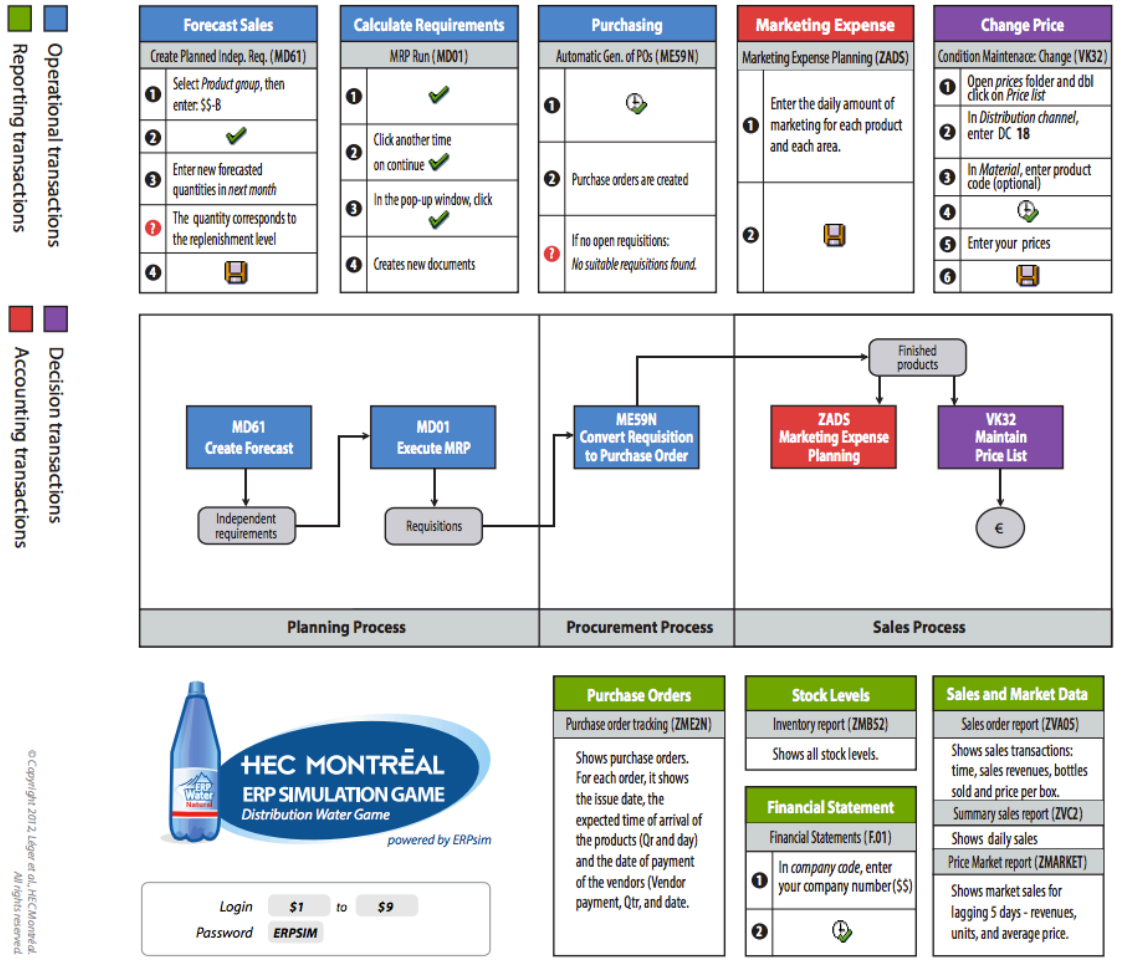
Appendix A. Job Aid
Distribution Game
(Leger et al. HEC Montreal, 2008-2013)



Appendix B. Pretest

Q1. Gender: Male Female

Q2. Age: _____

Q3. Year in School: Freshman Sophomore Junior Senior Master's PhD

Q4. College and Major: _____

Q5. Do you have experience/ basic knowledge on SAP, Oracle, PeopleSoft, or other business system?

Name	Do you have experience/ basic knowledge on it?	
SAP	Yes	No
Oracle	Yes	No
Epicor	Yes	No
PeopleSoft	Yes	No
Other business system	Yes	No

Q6. Please answer the following questions pertaining to each of the concepts listed by circling your response.

Concept	Do you know what it is?		How well do you think you understand it? 1= Not at all 5=Expert Knowledge				
Marketing	Yes	No	1	2	3	4	5
Inventory Management	Yes	No	1	2	3	4	5
Logistic/ Supply chain warehouse	Yes	No	1	2	3	4	5
Material Planning	Yes	No	1	2	3	4	5
Procurement (Buy)	Yes	No	1	2	3	4	5
Fulfillment (Sell)	Yes	No	1	2	3	4	5
Production (Make)	Yes	No	1	2	3	4	5
Bill of Materials	Yes	No	1	2	3	4	5
Company Code	Yes	No	1	2	3	4	5
Cost Center	Yes	No	1	2	3	4	5
Forecast Demand	Yes	No	1	2	3	4	5

Appendix C. Posttest

Q1. Gender: Male Female

Q2. Age: _____

Q3. Year in School: Freshman Sophomore Junior Senior Master's PhD

Q4. College and Major: _____

Q5. Please answer the following questions pertaining to each of the concepts listed by circling your response.

Concept	Do you know what it is?		How well do you think you understand it? 1= Not at all 5=Expert Knowledge				
ERP	Yes	No	1	2	3	4	5
SAP	Yes	No	1	2	3	4	5
Oracle	Yes	No	1	2	3	4	5
Epicor	Yes	No	1	2	3	4	5
PeopleSoft	Yes	No	1	2	3	4	5

Q6. Please answer the following questions pertaining to each of the concepts listed by circling your response.

Concept	Do you know what it is?		How well do you think you understand it? 1= Not at all 5=Expert Knowledge				
Marketing	Yes	No	1	2	3	4	5
Inventory Management	Yes	No	1	2	3	4	5
Logistic/ Supply chain warehouse	Yes	No	1	2	3	4	5
Material Planning	Yes	No	1	2	3	4	5
Procurement (Buy)	Yes	No	1	2	3	4	5
Fulfillment (Sell)	Yes	No	1	2	3	4	5
Production (Make)	Yes	No	1	2	3	4	5
Bill of Materials	Yes	No	1	2	3	4	5
Company Code	Yes	No	1	2	3	4	5
Cost Center	Yes	No	1	2	3	4	5
Forecast Demand	Yes	No	1	2	3	4	5

Appendix D. IRB approved document

PURDUE UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	HENRY KRAEBBER KNOY 133
From:	JEANNIE DICLEMENTI, Chair Social Science IRB
Date:	03/15/2013
Committee Action:	**Exemption Granted**
IRB Action Date:	03/15/2013
IRB Protocol #:	1302013314
Study Title:	Integrating the SAP software into the Manufacturing Technology Curriculum

The Institutional Review Board (IRB) has reviewed the above-referenced study application and has determined that it meets the criteria for exemption under 45 CFR 46.101(b)(1) .

If you wish to make changes to this study, please refer to our guidance **"Minor Changes Not Requiring Review"** located on our website at http://www.irb.purdue.edu/policies.php. For changes requiring IRB review, please submit an **Amendment to Approved Study** form or **Personnel Amendment to Study** form, whichever is applicable, located on the forms page of our website www.irb.purdue.edu/forms.php. Please contact our office if you have any questions.

Below is a list of best practices that we request you use when conducting your research. The list contains both general items as well as those specific to the different exemption categories.

General

- To recruit from Purdue University classrooms, the instructor and all others associated with conduct of the course (e.g., teaching assistants) must not be present during announcement of the research opportunity or any recruitment activity. This may be accomplished by announcing, in advance, that class will either start later than usual or end earlier than usual so this activity may occur. It should be emphasized that attendance at the announcement and recruitment are voluntary and the student's attendance and enrollment decision will not be shared with those administering the course.
- If students earn extra credit towards their course grade through participation in a research project conducted by someone other than the course instructor(s), such as in the example above, the students participation should only be shared with the course instructor(s) at the end of the semester. Additionally, instructors who allow extra credit to be earned through participation in research must also provide an opportunity for students to earn comparable extra credit through a non-research activity requiring an amount of time and effort comparable to the research option.
- When conducting human subjects research at a non-Purdue college/university, investigators are urged to contact that institution's IRB to determine requirements for conducting research at that institution.
- When human subjects research will be conducted in schools or places of business, investigators must obtain written permission from an appropriate authority within the organization. If the written permission was not submitted with the study application at the time of IRB review (e.g., the school would not issue the letter without

Appendix E. IRB minor change approved document

PURDUE
UNIVERSITY

HUMAN RESEARCH PROTECTION PROGRAM
INSTITUTIONAL REVIEW BOARDS

To:	HENRY KRAEBBER KNOY 133
From:	JEANNIE DICLEMENTI, Chair Social Science IRB
Date:	04/22/2013
Committee Action:	**Amendment to Approved Protocol**
IRB Action Date	04/21/2013
IRB Protocol #	1302013314
Study Title	Integrating the SAP software into the Manufacturing Technology Curriculum
Expiration Date	

Following review by the Institutional Review Board (IRB), the above-referenced protocol has been approved. This approval permits you to recruit subjects up to the number indicated on the application form and to conduct the research as it is approved. The IRB-stamped and dated consent, assent, and/or information form(s) approved for this protocol are enclosed. Please make copies from these document(s) both for subjects to sign should they choose to enroll in your study and for subjects to keep for their records. Information forms should not be signed. Researchers should keep all consent/assent forms for a period no less than three (3) years following closure of the protocol.

Revisions/Amendments: If you wish to change any aspect of this study, please submit the requested changes to the IRB using the appropriate form. IRB approval must be obtained before implementing any changes unless the change is to remove an immediate hazard to subjects in which case the IRB should be immediately informed following the change.

Continuing Review: It is the Principal Investigator's responsibility to obtain continuing review and approval for this protocol prior to the expiration date noted above. Please allow sufficient time for continued review and approval. No research activity of any sort may continue beyond the expiration date. Failure to receive approval for continuation before the expiration date will result in the approval's expiration on the expiration date. Data collected following the expiration date is unapproved research and cannot be used for research purposes including reporting or publishing as research data.

Unanticipated Problems/Adverse Events: Researchers must report unanticipated problems and/or adverse events to the IRB. If the problem/adverse event is serious, or is expected but occurs with unexpected severity or frequency, or the problem/even is unanticipated, it must be reported to the IRB within 48 hours of learning of the event and a written report submitted within five (5) business days. All other problems/events should be reported at the time of Continuing Review.

We wish you good luck with your work. Please retain copy of this letter for your records.

Ernest C. Young Hall, 10th Floor - 155 S. Grant St. - West Lafayette, IN 47907-2114 - (765) 494-5942 - Fax: (765) 494-9911