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Effectiveness of Using an Enterprise System to Facilitate Process-Centered Learning in Business Education.

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EFECTIVENESS OF USING AN ENTERPRISE SYSTEM TO FACILITATE PROCESS-CENTERED LEARNING IN BUSINESS EDUCATION

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University
and Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Interdepartmental Program in
Business Administration
(Information Systems and Decision Sciences)

by

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I dedicate this work to
my wife Mercedes and my son
Joseph
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ABSTRACT

This research investigates the effectiveness of using a commercial Enterprise Resource Planning System (ERP) as a supplement tool to teach Enterprise Information Systems concepts in Business Schools.

A state-of-the-art ERP System is an integrated enterprise software system that has a windows-based interface, a client-server architecture, and a modular and expandable structure. This complex computer environment provides a rich content domain where students can get exposure to key business, computer science, data communication, and information systems concepts.

A significant challenge facing business school educators is to identify how best to deploy a commercial ERP System in their academic environment. Furthermore, an issue that must be addressed, before implementing any new educational innovation, is whether the costs of changing the curriculum and then maintaining the new program will be justified in terms of learning effectiveness and efficiency.

To date, the educational benefits of the instructional uses of commercial ERP systems such as the SAP R/3 System have been established on the basis of anecdotal statements from faculty and students rather than on empirical and objectively measured data secured by sound research methods.

Thus, the main objectives of this study are to determine whether or not student’s performance, self-efficacy, and satisfaction are enhanced by the use of an ERP System as a support tool in learning business processes.

This study compares three delivery instructional methods. A traditional instruction method (lecture format plus reading/exercises) acts as the control. The
1. INTRODUCTION

This presentation outlines the challenges facing business schools in order to remain current with key business and business systems concepts, provides an overview of what is being done to meet those challenges, and discusses possible implications for the future. The chapter concludes with the research questions, the objectives, and contributions of this study.

1.1. The Problem Area

Business education, in particular Information Systems (IS) education, must constantly change in order to stay on top of key business and business systems concepts. How enterprise systems support the process-centered organization is a relatively new concept being taught today.

Enterprise systems, such as the Systems, Applications and Products in Data Processing, Release 3.0 (SAP R/3 System), support the need for enterprises to move from functional-oriented to process-oriented structures by taking a very process-oriented view of the business. “Process centering, more than anything else, means that people—all people—in the company recognize and focus on their processes....The key word...is ‘process’: a complete end-to-end set of activities that together create value to the customer” (Hammer, 1996).

A state-of-the-art Enterprise System is an integrated enterprise software system (generically referred to as Enterprise Resource Planning, or ERP) which has a windows-based interface, a client-server architecture, and a modular (each module is dedicated to a different area of business activities) and expandable structure. An ERP System
information infrastructure supports fundamental business processes of a firm, such as customer order processing, production order processing, purchase order processing, long-range planning, performance reporting, financial reporting, and accounting. Thus, the market for people, who can understand, work with, and implement these systems to support the process-centered organization, is strong and growing (Watson and Schneider, 1999).

To become process-centered, an organization requires a transformation of its workforce. Each worker will transform him or herself into a professional, “someone who is responsible for achieving a result rather than performing a task” (Hammer, 1996). “A worker is a kind of organic robot, operated by a manager via remote control. Professionals, on the other hand, possess ‘whole jobs,’ where they act and think for themselves” (Hammer, 1996). In addition, “One of the biggest shifts for an agile company is the shift away from functional or departmental thinking to process thinking. Functional thinking causes workers to think about their job and their department. Process thinking, on other hand, helps workers understand how potential improvements affect the company as a whole” (Howardell, 1999).

Thus, the increasing application of information technologies to support process-centered organization requires Business/Information Systems professionals to possess in-depth business functional knowledge and skills (Davenport and Short, 1990; Farmer, 1987; Hammer, 1990; Sullivan-Trainor, 1988; Nelson, 1991). Furthermore, a student’s success in the process-centered organization demands increasingly effective and efficient learning of Enterprise Resource Planning systems such the SAP R/3 System. Thus,
business schools are expected to graduate students with experience in these emerging technologies (Alavi, et al., 1995).

On the other hand, previous research suggests that the current Information Systems curricula in many universities are not well aligned with business needs (Lee, et al., 1995a). Faced with this challenge, a number of business schools have started the process of redesigning curriculums (i.e., Accounting, Information Systems, Finance, Human Resources, Operations Management) and instructional methods at both undergraduate and graduate levels. Most of the educational reengineering efforts are supported by the use of ERP systems such as SAP R/3 System provided by the SAP University Alliance Program.

1.2. SAP University Alliance Program

The SAP University Alliance (SAP-UA) program provides the link between Business Education, the ERP industry, and the Process-Centered Organization (Figure 1). Figure 1 illustrates the importance of SAP-UA in closing the gap between business education and business needs (Lee, et al., 1995a). Without the SAP-UA, isolated partnerships (represented by numbers 1, 2 and 3 in Figure 1) must be established among the three entities (Business Education, ERP Industry, and Process-Centered Organization).

Basically, the SAP-UA Program provides an academic entity (e.g., a University, College, School, or Department) with a completely functional SAP R/3 system for teaching and research. The program provides significant learning opportunities in the classroom. Students can develop a deeper and broader understanding of both the role that ERP Systems plays in a process-centered organization and the challenging task of
implementing and managing the ERP system function. From the basic business processes to the development and administrative activities of an enterprise system, there are many valuable hands-on learning experiences. Such an alliance offers hands-on exposure to a real ERP system and a repository of related resources (Watson and Schneider, 1999).

Figure 1 - SAP University Alliance (SAP-UA), Where Business Education Meets ERP Industry and the Process-Centered Organization.

The advantage of using information technology in education is that students are introduced to, and learn to apply, the very technologies businesses are using to gain competitive advantage (Leidner and Jarvenpaa, 1993). Given some of the advantages provided by the new information technology to Business Education, how then does an institution integrate a commercial ERP System such as the SAP R/3 System into their academic environment?

1.3. Integration of SAP into the Business Curriculum

To date, there is not a model for how to integrate the SAP R/3 System into the Business Curriculum. However, current integration efforts in several institutions provide support to the fact that to capitalize on the benefits of integrating the system into an
academic environment, an institution must first identify how to use the new information technology. Once a decision has been made to use the system, a set of questions tends to resolve around the implications of such system on business education (i.e., curriculum development, instruction, and assessment).

1.3.1. SAP R/3 System Use in a Business Curriculum

A number of potential applications of the SAP R/3 system in Business Schools have been identified (Watson and Schneider, 1999):

1. R/3 as a computer-based simulator:

Simulations are representations of reality and provide an interactive learning environment. The learners' actions are followed by feedback that allows the learner to deduce relationships between the variables and to formulate hypotheses about the effects of future manipulations. “Students learn not by memorization but by doing, albeit in a simulated environment” (Ives and Jarvenpaa, 1996). Business schools are known for their business simulators that create pseudo-corporate environments and challenge the decision-making skills of the students that play them. ERP systems provide such an environment in which to work. Compared to traditional simulators, ERP systems would be simulated at the transaction level. Unfortunately, such capabilities do not necessarily exist in commercial systems. Thus, to use R/3 as a computer-based simulator requires further research into the capabilities of specific systems.

2. R/3 for exposing students to the real business world in the classroom:

An ERP system provides a 'real-world exposure.' Students can take a look inside and see how the ERP system is built and can take it for a test run. After a few years of a traditional "stove-pipe" business education, students still have trouble understanding how
all the components of an integrated system fit together. The ERP system provides this perspective. Students also have access to the “best practices” business models available in ERP systems.

3. R/3 for supporting a cross-functional curriculum:

Cross-functional business programs have recently regained popularity. ERP systems can be customized to fit the business processes (cross-functional) defined by an organization. As such, cross-functional case studies can be developed for an ERP system where students are required to solve a business problem using that system. Any ERP-based exercise is a cross-functional exercise, but in-depth ERP-based case studies (that rival popular cross-functional Harvard Business School cases) are only beginning to develop.

4. R/3 for enriching specific curricula:

Many business schools are now seeking ways to increase the use of technology-supported learning in their existing programs. Specific curricula, at the local level, can easily be enriched using an ERP system, as this paper illustrates. Traditional ERP educational material, generally geared toward an end-user audience, must be reworked in order to consider it university-level educational material.

5. R/3 for research:

ERP systems create research opportunities. How these systems are developed, implemented, used, and how they will grow, present many opportunities for research.

6. R/3 for creating a competitive advantage:

As indicated earlier in this chapter, an industry has been created based on ERP systems success. These systems spawned a new job market that has consulting firms and
corporate leaders rethinking recruiting strategy. In addition, they provide an opportunity for academic units to develop a competitive advantage over rival schools.

Engaging in an ERP initiative can be justified simply by the need to know. Universities are criticized for their ignorance of and isolation from industry. Students and faculty knowledgeable about ERP systems help enhance the credibility of business schools in the eyes of industry. Watson and Schneider (1999) suggest that all of the above ways to use the SAP R/3 System are reasonable but some are more difficult to achieve than others. In addition, a significant amount of time, effort, and money is required to ensure a successful integration of the SAP R/3 System into the business curriculum (Watson and Schneider, 1999).

To date, the SAP R/3 System is being used primarily, with the objective of providing Business/IS students exposure to the real-world from the classroom. In addition, the SAP R/3 System is being used to enrich specific curriculum such as operations management, management information systems, accounting, human resources, etc. However, as stated by Horgan (1998), “Many well-meaning efforts at integrating technology into the curriculum have failed because they begin with the technology, rather than with teaching and learning outcomes.” Thus, after identifying the potential use of the SAP R/3 System in Business Education, one must focus on the implications of a particular use of the system in content, instruction, and assessment.

1.3.2. Implications of Using the SAP R/3 in Business Education

The field of Instructional Technology (IT-in education) embraces the ideas that determine how learning should be designed and the implications of integrating the SAP R/3 System into Business Education. Figure 2 illustrates how important developments in
Instructional Technology in education are in determining the most effective way to integrate the SAP R/3 System into business education.

Figure 2 - Instructional Technology in Education (IT in Education), Where Business Education Meets the SAP R/3 System.

For the purpose of this study, instructional technology is defined as the use of any Information Technology means (i.e., systems, computers, CD-ROMs, CBT, interactive media, modems, satellite, teleconferencing, etc.) to support learning.

The use of the SAP R/3 System as a teaching tool, to support learning in business education, has serious implications for decisions regarding curriculum development (selection and scope of the content), instruction (which organizational, delivery, and management strategies should be employed when presenting that content), and assessment (determining effectiveness of the new learning environment).

1.3.2.1. Curriculum

The educational implications of the SAP R/3 System, to support business education, are substantial and not difficult to demonstrate in relation to course content.
and quality, but the system's real effectiveness in student performance is unknown. In content, the SAP R/3 System allows departments to undertake realistic laboratory work (supplement theory with hands-on application) in support of courses relating to ERP, IS strategy, Business Process Reengineering (BPR), Electronic Commerce (EC), Supply Chain Management (SCM), and Change Management. Furthermore, the R/3 system supports the teaching of practical knowledge concepts such as integrated business processes, workflow, system administration, process mapping, etc.

In quality, a basic effect is to facilitate a change from teacher-centered methods of instruction of a high prescribed and closed nature to various student-centered approaches. Examples include laboratory classes with hands-on training, Graphical User Interface (GUI) navigation, GUI design, transaction processing & control, management reports, system management, testing, etc. In addition, an integrated software system such as the SAP R/3 System can be used to give students an appreciation of information systems (client/server systems) and the data-processing (relational databases) principles involved in areas such as accounting, finance, manufacturing, etc. These systems give students insight into many issues, for example, source document design and use; data integrity and security; and accounting, finance, manufacturing, etc., principles in real practice.

Thus, the SAP R/3 System in business education provides a number of benefits in content and quality of student learning/experiences and, almost incidentally, better prepares them for the world of work.

1.3.2.2. Instruction

A major implication of integrating the SAP R/3 System into the business curriculum is related to the delivery of the information (lectures) in the conventional
instruction mode. In general, conventional instruction is marked by instructor-provided learning objectives and assignments, large-group lectures, structured laboratory experiences, and periodic multiple-choice tests of achievement. The R/3 system could significantly affect the role of teachers, as well as the structure of schools and classrooms in the conventional classroom. For example, the most popular approach to delivery of concepts and facts is the lecture/textbook combination. In a typical lecture, a body of knowledge, including facts and concepts, is doled out in fifty-minute increments to a group of students by an instructor who talks for the vast majority of that period. The use of the SAP R/3 System as a teaching tool in the classroom could change the teacher's role from expert to facilitator or coach.

To supplement the lecture and textbook, most instructors provide homework exercises. These exercises usually serve two purposes — to let the student practice with the material and give early feedback on learning outcomes (this approach derives from the "active learning" literature, Bonwell and Eison, 1991). The SAP R/3 System can be used to supplement lectures by providing the interactive learner with the opportunity to experiment with concepts in a variety of settings. It provides opportunities to use a concept in a framework that can be designed to reinforce learning.

1.3.2.3. Assessment

A relationship must be established among content, instruction, and assessment. In general, computer-based instruction methods are assessed by using procedural and exploratory types of questions. On the other hand, conceptual and factual questions are used in traditional instruction methods. Furthermore, instruction will focus more and more on building feedback loops directly into the learning process.
Thus, our understanding of what students should learn, the effective ways to help them learn, and assessment of how much they learned should drive our instruction. On the other hand, information technology should serve content and pedagogy. Yet information technology has changed content and allows new forms of effective pedagogy.

1.4. Research Questions

Watson and Schneider pointed out:

For academic entities interested in providing an experiential-learning based hands-on approach to ERP systems education, there are a number of issues to consider. For example, what is the objective of an ERP initiative, how is an ERP system utilized by students, how does this enrich the curriculum, what are the benefits, and what are the costs? (1999)

To date, the educational benefits of instructional uses of the SAP R/3 System have been established on the basis of anecdotal statements from faculty and students rather than on empirical and objectively measured data secured by educational research methods. On the other hand, there is no single research effort focusing on the question related to the effectiveness of using the SAP R/3 System to facilitate knowledge/skills and understanding of contemporary business processes at the undergraduate or graduate levels.

The fact is, when new instructional methods are developed, the problem of assessing the method arises. Research questions such as the following should be answered:

1. Does the new instructional method improve student performance?
2. Does the new instructional method promote a positive attitude of acceptance?
3. Does the new instructional method heighten interest in further study of the subject matter?

4. What are the longitudinal effects on retention in the new instructional method?

5. What is the cost of the old versus the new instructional method?

6. What specific group activities work best in helping students learn particular concepts and develop particular skills?

7. What types of assessment procedures and instructional materials best inform teachers about students' understanding?

These are but a few of the possible research questions that might be considered.

This research focuses on effectiveness issues that address the following specific research questions in the context of ERP education:

(1) How effective is an instructional method that uses the SAP R/3 System as a support tool when compared to the traditional instructional method? (2) Does it lead to higher levels of performance, self-efficacy, and satisfaction?

1.5. Objectives

The main objective of this study is to determine whether or not student performance, self-efficacy, and satisfaction are enhanced by a particular method of instruction (i.e., traditional instruction, computer based hands-on the SAP R/3 System and computer based simulated hands-on the SAP R/3). Specifically, the question is whether using the SAP R/3 System, as a support tool for instruction, facilitates the gaining of knowledge and understanding of business processes (i.e., Manufacturing Planning and Execution Cycle, Order-to-Catch Cycle), focusing on relations among
functions, logical connections and SAP system's rules and coverage of the different operating steps.

A second objective is to determine whether or not learning styles as assessed by the Learning Style Inventory (Kolb, 1985) affect learning outcomes within the instructional methods.

1.6. Contribution of the Study

Stohr pointed out:

First, we have an obligation to our students and their future employers to teach effectively and to deliver an appropriate curriculum. Second, as the competition between business schools intensifies, teaching and curriculum issues are receiving more emphasis and teaching performance is becoming a more important input to faculty salary and promotion decision... There is therefore a pressing need for both IS practitioners and academics to understand the basics of effective teaching and to develop educational programs that fit the needs of their constituencies. This is specially true because the tools of our own profession, computers and communication networks, promise to revolutionize the business of education. (1995)

From an educational research standpoint, the information collected in this study can be used to build a body of knowledge about students' learning process when learning about ERP systems. It answers an important question that still needs to be asked: how does the use of an ERP system improve student learning of particular concepts and help overcome particular misconceptions? For example, what kind of hands-on exercises work best in developing the idea of particular concepts, such as a business process? Results of this research, along with the base of knowledge already existent on the use of information technology to enhance education, will help universities rethink what, in business education, is most important to learn; how it should be taught; and what evidence of success they should seek.
The results of the study will have strong implications for the education-information technology research stream. The education sector can be guided by a better understanding of the way an enterprise system can be integrated into the business curriculum. In addition, it is expected that this study will provide valuable empirical information on the integration of the SAP R/3 System into the business school curricula as a primary teaching tool to promote a more effective learning environment for business education.

1.7. Organization of this Document

In Chapter 2, the fundamental concepts used in previous educational models are established and some previous significant research is discussed. Training models are discussed and utilized as theoretical framework to develop a research model in Chapter 3. The research methodology employed in this study and discussion of variables and hypothesis to be tested are examined in chapter 4. Chapter 5 discusses data collection and data analysis. Data analysis and results are reported in Chapter 6. The discussion and conclusions of the study are reported in Chapter 7 and contribution and limitations are presented in Chapter 8, along with future research directions and suggestions.
2. LITERATURE REVIEW

This chapter provides an overview of the important theoretical and empirical findings in the process of integrating information technology into the classroom. First, three main questions to be addressed when integrating Information Technology (IT) into Education are examined: 1) How do students learn and what should be learned? (learning theory and curriculum development), 2) How should learning be designed? (instructional design), and 3) How will we know if learning occurs? (assessment). Then, a number of areas of interest and research that focus on specific information technology issues and their relation to education/training are presented. This review focuses on an examination of Learning Theory and Instructional Design.

2.1. Learning Theory and Curriculum Development

When describing how students learn or think, a particular learning theory has implications for the way of structuring the learning material (curriculum development) and the role of the student in the learning process (learning style) (Kolb, Robin, and McIntyre, 1974). On the other hand, determining the effectiveness of computer-related technologies on learning must take place within a theoretical framework to be meaningful (Jarvenpaa, et al., 1985). Thus, this research uses the Experiential Learning Theory (Kolb, 1984) as platforms to investigate learning effectiveness of computer-supported instruction.

The Experiential Learning Theory (Kolb, 1984) conceptualizes the learning process in such a way that differences in learner styles and corresponding learning environments can be identified. Briefly, the theory contends that an effective learner has four different abilities (called learning modes) – concrete experience (CE) skills,
reflective observation (RO) skills, abstract conceptualization (AC) skills, and active experimentation (AE) skills (Figure 3). That is to state that the learner must be able: 1) to get involved fully, openly, and without bias in new experiences, the emphasis is on feelings as opposed to thinking; 2) to reflect on and interpret these experiences from different perspectives, the emphasis is on understanding as opposed to practical application; 3) to create concepts that integrate these observations in logically sound theories, it emphasizes thinking as opposed to feeling; and 4) to use these theories to make decisions and solve problems leading to new experiences, the emphasis is on practical applications.

The basic premise of experiential learning theory is a simple description of the learning cycle, of how experience is translated into concepts that, in turn, are used as guides in the choice of new experiences (Kolb, Rubin, and McIntyre, 1974). Each step or mode (Figure 3) emphasizes different preferences. Using Concrete Experience (CE), individuals immerse themselves affectively in the immediacy of the learning experience. Those preferring Abstract Conceptualization (AC) take a rational and logical approach. With Reflective Observation (RO), a person impartially views a situation from many different perspectives. Those using Active Experimentation (AE) risk active participation in learning with “hands on” approaches. Typically, an individual begins the learning cycle by first having an immediate experience, which becomes the basis of observations and reflections. The individual then assimilates these observations and reflections into testable hypotheses, the learner creates a new concrete experience and starts the cycle anew.
Kolb (1984) asserts that people prefer learning methods based on how they combine the learning abilities represented in each mode; he defines four learning styles (Figure 3). Diversers combine CE and RO preferences and enjoy using their imagination. Assimilators link RO and AC skills and excel at inductive reasoning and integrating disparate observations. Convergers prefer the AC and AE modes and prefer practical problem solving and decision making. Accommodators use AE and CE and prefer actively learning in situations where they can exercise pragmatic approaches.

Figure 3 - Kolb's Model of Experiential Learning (Kolb, 1984)

Kolb, Rubin, and McIntype (1974) developed a self-description inventory, the learning style inventory, also called the Kolb Learning Style Inventory to measure an individual's strengths and weaknesses as a learner (learning style). The inventory yields six scores: concrete experience, reflective observation, abstract conceptualization, and
active experimentation, plus two combination scores that indicate the extent to which the individual emphasizes abstractness over concreteness (abstract conceptualization-concrete experience) and the extent to which an individual emphasizes active experimentation over reflective observation (active experimentation-reflective observation). Four dominant learning styles can be identified from these scores: the converger, the diverger, the assimilator, and the accommodator (Figure 3).

The converger’s dominant learning abilities are abstract conceptualization and active experimentation and their greatest strength lies in the practical application of ideas. The diverger (opposite of convergers) is best at concrete experience and reflective observation with strong imaginative ability. The diverger excels at viewing concrete situations from many perspectives. The assimilator’s strengths are in abstract conceptualization and reflective observation and are strong in creating theoretical models. Finally, the accommodator (opposite of assimilator) is best at concrete experience and active experimentation and his/her strength lies in performing tasks such as carrying out plans and experiments.

The scores from the Kolb Learning Style Inventory form can be plotted on a graph with a difference (active experimentation-reflective) observation score on x-axis and a difference (average abstract conceptualization-concrete experience) score on y-axis. Intersection of these two average scores determines the location on one of the quadrants on the graph. The first quadrant represents a diverger, the second an accommodator, the third a converger, and the fourth an assimilator (Figure 3).

The Kolb Learning Style Inventory has been criticized as having poor construct and face validity, poor reliability, and an abnormal distribution (Atkinson, 1989; Ruble
and Stout, 1993). Atkinson (1991) evaluated the Kolb Learning Style Inventory and reviewed studies of the inventory's design, reliability, and validity. Findings suggest that the inventory has weak internal consistency and weak stability. The 1985 revision of the Kolb Learning Style Inventory seems to have improved internal consistency, but stability and classification reliability were unchanged.

Bostrom, Olfman, and Sein (1993) maintain that even though available learning style instruments require additional validation, important research cannot always wait for the perfect measurement. Bostrom, Olfman, and Sein (1993) further state that imperfection in the 1976 version of the Kolb Learning Style Inventory did not significantly affect the operationalization of learning style in their studies. This research will use the Kolb Learning Style Inventory to measure the learning styles of end users as suggested by Bostrom, Olfman, and Sein (1993).

There is a relationship between Kolb's Experiential Learning Theory and Learning Styles. If one assumes that all experiential learning flows sequentially through Kolb's four stages of learning described earlier (Kolb, 1984), all four of Kolb's learning types experience these four stages. Even though all learners cycle sequentially through Kolb's four learning stages while learning new material, not all learners can apply what they have learned effectively and equally. Because of their traits (as opposed to state) each learner ultimately applies what they have learned according to Kolb's four learning styles. Thus, learning style is a trait-based phenomenon, whereas the learning process is a state-based phenomenon. State refers to temporary behavior whereas trait is based on the long-term behavior of an individual (Spence, 1995).
The Experiential Learning Model (Figure 3) provides two fundamental dimensions to the learning process: (1) concrete experiencing (CE) of events at one end and abstract conceptualization (AC) at the other and (2) active experimentation (AE) at one end and reflective observation (RO) at the other.

The first dimension, CE-AC, provides the basis for curriculum development with respect to the content of instruction (Figure 4). It represents two types of information content provided to students during instruction: procedural knowledge and concepts and general knowledge (Simon et al. 1996). Procedural knowledge emphasizes sequences of steps that tell us how to reach a goal, such as steps necessary to complete a customer order transaction in software application such as the SAP R/3 System. On the other hand, concepts and general knowledge emphasizes the more abstract concepts and principles in some area and tell us, for example, why an integrated system is important to manage customer orders and provides background information about computers – some history, components, and how computers work. Nearly, all learning tasks can be taught either procedurally or declaratively or both. For example, we can know how to complete a customer order without knowing why, and vice versa. In the case of the SAP R/3 System use, conceptual knowledge provides students with key concepts and information on business processes. It helps students understand the reason to perform a particular procedure using the system. On the other hand, procedural knowledge provides step-by-step instructions to help students perform SAP tasks (transactions), some tasks of which can be demonstrated by the instructor during class.

The second dimension (Figure 4), AE-RO, represents a chain of instruction methods (Simon, et al., 1996). First, at one end of the chain is the traditional instruction
method that corresponds to reflective observation (RO), a condition where the learner/trainee has a passive role in the learning process, the student listens and reflects on the ideas presented by the instructor. Second, the instruction method, behavior modeling, is a non-traditional technique occupying the middle of the chain. This method seeks to change the environment and conditions through which the student understands and grasps material. The delivery is one that uses a combination of the previous concepts, providing a lecture format driven by specific learning points and hands-on experimentation. During the modeling treatment there is continuous feedback between the instructor and the students, which encourages student participation and experimentation (Simon, et al., 1996).

![Comprehensive Experimental Training Model (Simon, et al., 1996)](image)

Third, at the other end of the chain (Figure 4) is the exploration instruction method, it matches the active experimentation anchor. This instruction technique
emphasizes the concepts of hands-on interaction and practical application as a means to learn the material.

Kolb’s Experiential Learning Theory and Learning Styles (Kolb, 1984; Simon, et al., 1996) provide an approach to learning that emphasizes the fact that individuals perceive and process information in very different ways. The theory implies that the amount of learning by an individual is a function of the fit between the educational experience being provided and an individual’s particular style of learning. The most effective methods of educating/training need to be matched with the specific needs and learning styles of individuals (Nelson, 1991). As a result, the experiential learning theory as well as an individual’s learning style has implication for curriculum development, instruction, and assessment.

Educators must place emphasis on intuition, feeling, sensing, and imagination, in addition to traditional skills of analysis, reason, and sequential problem-solving when developing curriculum material. Instruction methods should be designed to connect with all four learning styles using various combinations of experience, reflection, conceptualization, and experimentation. For example, instructors can introduce a wide variety of experiential elements into the classroom, such as sound, visuals, movement, experience, etc. A variety of assessment techniques should be employed that focus on the development of “whole brain” capacity and each of the different learning styles.

2.2. Instructional Design

Instructional design in education is like what architecture is to the building industry (Jegede, Walkington, and Naidu, 1995). In a particular learning environment, the expected outcomes of learning are predetermined and are dependent on an efficient and
effective design of instructional materials often undertaken by a group or team using relevant ideas from learning theories (Jegede, et al., 1995).

The design and development of the course modules for the lessons that comprise the treatments for this study is carried out following an instructional system design (ISD) approach (Rothwell and Kazanas, 1998) to prescribing optimal learning performance. The goal of ISD is adaptive instruction, that is, tailoring learning materials to the particular learning needs of the student at a particular time. ISD seeks to individualize instruction by adapting to student needs, as these needs are inferred by the system. Thus, adaptation requires that all students' needs and system responses be essentially preplanned and provided for explicitly in the system (Duchastel, 1986; Rothwell and Kazanas, 1998). The ISD approach of instruction involves the following main steps (Figure 5):

1. Requirement Analysis

   It involves students' needs assessment, students' characteristics, class environment, and analysis of job, task, and content (Figure 5).

Students' needs assessment

   The purpose of the needs assessment, as stated by the author (Rothwell and Kazanas, 1998), is to uncover precisely what the human performance problem is, whom it affects, how it affects them, and what results are to be achieved by instruction. A number of studies have reported on the educational needs (knowledge/skills) that Information Systems and End-User personnel must posses to successfully perform their jobs (Cheney and Lyons, 1980; Nelson, 1991; Trauth, et al., 1993; Lee, et al., 1995a).
Nelson (1991) reviews the literature pertaining to learning needs of two distinct classes of employees: IS and end-users personnel. Then based on his research findings, he provides a number of recommendations to IS practitioners and academicians: 1) improve the general IS knowledge of all employees. For example, it is apparent that both IS and end-user personnel need to know more about such issues as the use of IS/IT for competitive advantage, the fit between IS and the organization, and the potential for information systems and technology within the organization. On the other hand, given the role that higher education plays on the early stages of employee development, it is recommended that universities pay more attention to the IS-related education of all students, regardless of major; 2) improve the organizational knowledge of IS personnel. IS employees need to know something about the environmental constraints within which the organizations operates (e.g., government regulations, supplier relationships, competition, etc.); 3) improve the technical and IS product-related skills of end users. Technical and IS product-related skills need to be learned as early in a student’s education as possible and then updated and applied throughout the remainder of his or her career; 4) educate IS and end-user personnel to make each more sensitive to the other’s problems. There is a need to close the communication gap that frequently arises between groups of personnel with dissimilar backgrounds. Often, IS personnel do not know enough about the business they operate within, and end users do not know enough about technology and its potential use within the business. Thus, the communication gap is due, to a great extent, to the lack of knowledge between the two groups, thereby undermining productivity within the organization. Education and training programs requiring group discussion provide excellent opportunities to facilitate exchange of personnel between
functional areas; and 5) conduct periodic needs assessments. A number of steps should be undertaken to address the specific needs of individual organizations: a) conduct knowledge/skill needs assessment, b) determine requisite areas of significant deficiency, c) determine appropriate education/training programs, d) implement education/training program(s), and e) conduct post-education/training assessment.

Lee, et al. (1995a) reports on the impact that current changes in the Information Systems (IS) field have on the skills and knowledge requirements of IS professionals. He investigates four broad categories of critical IS knowledge/skills requirements: 1) technical specialties knowledge/skills, 2) technology management knowledge/skills, 3) business functional knowledge/skills, and 4) interpersonal and management knowledge/skills. Then he relates these requirements to the academic preparation of future IS professionals. He recommends focusing on the career path of the graduates when designing IS curriculum. For instance, two alternative curriculums could be designed, one might prepare IS graduates to work in the central IS organization. Such a curriculum would focus on technology specialties and technology management. The other curriculum might focus on the growing area of integrating information technology with business needs (i.e., reengineering). Such a curriculum would require a radically different combination of courses in technology, business, and behavioral science. Furthermore, the content of various courses in each curriculum must be designed specifically to meet the program's particular career path objectives. For example, the content of the systems analysis course would differ significantly for these two types of programs. Systems analysis for the central IS organization would place new emphasis on business planning and integration; whereas, systems analysis for the users would shift
from the traditional systems development life cycle to business analysis and rapid prototyping. In addition, some topics, such as systems integration, would be emphasized across different IS curricula, but with different orientation. If a program is preparing people for careers in the central IS organization, then the topic would focus on integrating the components of the information technology infrastructure: hardware, software, data, and systems. If, on the other hand, students are preparing for career in functional areas, the topic would focus on integrating solutions across facets of the business operation.

![Diagram of Designing Instructional Material](image)

**Figure 5 - Steps for Designing Instructional Material**

**Learners' characteristics**

Researchers have identified the importance of human factors within the information systems domain and in various disciplines such as education, psychology, and computer science (Mason and Mitroff, 1973). One of the key variables that has been
emphasized, in prior research, is the importance of individual differences in the learning process (Bostrom, et al., 1988).

Research on individual differences such as cognitive processes and skills (Todd and Benbasat, 1987; Ramaprasad, 1987), cognitive style (Benbasat and Taylor, 1978), learning styles (Bostrom, et al., 1993), and demographic differences (Parasuraman and Igbaria, 1990) indicates their influence on individual performance.

To be effective, an education/training method needs to be matched with the specific needs and learning styles of individuals (Nelson, 1991, Bostrom, et al., 1990, Kolb, 1984). On the other hand, educational institutions are being challenged to respond to the increasing diversity of students (i.e., variation in motivation, time management, learning styles, maturity, etc.).

To deal with diversity in the student population, institutions must address two main issues. First, students' roles in the educational process should be conceptualized in ways that go beyond the traditional view of them as customers for, or recipients of, education. Students are the raw materials for education and the primary products of educational transformation; and, most important, they are key members of the labor force involved in creating education (Lengnick-Hall, 1996; Lengnick-Hall and Sanders, 1997). Then, a measure of diversity must be established that includes selected demographic, experiential, and learning style differences among students. Since the focus must be on learning, learning style differences are expected to be among the most crucial measures of diversity. Kolb (1984) defines learning styles as the way people learn and how they solve problems and deal with new situations and information. Kolb's experiential
learning theory and learning style inventory (Kolb, 1984) provide a means to match instruction and students characteristics as explained in section 2.1.

Thus, individual differences among students as raw materials (e.g., learning styles, cultural orientations, experience, and interest) must be met by equally diverse learning process options (e.g., assignments, application contexts, methods for presenting material) if consistent, high-quality outcomes (i.e., learning and high levels of satisfaction) are to result (Lengnick-Hall, 1997).

Class environment

One must ensure that instruction is prepared with regard to available resources, constraints, and culture of the institution. The class environment must focus on three related environments: 1) the development environment, meaning the setting in which instruction will be prepared; 2) the delivery environment, meaning the work settings in which instruction will be presented; and 3) the application environment, meaning the work settings in which learners will be expected to apply what they learn (Rothwell and Kazanas, 1998).

Analysis of job, task, and content

Job analysis examines what people do, how they do it, and what results they achieve by doing it. Task analysis involves examining how people perform work activities. A task is a discrete unit of work performed by an individual. Training literature is full of information on developing task-oriented training documents, such as training manuals. Tasks are divided into two major types: a) cognitive tasks are performed mentally (i.e., select a personal computer), and b) action tasks, have a set of clearly
defined steps that are observable, independent of other actions, and can be measured and observed (i.e., update a computerized mailing list).

Human ability and task skills, in combination, affect the learning process when acquiring computer skills (Gattiker, 1992). In addition to task skills, Gattiker (1992) discusses the relationship between task constraints and the computer skills necessary for employees to satisfactorily perform computer-mediated tasks on-the-job. Gattiker (1992) identifies three constraints of task—transfer-of-learning, complexity, and consistency.

An individual’s performance will be superior if there is an increasing degree of positive transfer-of-learning (Gattiker, 1992). Transfer-of-learning depends on the similarity between two tasks. For example, an individual’s familiarity with WordPerfect (Ver. 5.1) software may aid in learning other word processing software such as Microsoft Word (Ver. 6.0) for windows. Task complexity depends upon how easy is it for an individual to learn a new task. For example, a novice user may perceive learning a new software package a more complex process than an individual familiar with a similar software package. The perceived complexity of the technology increases the demand upon the individual’s cognitive resources, thereby limiting the transfer-of-training from a previous job situation (Gattiker, 1992). Task consistency also demands different levels of cognitive abilities depending upon the degrees of consistency between tasks (Gattiker, 1992).

Content analysis addresses the question: What should students learn? Two types of content are defined: concepts and procedures. Concepts are fact-based, ‘knowing that’ or ‘knowing about.’ For example, basic definitions, properties, notation, concepts, relationships, principles, etc., are fact-based concepts. Procedures are task-based,
'knowing how'; the steps of procedures are ordered with respect to time. For example, analyze a system, select a model, formulate a model, use computer software, etc., are task-based (Simon, et al., 1996).

There is a strong relationship between the content delivery during a class and teaching method (Leidner and Jarvenpaa, 1993). For example, Leidner and Jarvenpaa (1993) found that in-class learning had a procedural focus when computer-based methods were employed and a theoretical focus utilized traditional methods. In-class learning also depends upon how content is presented to the class. For example, Lusk and Kersnick (1979) measured the effect of the presentation mode on learning and performance. Subjects in their experiment perceived tables to be less complex than graphs. However, Jarvenpaa and Dickson (1988) and Dickson, DeSanctis, and McBride (1986) found that the relationship between the presentation format and performance depends upon task complexity.

2. Set Objectives and Performance Measurement

Instructional designers convert the results of task or content analysis into specific performance objectives by three steps (Rothwell and Kazanas, 1998): 1) In establishing instructional purpose; purpose means the primary reason for a planned instructional experience. There are typically four choices: a) increasing learners’ knowledge, b) changing attitudes or feelings, c) building skills, or d) combining one or more of the other three choices. 2) In classifying learning tasks, one must ask the question: What kind of instruction will be necessary to instruct people to perform this task or demonstrate this knowledge? Only four answers to this question are possible. Instruction can be designed
for a) knowledge, b) feelings, c) skills, or d) some combination of the first three. 3) Finally, analyzing the learning task is the last step.

After defining instructional objectives, a set of performance measures can be used. Some types of performance measures are essay, fill-in-the-blank, completion, multiple-choice, true-false, matching, projects, etc.

In the context of teaching effectiveness, in addition to performance, a number of learning outcome variables such as student involvement and participation, cognitive engagement, technology self-efficacy, attitudes toward the technology employed and the usefulness of the technology have been suggested (Leidner and Jarvenpaa, 1995). Students' level of involvement and participation in the learning process are particularly important to teaching effectiveness. Learning is best accomplished through the active involvement of students (Leidner and Jarvenpaa, 1993; Alavi, et al., 1995).

The concept of self-efficacy (Bandura, 1986) is relevant to teaching effectiveness. Compeau and Higgins (1995a) suggested that "the belief that one has the capability" to interact with a given technology plays a significant role in users' expectations and performance.

3. Delivering the Instruction Effectively

A systematic instructional design approach requires the design and development of the presentation and the management of instruction once the objectives have been defined for a course or lesson. It includes choosing the appropriate instructional strategy and then designing the instructional material (Figure 5). In a general sense, strategies are a set of decisions that result in a plan, method, or series of activities aimed at obtaining a specific goal. A strategy is like a blueprint, it shows what must be done, but does not
Instructional strategies describe a general approach to instruction but do not prescribe how to organize, sequence, or present in instruction (Jonassen, et al., 1990). Thus, instructional strategies are the plans and techniques that the teacher or instructional designer uses to engage the learner.

Designing Instructional Material: The Minimalist Theory

The Minimalist theory is a framework for the design of instruction, especially training materials for operating a computer. It is based on the following minimalist principles: (1) all learning tasks should be meaningful and self-contained activities, (2) learners should be given realistic projects as quickly as possible, (3) instruction should permit self-directed reasoning and improvising by increasing the number of active learning activities, (4) training materials and activities should provide for error recognition and recovery and, (5) there should be a close linkage between the training and actual system users (Carroll, et al., 1987; Lazonder & Van der Meij, 1993). Previous research in the computer software training domain provide examples of training manuals designed to reflect both exploration-based and instruction-based instructional approaches (Davis and Bostrom, 1993; Carroll, et al., 1987). The Carroll, et al. (1987) manual uses an exploration-based approach to train users on word processing programs. The exploration manual encourages an inductive approach to learning by requiring subjects to first work through examples provided to them, then create examples on their own. To encourage subjects to explore the computer system, the exploration manual is left incomplete (hence, the name “minimal manual” – coined by Carroll, et al., 1987). On the other hand, the instruction-based manual encourages a deductive approach to learning. First, it presents subjects with general rules for performing commands or operations.
Then it follows these rules with specific examples. Unlike the exploration manual, the instruction-based manual is relatively complete. That is, it leaves little control to the learner. In addition, it emphasizes specific features of the system rather than overall tasks.

2.3. Assessment

Following the analysis of the learning process (how students learn and what they should learn), the design of the instruction, and the production of the instructional program, it is desirable to determine if the instruction program works and what the students have learned. The assessment of the learning environment can be divided into two parts: formative evaluation and summative evaluation. The use of formative evaluation will permit the instructional developers to improve the quality of the current and future materials. Specifically, formative evaluation is used to define and refine the goals and methods during the design process. On the other hand, summative evaluation will ensure that there is a correlation between the intended instruction outcomes and the real ones. Specifically, summative evaluation is used to determine whether an instructional method is effective after it has been developed.

For formative evaluation, a pilot study is often implemented to generate qualitative information based on questionnaires given to the subjects about their opinion on the prototype instructional method. Based on the results of this pilot study, a number of issues such as content, delivery, and assessment are identified and improved for further implementation.

In terms of summative assessment, without doubt, a most interesting research topic is a comparison between technology supported instruction and the traditional instructional approach. The application of effective instructional methods is an important
consideration in educational and training programs (Alavi, 1994; Maul and Spotts, 1993; Kulik, et al., 1980). Consequently, this study will concentrate on the summative assessment, and specifically, on how effectiveness can be measured.

2.4. Related Previous Research

To date, there is no single research effort focusing on overall questions relating to the effective use of enterprise systems to support business education. There are, however, two broad categories of related studies: 1) a number of studies concentrate on the use of the computer as a tool that is utilized in the “classroom,” addressing children in primary schools or students in post-secondary education, and 2) several studies report on the use of the computer as a tool to be used in future work-related situations. Major concepts as well as the purpose, findings and limitations of relevant studies are discussed briefly in this section.

2.4.1. Education or Training

A distinction must be made between computer-based training (CBT) and computer-assisted instruction (CAI). CAI deals with learning as opposed to training, with the implication that certain aspects of education cannot be taught but can be learned. On the other hand, it is important to realize the word “assisted,” with the implication that it is the child or the adult learner who is central to the process (Curry and Moutinho, 1992). Research on CAI applications, where an interactive computer program is used for delivery of information in sequential or nonlinear modes to challenge a student’s knowledge and understanding of subject matter, are often reported when examining the educational use of computers (Alavi, 1994; Leidner and Jarvenpaa, 1993). CAIs provide a variety of instructional capabilities (i.e., drill and practice, test taking, games,
simulation), subject matter, feedback mechanisms, student's speed and sequence of material presentation control (Leidner and Jarvenpaa, 1995, 1993).

2.4.2. Computers Use in Education

A study was conducted to determine if two CAI design strategies affected the outcome of education when controlling for learning styles (Cordell, 1991). A statistically significant difference was found between the posttest scores for the two instructional design groups of CAI: sequential and non-linear (branching). However, no statistically significant difference was found for factor learning styles and there was no significant difference on posttest scores for the interaction of learning styles and instructional design. Cordell (1991) attributes the results to a number of limitations such as subject selection, volunteers who may not have been representative of the population in general, geographical location, and instrumentation (i.e., the learning style inventory may not be valid for all types of learners).

Niemiec and Walberg (1987) provide a synthesis of computer-assisted instruction research at all levels of implementation. Results indicated that typical effect of CAI is to raise outcome measures moderately by 0.42 standard deviation units. The average and typical effect of CAI is to place the average students using it at the 66th percentile of traditional groups. They based their finding on 16 literature reviews of CAI.

In a comparison between computer-assisted instruction and teacher-directed instruction, White and White (1997) reported that community college students receiving CAI exhibited higher computer competence than those receiving a teacher-directed method of instruction. The study included a number of dependent variables such as sex,
educational level, major, computer experience, retention rate, computer anxiety, and their interactions.

Kulik, et al. (1980) carried out a meta-analysis of past research from 1967 to 1978. A meta-analysis provides a statistical analysis of a large collection of results from individual studies for the purpose of integrating findings. Their meta-analysis was based on 59 studies conducted at the college level. In the meta-analysis, Kulik, et al. (1980) examined student performance levels on such attributes as learning, student attitudes, student course completion, instructional time, and the correlation between aptitude and achievement. They determined that computer-based instruction (CBI) raised students' achievement by 0.25 standard deviation units. They interpreted this to mean that the typical CBI college students performed at the 60th percentile as opposed to the 50th percentile for the control students (conventional instruction). With respect to the validity of the studies included in the meta-analysis, they found little relationship between design features of experiments and experimental outcomes. For the most part, design features of experiments did not influence outcomes. Quasi-experimental studies and true experiments produced similar results. Experiments with controls for historical effects yielded the same results as experiments without historical controls; nor, did settings influence findings in any substantial way. Only one variable predicted study outcome in the meta-analysis, and that was use of a design that controlled for instructor effects. Studies in which different teachers taught computer-based and conventional sections of a course produced more clear-cut examination differences and favored computer-based teaching. In studies in which a single teacher taught both experimental and control classes, differences were less pronounced.
2.4.3. Computer Use in Training (End User Training)

A number of studies have investigated the inputs, processes, and outcomes associated with training end-users to utilize computer systems and software in future work-related situations. Following Bostrom, et al. (1988), the input to the training process include cognitive characteristics of the trainee (i.e., cognitive style, learning style, abilities), the system/software to be learned (i.e., ease of use, task domain-system match), and the training environment (i.e., methods of training such as conceptual models). The outputs of the process are changes in the characteristics of the trainee (i.e., performance, attitudes). The training process includes exposure to the material to be learned and exercises to supplement this exposure.

Previous studies on EUT have investigated a variety of issues. Davis and Bostrom (1993) conducted a laboratory experiment to investigate the impacts of two types of training methods (exploration training and instruction-based training) and two computer interfaces (a direct manipulation interface (DMI) and a command-based interface). Users’ learning performance (hands-on use) and attitudes toward computer systems (perceptions of its ease of use) were the dependent variables. Analysis of the data collected indicated that only the computer interface effect was significant. Individuals using DMI performed significantly better than those using the command-based interface. On the other hand, there was no difference between the two groups in terms of perceived ease of system use. Furthermore, no significant difference was found between the two training methods. The authors attributed three possible limitations which affected the results on the training method. First, all subjects in the study were college sophomores, thus, it is highly likely that most of them were accustomed to very structured learning environments. As a result,
they may have been more comfortable with training that provided all steps for them, as the instruction-based training did. This, in turn, may have mitigated some of the effects of exploration training. Second, it might be possible that exploration training provides some advantages that may only be realized when individuals are given longer periods of time to use the system. And third, it may be that certain trainee characteristics that had been unaccounted for canceled out any effects of training methods.

The trainee is the focal point of end-user training. Each trainee brings their own set of personality traits and differences. Researchers have identified the importance of human factors within the information systems domain and in various disciplines such as education, psychology, and computer science (Mason and Mitroff, 1973). One of the key variables emphasized in prior research is the importance of individual differences in the learning process (Bostrom, et al., 1988). Individual differences include trainees’ experience with the software tool, task-domain knowledge, cognitive traits, motivational traits and so forth (Bostrom, et al., 1988). In addition demographic differences between individuals such as gender, age, years of experience, and job functions also influence end-user training.

Bostrom, et al. (1990) investigated the importance of learning styles. They provided a comprehensive list of prior studies on individual differences associated with learning about end-user software. They infer that learning is an important variable in the context of learning about software. The authors believe that while other cognitive traits lack the theoretical basis for expecting an effect, learning style is well-grounded in learning theory. There are several competing theoretical models about learning style, each having merit (Bostrom, et al. 1990). Bostrom, et al. (1990) chose to use Kolb’s
learning style theory in their research because it is widely used in research and practical information system applications.

Compeau and Higgins (1995a) examined the training process, and compared a behavioral modeling training program, based on Social Cognitive Theory (Bandura, 1977, 1986, 1991) to a more traditional, lecture-based program. The purpose of their study was to provide further insight into the questions of training method effectiveness and learning processes. The context of the study was Lotus 1-2-3 and WordPerfect training for professionals who had little or no knowledge about computers. Based on the Social Cognitive Theory premise that behavior modeling influences the observers' perception of their own ability to perform a task, the study basically compared behavior modeling versus non-modeling (lecture-based) training methods. The modeling method manipulation consisted of videotapes demonstrating the steps necessary to achieve certain tasks in Lotus 1-2-3 and WordPerfect.

Their findings established a strong influence of self-efficacy over performance in both training methods. They also found that behavior modeling was more effective than the traditional lecture-based model for training in Lotus 1-2-3, resulting in higher self-efficacy and higher performance. However, this was not the case for training in WordPerfect. The internal validity of these findings might have been affected by the fact that different actors were used in the videotapes and the fact that there was a practice session after measuring self-efficacy and before the performance test. The external validity may have been also threatened by the fact that the subjects were professionals in small organizations, and generalization to all types of organizations may be limited.
A number of studies have been conducted using either laboratory or field experiments to compare the effectiveness of instruction-based training (IBT) versus computer-based training (CBT) (Czaja, et al., 1986; Maul and Spotts, 1993; Bowman, et al., 1995). However, these studies have reported conflicting results.

When evaluating three training strategies (IBT, manual, and CBT) for their effectiveness in teaching naive computer users to use a word processing system, CBT was found to be a less effective teaching method than either IBT or manual-based training (Czaja, et al., 1986). None of the strategies were considered efficient, indicating a need for the development of appropriate training methods for computer tasks.

Maul and Spotts (1993) implemented a pretest/posttest experimental design to compare CBT and the classroom training approach. A total of 20 employees (10 employees per group) from a large local manufacturing company participated in the study. They were provided with a basic course stressing the fundamentals of pneumatic devices. Performance was measured by using a multiple-choice test. They found no statistically significant difference in learning. There was significant difference in instructional time with the CBT showing a large decrease. Two major limitations of this study was the small sample size (10 employees) and that it did not address the issue of stability of learning over a longer period of time.

Bowman, et al. (1995) conducted an empirical test to assess the effectiveness of CBT. They examined the effectiveness of CBT in teaching specific microcomputer software application skills at a western business college — specifically, the operating system, word-processing, spreadsheet, and data base skills typically taught in entry-level computer classes. The study compared two groups: 1) an experimental group using CBT
and 2) a control group using traditional lectures. Three types of variables were used to assess effectiveness of computer-based training: 1) totals for homework scores, 2) scores on each of two in-class examinations, and 3) survey measures of comfort level and satisfaction were used as a measure of performance by the control and experimental groups. They found no significant difference between the two groups. However, the control group expressed a significant preference for CBT. Bowman, et al. states that “it is important to note that lack of statistically-significant differences between CBT-taught students and the traditionally-taught students in this study do not automatically or uniformly apply to all other disciplines or all types of computer tasks” (1995).

The above studies indicate conflicting views about IBT versus CBT. Both IBT and CBT attempt to provide an understanding about a specific software tool; however, there is a tradeoff between the quality of training, the cost of training, and most importantly, end-user satisfaction with the training because it determines how well a specific training technique is accepted by trainees.

In summary, the results of the prior studies indicate that independent variables used were training methods, training content, and demographic variables. Dependent variables included performance and attitudes. The research models used field experiment, laboratory experiment, survey, or were quasi-experiments.

2.5. Summary

This chapter discusses the important theoretical and empirical findings related to information-technology (computer and communication) use in the classroom. Chapter 3 combines this literature review along with a theoretical framework to provide the research model used in the study.
3. THEORETICAL FRAMEWORK

In this chapter, the theoretical basis that defines the boundary for the current study is discussed. To measure effectiveness, this study is based on two research frameworks reported in the information systems literature (Leidner and Jarvenpaa, 1993; Bostrom, et al., 1988) to develop conceptualization of key technology-instruction learning outcomes relating to teaching effectiveness and of factors that may influence these outcomes. Specifically, the Leidner and Jarvenpaa (1993) research model for electronic classroom learning and the Bostrom, Olfman, and Sein (1988) end-user training model are used in developing a research model. Each is briefly described and based on the similarities and differences between these models; major constructs of the research model for this study are identified. The relationships between these constructs are then expressed as a set of hypotheses to be tested.

3.1. Leidner and Jarvenpaa's Electronic Classroom Learning Model

Leidner and Jarvenpaa (1993) conducted a case study to explore how computer technology is used in the university classroom and how computer-based teaching methods differ from traditional teaching methods in terms of class interaction and in-class learning. It is implied in the electronic classroom learning model (Figure 6) that subject matter, available technology, and instructor characteristics influence the training strategy. Students and instructor individual differences mediate the impact of the teaching strategy on class interaction and in-class learning. In-class learning and class interaction affect out-of-class learning and class performance. In-class learning refers to educational material learned in the class (from teacher's presentation); whereas, class interaction refers to the class discussion among students and between students and teachers.
Figure 6 - The Electronic Classroom Learning Model (Leidner and Jarvenpaa, 1993). Boxes around text have been added.

It is implied by the electronic classroom learning model that the effectiveness of class performance is contingent upon several factors. Leidner and Jarvenpaa (1993) suggest that new teaching methods may have to be developed in order to effectively use the technology. Thus, the importance of this work for the purpose of this study is not just the principle of integrating information technology in the classroom but Leidner and Jarvenpaa’s conclusion “that there are many potential computer-based methods and that the methods can have different outcomes; it is therefore the method of using the technology and not the technology itself that has an effect on classroom activity” (Leidner and Jarvenpaa 1993).

3.2. Bostrom, Olfman, and Sein’s End-User Training Model

Bostrom, Olfman, and Sein (1988) developed a model to investigate the training/learning process as shown in Figure 7. Their model was based on concepts from cognitive psychology, educational psychology, information systems, and computer science. The main components of the end-user training model (Figure 7) are: the trainee’s mental model, training outcomes, training methods, the target system, and individual differences. Each of the rectangles in Figure 7 represents a researchable set of variables;
each of the numbers in parentheses indicates linkages between the rectangles. In the model, the dotted lines of relationships 2 and 4 indicate that individual differences interact with the target system and/or training method to influence training outcomes. On the other hand, the solid lines and associated relationships are direct influences among variables. The main variables are explained in the following discussion.

![Diagram of the Research Model for End-User Training](image)

**Figure 7 - The Research Model for End-User Training** (Bostrom, Oflman, and Sein, 1990).

### 3.2.1. Trainee's Mental Model

The focal point of the end-user training model is the trainee's mental model. The basic premise of end-user training is that an individual can form a mental model of the target system by using the system (mapping via usage), by drawing an analogy from previous experience (mapping via analogy), and through training (mapping via training). Learning is viewed as a process of model transformation, that is a progression through
increasingly sophisticated mental models where each reflects a more adequate understanding of the target software (Bostrom, Olfman, and Sein, 1990).

3.2.2. Training Outcome

According to Bostrom, Olfman, and Sein (1990), generally there are two types of training outcomes: understanding (measured through learning performance) and motivation to use the system (measured through attitudes toward the system). Instruments to measure training outcomes depend upon the task for which an individual is trained. Correctness of the subject’s mental model of the system (relationship 7) and thus learning performance can be measured through several means such as performance in creative tasks, number and types of errors, and system comprehension. Attitudes can be directly affected by the target system (relationship 6) or by training method (relationship 8). Finally, attitude and learning performance may affect each other (relationship 9). In addition, outcomes may be measured before and after the training to determine the effectiveness of the training method.

3.2.3. Training Methods

Training can have several dimensions (Bostrom, Olfman, and Sein, 1990). One dimension of training can be in the form of group versus individual training and self-paced training. Another dimension of training is the training method. The training approach and use of conceptual models are the two main components of the training method. Previous studies report on two main training approaches: 1) exploration-oriented (inductive, trial and error, high learner control, incomplete learning materials, relevant task focus) and 2) instruction-oriented (deductive, programmed, low learner control, complete materials, features focus) (Bostrom, Olfman, and Sein, 1990). The use of
conceptual models is another component of the training method. A conceptual model is an instructional representation of a target system that will enable a learner to produce a mental model of the system. The two types of conceptual models are analogical and abstract. Analogical models represent the target software in terms of another system. Abstract models are synthetic representations of the target software (Bostrom, Olfman, and Sein, 1990).

3.2.4. Target System

The target system is the system the learner is attempting to learn. A target system could be a new application software package such as word processor, an interface such as direct manipulation or command-based, a new programming language, or a database. In general, to the user, the interface is the system. The interface can provide a model of a computer system by presenting a manipulatable equivalent of the conceptual model (as in icon-based [graphic] direct manipulation systems) or by presenting an implicit model through the functions provided by a command language or menu system (Bostrom, Olfman, and Sein, 1990). The target system may directly impact the training outcome as shown in Figure 7.

3.2.5. Individual Differences

Variations in human behavior, often expressed as individual differences among end users, may include cognitive traits (e.g., learning style, visual ability, cognitive process), motivational traits (e.g., self-concept, need for achievement, attitude toward computers), and demographic factors (e.g., previous computer experience, task domain knowledge) (Bostrom, Olfman, and Sein, 1988). Thus, differences among end-users make the individual (student) a contingent factor.
There are three ways by which individual differences influence mental model formation (Figure 7): direct influence (relationship 3), indirect influence via use of the target system (relationship 2), and indirect influence via the training method (relationship 4) (Bostrom, Olfinan, and Sein, 1990).

In summary, the end-user training model (Bostrom, Olfinan, and Sein, 1990, Figure 7) suggests that training outcomes (user attitudes and learning performance) are influenced by three important factors: characteristics of the target system (or the system being learned), training method, and trainee characteristics.

3.2.6. Summary of the Models

Several conclusions can be drawn from the two models. First, each model identifies learner (trainee), instructor (trainer), outcome, and training strategies/methodologies as primary variables.

The electronic classroom learning model (Leidner and Jarvenpaa, 1993) (Figure 6) is described in the context of academic education. The end-user training model (Bostrom, Olfinan, and Sein, 1990) (Figure 7) is described in the context of organizational employees. However, the two models refer to the same primary elements.

Second, the electronic classroom learning and the end-user training models view learner/teacher control variable as a subset of training method. It means that both learner and teacher have a certain level of control during the training process.

Third, even though the two models were developed for educating/training individuals, each model exhibits a different focus. The electronic classroom model focuses on effective use of the computer technology in the classroom. The end-user training model focuses on the end-user of information technology.
Fourth, the electronic classroom learning and end-user training models do not address learning strategy as a separate variable but seem to have assumed them to be a part of the training outcome.

Finally, the electronic classroom model (Leidner and Jarvenpaa, 1993) implies that the effectiveness of class performance is contingent upon a number of factors. Bostrom, Olfinan, and Sein (1990) end-user model also identified contingent factors to be considered during training. Thus, after identifying a set of contingent variables, a comprehensive research model can be proposed to measure the effectiveness of a particular learning environment.

3.3. Research Model

The research model (Figure 8) developed for this study is based on the analysis of the previous two models and the Kolb's Experiential Learning Model (Kolb, 1984; Simon, et al., 1996) discussed in Chapter 2. The basic elements of the end-user training framework used in this study is shown in the research model. Overall, the research model developed (Figure 8) is based on the Bostrom, Olfinan, and Sein (1988) end-user model.

The end-user model suggests that training outcomes (user attitudes and learning performance) are influenced by three important factors: characteristics of the target system (or the system being learned), training methods, and individual differences (Bostrom, Olfinan, and Sein, 1988). Figure 8 focuses only on the influences of the individual differences and instruction (training) methods on education outcomes (training). It defines individual characteristics based on Kolb's Experiential Learning Theory/Learning Styles (Kolb, 1984) and instruction methods based on a traditional method (control) and two computer-based instruction oriented approaches (simulated
hands-on and hands-on system). Educational outcomes include performance, self-efficacy, and user satisfaction. In Figure 8, solid lines with arrows indicate a set of research hypotheses (main effects) and a dotted line connecting the two main independent variables represent an interaction effect to be tested. Each factor in the research model is explained below as well as their linkages to educational outcomes. Then research hypotheses are stated.

**Figure 8 - Research Model**

3.3.1. Instructional Method

Instructional method refers to the actual delivery of instruction. Several researchers agree that the instruction method influences an individual’s performance (Leidner and Jarvenpaa, 1993; Bostrom, Olfman, and Sein, 1990). The types of instruction method used in this study are: a) a traditional instruction method that acts as the control (lecture plus reading/exercises), b) a computer-based method with hands-on
SAP R/3 System, and c) a computer-based method with the simulated hands-on the SAP R/3 System.

3.3.2. Individual Differences

It is clear from the educational and training models described earlier that the student or trainee is the focal point of education/training. It was also stated that it is important to consider individual differences in information systems effectiveness studies (Bostrom, Olfman, and Sein, 1988, 1990, 1993; Todd and Benbasat, 1987; Parasuraman and Igbaria, 1990; Czaja, et al., 1989; Zmud, 1979).

Thus, it is reasonable to consider individual differences among end-users in an information system education/training program. In this study, individual differences, "variations in human behavior among end users" include cognitive traits (e.g., learning style), motivational traits (e.g., self-concept, attitude toward computers), and demographic factors (e.g., gender, age, previous computer experience, task domain knowledge).

3.3.3. Outcomes

A key aspect of instruction effectiveness is student performance. However, reviews of research comparing the effectiveness of educational computer-based and traditional instruction have found no or few differences in student achievement.

It is argued that "just" evaluating the effectiveness of computer-based instruction on students’ performance scores may not provide a comprehensive picture of the effectiveness of the program (Compeau and Higgins, 1995a). Thus, following this argument and Leidner and Jarvenpaa’s (1995) taxonomy of learning outcomes, in
addition to performance, the present study examines such outcomes relating to instruction effectiveness as self-efficacy and user satisfaction.

3.4. Hypotheses

The relationship between the constructs on the research model (Figure 8) are expressed as a set of hypotheses (H1 to H9) to be tested. The research model suggests several relationships between the variables. In this section, these relationships are formulated as a set of hypotheses. The overall research hypothesis of this study is that there will be no difference in performance between the group that receives hands-on experience with the SAP R/3 System and all other groups (control group, and simulated hands-on the SAP R/3 System group).

3.4.1. Relationship between Instructional Method and Outcomes

The instructional method refers to the actual delivery of course material. In the context of training, several researchers agree that the training method influences trainee's performance (Bostrom, Olfman, Sein, 1990; Leidner and Jarvenpaa, 1993; Maul and Spotts, 1993; Czaja, et al., 1986). On the other hand, previous studies have also reported mixed results about the outcomes of traditional instruction versus computer-based instruction (Bowman, et al., 1995).

The main focus of this study is to determine whether there will be any difference between the performance of subjects who are provided three different delivery instructional methods: a) a traditional instruction method that acts as the control (lecture plus reading/exercises), b) a computer-based method with hands-on SAP R/3 System, and c) a computer-based method with simulated hands-on the SAP R/3 System. Accordingly, Hypothesis 1 is as follows:
**H1:** There will be no difference in *performance scores* between the group that receives hands-on experience with the SAP R/3 System and all other groups.

Self-efficacy is "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with skills one has but with judgments of what one can do with whatever one possesses" (Bandura, 1986).

Research has shown that low-efficacy beliefs are negatively related to subsequent task performance (Bandura and Cervone, 1986). Thus, since a major goal of any educational program is that the learner will apply the knowledge/skills learned to real life situations (future work environment), then a desirable outcome would seem to be higher levels of self-efficacy in addition to the performance outcome. Accordingly, hypothesis 2 is as follows:

**H2:** There will be no difference in *self-efficacy* between the hands-on SAP R/3 System instruction group and the simulated hands-on SAP R/3 System instruction group.

User Satisfaction may be defined as the extent to which users believe the information system available to them meets their information requirements (Ives, et al., 1983). However, in the context of the present study, the purpose of using a measure of end-user satisfaction is to evaluate the quality of instruction and instructional materials (e.g., lecture presentation, tools, manuals, etc.). Furthermore, it has been concluded that although a training program closely follows suggested training models and prescriptions, the quality of instruction and instructional material have a significant impact on the outcome of any educational/training program (Cronan and Douglas, 1990). Thus,
satisfaction is not measured to predict behavior (e.g., usage) but to learn how to design instruction using the information technology available. Satisfaction has been studied in the context of designing a collaborative learning mode of instruction (Alavi, 1994; Alavi, et al., 1995). It has been shown that instruction-supported collaborative learning enhances learning achievement, student satisfaction with the learning process, and outcomes promote a positive learning climate (Alavi, 1994; Alavi, et al., 1995; Kulik, et al., 1980).

In the context of curriculum development, instructional design, and assessment, two elements of satisfaction are important to measure in any educational setting: satisfaction with the results of the instruction and satisfaction with the way in which the instruction was delivered. If an instructional method is effective, then students are expected to consistently report high levels of satisfaction with both the results of courses and the learning process (Lengnick-Hall and Sanders, 1997). Accordingly, Hypothesis 3 is as follows:

**H3:** There will be no difference in user satisfaction between the hands-on SAP R/3 System instruction group and the simulated hands-on SAP R/3 System instruction group.

3.4.2. Relationship among Self-efficacy, User Satisfaction and Performance

An important effect of self-efficacy is performance (Bandura, 1991; Bandura and Adams, 1977). Research has shown that self-efficacy perceptions are positively related to trainee satisfaction and learning in microcomputer training (Gist, et al., 1989; Oliver and Shapiro, 1993). Based on past performances that are made by low- and high-self-efficacy individuals, Gist and Mitchell (1992) provide an explanation for the relationship between self-efficacy and both satisfaction and performance. They argue that when individuals
with high or low self-efficacy succeed, they both make internal attributions for their success (i.e., ability). However, when individuals fail, those with high self-efficacy attribute their failure to external factors (e.g., bad luck), while those with low self-efficacy attribute their failure to lack of ability. Consequently, it is possible that individuals with high levels of self-efficacy will be more likely (than those with low levels of self-efficacy) to persist in spite of any experienced difficulty (Gist and Mitchell, 1992). In addition, individuals with high self-efficacy are likely to be more satisfied due to the perceived value of personal accomplishment (Bandura, 1986). Thus, this study proposes that Self-efficacy and User Satisfaction will relate positively to individual performance. Accordingly, Hypotheses 4 and 5 are as follows:

**H4:** There will be no difference in *performance scores* between individuals with high *self-efficacy* and those with low *self-efficacy.*

**H5:** There will be no difference in *performance scores* between subjects who are more *Satisfied* with the learning process and those who are less *Satisfied.*

### 3.4.3. Relationship between Individual’s Learning Style and Outcomes

As stated in Chapter 2, to be effective, an education/training method needs to be matched with the specific needs and learning styles of individuals (Nelson, 1991; Bostrom, et al., 1990; Kolb, 1984). On the other hand, educational institutions are being challenged to respond to the increasing diversity of students (i.e., variation in motivation, time management and learning styles, maturity, etc.). Thus, individual differences among students as raw materials (e.g., learning styles, cultural orientations, experience, and interest) must be met by equally diverse learning process options (e.g., assignments,
application contexts, and methods for presenting material) if consistent, high-quality outcomes (i.e., learning and high levels of satisfaction) are to result (Lengnick-Hall and Sanders, 1997).

The Learning Style variable is used to determine whether or not individual differences affect student performance, self-efficacy and satisfaction. Learning style is defined as the way people learn and how they solve problems and deal with new situations and information (Kolb, 1984). Kolb (1984) argued that effective learning requires a four-stage cycle. Each stage of the cycle highlights different learning modes: concrete experience, reflective observation, abstract conceptualization, and active experimentation. An individual’s learning style is the combination of the four learning modes. Kolb (1984) identifies four learning styles: accommodators, divergers, convergers, and assimilators. Learning styles reflect two dimensions. One dimension, active/reflective, indicates whether individuals learn best by doing or by thinking. The other dimension, concrete/abstract, indicates whether individuals emphasize concrete experience or abstract ideas when they learn.

The objective of incorporating this variable in the study is to examine the role of the learning style on learning about Enterprise Systems. Previous research (Bostrom, et al., 1990) has indicated that instruction programs designed to complement an individual’s learning style increases the instruction program’s effectiveness. However, the experiential learning theory does not provide help to decide which learners would excel with which instructional method. Kolb did not theorize about hands-on training and without hands-on training instructional methods. Thus, it is envisioned that there is a
relationship between the individual’s learning style and outcomes (performance, self-efficacy, and satisfaction). Accordingly, Hypotheses 6, 7 and 8 are as follows:

**H6**: *Subjects' Learning Style does not influence the Performance of Subjects.*

**H7**: *Subjects' Learning Style does not influence the Self-efficacy of Subjects.*

**H8**: *Subjects' Learning Style does not influence the Satisfaction of Subjects.*

### 3.4.4. Interaction between Instructional Method and Individual’s Learning Style

Research on computer training methods has addressed two main issues. One issue deals with the examination of various individual characteristics, such as personality dimensions and cognitive ability that predicts successful learning of computer software (Bostrom, et al., 1990). And the other issue relates to the effectiveness of training methods (Sein and Robey, 1991). However, there is a need to examine the interaction between individual characteristics and training methods. Thus, this study uses learning style to investigate the impact of its interaction with the instructional method on the individual’s performance. This study does not use learning style as a control variable. The impact of learning style will allow additional explanation of any difference in performance between individuals, if necessary. Accordingly, Hypothesis 9 is as follows:

**H9**: There is no significant interaction effect of learning style and instruction method on the performance, self-efficacy, and satisfaction of subjects.

### 3.5. Summary

The research model presented in this chapter is based on the educational and training models suggested by previous studies. Ramifications of the Experiential Learning Theory (Kolb, 1984), the Leidner and Jarvenpaa (1993) research model for electronic classroom learning and the Bostrom, Olfman, and Sein (1988) end-user
training model supplied the theoretical basis for selecting the dependent and independent variables of the research model for this study. The research model depicts the relationships between the independent and dependent variables. A set of hypotheses was developed from the relationships between variables. Hypotheses were stated in the null form, that is, there is no main interaction effect of instructional method and learning styles on performance. The research methodology used in the present investigation is discussed in chapter 4. This includes sections on the research design, the population and sample, research variables, design structure, and procedures.
4. RESEARCH METHODOLOGY

A number of relationships between the constructs identified in the previous frameworks are suggested as a research framework for this study. These relationships were expressed as hypotheses and will be tested in the field setting. The research methodology to be used is a field experiment. A series of three experiments were conducted to test the hypotheses developed in Chapter 3. This chapter describes the research methodology employed. The research design, content, population and sample, independent and dependent variables, experimental design structure, and procedure are discussed.

4.1. Research Design

A series of true field experiments (Table 1) were conducted in order to investigate the effectiveness of using the SAP R/3 System to enhance knowledge and understanding of business processes. They are true experiments (as opposed to quasi-experiments) due to the fact that the randomization element was present when selecting the subjects and when assigning them to both the treatment and the control groups (Cook and Campbell, 1976). Table 1 presents a characterization of the experiments based on academic program and content/task of the courses. A detailed description of the main attributes of the experiments is provided in the next section.

When designing field experiments caution must be taken to insure internal construct, and external validity. Internal validity is "the approximate validity with which we infer that a relationship between two variables is causal or that the absence of a relationship implies the absence of cause" (Cook and Campbell, 1979). For example, in
the context of the present study, one wishes to examine whether the use of the SAP R/3 System improves student understanding of course material (i.e., business processes).

Table 1 - Classification of Experiments by Academic Program and Content/Task

<table>
<thead>
<tr>
<th>Academic Program</th>
<th>Content/Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manufacturing Planning and Execution Cycle</td>
</tr>
<tr>
<td></td>
<td>Order-to-Cash Cycle</td>
</tr>
<tr>
<td>Graduate</td>
<td>Experiment I (BADM 7120)</td>
</tr>
<tr>
<td></td>
<td>Introduction to Operations Management</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>Experiment II (ISDS 3115)</td>
</tr>
<tr>
<td></td>
<td>Introduction to Operations Management</td>
</tr>
<tr>
<td></td>
<td>Experiment III (ISDS 3100)</td>
</tr>
<tr>
<td></td>
<td>Introduction to Information Systems</td>
</tr>
</tbody>
</table>

In this case, the cause construct is the SAP R/3 System and the effect (understanding), operationalized them—turned them into reality by developing the hands-on exercises using SAP R/3 and a measure of knowledge of the course material (in-class test). In this context, if one assumes that there is a relationship between the two variables then internal validity refers to whether one can make a claim that providing students with hands-on experience (treatment) causes the outcomes in our study (better performance) (Cook and Campbell, 1979).

Construct validity refers to whether one can claim that the hands-on exercises reflect well the construct of the program and that the measure reflect well the idea of the construct of the measure, assuming that there is a causal relationship in the study between the variables (Cook and Campbell, 1979). In other words, the question is: did we implement the program we intended to implement and did we measure the outcome we intended to measure? In yet other terms, did we operationalize well the ideas of the cause and the effect? On the other hand, to have construct validity, an instrument must first
have content validity. This means that it must adequately represent the domain of interest and use terminology readily understood and agreed upon by members of the field of interest (Churchill, 1979). In the context of the present study, the instruments (pretest and posttest) used have content validity because the questions are directly tied to various aspects of ERP and SAP R/3 literacy (e.g., knowledge about ERP systems, client/server architecture, business processes, etc.). Furthermore, the questions are clearly worded so that there is little room for subjective interpretation.

External validity refers to whether one can generalize the effect to other persons, places or times, assuming that there is a causal relationship in the study between the constructs of the cause and the effect. Since there are three ways one can be wrong: people, place or time, there are three major threats to external validity: a) results could be attributed to unusual type of people who were in the study or b) one could argue that it might only work because of the unusual place in which the researcher did the study or c) one might suggest that the researcher did his/her study at a peculiar time. To improve external validity one should use random selection, then once selected, one should try to assure that the respondents participate in the study and keep the dropout rates low (Cook and Campbell, 1979). Thus, the lack of validity in a study results in the inability to make any statements about cause-and-effect relationships and thereby, invalidates the experiment.

The focus of this study is on how different instructional approaches (i.e., traditional instruction, computer-based hands-on instruction and computer-based simulated hands-on instruction) facilitates the knowledge and understanding of business processes (i.e., Manufacturing Planning and Execution Cycle, Order-to-Cash Cycle).
4.2. Course Description

This study was conducted as part of regular class lessons in three different courses offered by the Information Systems and Decisions Science Department at Louisiana State University (LSU, 1999). The following is a catalog description of the courses listed in the LSU General Catalog, 1999-2000. Each course represents an experimental population (Table I).

Operations Management (BADM 7120) – Experiment I

This is an MBA course that covers major problems and decisions of operations management: operations strategy, process and capacity planning, quality planning, materials planning, supply chain management.

Introduction to Operations Management (ISDS 3115) – Experiment II

This is a junior course that covers principles and methodologies concerning productivity and quality of manufacturing and service organizations; production and service systems design; process and capacity design; total quality management; systems for just-in-time and purchasing management; inventory and materials management.

Management of Information Resources (ISDS 3100) – Experiment III

This is a junior course that covers information as a resource; issues in information resource management; elements of information systems; development and maintenance of information systems; controlling information resources.

4.3. Population and Sample

The population studied in this investigation is undergraduate and graduate business students in a public university in the State of Louisiana. The study involves three different student populations (BADM 7120, ISDS 3115, and ISDS 3100).
Populations are differentiated by academic program (undergraduate or graduate), academic status (part-time or full-time students), age structure, etc. On the other hand, the target population involves two different domains (operations management and information systems).

The sample (subjects) size by course and number of sections is presented in Table 2. The sample comprises a total of 53 students enrolled in two sections of the course entitled Operations Management (BADM 7120). A total of 284 undergraduate students were enrolled in five sections of the course entitled Introduction to Operations Management (ISDS 3115). A total of 53 students were enrolled in two sections of the course entitled Management of Information Resources (ISDS 3100). These three courses represent three different populations based on the academic level and the course content as described above.

Table 2 - Sample Size by Course

<table>
<thead>
<tr>
<th>Course</th>
<th>N</th>
<th>Number of Sec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BADM 7120 - Operations Management</td>
<td>53</td>
<td>2</td>
</tr>
<tr>
<td>ISDS 3115 - Introduction to Operations Management</td>
<td>284</td>
<td>5</td>
</tr>
<tr>
<td>ISDS 3100 - Management of Information Resources</td>
<td>53</td>
<td>2</td>
</tr>
</tbody>
</table>

Subjects are randomly assigned to the treatment groups (hands-on exercises using SAP R/3 System instruction and simulated hands-on exercises using SAP R/3 System instruction).

The Manufacturing Planning and Execution Cycle is chosen as the domain area to be used in the experiments I and II (BADM 7120 and ISDS 3115, respectively). The Customer Order Management Cycle is chosen as the domain area for the course ISDS 3100 (experiment III). None of the students enrolled in ISDS 3115, or ISDS 3100 would
have been exposed to this topic before encountering it in this course. In the case of BADM 7120, some of the students have already some exposure to the software.

4.4. Research Variables

The variables to be considered for the present study are provided in Table 3. The two independent variables are the instructional method (traditional acts as the control, computer-based hands-on SAP R/3 System, and computer-based simulated hands-on SAP R/3 System via Web) and Learning Style (Diverger, Assimilator, Converger, and Accommodator). Experiments I (BADM 7120) and III (ISDS 3100) only compare two instructional methods (computer-based hands-on SAP R/3 System, and computer-based simulated hands-on SAP R/3 System via Web) and do not measure learning style. In contrast, experiment II (ISDS 3115) does involve all three instructional methods and learning styles.

Table 3 - Variables to be Considered in the Study

<table>
<thead>
<tr>
<th>Independent</th>
<th>Dependent</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Instructional Method:</td>
<td>• Performance</td>
</tr>
<tr>
<td>1. Traditional (Control)</td>
<td>• Self-Efficacy (Compeau and Higgins, 1995b)</td>
</tr>
<tr>
<td>2. Computer based Hands-on (System)</td>
<td>• User Satisfaction (Doll and Torkzadeh, 1988)</td>
</tr>
<tr>
<td>3. Computer based Simulated Hands-on (no System)</td>
<td></td>
</tr>
<tr>
<td>via Web</td>
<td></td>
</tr>
<tr>
<td>• Learning Style (Kolb, 1985)</td>
<td>Other Variables</td>
</tr>
<tr>
<td>1. Diverger</td>
<td>- Knowledge/Skills Assessment</td>
</tr>
<tr>
<td>2. Assimilator</td>
<td>- Demographic Characteristics</td>
</tr>
<tr>
<td>3. Converger</td>
<td>- Attitude Toward Computers Technology</td>
</tr>
<tr>
<td>4. Accommodator</td>
<td>- Lecture Satisfaction</td>
</tr>
<tr>
<td></td>
<td>- Lecture Evaluation</td>
</tr>
</tbody>
</table>

The dependent variables (Table 3) are (1) student performance, which will be measured by student grades on a test given at the end of the experiments; (2) self-efficacy, which will be measured by a survey instrument developed by Compeau and Higgins.
Higgins (1995b); (3) satisfaction, which will be measured by a survey instrument developed by Doll and Torkzadeh (1988).

Information on a number of other variables will be measured to be used in the analysis as covariates (Table 3): knowledge/Skills assessment, demographic characteristics, attitude toward computer technology (Kinzie, et al., 1994), lecture satisfaction, and lecture evaluation.

4.4.1. Instructional Method

Instructional method refers to the actual delivery of the content. Several researchers agree that instructional/training method influences students/trainee’s performance (Bostrom, Olfman, and Sein, 1990; Leidner and Jarvenpaa, 1993). The types of instruction methods (Figure 9) used in this study are: a) a traditional instruction method that acts as the control (lecture plus reading/exercises), b) a computer-based method with hands-on SAP R/3 System, and c) a computer-based method with simulated hands-on the SAP R/3 System via Web. Figure 9 illustrates the operationalization of the instructional methods (Content).

The content (Figure 9) was a set of two 50-minute lectures on Enterprise Resource Planning (ERP) Systems and either a lecture on Manufacturing Planning and Execution (MPE) or Order-to-Cash Cycle (OTC) designed and taught by the same instructor. After the first lecture session on ERP, the BADM 7120 and ISDS 3115 groups received a lecture on the Manufacturing Planning and Execution Cycle (MPE) (Figure 9, solid line). The ISDS 3100 class received instruction on ERP and the Order-to-Cash Cycle (OTC) instead of the Manufacturing Planning and Execution Cycle (MPE) given to BADM 7120 and ISDS 3115 students (Figure 9 dashed line). After the two class
lectures were completed, each student received a handbook packet containing the instruction to do the assignment. For the assignment, a combination of an exploration and instruction-based manual was operationalized by following the Minimalist theory (Carroll, et al., 1987; Lazonder & Van der Meij, 1993) as described in Chapter 2.

![Course Diagram]

**Figure 9 - Lecture Content**

4.4.2. Learning Style

Individual learning style is an independent variable in this study. Researchers believe that learning style is a good predictor of an individual's preferred learning behavior (Bostrom, Olfman, and Sein, 1993). This study uses learning style to investigate the impact of its interaction with the instructional method on the individual's performance. This study does not use learning style as a control variable. Learning Style is measured only in Experiment II corresponding to ISDS 3115. The impact of learning
style will allow additional explanation of any difference in performance between students, if necessary. The learning style is measured by the Kolb’s Learning Style Inventory (Kolb, 1985) (Appendix-B).

4.4.3. Outcome/Performance

Performance (knowledge and understanding of business process and the SAP R/3 System) is measured at the end of the instruction session in the classroom. Performance is measured both in quantitative and qualitative terms. Tested scales for the model’s constructs (Figure 8) were used whenever they were available, and were modified only as absolutely necessary to apply to the study context.

Learning performance is measured at one level: acquisition of declarative knowledge. Declarative knowledge refers to the concepts, principles, issues, and facts presented in a learning situation. Thus, the quantitative performance measure will be an in-class multiple-choice/true-false test on the lecture material and on the class assignment (reading/exercise, computer-based hands-on SAP R/3 System exercises and simulated computer-based hands-on SAP R/3 System exercises) (Appendix D).

The qualitative performance measure will include a student’s Self-Efficacy and student’s Satisfaction with the instructional methods.

4.4.4. Self-Efficacy Instrument

Self-efficacy theory suggests that individuals must feel confident in using a particular technology in order to effectively employ it (Bandura, 1977). High correlation is often found between reported self-efficacy and subsequent performance (Bandura and Adams, 1977). In this study, self-efficacy is measured by administering a ten-item scale instrument developed by Compeau and Higgins (1995b) (Appendix E). The instrument
has proven to have a high reliability (Cronbach's alpha = 0.94). The Compeau and Higgins (1995b) instrument measures "People's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with skills one has but with judgments of what one can do with whatever one possesses" (Bandura, 1986).

4.4.5. User Satisfaction Instrument

User satisfaction is measured by administering an instrument based on Doll and Torkzadeh's (1988) end-user satisfaction instrument (Appendix F). The Doll and Torkzadeh (1988) instrument measures the end-user computing satisfaction construct and uses three major factors: content/format, accuracy/timeliness, and ease of use/efficiency. Since a major concern in using an Enterprise System is its ease of use and content/format rather than accuracy/timeliness, the Doll and Torkzadeh (1988) instrument is modified and used as a guideline to include items that focus on ease of use and content. The purpose of using a measure of user satisfaction is to evaluate the instruction design (e.g., manuals). Thus, satisfaction is not measured to predict behavior (e.g., usage) but to learn how to develop better instructional material.

4.5. Experimental Design Structure

The research design for this study follows a true experimental design. Experimental units (students) were randomly assigned the treatment groups (computer-based hands-on SAP R/3 System and computer-based simulated hands-on SAP R/3 System) without consideration of their learning style. Randomization was done by following the method established by Neter, et al. (1990) and using a uniform random number generator from Microsoft Excel. When control over the independent variable(s)
is/are exercised through random assignments, the resulting experimental data provide much stronger information about cause-and-effect relationships than do observational data (Neter, et al., 1990).

Experiments I and III involve only one factor (instructional method). Experiment II is a two-factor design, where instructional method is the independent variable and learning style is the moderating independent variable. The result is a 3 X 4 factorial design (Table 4). The main dependent variable is performance as measured by the scores on a posttest. The test was identical for the three experimental groups.

Table 4 - Experimental Design Structure for Experiment II

<table>
<thead>
<tr>
<th>Instructional Method (A)</th>
<th>Learning Style (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diverger</td>
</tr>
<tr>
<td></td>
<td>Assimilator</td>
</tr>
<tr>
<td></td>
<td>Converger</td>
</tr>
<tr>
<td></td>
<td>Accommodator</td>
</tr>
<tr>
<td>Control (j = 1)</td>
<td>k = 1</td>
</tr>
<tr>
<td></td>
<td>A_1B_1</td>
</tr>
<tr>
<td>Hands-on System (j = 2)</td>
<td>k = 2</td>
</tr>
<tr>
<td></td>
<td>A_1B_2</td>
</tr>
<tr>
<td>Simulated Hands-on System (j = 3)</td>
<td>k = 3</td>
</tr>
<tr>
<td></td>
<td>A_1B_3</td>
</tr>
<tr>
<td></td>
<td>A_2B_1</td>
</tr>
<tr>
<td></td>
<td>A_2B_2</td>
</tr>
<tr>
<td></td>
<td>A_2B_3</td>
</tr>
<tr>
<td></td>
<td>A_2B_4</td>
</tr>
<tr>
<td></td>
<td>k = 4</td>
</tr>
<tr>
<td></td>
<td>A_3B_1</td>
</tr>
<tr>
<td></td>
<td>A_3B_2</td>
</tr>
<tr>
<td></td>
<td>A_3B_3</td>
</tr>
<tr>
<td></td>
<td>A_3B_4</td>
</tr>
</tbody>
</table>

4.6. Experimental Procedure

The implementation of the experiments is illustrated in Figure 10. As depicted in the figure, the experimental procedure included four main phases. During Phase 1, Pre-instruction activities, the course instructor introduced the researcher and gave a brief introduction to explain the nature and purpose of the study. Subjects (students) were told that the study’s main objective was to investigate ways to improve the business school curricula. Then, subjects were given enough time to complete an in-class background knowledge assessment and the Learning Style Inventory, if applicable. A preliminary survey to collect data on demographic characteristics, attitudes toward computer
technologies, and previous experience with, and current use of computer technologies was given to subjects to fill out at home and bring to the next class session. The same script was followed in every class.

During Phase 2, a set of two 50-minute lectures were presented on Enterprise Resource Planning (ERP) Systems and either a lecture on Order-to-Cash Cycle (OTC) or Manufacturing Planning and Execution (MPE) business processes. Following the lectures, an assignment was provided to the students.

![Experimental Procedure Diagram]

Figure 10 - Experimental Procedure

There were three types of assignments: a) reading & exercises, this is a traditional textbook reading and homework exercise that is given to students to support in-class lecture, b) hands-on R/3, this is a hands-on experience exercise that ask students to
perform a series of business transactions using the SAP R/3 Systems, and c) simulated hands-on R/3 via Web, this is similar to the hands-on R/3 assignment but instead of using the system, students are asked to observe a series of Lotus ScreenCam demonstrations of how to perform the business transactions using the system. Students were given a week to complete the assignment (Phase 3).

During Phase 4, immediately after the due date of the assignment, subjects were given enough time to fill out post-instruction surveys (i.e., Self-efficacy, end-user computing satisfaction, user-lecture satisfaction, and lecture session evaluation). Then, a comprehension test was administered. The posttest was composed of multiple choice/true-false questions that emphasized the understanding of the declarative knowledge on ERP and business processes, it lasted approximately 20 minutes.

4.7. Summary

The research design, population and sample, and operationalization of the instruments, and experimental procedure for this study were discussed in Chapter 4. Table 5 presents a summary of the main attributes by experiment. Data collection and measures are presented in Chapter 5.

**Table 5 - Summary Description of the Main Attributes of the Experiments**

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Academic program</th>
<th>Sample Size</th>
<th>Independent Variable</th>
<th>Dependent Variable</th>
</tr>
</thead>
</table>
5. DATA COLLECTION AND MEASURES

This chapter discusses the implementation of the research methodology to test the hypotheses proposed in Chapter 3. The first section begins with a review of the data collection procedure. Then, Section 2 presents the operationalization of the research variables in the research model.

5.1. Data Collection

5.1.1. Administration of Instruments

Consistency in administrating the instruments is a key factor to the validity of the experiment. The researcher administrated the surveys in an identical fashion in all nine sections. First, the instructor presented a short description of the proposed investigation and the value added to the educational environment. Second, the researcher was introduced to the class. The researcher explained the questions to the students and asked for their cooperation in filling out the surveys. The importance of carefully filling out the questionnaires was emphasized and sufficient time was allowed. The students were assured that the information they provided will remain strictly confidential and that their grades will not be affected in any way.

5.2. Operationalization of Research Variables

Operational definitions specified how research constructs and variables will be measured. Although some of the operationalizations have already been presented in the discussion of the literature, all proposed operationalizations are discussed in this chapter for the sake of completeness. Thus, this section presents the surveys and the instruments used to measure the performance, self-efficacy and user satisfaction, as well as a brief discussion of the validity and reliability of the instruments.
5.2.1. Preliminary Survey

In order to establish a baseline of each sample population, all subjects were surveyed on the following individual characteristics:

- Demographic information (age, gender)
- Academic information (level, major, GPA)
- Access to a Computer (home, work)
- Access to the Internet (home, work)
- Previous Experience with, and current use of, computer technology
- Attitude toward computer technology

Appendix-A shows the 23-question survey. Demographic data were used in assessing the prior knowledge of the subjects.

5.2.2. Learning Style Instrument

A learning style instrument (Appendix B) was administered to measure subject’s learning style. Learning style was used to detect any significant interaction between instructional approaches and learning style. A learning style inventory is designed to measure an individual’s strengths and weaknesses as a learner. The learning style inventory measures an individual’s relative emphasis on the four learning abilities (concrete experience, reflective observation, abstract conceptualization, and active experimentation) by asking him or her to rank, in order, four words that describe these different abilities (Kolb, 1984).

5.2.3. Pre-Treatment Knowledge/Skills Assessment

The basic knowledge/skills initial assessment was given to all subjects in the first lecture (i.e., Enterprise Systems). The assessment was a 15 multiple-choice quiz that
covered basic concepts about legacy systems, Enterprise Resource Planning, the SAP R/3 System, and either Manufacturing Planning Execution or the Order-to-Cash cycle. The quiz was graded on a scale of 1 to 10. A copy of the quiz used in the ISDS 3115 course is provided in Appendix C.

5.2.4. Measuring Performance

A true-false, multiple-choice examination was used to measure knowledge and understanding of the concepts underlying Enterprise Systems and either Manufacturing Planning and Execution or Order-to-Cash cycles processes. The performance measure instrument used in ISDS 3115 is provided in Appendix D. The test was graded on scale of 1 to 100.

Grades on the assignments were examined, but were not used in the measurement of performance. This is because there is no guarantee that these assignments were undertaken by the sole efforts of the student; thus, they may not be a reliable measure of the learning effectiveness.

5.2.5. Measuring Self-Efficacy

Factors such as poor reliability and validity of measuring instruments have contributed to weak and inconsistent results in MIS research (Jarvenpaa and Dickson, 1985). As a result, information systems researchers are encouraged to use previously developed and validated instruments as much as possible. In this study, the Self-Efficacy measuring instrument developed and validated by Compeau and Higgins (1995) is used (Appendix-E). The instrument consists of a 10-item questionnaire asking students if they felt that they could do a task using a software package under various circumstances.
Initially, the students are asked to react with a "yes" or a "no" answer. If "yes," then they are asked to rank their degree of confidence on a scale of 1 to 10.

5.2.6. Measuring User Satisfaction

This study uses a modified version of the Doll and Torkzadeh (1988) end-user computing satisfaction instrument (Appendix F). The original twelve question end-user satisfaction instrument has a Cronbach's alpha reliability of $r = 0.98$ (Doll and Torkzadeh, 1988). The instrument measures the end-user computing satisfaction construct and uses three major factors: content/format, accuracy/timeliness, and ease of use/efficiency. Since a major concern in using an Enterprise System is its ease of use and content/format rather than accuracy/timeliness, the Doll and Torkzadeh (1988) instrument is modified and used as a guideline to include items that focus on ease of use and content.

5.2.7. Other Measurement items

Two additional instruments were used to measure the students' satisfaction with the lecture presentations (Appendix G) and evaluation of the instructor's presentation (Appendix H) of the class material. It is expected that the information provided by these instruments can clarify possible hypotheses test results.

5.3. Summary

This chapter discusses the data collection procedures followed by the operationalization of the data collection instruments.
6. DATA ANALYSIS AND RESULTS

This chapter presents the results from the data analyses. The chapter begins with a discussion of the main statistical techniques that are used for the analyses. Then, for each experiment, the validity and reliability analysis, descriptive statistics, and hypotheses testing results are presented. A summary of the results is presented at the end of each experiment’s results.

6.1. Statistical Technique for the Analysis

This section briefly explains the main data analysis approaches adopted in the study, if applicable. The Statistical Analysis Systems (SAS) software package is used to run the statistical analyses (SAS Institute, 1989).

6.1.1. Nonparametric Statistical Methods

When experimental data are not normally distributed, the efficacy of standard parametric statistical tests, such the F-test, is affected. Although the F-test for the analysis of variance is robust against departures from normality, two primary effects result when the normality assumption is violated. First, nonnormality will influence the ability of a statistical test to perform at the stated α-level. Cochran (1947) refers to this effect as the validity effect. Second, nonnormality will also affect the power of a statistical test to detect differences when real differences in the data actually exist. Two approaches are often recommended when data are not normally distributed: a) transform for normality, or b) apply nonparametric statistical methods (Neter, et al., 1990).

Thus, in this study both procedures, data transformation and use of nonparametric test, were implemented. In particular, this study uses the Kruskal-Wallis test as an
alternative to the one-way analysis of variance method (Neter, et al., 1990) when appropriate.

6.1.2. Regression Approach to Two Factor Analysis of Variance

When experimental group sample sizes are unequal, the analysis of variance for two-factor studies becomes more complex. A number of problems must be dealt with to obtain a valid test of hypotheses (main and interactions effects). For example, the least squares equations are no longer of a simple structure, yielding direct and ease solutions and the formulas normally used for computation are not appropriate. Furthermore, the factor effect component sums of squares are no longer orthogonal – that is, they do not sum to Sum of Squares Treatment (Neter, et al., 1990).

An approach often used to obtain the proper sums of squares for testing factor interactions and main effects when sample sizes are unequal is through the regression approach described by Neter, et al. (1990). When compared to the traditional Analysis of Variance (ANOVA) procedure, the only difference when sample sizes are unequal is that a reduced model needs to be fitted for each test of factor interaction and main effects.

Regression analysis can be used to conduct ANOVA when sample sizes are unequal. The outcome in the regression analysis is the same as that in the ANOVA. The predictors are the grouping factors (experimental groups and learning style). Unlike ANOVA, one must assign specific values to the predictors. The X matrix has one row for each experimental observation, and one column for each term in the model including the constant.
A two-factor analysis requires creation of codes for the levels of factor one (A) and factor two (B) as well as codes for the AB interaction. The interaction code is created by multiplying each column of A by each column of B. The regression analysis including all five variables will generate regression sum of squares equal to $SS_A + SS_B + SS_{AB}$ and residual sum of squares equals $SS_{Error}$. In order to estimate the $SS_A$, $SS_B$, and $SS_{AB}$ separate regressions (Full Model (1) and Reduce Models) must be conducted including only the A-terms, B-terms, and interaction terms, respectively. Then, the F-tests are computed by hand using the sums of squares generated (Reduce Models) and the $SS_{Error}$ generated by the full model. The Full Model is:

\[
Y_{ijk} = \mu + \alpha_1 X_{ijk1} + \alpha_2 X_{ijk2} + \beta_1 X_{ijk3} + \beta_2 X_{ijk4} + \beta_3 X_{ijk5} + (\alpha \beta)_{11} X_{ijk1} X_{ijk3} + (\alpha \beta)_{12} X_{ijk1} X_{ijk4} + (\alpha \beta)_{13} X_{ijk1} X_{ijk5} + (\alpha \beta)_{21} X_{ijk2} X_{ijk3} + (\alpha \beta)_{22} X_{ijk2} X_{ijk4} + (\alpha \beta)_{23} X_{ijk2} X_{ijk5}
\]

(1)

where $i$ represents the instructional method factor effect at three levels ($i = 1, 2, 3$) and $j$ is the learning style factor effect at four levels ($j = 1, 2, 3, 4$). Since there are unequal observations per cell, the coefficients and sum of squares will be different in the full model and in the reduced model. In other words, the effects are not orthogonal, sums of squares and coefficients change as terms are added and deleted from the model.

The above regression approach can be performed using the Statistical Analysis System (SAS). Specifically, the outputs that are the equivalent of the regression results
are provided by the TYPE III or Type IV sum squares in SAS PROC GLM (Neter, et al., 1990). This study used the above procedure when appropriate.

6.1.2.1. Pairwise Comparisons of Factor Level Means

The F-test is a very general test. When one rejects the null hypothesis and thus concludes that the group means differ, one does not know which groups differ from each other and which ones do not. In the case of post hoc tests (no specific differences to be tested were specified prior to conducting the experiment), the Tukey multiple comparison method is conservative when sample sizes are unequal (Neter, et al., 1990). Thus, the study uses the Tukey method to perform multiple comparisons among experimental groups. The family confidence coefficient was specified to be 0.90. This study uses the formulas provided by Neter et al. (2, 3, 4, and 5) for the point estimates and estimated variances to compute confidence intervals of the pairwise comparisons of the experimental group factor level means (1990).

\[
\hat{\mu}_j = \frac{\sum_i Y_{ij}}{a}
\]  

(2)

Difference

\[
\hat{D} = \hat{\mu}_j - \hat{\mu}_j
\]  

(3)

\[
T = \frac{1}{\sqrt{2}} q \left( 1 - \alpha ; b, n_r - ab \right)
\]  

(4)
Variance

\[ s^2 \{ \hat{D}_1 \} = \frac{MSE}{a^2} \sum_i \left( \frac{1}{n_{ij}} + \frac{1}{n_{ij'}} \right) \]  

(5)

6.1.2.2. Assumptions

The validity of the hypotheses tests is based on several assumptions. One is that the errors are normally distributed. This assumption was tested by using the Normal option in the Proc Univariate SAS statement (SAS, 1989) to perform the Shapiro-Wilk test (W).

Another assumption is that the group variances are equal. There are several ways to test this hypothesis. They all test the null hypothesis that the variances are equal against the alternative that they are not. The most widely used test is the Bartlett test of homogeneity of variance. It is appropriate when the groups are of unequal size. Thus, this study used the Bartlett test of homogeneity of variance.

6.1.3. Analysis of Covariance (ANCOVA)

Covariance analysis is used to reduce error variability (Neter, et al., 1990). Error variability is reduced by utilizing the relationship between the dependent variable (i.e., performance, self-efficacy, satisfaction) and one or more independent quantitative variables for which observations are available (i.e., initial skills/assessment scores, attitude toward computers) in order to make the study a more powerful one for comparing treatment effects.

Independent variables are called concomitant variables in ANCOVA. Concomitant variables often used with human subjects include prior experience with computers (Santhanam and Sein, 1994; Sein and Bostrom, 1989), knowledge/skills.
before treatment (Olfman and Mandviwalla, 1994; Davis and Davis, 1990), pre-study
attitudes, age, etc. In this study, data were collected on a number of variables (i.e.,
knowledge/skills assessment, attitude toward computers, etc.) to be used as covariates.
Thus, the hypothesis test included as an initial step the Analysis of Covariance.

6.1.4. Power Analysis

Power analysis is used to evaluate the performance of a particular statistical test
(s) under a particular condition. The power of a statistical test of a null hypothesis is the
probability that it will lead to the rejection of the null when it is false. Thus, the higher
the power, the greater the probability of detecting a statistically significant difference at
a given alpha level.

Power depends upon three parameters: i) the significance level (alpha), ii) the
sample size (n), and iii) the "effect size" or degree to which the phenomenon exist
(Cohen, 1977). Alpha (α) is the probability of a type-I error. A type-I error occurs
when an experiment results in the rejection of the null hypothesis when the null
hypothesis is true.

The Effect size is the size of the change in the parameter of interest that can be
detected by an experiment. For example, what is the performance score difference that
one is interested in determining between experimental groups (i.e., two, three, four,
five, etc. average points difference)? Cohen (1988) has designed value of Effect Size
less than 0.1 as small, values around 0.25 to be medium, and values over 0.40 to be
large. Effect size is defined as:

\[ f = \frac{\sigma_m}{\sigma} \]  

(6)
where is $\sigma_m$ the standard deviation of the group means and $\sigma$ is the standard deviation of values within a cell. The value of $\sigma_m$ is computed as:

$$\sigma_m = \sqrt{\frac{df_{numerator} \cdot (F)(MSE)}{N}}$$

where $N$ is the total number of observations, $MSE$ is the mean square error, $df$ is the numerator degrees of freedom, and $F$ is the F-ratio of the term.

There are two main types of power analyses that are often performed: 1) a power analysis is performed during the design phase of a study to determine the sample size for a given alpha and beta (Type-II error), where power is 1-beta; 2) a power analysis is done as a post-hoc analysis, which is after the study is concluded. Power analysis after data have been collected involves answering questions such as 2a) What sample size would have been needed to detect a difference (effect size) of the magnitude observed in the study with $\alpha = 0.05$ and $\beta = 0.20$ (power = 0.8)? 2.b) what is the smallest difference (effect size) that could be detected with this sample size at certain values of alpha and beta? 2c) What was the power of the test procedure?

For the purpose of this study, Cohen’s (1977) method is used to compute power. Specifically, power analysis is used to answer question 2c. Thus, the power values computed are for the case when the effect associated with the alternative hypotheses are equal to those given by the data.

6.2. Experiment I (BADM 7120)

In this experiment, a completely randomized factorial design was used to determine if there are any differences in performance, self-efficacy, and satisfaction between subjects that receive two different instructional methods. In one instructional
method, students receive traditional lecture format, but also have full access to simulated hands-on SAP R/3 System via Web transaction exercises (Simulated Hands-On). In the other method, students receive the traditional lecture format with full access to hands-on SAP R/3 system transaction exercises (Hands-On).

6.2.1. Validity and Reliability Analysis

6.2.1.1. Content Validity

Content validity refers to the extent to which the items making up a measure are a representative sample of the domain of items associated with the variable being measured (Straub, 1989). Thus, content validation mostly relies on the expert’s judgement. In this study, the utilization of operationalizations from previous studies enhanced the content validity of the instruments.

6.2.1.2. Construct Validity

Construct validity refers to the extent to which the instrument is in fact measuring. It is, in fact, an operational issue (Straub, 1989). For items that were constructed out of suggestions in the literature and have not been used before, factor analysis is an effective means of confirming their construct validity (Straub, 1989). Factor analysis was performed for each of the instruments used on the study. Table 6 presents the results from factor analysis for each research variable consisting of more than three questionnaire items.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Eigenvalue</th>
<th>Variance Explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Efficacy</td>
<td>5.79</td>
<td>58 %</td>
</tr>
<tr>
<td>Computer User Satisfaction</td>
<td>4.12</td>
<td>59 %</td>
</tr>
<tr>
<td>Attitude toward Computers</td>
<td>6.20</td>
<td>69 %</td>
</tr>
<tr>
<td>Lecture Satisfaction</td>
<td>4.39</td>
<td>44 %</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>3.88</td>
<td>55 %</td>
</tr>
</tbody>
</table>
Only the first component displayed eigenvalues greater than one (Table 6), and the result of the scree test also suggested that only the first component was meaningful. In interpreting the factor pattern, an item was said to load on a given component if the factor loading was 0.50 or greater for that component, and was less than 0.50 for the others (Straub, 1989). All the individual questionnaire items have a factor loading greater than 0.50. Thus, using these criteria, it can be argued that the measures have higher construct validity.

6.2.1.3. Internal Consistency

Reliability is usually defined, in practice, in terms of the consistency of the scores that are obtained on the observed variables. An instrument is said to be reliable if it is shown to provide consistent scores upon repeated administration, upon administration by alternate forms, and so forth. A variety of methods of estimating scale reliability are actually used in practice.

Cronbach’s coefficient alpha (Cronbach, 1951) was used to assess the internal consistency reliability of the scales. Briefly, internal consistency is the extent to which the individual items that constitute a test correlate with one another or with the test total. The results from this procedure for a number of instruments used in this study have been summarized in Table 7. Coefficient alpha reliability estimates all exceeded 0.8.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of Items</th>
<th>Alpha</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Efficacy</td>
<td>10</td>
<td>0.92</td>
<td>53</td>
</tr>
<tr>
<td>Computer User Satisfaction</td>
<td>7</td>
<td>0.87</td>
<td>53</td>
</tr>
<tr>
<td>Attitude toward Computers</td>
<td>9</td>
<td>0.93</td>
<td>53</td>
</tr>
<tr>
<td>Lecture Satisfaction</td>
<td>10</td>
<td>0.85</td>
<td>53</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>7</td>
<td>0.86</td>
<td>53</td>
</tr>
</tbody>
</table>

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According to Straub (1989), a reliability coefficient greater than or equal to 0.8 is acceptable. The researcher concluded that the internal consistency reliability coefficient (alpha) of the instruments was acceptable for purposes of this study.

6.2.2. Descriptive Statistics

Demographic data were collected on all of the subjects. The demographic data were used to assess the subject’s knowledge and experience about computer technologies before the treatment and thus, establish if experimental groups were equivalent. Data were analyzed in two ways. First, a series of frequency distributions were compiled on the demographic as well as previous experience with, and current use of computer technologies to examine the variety of inputs (individual differences among students) into the experimental groups. Then appropriate statistical tests were used to compare variety among the groups. Thus, this section summarizes the results of the demographic data.

6.2.2.1. Subjects Profile

The distribution of the subjects' participation according to their major area of study, age, work experience, and gender by experimental group (Simulated Hands-On the SAP R/3 System (n=26) and Hands-On the SAP R/3 System (n=27)) is presented in Table 8. There were seven categories of study — Finance, Accounting, Marketing, Information Systems, Operations Management, General Business, and others. Of the overall subjects sample (n=53), approximately 5.7% of subjects were in Finance, 5.7% in Accounting, 5.7% in Marketing, 13.2% in Information Systems, 39.6% in Operations Management, 18.9% in General Business, and about 11.2% had another major. Approximately 17.0% of the participants were less than 25 years of age, 62.3% of the
total participants were between 25 and 30 years of age, 5.7% between 30 and 35 years of age, and 15.0% older than 35.

Table 8 - Summary of Response Percentages for Subject's Attributes by Experimental Group.

<table>
<thead>
<tr>
<th>Items</th>
<th>Experimental Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simulated</td>
<td>Hands-On</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n=26)</td>
<td>(n=27)</td>
<td></td>
</tr>
<tr>
<td>Major Area of Study:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Finance</td>
<td>4.0</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>2. Accounting</td>
<td>-</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>3. Marketing</td>
<td>-</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>4. Information Systems</td>
<td>8.0</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>5. Operations Management</td>
<td>52.0</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>6. General Business</td>
<td>20.0</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>7. Others</td>
<td>16.0</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Age:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. &lt;25</td>
<td>15.4</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td>2. 25-30</td>
<td>61.5</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td>3. 30-35</td>
<td>3.8</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>4. &gt;35</td>
<td>19.3</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Work Experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 1-5 years</td>
<td>46.2</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td>2. 6-10 years</td>
<td>30.8</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>3. &gt; 11 years</td>
<td>23.0</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Male</td>
<td>38.5</td>
<td>48.1</td>
<td></td>
</tr>
<tr>
<td>2. Female</td>
<td>61.5</td>
<td>51.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

With respect to work experience, 54.7% of the subjects had between 1 and 5 years of experience. Approximately 28.3% had between 6 and 10 years, and 17.0% had more than 11 years. The proportions of male and female participants were approximately 43.4% and 56.6% of the total sample, respectively. The distribution of subject's gender
by experimental group is presented in Table 8. Overall, there is no difference in male and female participants by group.

Overall, responses to the preliminary survey on subject’s demographic characteristics show that participants were mostly operations management and general business majors (39.6% and 18.9%, respectively), age between 25-30 (62.3%), with a work experience between 1 to 5 years (54.7%), and 43.4% males and 56.6% females.

A close examination of Table 8 by experimental group indicates that both groups were similar with respect to major area of study, age, work experience, and gender.

6.2.2.2. Previous Experience with Computers

A summary of subject’s access and previous experience with computers by experimental group is shown in Table 9.

Overall (n=53), approximately 91% of the subjects had access to computers at home and 87% had access to the Internet at home. Results indicate that on the average, subjects were frequent users of computers (4.17), using computers at home and several times a week (2.15) at work.

Furthermore, subjects used electronic mail (1.55) and the World Wide Web search (2.39), about once a day. Overall subjects had familiarity with software to some extent. On the other hand, data suggest that experimental groups were equivalent with respect to computer experience and current use of it.

6.2.2.3. Outcome and Other Variables

Table 10 summarizes the mean and standard deviation (Std) for each dependent variable (Performance, Self-Efficacy, and Computer User Satisfaction) as well as other
variables by experimental group. Statistical inference of the variables is presented in the next section.

Table 9 - Summary of Mean Responses and Standard Deviations of Overall Sample from Previous Experience with, and Current Use of Computer Technology Survey.

<table>
<thead>
<tr>
<th>Item</th>
<th>Instrument Scale</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Simulated Hands-On (n=26)</td>
</tr>
<tr>
<td>1. Access to computer at home (yes)</td>
<td>Yes or No</td>
<td>92.3%</td>
</tr>
<tr>
<td>2. Access to Internet at home (yes)</td>
<td></td>
<td>88.5%</td>
</tr>
<tr>
<td>3. Previous experience with computers</td>
<td>1 = No Experience to 5 = Professional User</td>
<td>4.19 ± 0.85</td>
</tr>
<tr>
<td>4. Frequency of computer use at home</td>
<td>1 = Several Times a Day</td>
<td>2.11 ± 1.14</td>
</tr>
<tr>
<td>5. Frequency of computer use at work</td>
<td></td>
<td>1.42 ± 1.17</td>
</tr>
<tr>
<td>6. Frequency of Electronic Mail use</td>
<td></td>
<td>1.38 ± 1.13</td>
</tr>
<tr>
<td>7. Frequency of World Wide Web search</td>
<td></td>
<td>2.19 ± 1.26</td>
</tr>
<tr>
<td>8. Frequency of Participation in Chat or Discussion groups</td>
<td>5 = Once a Month</td>
<td>3.23 ± 2.12</td>
</tr>
<tr>
<td>9. Knowledge of Word Processing</td>
<td>0 = Not at All to 5 = To a Very Great Extent</td>
<td>4.23 ± 1.07</td>
</tr>
<tr>
<td>10. Knowledge of Presentation Software</td>
<td></td>
<td>4.15 ± 1.12</td>
</tr>
<tr>
<td>11. Knowledge of Spreadsheets</td>
<td></td>
<td>3.23 ± 1.27</td>
</tr>
<tr>
<td>12. Knowledge of Database Systems</td>
<td></td>
<td>2.69 ± 1.35</td>
</tr>
<tr>
<td>13. Knowledge of Electronic Mail</td>
<td></td>
<td>1.85 ± 1.22</td>
</tr>
<tr>
<td>14. Knowledge of Statistical Packages</td>
<td></td>
<td>4.35 ± 1.09</td>
</tr>
</tbody>
</table>

Table 10 - Descriptive Statistics for Outcome and Other Variables by Experimental Group (Mean ± Std).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simulated Hands-On (n=26)</td>
</tr>
<tr>
<td>Performance</td>
<td>62.19 ± 7.20</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>6.30 ± 2.01</td>
</tr>
<tr>
<td>Computer User Satisfaction</td>
<td>3.03 ± 0.76</td>
</tr>
<tr>
<td>Skills Assessment</td>
<td>47.31 ± 10.80</td>
</tr>
<tr>
<td>Attitude toward Computers</td>
<td>4.78 ± 0.92</td>
</tr>
<tr>
<td>Lecture Satisfaction</td>
<td>2.72 ± 0.52</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>3.09 ± 0.72</td>
</tr>
</tbody>
</table>

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6.2.3. Hypotheses Test

6.2.3.1. Relationship Between Main Variables

To test for any relationship between pairs of variables (bivariate correlation), a correlation analysis was conducted. Table 11 provides the correlation matrix (Pearson correlation coefficients) between the variables. Numbers in parenthesis are probabilities.

Table 11 - Pearson Correlation Coefficients (alpha=0.05, n=53)

<table>
<thead>
<tr>
<th>Skills Assessment</th>
<th>Performance</th>
<th>Self-Efficacy</th>
<th>User Satisfaction</th>
<th>Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills Assessment</td>
<td>1.00000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>0.07868 (0.5755)</td>
<td>1.00000 (0.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>0.13149 (0.3484)</td>
<td>0.19804 (0.1552)</td>
<td>1.00000 (0.0)</td>
<td></td>
</tr>
<tr>
<td>User Satisfaction</td>
<td>0.20173 (0.1475)</td>
<td>0.29271 (0.0334)</td>
<td>0.27955 (0.0426)</td>
<td>1.00000 (0.0)</td>
</tr>
<tr>
<td>Attitude</td>
<td>0.14159 (0.3119)</td>
<td>0.38564 (0.0043)</td>
<td>0.47075 (0.0004)</td>
<td>0.06977 (0.6196)</td>
</tr>
</tbody>
</table>

There was a significant correlation between attitude toward computers and performance scores ($r = 0.38564, p = 0.0043$) as well as between attitude and self-efficacy ($r = 0.47075, p = 0.0004$). There was no other significant correlation between the other pairs of variables.

6.2.3.2. Differences Between Experimental Groups Before Treatment

Kruskal-Wallis test was used to test differences in preliminary survey results between experimental groups.

Table 12 - Results of Kruskal-Wallis Test

<table>
<thead>
<tr>
<th>Variable</th>
<th>CHISQ</th>
<th>Prob&gt;CHISQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge/Skills Assessment</td>
<td>0.0001</td>
<td>0.9924</td>
</tr>
<tr>
<td>Previous Experience with Computers</td>
<td>0.36</td>
<td>0.5472</td>
</tr>
<tr>
<td>Attitudes toward Computers</td>
<td>0.83</td>
<td>0.3636</td>
</tr>
</tbody>
</table>
Chi-Square (CHISQ) values showed no significant difference between the experimental group's knowledge/skills assessment, previous experience with computers, and attitude toward computers (at the 0.05 alpha level). Table 12 reports the test results. Following is the result of the statistical analyses performed in order to address the above research questions.

Performance, Self-efficacy, and Satisfaction Difference

A number of factors associated with learning could influence performance, self-efficacy, and satisfaction, in the instructional method domain. In order to investigate this possibility, a series of covariate analyses were conducted. Covariate analyses were conducted using skills/knowledge assessment, prior experience with computers, and attitudes toward computers as covariates. No significant (p>0.05) covariate effects were found for either of these variables. This suggests that an ANOVA should have been computed instead.

Results of individual Analysis of Variance (ANOVAs) is provided in Tables 13, 14, and 15 for main research variables Performance, Self-Efficacy, and Satisfaction, respectively. As can be observed from the tables, there were not significant differences in student performance, self-efficacy, and satisfaction between the two experimental groups (p > 0.05). The Power analysis results of the ANOVA F-tests obtained are provided in Table 16. Overall, effect sizes were small and powers were low.

An important condition for the application of parametric statistics is that the error terms are normally distributed and they have constant variance. Residual analysis was performed by computing the Shapiro-Wilk test ($W$) and the Bartlett test to check the
normality and constant variance of the error terms. The results of the test are provided for each dependent variable in Tables 13, 14, and 15.

Table 13 - ANOVA Table for Student’s Performance

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>45.77</td>
<td>1</td>
<td>45.77</td>
<td>1.14</td>
<td>0.291</td>
</tr>
<tr>
<td>Error</td>
<td>2050.04</td>
<td>51</td>
<td>40.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>2095.81</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: $W$:Normal = 0.9704, Pr<$W$=0.3643
Homogeneity of Variance Bartlett’s test: Chi-square=2.08, Alpha=0.148

The conclusion based on the results is that there is not evidence of departure from normality and constant variance assumptions. Thus, the application of the Parametric statistics is valid for the data analyzed.

Self-Efficacy Difference

Table 14 - ANOVA Table for Student’s Self-Efficacy

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>2.12</td>
<td>1</td>
<td>2.12</td>
<td>0.69</td>
<td>0.410</td>
</tr>
<tr>
<td>Error</td>
<td>156.54</td>
<td>51</td>
<td>3.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>158.66</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: $W$:Normal = 0.9752, Pr<$W$=0.5305
Homogeneity of Variance Bartlett’s test: Chi-square=2.46, Alpha=0.116

Computer User Satisfaction Difference

Table 15 - ANOVA Table for Student’s Computer Satisfaction

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>1.53</td>
<td>1</td>
<td>1.53</td>
<td>2.63</td>
<td>0.111</td>
</tr>
<tr>
<td>Error</td>
<td>29.59</td>
<td>51</td>
<td>0.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>31.12</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: $W$:Normal = 0.9703, Pr<$W$=0.3622
Homogeneity of Variance Bartlett’s test: Chi-square=0.0005, Alpha=0.981
Table 16 - Power Calculations for Tested Variables

<table>
<thead>
<tr>
<th>Variable Tested</th>
<th>Effect Size</th>
<th>Noncentrality Parameter ((\lambda))</th>
<th>(\text{*Power})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>0.1466</td>
<td>1.139</td>
<td>0.182</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>0.1141</td>
<td>0.691</td>
<td>0.129</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.2231</td>
<td>2.630</td>
<td>0.356</td>
</tr>
</tbody>
</table>

* Observed Power computed using alpha=0.05, N = 53

Lecture Satisfaction and Lecture Evaluation Differences

Kruskal-Wallis test was performed on lecture satisfaction and lecture evaluation variables in the study to determine if there was a significant difference between experimental groups. Results of the statistical test (Table 17) indicate that groups (hands-on and simulated hands-on) are not significantly different with respect to lecture evaluation and lecture satisfaction.

Table 17 - Results of Kruskal-Wallis Test

<table>
<thead>
<tr>
<th>Variable</th>
<th>CHISQ</th>
<th>Prob&gt;CHISQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture Satisfaction</td>
<td>2.78</td>
<td>0.0901</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>1.56</td>
<td>0.2115</td>
</tr>
</tbody>
</table>

6.2.4. Summary of Experiment I

This study compared, through a classroom experiment, two approaches for teaching business processes to graduate students taking an Operations Management course. A total of 53 students were randomly assigned to two groups. Both groups were taught in a standard lecture format (using Power Point presentation) by the same instructor. However, for one group, simulated hands-on, an assignment exercise that asked students to watch a series of screencam demonstration movies of how to perform transactions using the SAP R/3 System was provided. For the hands-on group, the same
assignment exercise was provided but students were asked to perform the transactions on real-time using the SAP R/3 System. Both groups were given a week to complete the assignments.

Both groups were given the same pre- and posttest, as well as questionnaires to measure self-efficacy, user satisfaction, computer experience, and attitudes. The primary question of interest for this study was whether the instructional design for the hands-on group was more effective than that for the simulated hands-on group as measured by performance, self-efficacy, and satisfaction.

As a starting point, in comparing simulated hands-on and hands-on experimental groups, a series of covariate analyses were conducted using skills/knowledge assessment, prior experience with computers, and attitudes toward computers as covariates. No significant covariate effects were found for either of these variables. Therefore, analysis of variance was used to analyze the data. Results of the analysis of variance indicated that there were not significant differences in performance, self-efficacy, and computer satisfaction between the experimental groups.

6.3. Experiment II (ISDS 3115)

This experiment uses a two-factor design to determine whether or not student performance, self-efficacy, and satisfaction are enhanced by a particular method of instruction (control, simulated hands-on the SAP R/3 System via Web, and hands-on the SAP R/3 System). A second research objective was to determine whether or not learning styles (diverger, assimilator, converger, and accommodator) affect learning outcomes within the instructional methods. The following report reveals the data analyses and results of the experiment.
6.3.1. Validity and Reliability Analysis

6.3.1.1. Content and Construct Validity

Content validity, as in Experiment I, was established by using previous validated instruments and 'expert judgement'. Factor analysis was used to establish construct validity. The results of the factor analysis are displayed in Table 18. All items load higher than 0.50 for the first component. Thus, one can argue that the measures have higher construct validity.

Table 18 - Factor Analysis for Multiple-Item Measures, Factor I

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor I Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.76</td>
</tr>
<tr>
<td>2</td>
<td>0.76</td>
</tr>
<tr>
<td>3</td>
<td>0.88</td>
</tr>
<tr>
<td>4</td>
<td>0.86</td>
</tr>
<tr>
<td>5</td>
<td>0.88</td>
</tr>
<tr>
<td>6</td>
<td>0.87</td>
</tr>
<tr>
<td>7</td>
<td>0.86</td>
</tr>
<tr>
<td>8</td>
<td>0.80</td>
</tr>
<tr>
<td>9</td>
<td>0.79</td>
</tr>
<tr>
<td>10</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Eigenvalue: 6.79
Percent Variance Explained: 67.92

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor I Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.78</td>
</tr>
<tr>
<td>2</td>
<td>0.77</td>
</tr>
<tr>
<td>3</td>
<td>0.75</td>
</tr>
<tr>
<td>4</td>
<td>0.85</td>
</tr>
<tr>
<td>5</td>
<td>0.87</td>
</tr>
<tr>
<td>7</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Eigenvalue: 4.05
Percent Variance Explained: 67.50

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor I Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.80</td>
</tr>
<tr>
<td>2</td>
<td>0.80</td>
</tr>
<tr>
<td>3</td>
<td>0.75</td>
</tr>
<tr>
<td>4</td>
<td>0.63</td>
</tr>
<tr>
<td>5</td>
<td>0.65</td>
</tr>
<tr>
<td>6</td>
<td>0.71</td>
</tr>
<tr>
<td>7</td>
<td>0.72</td>
</tr>
<tr>
<td>8</td>
<td>0.73</td>
</tr>
<tr>
<td>9</td>
<td>0.77</td>
</tr>
<tr>
<td>10</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Eigenvalue: 5.61
Percent Variance Explained: 56.10

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor I Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.74</td>
</tr>
<tr>
<td>2</td>
<td>0.57</td>
</tr>
<tr>
<td>3</td>
<td>0.84</td>
</tr>
<tr>
<td>4</td>
<td>0.86</td>
</tr>
<tr>
<td>5</td>
<td>0.79</td>
</tr>
<tr>
<td>7</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Eigenvalue: 3.69
Percent Variance Explained: 61.57

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor I Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.82</td>
</tr>
<tr>
<td>16</td>
<td>0.84</td>
</tr>
<tr>
<td>17</td>
<td>0.77</td>
</tr>
<tr>
<td>18</td>
<td>0.81</td>
</tr>
<tr>
<td>19</td>
<td>0.79</td>
</tr>
<tr>
<td>20</td>
<td>0.60</td>
</tr>
<tr>
<td>21</td>
<td>0.72</td>
</tr>
<tr>
<td>22</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Eigenvalue: 4.67
Percent Variance Explained: 58.30
6.3.1.2. Internal Consistency

Cronbach’s coefficient alphas (Cronbach, 1951) are presented in Table 19. The Cronbach alphas were 0.94 for Self-efficacy, 0.87 for Computer User Satisfaction, 0.89 for Attitudes toward Computers, 0.90 for Lecture Satisfaction, and 0.88 for Lecture Evaluation. These high values of alpha coefficients indicate that the items under these constructs adequately measure the constructs. Thus, the researcher concluded that the internal consistency reliability coefficient (alpha) of the instruments was acceptable for purposes of this study.

Table 19 - Number of Items and Coefficient Alpha Reliability Estimates for the Study's Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of Items</th>
<th>Alpha</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Efficacy</td>
<td>10</td>
<td>0.94</td>
<td>217</td>
</tr>
<tr>
<td>Computer User Satisfaction</td>
<td>7</td>
<td>0.87</td>
<td>217</td>
</tr>
<tr>
<td>Attitudes toward Computers</td>
<td>8</td>
<td>0.89</td>
<td>284</td>
</tr>
<tr>
<td>Lecture Satisfaction</td>
<td>10</td>
<td>0.90</td>
<td>284</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>6</td>
<td>0.88</td>
<td>284</td>
</tr>
</tbody>
</table>

6.3.2. Descriptive Statistics

This section provides a summary of the demographic data collected on all of the subjects. The section starts by providing a distribution of the subjects by experimental group. Then, a series of frequency distributions are compiled on the demographic as well as previous experience with computer information.

6.3.2.1. Distribution of Subjects

A total sample of 284 subjects participated in the experiment. The distribution of the subjects’s learning style by experimental group is presented in Table 20. Numbers in parenthesis are percentages.
The proportion of participants according to instructional method were 23.59%, 39.44%, and 36.97% for the control, simulated hands-on, and hands-on experimental group, respectively. On the other hand, overall, there were 17.25% divergers, 35.91% assimilators, 29.23% convergers, and 17.61% accommodators.

Table 20 - Distribution of Subjects by Experimental Group and Learning Style Mode

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Learning Style Mode</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diverger</td>
<td>Assimilator</td>
</tr>
<tr>
<td>Control</td>
<td>9 (3.17%)</td>
<td>21 (7.39%)</td>
</tr>
<tr>
<td>Simulated Hands-On</td>
<td>21 (7.39%)</td>
<td>42 (14.79%)</td>
</tr>
<tr>
<td>Hands-On</td>
<td>19 (6.69%)</td>
<td>39 (13.73%)</td>
</tr>
<tr>
<td>Total</td>
<td>49 (17.25%)</td>
<td>102 (35.91%)</td>
</tr>
</tbody>
</table>

The Chi-Square test for $k$ independent samples was computed to test if the proportion of subjects in each learning style was the same in each of the Experimental Groups. The results of the analysis indicated that there is not a significant difference (Chi-Square = 3.493, $p = 0.745$) in the proportion of the subject’s learning style by experimental group. Thus, the subject’s learning style was similar among experimental groups.

Although, there is not significant difference in the distribution of the subject’s learning style by experimental group, the presence of unequal sample sizes represents an issue that must be addressed when deciding on a specific statistical technique for analysis. The fact is that even in experimental studies one may encounter unequal treatment sample sizes because of a variety of uncontrolled situations such as illness of subject, incomplete records, technical problems, etc. Thus, it is recommended to select the most powerful statistical test that is available and appropriate for the study at hand.
(Baroudi and Orlikowski, 1989). In this study, the regression approach to ANOVA is used to correct for unequal sample sizes.

6.3.2.2. Subjects Profile

Table 21 reports the distribution of the subjects’ participation according to their major area of study, level of education, overall GPA, age, and gender by experimental group. Seven categories of study were included in the survey — Finance, Accounting, Marketing, Information Systems, Operations Management, General Business, and others.

Of the subjects sample (n=284), approximately 19.0% of the subjects were in Finance, 16.9% in Accounting, 19.0% in Marketing, 15.9% in Information Systems, 1.1% in Operations Management, 13.7% in General Business, and about 14.4% had other majors.

There were only three major categories of education — junior, sophomore, and senior. Approximately 20.40% of subjects were junior, 0.37% sophomore, and 79.23% senior undergraduates. Experimental groups had a similar percentage of the subject’s academic level (Table 21).

Of the total subjects sampled, approximately 8.0% had an overall GPA less than 2.5, 40.2% between 2.5 and 3.0, 35.3% between 3.0 and 3.5, and 16.5% greater than 3.5. The relative frequency distribution by experimental group is provided in Table 21.

The proportions of male and female participants were approximately 52.8% and 47.2% of the total sample, respectively. The distribution of the subject’s gender by experimental group is presented in Table 21. Overall, there is no difference in male and female participants by group. Approximately 75% of the total participants were between 20 and 22 years of age, 16.2% between 22 and 25 years of age, and 8.8% older than 25.
### Table 21 - Summary of Response Percentages for Subject’s Attributes by Experimental Group.

<table>
<thead>
<tr>
<th>Items</th>
<th>Control (n=67)</th>
<th>Simulated Hands-On (n=112)</th>
<th>Hands-On (n = 105)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Area of Study:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Finance</td>
<td>17.9</td>
<td>18.7</td>
<td>20.0</td>
</tr>
<tr>
<td>2. Accounting</td>
<td>10.4</td>
<td>17.0</td>
<td>21.0</td>
</tr>
<tr>
<td>3. Marketing</td>
<td>29.9</td>
<td>18.7</td>
<td>12.4</td>
</tr>
<tr>
<td>4. Information Systems</td>
<td>17.9</td>
<td>17.0</td>
<td>13.3</td>
</tr>
<tr>
<td>5. Operations Management</td>
<td>1.5</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>6. General Business</td>
<td>13.4</td>
<td>11.6</td>
<td>16.2</td>
</tr>
<tr>
<td>7. Others</td>
<td>9.0</td>
<td>16.1</td>
<td>16.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Academic Class Level:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Freshman</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Sophomore</td>
<td>14.9</td>
<td>18.8</td>
<td>25.7</td>
</tr>
<tr>
<td>3. Junior</td>
<td>-</td>
<td>-</td>
<td>1.0</td>
</tr>
<tr>
<td>4. Senior</td>
<td>85.1</td>
<td>81.2</td>
<td>73.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Overall GPA:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. &lt;2.5</td>
<td>10.4</td>
<td>7.1</td>
<td>7.6</td>
</tr>
<tr>
<td>2. 2.5-3.0</td>
<td>49.3</td>
<td>34.8</td>
<td>40.0</td>
</tr>
<tr>
<td>3. 3.0-3.5</td>
<td>26.9</td>
<td>41.1</td>
<td>34.3</td>
</tr>
<tr>
<td>4. &gt;3.5</td>
<td>13.4</td>
<td>17.0</td>
<td>18.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Age:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. &lt;19</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. 20-22</td>
<td>73.1</td>
<td>78.6</td>
<td>72.4</td>
</tr>
<tr>
<td>3. 22-25</td>
<td>19.4</td>
<td>14.3</td>
<td>16.2</td>
</tr>
<tr>
<td>4. &gt;25</td>
<td>7.5</td>
<td>7.1</td>
<td>11.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Gender:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Male</td>
<td>52.2</td>
<td>50.0</td>
<td>56.2</td>
</tr>
<tr>
<td>2. Female</td>
<td>47.8</td>
<td>50.0</td>
<td>43.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Overall, responses to the preliminary survey on the subject’s demographic characteristics indicates that participants were mostly marketing and finance majors (19.0%, respectively), senior academic level (79.23%), with an overall GPA between 2.5-3.00 (40.2%), age between 20-22 (75%), and 52.8% males and 47.2% females. In general, data indicate that groups were equivalent at the beginning of the study.
6.3.2.3. Previous Experience with Computers

Table 22 contains the subject's access and previous experience with computers by experimental group. Overall, approximately 83% of the subjects had access to computers at home and 73% had access to the Internet at home. On the average, subjects were frequent users of computers (3.67), using computers at home and several times a week (1.39) at work. Furthermore, subjects used electronic mail (2.27) and the World Wide Web search (2.62) about once a day. Overall, subjects had familiarity with software to some extent.

<table>
<thead>
<tr>
<th>Item</th>
<th>Instrument Scale</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Control (n=67)</td>
</tr>
<tr>
<td>1. Access to computer at home (yes)</td>
<td>Yes or No</td>
<td>89.6%</td>
</tr>
<tr>
<td>2. Access to Internet at home (yes)</td>
<td></td>
<td>83.6%</td>
</tr>
<tr>
<td>3. Previous experience with computers</td>
<td>1 = No Experience to 5 = Professional User</td>
<td>3.65 ± 0.66</td>
</tr>
<tr>
<td>4. Frequency of computer use at home</td>
<td>1 = Several Times a Day to 5 = Once a Month</td>
<td>2.40 ± 1.15</td>
</tr>
<tr>
<td>5. Frequency of computer use at work</td>
<td></td>
<td>1.36 ± 1.37</td>
</tr>
<tr>
<td>6. Frequency of Electronic Mail use</td>
<td></td>
<td>2.29 ± 1.29</td>
</tr>
<tr>
<td>7. Frequency of World Wide Web search</td>
<td></td>
<td>2.45 ± 1.28</td>
</tr>
<tr>
<td>8. Frequency of Participation in Chat or Discussion groups</td>
<td></td>
<td>3.67 ± 1.89</td>
</tr>
<tr>
<td>9. Knowledge of Word Processing</td>
<td>0 = Not at All to 5 = To a Very Great Extent</td>
<td>4.22 ± 0.69</td>
</tr>
<tr>
<td>10. Knowledge of Presentation Software</td>
<td></td>
<td>3.61 ± 0.85</td>
</tr>
<tr>
<td>11. Knowledge of Spreadsheets</td>
<td></td>
<td>3.37 ± 1.11</td>
</tr>
<tr>
<td>12. Knowledge of Database Systems</td>
<td></td>
<td>2.58 ± 1.16</td>
</tr>
<tr>
<td>13. Knowledge of Electronic Mail</td>
<td></td>
<td>1.85 ± 1.14</td>
</tr>
<tr>
<td>14. Knowledge of Statistical Packages</td>
<td></td>
<td>4.36 ± 0.93</td>
</tr>
</tbody>
</table>

6.3.2.4. Knowledge/Skill Assessment

The average score and standard deviation (Std) obtained by the participants on the 15-item knowledge/skills assessment test is presented in Table 23. Statistical analysis of the data is addressed in the next section.
Table 23 - Knowledge/Skills Assessment Test Scores by Experimental Group and Learning Style.

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Mean ± Std</th>
<th>Learning Style</th>
<th>Mean ± Std</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>36.96 ± 12.19</td>
<td>Diverger</td>
<td>37.11 ± 10.23</td>
<td>9</td>
</tr>
<tr>
<td>(n = 67)</td>
<td></td>
<td>Assimilator</td>
<td>40.90 ± 12.12</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Converger</td>
<td>35.12 ± 14.51</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accommodator</td>
<td>33.85 ± 7.41</td>
<td>13</td>
</tr>
<tr>
<td>Simulated Hands-on</td>
<td>44.25 ± 10.67</td>
<td>Diverger</td>
<td>40.68 ± 10.46</td>
<td>21</td>
</tr>
<tr>
<td>(n = 112)</td>
<td></td>
<td>Assimilator</td>
<td>46.59 ± 13.50</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Converger</td>
<td>45.06 ± 13.35</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accommodator</td>
<td>39.56 ± 9.84</td>
<td>21</td>
</tr>
<tr>
<td>Hands-on</td>
<td>44.00 ± 12.60</td>
<td>Diverger</td>
<td>42.52 ± 11.92</td>
<td>19</td>
</tr>
<tr>
<td>(n = 105)</td>
<td></td>
<td>Assimilator</td>
<td>44.64 ± 9.24</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Converger</td>
<td>43.57 ± 11.45</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accommodator</td>
<td>46.09 ± 11.42</td>
<td>16</td>
</tr>
</tbody>
</table>

6.3.2.5. Dependent Variables

Table 24 presents the mean, standard deviations (Std), and sample sizes (N) for each dependent variable (outcomes) by experimental group and learning style.

The mean of the performance measurement fluctuated from 59.15 ± 10.98 to 67.07 ± 7.88. On the average, the subject's self-efficacy ranged from 6.11 ± 2.06 to 7.14 ± 1.63 (where 1 indicates "Not at all confidant," 5 indicates "Moderately confidant," and 10 indicates "Totally confidant."). In general, the student's satisfaction was relatively low: the mean satisfaction measurement scale ranged from 2.42 ± 0.73 to 2.93 ± 0.72 (where 1 = Very Low, 2 = Low, 3 = Medium, 4 = High, and 5 = very High) (Table 24).

6.3.2.6. Summary of the Mean of Other Variables

The mean and standard deviation of the attitude toward computers, lecture satisfaction, and lecture evaluation scales were computed (Table 25).

The mean of the attitude measurement scale fluctuated from 4.18 ± 0.50 to 3.66 ± 0.76. In a similar way, the mean of the lecture satisfaction and lecture evaluation varied from 2.63 ± 0.82 to 3.23 ± 1.04 and 2.94 ± 0.67 to 3.34 ± 0.83, respectively.
Table 24 - Descriptive Statistics for Dependent Variables by Experimental Group and Learning Style.

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Learning Style</th>
<th>Outcomes (Mean ± Std)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Performance</td>
<td>Self-Efficacy</td>
</tr>
<tr>
<td>Control</td>
<td>Diverger</td>
<td>61.22 ± 10.06</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Assimilator</td>
<td>62.62 ± 8.30</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Converger</td>
<td>60.21 ± 11.09</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Accommodator</td>
<td>59.15 ± 10.98</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mean ± Std</strong></td>
<td><strong>60.89 ± 9.99</strong></td>
</tr>
<tr>
<td>Simulated</td>
<td>Diverger</td>
<td>64.20 ± 6.30</td>
<td>6.51 ± 1.65</td>
</tr>
<tr>
<td>Hands-On</td>
<td>Assimilator</td>
<td>67.07 ± 7.88</td>
<td>6.33 ± 1.80</td>
</tr>
<tr>
<td></td>
<td>Converger</td>
<td>64.30 ± 7.01</td>
<td>6.85 ± 1.63</td>
</tr>
<tr>
<td></td>
<td>Accommodator</td>
<td>66.52 ± 6.67</td>
<td>6.61 ± 1.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mean ± Std</strong></td>
<td><strong>65.53 ± 7.37</strong></td>
</tr>
<tr>
<td>Hands-On</td>
<td>Diverger</td>
<td>62.21 ± 8.14</td>
<td>6.11 ± 2.06</td>
</tr>
<tr>
<td></td>
<td>Assimilator</td>
<td>66.26 ± 8.90</td>
<td>6.47 ± 1.73</td>
</tr>
<tr>
<td></td>
<td>Converger</td>
<td>64.45 ± 9.13</td>
<td>7.14 ± 1.63</td>
</tr>
<tr>
<td></td>
<td>Accommodator</td>
<td>62.69 ± 8.08</td>
<td>6.40 ± 1.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mean ± Std</strong></td>
<td><strong>64.44 ± 8.74</strong></td>
</tr>
</tbody>
</table>

6.3.3. Hypotheses Test

6.3.3.1. Relationship Between Main Variables

The correlation coefficients between pairs of variables are shown in Table 26. Analyses showed that there is a significant relationship (* α = 0.05/10, p<0.005) between the student’s scores in the skills assessment test and performance, self-efficacy and user satisfaction, and self-efficacy and attitude (Table 26). The fact that there was not a significant relationship between performance and either self-efficacy or satisfaction suggests that a Multivariate Analysis of Variance (MANOVA) may not be appropriate for this study.
Table 25 - Mean and Standard Deviation for Attitude toward Computers, Lecture Satisfaction, and Lecture Evaluation Measures by Experimental Group and Learning Style.

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Learning Style</th>
<th>Other Variables (Mean ± Std) N</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Attitude toward Computers</td>
<td>Lecture Satisfaction</td>
<td>Lecture Evaluation</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Diverger</td>
<td>3.87 ± 0.67</td>
<td>3.23 ± 1.04</td>
<td>3.16 ± 1.05</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Assimilator</td>
<td>3.94 ± 0.59</td>
<td>2.92 ± 0.76</td>
<td>3.34 ± 0.83</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Converger</td>
<td>4.10 ± 0.75</td>
<td>2.93 ± 0.71</td>
<td>3.24 ± 0.84</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Accommodator</td>
<td>3.96 ± 0.79</td>
<td>3.02 ± 0.67</td>
<td>3.32 ± 0.77</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.99 ± 0.69</td>
<td>2.99 ± 0.76</td>
<td>3.27 ± 0.84</td>
<td>67</td>
</tr>
<tr>
<td>Simulated Hands-On</td>
<td>Diverger</td>
<td>3.66 ± 0.76</td>
<td>2.81 ± 0.70</td>
<td>3.12 ± 0.70</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Assimilator</td>
<td>3.72 ± 0.79</td>
<td>2.79 ± 0.71</td>
<td>3.18 ± 0.80</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Converger</td>
<td>4.14 ± 0.66</td>
<td>2.63 ± 0.82</td>
<td>3.14 ± 0.77</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Accommodator</td>
<td>3.86 ± 0.74</td>
<td>2.90 ± 0.81</td>
<td>2.94 ± 0.98</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.84 ± 0.76</td>
<td>2.78 ± 0.75</td>
<td>3.12 ± 0.81</td>
<td>112</td>
</tr>
<tr>
<td>Hands-On</td>
<td>Diverger</td>
<td>3.81 ± 0.61</td>
<td>2.98 ± 0.50</td>
<td>3.25 ± 0.62</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Assimilator</td>
<td>3.95 ± 0.71</td>
<td>2.89 ± 0.71</td>
<td>3.15 ± 0.66</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Converger</td>
<td>4.18 ± 0.50</td>
<td>2.79 ± 0.60</td>
<td>2.94 ± 0.67</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Accommodator</td>
<td>4.01 ± 0.81</td>
<td>2.84 ± 0.60</td>
<td>3.00 ± 0.72</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.00 ± 0.66</td>
<td>2.87 ± 0.62</td>
<td>3.09 ± 0.66</td>
<td>105</td>
</tr>
</tbody>
</table>

6.3.3.2. Differences Between Experimental Groups Before Treatment

To determine whether or not experimental groups were equivalent before the experimental treatment was applied, data collected on previous experience with computers, background knowledge/skills assessment, and attitude toward computers were analyzed using the Kruskal-Wallis test and Analysis of Variance (ANOVA).

The results of the Kruskal-Wallis tests show that there is no statistical significant difference among experimental groups (control, hands-on, and simulated hands-on) with regard to previous computer experience of the subjects (CHISQ = 1.4976, Prob > CHISQ = 0.4729).
<table>
<thead>
<tr>
<th></th>
<th>Skills Assessment</th>
<th>Performance</th>
<th>Self-Efficacy</th>
<th>User Satisfaction</th>
<th>Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills Assessment</td>
<td>1.00000 (0.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>* 0.22396 (0.0009)</td>
<td>1.00000 (0.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>0.14207 (0.0365)</td>
<td>0.09327 (0.1710)</td>
<td>1.00000 (0.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>User Satisfaction</td>
<td>0.06745 (0.3226)</td>
<td>0.18078 (0.0076)</td>
<td>* 0.34928 (0.0001)</td>
<td>1.00000 (0.0)</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>0.08755 (0.1989)</td>
<td>0.01110 (0.8708)</td>
<td>* 0.34210 (0.0001)</td>
<td>-0.03818 (0.5759)</td>
<td>1.00000 (0.0)</td>
</tr>
</tbody>
</table>

Note. Numbers in parenthesis are probability values. * significant at alpha = 0.05

The test on background knowledge/skills assessment indicated that there is significant statistical difference (CHISQ = 17.571, Prob > CHISQ = 0.0002) in knowledge/skills assessment scores among subjects before the treatment. Students scores are higher in the simulated hands-on via web instructional method than the control group. But simulated hands-on scores are similar to the hands-on group. Thus, the results suggest that pretest scores (knowledge/skills assessment) can be used as a covariate in further analyses.

Attitude toward computers, a construct, was analyzed by using one-way Analysis of Variance (ANOVA) statistical method since the data conformed with the assumptions of the F-test previously indicated. The results of the ANOVA indicated that there is no significant difference among subjects that received the hands-on instruction method and those who received the simulated hands-on instruction method (p > 0.05).

6.3.3.3. Differences Between Experimental Groups After Treatment

This section reports the test results of individual hypotheses previously proposed in this study (Chapter 3). The main problem was to determine whether or not a particular
instructional method can affect outcomes (performance, self-efficacy, and user satisfaction) of learning about business processes.

The independent variables were experimental group (Instructional Method represented by control, simulated hands-on, and hands-on the R/3 system) and learning style (four learning style groups: accommodator, assimilator, diverger, and converger). The average number of subjects per cell was 23.

As an initial step on the analysis, Analysis of Covariance (ANCOVA) was performed. It was expected that knowledge/skills assessment score (pretest) could affect the dependent variables. The results of the analysis indicated that the means of the treatments do not depend on the value of the covariate ($p > 0.05$). Thus, in this case the next step in the analysis was to use the Regression Approach to ANOVA to test the hypotheses (compare cell means).

The Regression Approach to Analysis of variance (ANOVA) was used to analyze the data collected from the 284 students involved in the study. The main hypotheses to be tested are listed in Table 27.

Student’s Performance (H1, H6, H9)

Table 28 reports the results of the analysis. The F-value for the experimental group was 5.62, which is statistically significant ($p < 0.05$), indicating a significant difference on performance scores among the control, simulated hands-on via web, and hands-on groups. Thus, hypothesis H1 was rejected.

The learning style factor was not statistically significant ($p > 0.05$), indicating no significant difference on performance scores among the four learning style groups. No significant interaction effect is present between the two factors. The F for interaction was

103
0.35 and was not statistically significant indicating that there is no significant relationship between learning instructional method and learning style. Thus, hypotheses six and nine were not rejected (H6 and H9).

Table 27 - Hypotheses to be Tested

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>There will be no difference in performance scores between the group that receives hands-on experience with the SAP R/3 System and all other groups.</td>
</tr>
<tr>
<td>H2</td>
<td>There will be no difference in self-efficacy between the hands-on SAP R/3 System instruction group and the simulated hands-on SAP R/3 System instruction group.</td>
</tr>
<tr>
<td>H3</td>
<td>There will be no difference in user satisfaction between the hands-on SAP R/3 System instruction group and the simulated hands-on SAP R/3 System instruction group.</td>
</tr>
<tr>
<td>H4</td>
<td>There will be no difference in performance scores between individuals with high self-efficacy and those with low self-efficacy.</td>
</tr>
<tr>
<td>H5</td>
<td>There will be no difference in performance scores between subjects who are more satisfied with the learning process and those who are less satisfied.</td>
</tr>
<tr>
<td>H6</td>
<td>Subjects’ learning style does not influence the performance of subjects.</td>
</tr>
<tr>
<td>H7</td>
<td>Subjects’ learning style does not influence the self-efficacy of subjects.</td>
</tr>
<tr>
<td>H8</td>
<td>Subjects’ learning style does not influence the satisfaction of subjects.</td>
</tr>
<tr>
<td>H9</td>
<td>There is no significant interaction effect of learning style and instruction method on the performance scores, self-efficacy, and satisfaction of subjects.</td>
</tr>
</tbody>
</table>

Since the overall test for significance for the experimental group factor effect led to rejection of the null hypothesis, a pairwise multiple comparison test was computed to find the main source of the factor effect. The Tukey multiple comparison method was performed on the twelve cell means.

Pairwise Comparisons Computation for H1

The Tukey multiple comparison analysis (family confidence coefficient of 0.90) revealed that students receiving simulated hands-on the SAP R/3 system on the average scored higher on the written test (65.52 ± 0.89) than students from the control group (60.80 ± 1.12). Further, the other two pairwise comparisons (experimental control group
vs hands-on experimental group (63.90 ± 0.84) and simulated hands-on vs hands-on experimental groups) did not show significantly different mean changes in performance.

Table 28 - ANOVA Table for Student’s Performance

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>748.657</td>
<td>2</td>
<td>374.328</td>
<td>5.115</td>
<td>0.007</td>
</tr>
<tr>
<td>Learning Style (B)</td>
<td>416.520</td>
<td>3</td>
<td>138.840</td>
<td>1.897</td>
<td>0.130</td>
</tr>
<tr>
<td>AB Interaction</td>
<td>181.214</td>
<td>6</td>
<td>30.202</td>
<td>0.413</td>
<td>0.870</td>
</tr>
<tr>
<td>Error</td>
<td>19906.379</td>
<td>272</td>
<td>73.185</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: $W$: Normal = 0.9813, Pr<$W$ = 0.3136
Homogeneity of Variance Bartlett’s test: Chi-Square = 13.77, Alpha=0.246

Conclusion

One concludes from these confident intervals with 90% family confidence coefficient that students receiving simulated hands-on the SAP R/3 System on the average scored higher on the written test (Least square mean = 65.52 and Standard Error = 0.89) than students from the control group (Least square mean = 60.80 and a Standard Error = 1.12). Furthermore, the other two pairwise comparisons (experimental control group vs. hands-on experimental group) (Least square mean = 63.90 and Standard Error = 0.84) and (simulated hands-on vs. hands-on experimental groups) do not show significantly different mean changes in performance.

Self-Efficacy (H2, H7, H9)

Hypotheses 2, 7 and 9 could not be rejected since there were not significant main effects (instructional methods and learning style) or interaction effect when evaluating the student’s self-efficacy. Results of the statistical analysis are reported in Table 29.
Table 29 - ANOVA Table for Student's Self-Efficacy

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>0.103</td>
<td>1</td>
<td>0.103</td>
<td>0.034</td>
<td>0.854</td>
</tr>
<tr>
<td>Learning Style (B)</td>
<td>15.665</td>
<td>3</td>
<td>5.222</td>
<td>1.719</td>
<td>0.164</td>
</tr>
<tr>
<td>AB Interaction</td>
<td>3.608</td>
<td>3</td>
<td>1.203</td>
<td>0.396</td>
<td>0.756</td>
</tr>
<tr>
<td>Error</td>
<td>634.69</td>
<td>209</td>
<td>3.037</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: W:Normal = 0.9613, Pr<W = 0.0002
Homogeneity of Variance Bartlett's test: Chi-Square = 2.03, Alpha=0.958

User Satisfaction (H3, H8, H9)

The regression approach to analysis of variance did not reveal a significant main effect for instructional method, learning style or an interaction effect between instructional method and learning style. The results of the data analysis are provided in Table 30. Thus, hypotheses three, eight, and nine (H3, H8, and H9) could not be rejected when using user satisfaction as a dependent variable.

Table 30 - ANOVA Table for Student's Satisfaction

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>1.456</td>
<td>1</td>
<td>1.456</td>
<td>2.522</td>
<td>0.114</td>
</tr>
<tr>
<td>Learning Style (B)</td>
<td>3.713</td>
<td>3</td>
<td>1.238</td>
<td>2.144</td>
<td>0.096</td>
</tr>
<tr>
<td>AB Interaction</td>
<td>0.282</td>
<td>3</td>
<td>0.093</td>
<td>0.163</td>
<td>0.921</td>
</tr>
<tr>
<td>Error</td>
<td>120.669</td>
<td>209</td>
<td>0.577</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: W:Normal = 0.9772, Pr<W = 0.1506
Homogeneity of Variance Bartlett's test: Chi-Square = 7.87, Alpha=0.344

Power Analysis

A post-hoc evaluation was performed on the statistical tests computed previously. The results of the power analyses are reported in Table 31. As stated before, power of a test is a function of alpha, sample size, and effect size.
Overall, effect sizes were relatively small based on Cohen’s (1988) criteria. On the other hand, in general, power was low, except for the test of hypothesis 1 (H1) that was rejected.

### Table 31 - Power Calculations for Tested Hypotheses

<table>
<thead>
<tr>
<th>Effect</th>
<th>Dependent Variable</th>
<th>Test Decision</th>
<th>Effect Size</th>
<th>Noncentrality Parameter ($\lambda$)</th>
<th>*Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>Performance H1</td>
<td>Reject</td>
<td>0.1900  10.230</td>
<td>0.820</td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy H2</td>
<td>Not Reject</td>
<td>0.00125  0.034</td>
<td>0.054</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction H3</td>
<td>Not Reject</td>
<td>0.1078  2.522</td>
<td>0.353</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Style (B)</td>
<td>Performance H6</td>
<td>Not Reject</td>
<td>0.1415  5.691</td>
<td>0.488</td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy H7</td>
<td>Not Reject</td>
<td>0.1540  5.158</td>
<td>0.446</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction H8</td>
<td>Not Reject</td>
<td>0.1722  6.431</td>
<td>0.541</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB Interaction</td>
<td>Performance H9</td>
<td>Not Reject</td>
<td>0.0930  2.476</td>
<td>0.171</td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy H9</td>
<td>Not Reject</td>
<td>0.0740  1.188</td>
<td>0.128</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction H9</td>
<td>Not Reject</td>
<td>0.0149  0.488</td>
<td>0.080</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Observed Power computed using alpha = 0.05, N = 284

Relationship among Self-efficacy, User Satisfaction and Performance (H4, H5)

Although the objective of this research does not involve testing a theoretical model (i.e., structural model) that specifies causal relationship between performance (endogenous variable), and self-efficacy and satisfaction (exogenous variables); hypotheses H4 and H5 were stated to investigate whether the student’s performance is influenced by his/her self-efficacy perception, and satisfaction.

As an initial step, a simple correlation analysis was performed by an experimental group; results of the analysis are provided in Table 32. The only significant correlation (*) was between Satisfaction and Self-Efficacy for both experimental groups.

As opposed to causal relationship between variables, a simple correlation between two variables (i.e., satisfaction and self-efficacy) does not mean that one causes the other. In other words, one can not assume that if the student’s satisfaction is improved by a particular method of instruction then his/her self-efficacy perception is going to improve.
as well. Furthermore, one can not assume that high satisfaction leads to high performance. Thus, path analysis needs to be used in order to investigate any causal relationship among variables.

Table 32 - Pearson Correlation Coefficients (r) among Outcome Variables by Experimental Group.

| Experimental Group   | Variables                  | N   | r       | Prob > |R|
|----------------------|----------------------------|-----|---------|--------|
| Simulated Hands-On   | Performance vs. Satisfaction | 112 | 0.2117  | 0.0301 |
|                      | Performance vs. Self-Efficacy |     | 0.1206  | 0.2201 |
|                      | Satisfaction vs. Self-Efficacy |     | 0.3722  | *0.0001|
| Hands-On             | Performance vs. Satisfaction | 105 | 0.1722  | 0.0694 |
|                      | Performance vs. Self-Efficacy |     | 0.0635  | 0.5056 |
|                      | Satisfaction vs. Self-Efficacy |     | 0.3320  | *0.0003|

* Significant at alpha = 0.05

This study assumes a manifest variable model to test the hypothesized relationships among performance, self-efficacy, and satisfaction. In other words, the path analysis is used to analyze a causal model in which all variables are manifest (observed) variables. A manifest variable is one that is directly measured or observed in the course of an investigation.

In path analysis, the causal model is formulated as a path diagram, in which arrows connecting variables represent (co)variances and regression coefficients (See Figure 11). Initially, it was hypothesized that there would be a direct relationship between Performance and Self-Efficacy (H4) and Performance and Satisfaction (H5). Path analysis was performed on the data obtained by experimental group to test the initial theoretical model.

Analysis of the causal model is performed using PROC CALIS, a SAS procedure that can be used for path analysis, confirmatory factor analysis, structural equation modeling with latent variables, and other purposes (Hatcher1994).
Results of the path analysis did not support the model (Goodness of Fit Index by experimental group was highly significant, $p < 0.05$). Thus, hypotheses H4 and H5 could not be rejected.

A revised theoretical model for each experimental group was proposed (Figure 12). The models propose that an individual’s performance is positively related to an individual’s satisfaction which is at the same time related to his/her self-efficacy perceptions.

![Initial Theoretical Model](image)

**Figure 11 - Initial Theoretical Model**

![Revised Theoretical Model by Experimental Group](image)

**Figure 12 - Revised Theoretical Model by Experimental Group, Where P1 to P4 are Path Coefficients to be Estimated and E1-E4 Represent Residual Terms.**
The results of the path analysis by experimental group are reported in Table 33. The Goodness of Fit Index (Chi-Square test) for both experimental group models was not statistically significant (p > 0.05). As a result, the theoretical models provide a good fit. All paths standardized coefficients were statistically significant (p < 0.05) except for P1. However, the variance explained by the models is very low ($R^2$) which means that they have low predictive power.

Table 33 - Standardized Path Coefficients for Performance and Satisfaction Variables by Experimental Group (* Significant at alpha = 0.05).

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Chi-Square Path Coefficient</th>
<th>Standardized Coefficient</th>
<th>Standard Error</th>
<th>T-value</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulated</td>
<td>0.0052</td>
<td>P1</td>
<td>0.1722</td>
<td>0.8692</td>
<td>1.8418 0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2</td>
<td>0.3320</td>
<td>0.0420</td>
<td>*3.7087 0.11</td>
</tr>
<tr>
<td>Hands-On</td>
<td>0.2215</td>
<td>P3</td>
<td>0.2117</td>
<td>1.1534</td>
<td>*2.2095 0.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P4</td>
<td>0.3723</td>
<td>0.0368</td>
<td>*4.0903 0.14</td>
</tr>
</tbody>
</table>

6.3.4. Summary of Experiment II

The validity and reliability analysis reported, including content and construct validity and internal consistency reliability, indicates that the instruments used to measure the response variables were highly reliable. The factor analysis reported above provides evidence of the construct validity of the instruments used. Furthermore, the results of the Cronbach alpha test indicate high reliability of the instruments.

Descriptive statistics, including percent frequency distributions, mean and standard deviations, were reported for all quantity measures used in the experiment. Overall, the computed statistics by experimental groups indicates that groups were equivalent at the beginning of the application of the experimental treatment. Statistical inference, including Pearson correlations, non-parametric test, and parametric test, are
reported for investigating the hypotheses proposed. The results of the main hypothesis can be stated as follows:

Hypothesis 1 (H1), proposing that there will be no difference in performance scores between the group that receives hands-on experience with the SAP R/3 System and all other groups, was not supported. The regression analysis approach for two-factor analysis of variance revealed a significant relationship (* $\alpha < 0.05$) between instructional method and performance. There was not a significant relationship between learning style and performance (Hypothesis H6). In addition, there was not a significant interaction effect (Hypothesis H9).

The Tukey multiple comparison analysis revealed that students receiving the simulated hands-on the SAP R/3 System on the average scored higher on the written test ($65.52 \pm 0.89$) than students from the control group ($60.80 \pm 1.12$). Furthermore, the other two pairwise comparisons (experimental control group vs. hands-on experimental group ($63.90 \pm 0.84$) and simulated hands-on vs. hands-on experimental groups) did not show significantly different mean changes in performance.

Hypothesis 2 (H2), proposing that there will be no difference in self-efficacy between the hands-on SAP R/3 System instruction group and the simulated hands-on SAP R/3 System instruction group, was supported. Furthermore, there was not a significant relationship between learning style and self-efficacy (Hypothesis H7). In addition, there was not a significant interaction effect (Hypothesis H9).

Hypothesis 3 (H3), proposing that there will be no difference in user satisfaction between the hands-on SAP R/3 System instruction group and the simulated hands-on SAP R/3 System instruction group, was supported. In addition, there was not a significant
relationship between learning style and satisfaction (Hypothesis H8). On the other hand, there was not a significant interaction effect (Hypothesis H9).

Path analysis was performed to investigate hypotheses H4 and H5. Results of the analysis did support the hypotheses. No significant relationship was found between Performance and Self-Efficacy (H4) and Performance and Satisfaction (H5).

6.4. Experiment III (ISDS 3100)

6.4.1. Validity and Reliability Analysis

A major concern when using measurement scales such as self-efficacy, satisfaction, etc., is the validity and reliability of such scales. Two types of validity must be addressed: content validity and construct validity. Content validity refers to how the instrument chosen relates to the nature of the issue being measured. An extensive survey of the relevant literature was undertaken to understand the important aspects of each major variable and its components, so that content validity was ensured.

Factor analysis was used to examine the construct validity of the instruments. Table 34 shows the instrument name, eigenvalue, and corresponding variance explained for Factor I. The magnitude of the eigenvalues is greater than one that suggests the presence of a dominant global factor.

Instruments were tested for reliability using the Cronbach alpha test applied to inter-item scores. All constructs had measures of internal consistency that exceeded 0.8 which is typically the criterion value for inter-item reliability. Thus, all of the constructs were reliable. The results of the reliability analysis are reported in Table 34. The validity and reliability analysis results for the instruments used in the study satisfied the criteria for further use. Thus, no changes to these constructs were performed.
Table 34 - Factor Analysis and Coefficient Alpha Reliability Estimates for the Study's Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1</th>
<th>Coefficient Alpha Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eigenvalue</td>
<td>Variance Explained</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>7.12</td>
<td>71 %</td>
</tr>
<tr>
<td>Computer User Satisfaction</td>
<td>4.30</td>
<td>61 %</td>
</tr>
<tr>
<td>Attitude toward Computers</td>
<td>4.53</td>
<td>65 %</td>
</tr>
<tr>
<td>Lecture Satisfaction</td>
<td>6.38</td>
<td>64 %</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>4.92</td>
<td>70 %</td>
</tr>
</tbody>
</table>

6.4.2. Descriptive Statistics

6.4.2.1. Subjects Profile

Table 35 presents a demographic profile of the participants. Subjects consisted of 53 students majoring in a variety of areas. Overall, 70% of the subjects were majoring in Information Systems.

Of the 53 students, 62% of whom were male, approximately 75% were between 20-22 years of age and 83% had between 1-5 years of work experience. Details of the subject’s profile information by survey item and experimental group are provided in Table 35.

6.4.2.2. Previous Experience with Computers

A summary of subject’s access and previous experience with computers by experimental group is shown in Table 36.

Overall (n=53), approximately 83% of the subjects had access to computers at home and 81% had access to the Internet at home. Results indicate that on the average subjects were frequent users of computers (3.84), using computers at home and several times a week (1.64) at work. Furthermore, subjects used electronic mail (1.96) and the
World Wide Web search (2.12), about once a day. Overall subjects had familiarity with software to some extent.

Table 35 - Summary of Response Percentages for Subject's Attributes by Experimental Group.

<table>
<thead>
<tr>
<th>Item</th>
<th>Experimental Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simulated Hands-On</td>
<td>Hands-On</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n=27)</td>
<td>(n=26)</td>
<td></td>
</tr>
<tr>
<td>Major Area of Study:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Finance</td>
<td>3.7</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>2. Accounting</td>
<td>-</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>3. Marketing</td>
<td>3.7</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>4. Information Systems</td>
<td>77.8</td>
<td>69.4</td>
<td></td>
</tr>
<tr>
<td>5. Operations Management</td>
<td>-</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>6. General Business</td>
<td>11.1</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>7. Others</td>
<td>3.7</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Age:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. &lt;19</td>
<td>3.7</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2. 20-22</td>
<td>74.1</td>
<td>76.9</td>
<td></td>
</tr>
<tr>
<td>3. 23-25</td>
<td>14.8</td>
<td>15.4</td>
<td></td>
</tr>
<tr>
<td>4. &gt;25</td>
<td>7.4</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Work Experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 1-5 years</td>
<td>85.2</td>
<td>80.8</td>
<td></td>
</tr>
<tr>
<td>2. 6-10 years</td>
<td>11.1</td>
<td>15.4</td>
<td></td>
</tr>
<tr>
<td>3. &gt; 11 years</td>
<td>3.7</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Male</td>
<td>70.4</td>
<td>53.8</td>
<td></td>
</tr>
<tr>
<td>2. Female</td>
<td>29.6</td>
<td>46.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

6.4.2.3. Outcome and Other Variables

Descriptive statistics for outcome variables as well as other variables are reported in Table 37. Statistical inference of the variables is presented in the next section.
6.4.3. Hypotheses Test

6.4.3.1. Relationship Between Main Variables

The relationship between pairs of variables used in the study was examined by computing Person Correlation Coefficients. The correlation matrix is presented in Table 38. None of the correlations were statistically significant at alpha level of 0.05 (0.05/10 = 0.005).

Table 36 - Summary of Mean Responses and Standard Deviations of Overall Sample from Previous Experience with, and Current Use of Computer Technology Survey.

<table>
<thead>
<tr>
<th>Item</th>
<th>Instrument Scale</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Access to computer at home (yes)</td>
<td>Yes or No</td>
<td>77.8%</td>
</tr>
<tr>
<td>2. Access to Internet at home (yes)</td>
<td></td>
<td>77.8%</td>
</tr>
<tr>
<td>3. Previous experience with computers</td>
<td>1 = No Experience to 5 = Professional User</td>
<td>4.00 ± 0.68 3.69 ± 0.68</td>
</tr>
<tr>
<td>4. Frequency of computer use at home</td>
<td>1 = Several Times a Day to 5 = Once a Month</td>
<td>1.56 ± 1.45 1.73 ± 1.15</td>
</tr>
<tr>
<td>5. Frequency of computer use at work</td>
<td></td>
<td>1.41 ± 1.37 1.31 ± 1.67</td>
</tr>
<tr>
<td>6. Frequency of Electronic Mail use</td>
<td></td>
<td>2.00 ± 1.30 1.92 ± 0.93</td>
</tr>
<tr>
<td>7. Frequency of World Wide Web search</td>
<td></td>
<td>2.00 ± 1.27 2.23 ± 1.07</td>
</tr>
<tr>
<td>8. Frequency of Participation in Chat or Discussion groups</td>
<td></td>
<td>3.14 ± 1.70 2.81 ± 2.28</td>
</tr>
<tr>
<td>9. Knowledge of Word Processing</td>
<td>0 = Not at All to 5 = To a Very Great Extent</td>
<td>4.30 ± 0.67 4.27 ± 0.72</td>
</tr>
<tr>
<td>10. Knowledge of Presentation Software</td>
<td></td>
<td>3.70 ± 1.03 3.46 ± 0.71</td>
</tr>
<tr>
<td>11. Knowledge of Spreadsheets</td>
<td></td>
<td>3.37 ± 1.21 3.38 ± 1.06</td>
</tr>
<tr>
<td>12. Knowledge of Database Systems</td>
<td></td>
<td>2.70 ± 1.29 2.50 ± 1.30</td>
</tr>
<tr>
<td>13. Knowledge of Electronic Mail</td>
<td></td>
<td>1.81 ± 1.24 1.61 ± 1.23</td>
</tr>
<tr>
<td>14. Knowledge of Statistical Packages</td>
<td></td>
<td>4.11 ± 1.05 4.08 ± 0.89</td>
</tr>
</tbody>
</table>

Table 37 - Descriptive Statistics for Outcome and Other Variables by Experimental Group (Mean ± Std).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simulated Hands-On (n = 27)</td>
</tr>
<tr>
<td>Skills Assessment</td>
<td>47.37 ± 16.83</td>
</tr>
<tr>
<td>Performance</td>
<td>67.33 ± 11.08</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>6.49 ± 1.86</td>
</tr>
<tr>
<td>Computer User Satisfaction</td>
<td>2.90 ± 0.83</td>
</tr>
<tr>
<td>Attitude toward Computers</td>
<td>3.79 ± 0.56</td>
</tr>
<tr>
<td>Lecture Satisfaction</td>
<td>2.89 ± 0.78</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>3.24 ± 0.83</td>
</tr>
</tbody>
</table>

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Table 38 - Pearson Correlation Coefficients (alpha = 0.05, n=53)

<table>
<thead>
<tr>
<th>Skills Assessment</th>
<th>Performance</th>
<th>Self-Efficacy</th>
<th>User Satisfaction</th>
<th>Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills Assessment</td>
<td>1.00000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>0.24019</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>0.06315</td>
<td>0.08597</td>
<td>1.00000</td>
<td></td>
</tr>
<tr>
<td>User Satisfaction</td>
<td>-0.20782</td>
<td>-0.00021</td>
<td>0.30612</td>
<td>1.00000</td>
</tr>
<tr>
<td>Attitude</td>
<td>0.35151</td>
<td>0.06581</td>
<td>0.41735</td>
<td>-0.04914</td>
</tr>
</tbody>
</table>

Note. Numbers in parenthesis are probability values.

6.4.3.2. Differences Between Experimental Groups Before Treatment

A non-parametric Kruskal-Wallis test was used to analyze the statistical differences between the two instructional methods (simulated hand-on and hands-on the R/3 system). A non-parametric test was considered more appropriate due to the small sample sizes and nonnormal distributions. The Kruskal-Wallis test results (at the alpha 0.05 level of significance) indicated no significant differences in responses between the simulated hands-on and the hands-on experimental group. Table 39 reports the test statistic (CHISQ) and the probability values (Prob>CHISQ) for each variable tested. Based on the results of the test on knowledge/skills assessment, previous experience with computers, and attitudes toward computers, one can conclude that groups were equivalent before the experimental treatment was applied.

Table 39 - Results of Kruskal-Wallis Test

<table>
<thead>
<tr>
<th>Variable</th>
<th>CHISQ</th>
<th>Prob&gt;CHISQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge/Skills Assessment</td>
<td>0.02</td>
<td>0.8992</td>
</tr>
<tr>
<td>Previous Experience with Computers</td>
<td>1.99</td>
<td>0.1573</td>
</tr>
<tr>
<td>Attitudes toward Computers</td>
<td>2.04</td>
<td>0.1529</td>
</tr>
<tr>
<td>Lecture Satisfaction</td>
<td>0.78</td>
<td>0.3775</td>
</tr>
<tr>
<td>Lecture Evaluation</td>
<td>2.47</td>
<td>0.1162</td>
</tr>
</tbody>
</table>

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6.4.3.3. Differences Between Experimental Groups After Treatment

Tables 40, 41, and 42 present the results for the Analysis of Variance (ANOVA) conducted on the data for the student’s performance scores, self-efficacy, and satisfaction. Table 43 reports the calculation of the Power analysis. Overall, effect size was small and powers were low. As stated in chapter 3, the main hypotheses to be tested were:

Table 40 - ANOVA Table for Student’s Performance

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>2.22</td>
<td>1</td>
<td>2.22</td>
<td>0.02</td>
<td>0.9015</td>
</tr>
<tr>
<td>Error</td>
<td>7351.85</td>
<td>51</td>
<td>144.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>7354.07</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: W:Normal = 0.9622, Pr<W = 0.1813
Homogeneity of Variance Bartlett’s test: Chi-Square = 0.5725, Alpha = 0.45

H1: There will be no difference in performance scores between the group that receives simulated hands-on experience with the SAP R/3 System and the group that receives hands-on experience with the SAP R/3 System. The results of the ANOVA presented in Table 40 show that there are no significant differences between the performance scores of the subjects participating in the simulated hands-on group and those included in the hands-on experimental group. Thus, hypothesis H1 can not be rejected.

H2: There will be no difference in the student’s self-efficacy between the group that receives simulated hands-on experience with the SAP R/3 System and the group that receives hands-on experience with the SAP R/3 System. Results of the statistical analysis...
(Table 41) does support this hypothesis, thus there is not a significant difference in self-efficacy between the two experimental groups.

Table 41 - ANOVA Table for Student’s Self-Efficacy

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>4.40</td>
<td>1</td>
<td>4.40</td>
<td>1.49</td>
<td>0.2283</td>
</tr>
<tr>
<td>Error</td>
<td>150.98</td>
<td>51</td>
<td>2.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>155.38</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: W:Normal = 0.9591, Pr<W = 0.1268
Homogeneity of Variance Bartlett’s test: Chi-Square = 0.8015, Alpha = 0.37

H3: There will be no difference in students satisfaction between the group that receives simulated hands-on experience with the SAP R/3 System and the group that receives hands-on experience with the SAP R/3 System. To test this hypothesis, an analysis of variance was performed. The results of the analysis are reported in Table 42. It is concluded that there is not evidence to reject the null hypothesis.

Table 42 - ANOVA Table for Student’s Computer Satisfaction

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Type III Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (A)</td>
<td>2.03</td>
<td>1</td>
<td>2.03</td>
<td>3.05</td>
<td>0.0870</td>
</tr>
<tr>
<td>Error</td>
<td>34.08</td>
<td>51</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>36.11</td>
<td>52</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normality Test: W:Normal = 0.98, Pr<W = 0.7205
Homogeneity of Variance Bartlett’s test: Chi-Square = 0.0219, Alpha = 0.88

Table 43 - Power Calculations for Tested Variables

<table>
<thead>
<tr>
<th>Variable Tested</th>
<th>Effect Size</th>
<th>Noncentrality Parameter (□)</th>
<th>*Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>0.0170</td>
<td>0.015</td>
<td>0.052</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>0.1675</td>
<td>1.487</td>
<td>0.223</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.2391</td>
<td>3.045</td>
<td>0.402</td>
</tr>
</tbody>
</table>

* Observed Power computed using alpha=0.05, N = 53
6.4.4. Summary of Experiment III

To evaluate the effectiveness of using an Enterprise Information System as a support tool to teach business processes at the undergraduate level, a field experimental was conducted involving 53 students enrolled in two sections of an Information Systems course.

Students were randomly assigned to either the simulated hands-on the SAP R/3 System or the hands-on the SAP R/3 System experimental groups. Both groups received two one-hour lecture sessions on Enterprise Information Systems and the Order-Cash Cycle (Customer Order Management) taught by traditional means.

After the lectures were completed, students were given a week to complete an assignment related to the business process. One group was asked to observe a series of ScreenCam demonstrations of the business transactions involved in the Business Process. The task of the other group, the hands-on the SAP R/3 Systems, involved conducting a number of real time business transactions corresponding to the Customer Order Management cycle using the R/3 System.

To measure the effectiveness of using the R/3 system, performance scores, self-efficacy, and computer satisfaction of the students in the two groups were compared. The results of the data analysis indicated that there was not a significant difference between the two groups. Both groups revealed similar examination scores and expressed similar levels of self-efficacy and computer satisfaction.

The overall conclusion is that the benefits of using the SAP R/3 Systems as a support tool to teach business process at the undergraduate level do not necessarily translate into better performance scores, self-efficacy, or satisfaction.
6.5. Summary

This chapter discusses the main statistical techniques utilized in the analysis followed by a presentation of the results.
7. DISCUSSION AND CONCLUSIONS

The primary goal of the present study was to assess the effectiveness of using an Enterprise System to facilitate the understanding of Enterprise Information Systems concepts, specifically business processes. Effectiveness was measured as a function of subjects' performance scores, self-efficacy perceptions, and level of computer satisfaction. The results reported in the previous chapter provide some interesting conclusions. This chapter discusses how the findings of the present study increase our knowledge of how effective the implementation of the SAP R/3 System is in support of business education.

7.1. Review of the Findings

Three experiments were conducted to investigate the effectiveness of using an Enterprise System to facilitate the understanding of Enterprise Information Systems concepts. The study used two domains (business processes) for the instructional material, the production process and the order fulfillment process. Following is a review of the results for each experiment.

7.1.1. Experiment I

The first experiment focuses on the influence of the instructional method on learning about enterprise information systems and the production process. This was a pilot study conducted to gain experience in applying the methodology (i.e., choice of variables, techniques for reducing error, and randomization of subjects) and construct-oriented evidence of the validity of the instruments.

Learning outcomes (performance, self-efficacy, and satisfaction) were examined as a function of instructional method, simulated hands-on and hands-on experience using
an Enterprise System and other moderating variables (i.e., previous knowledge/skills assessment, attitudes toward computers, etc.).

Graduate students were presented identical material on the domain of Enterprise Systems and Manufacturing Planning and Execution Process. After the lecture material presentation, students were given an assignment to help master the concept given in the lecture. An assignment asked students to view, via the web, a series of business process ScreenCam demonstrations (simulated hands-on). The assignment demonstrated to students how to carry out a specific task using the R/3 system (i.e., create independent requirements for a specified material). Another group of students received an assignment that asked them to perform the same transactions (business process) as the other group, but in real-time, using an Enterprise System (i.e., SAP R/3 System).

From the study results, it is clear that the use of the system does not invariably improve performance test scores, self-efficacy, or satisfaction of graduate students. Thus, the author concludes that providing students with the opportunity to perform transactions on a real-time system does not significantly enhance their understanding of the material domain.

A number of factors could have contributed to the similarity in learning outcomes between the two groups. For example, lack of commitment and motivation among the students could have been related to poor performance. Furthermore, both groups experienced low levels of self-efficacy and satisfaction. Motivation was not measured but interpreted based on the comments made by the subjects.
7.1.2. Experiment II

This study used a two-factor experimental design. The two factors were instructional method and learning style. The instructional method involved two experimental groups (simulated hands-on and hands-on experience using the SAP R/3 System) as described in Experiment I and a control group. The learning style factor included four levels (Diverger, Assimilator, Converger, and Accommodator).

Subjects from five sections of an undergraduate operations management course were randomly assigned to a control group and to one of two experimental conditions: simulated hands-on experience using SAP R/3 and hands-on experience using the SAP R/3 System. The differences were examined between groups (traditional instruction-control, simulated hands-on instruction, and hands-on instruction) using a two-way ANOVA.

This study demonstrated that there was a significant experimental/control main effect, but neither the learning style main effect, nor the interaction was significant. There was a significant difference in performance scores when comparing simulated hands-on and control groups, but the simulated hands-on and hands-on groups were not significantly different. The analysis revealed that students receiving simulated hands-on the SAP R/3 System on the average scored higher on the written test than students from the control group. Thus, the effectiveness of the hands-on experimental group was not supported by the data collected on this study.

7.1.3. Experiment III

This experiment was similar to Experiment I. It involved two experimental groups (simulated hands-on and hands-on experience using the SAP R/3 System) as
described in Experiment I, but using a different domain. In this study, the order-fulfillment process, also known as the order-to-cash process, was utilized as the learning domain. In addition, effectiveness was measured as a function of performance, self-efficacy, and satisfaction.

Results were similar to those observed in Experiment I. No significant main effect of instructional method existed on students' performance, self-efficacy, or satisfaction.

This result may be related to the students' interest and level of engagement in the assignment activity. Why did the hands-on the SAP R/3 System lead to unexpectedly poor results? Observations during the experiment suggest that subjects did not expend enough time on the exercises and thus failed to relate the lecture material to the exercises done using the system.

7.2. Discussion

Experimental studies have shown that IT use in the classroom has a positive effect on students' academic achievement, their attitude toward the subject matter, and their perceived satisfaction with the learning experience (Kulik, et al., 1980; Niemiec and Walberg, 1987; White and White, 1997, Bowman, et al., 1995). On the other hand, however, integration of IT into the school curricula requires a sound strategy to be successful.

Previous studies on education/training effectiveness have suggested that a number of factors such as instructional method and learning style, may influence important education/training outcomes (Cordell, 1991; Bostrom, et al., 1988, 1990; Davis and
Thus, this study investigated the influence of instructional method, and learning styles on student performance, self-efficacy, and satisfaction.

7.2.1. Effect of Instructional Method on Learning Outcomes

Overall, neither experiment demonstrated a relationship between hands-on experience using the SAP R/3 System and the subject's performance, self-efficacy, and satisfaction.

7.2.1.1. Performance

Why would the learning experienced by students using ScreenCams demonstration (simulated hands-on assignment) be equivalent to that of the real system (hands-on assignment)? Observations during the experiment suggest that initially the students' impressions toward the system were apprehensive, thus, they did not have a chance to become familiar with the R/3 System and because of their uneasiness they tended not to have learning high as a priority. This behavior will likely not occur during long-term training sessions. Furthermore, based on the observation of the study, two main reasons why this response is given, is that the time is spent worrying about the appearance of the screen and not enough time on what the message says. Too much time is spent on trying to enter the correct menu path, and not enough time on how to coax the learner into processing and application.

Why should one expect a better student performance, self-efficacy, and satisfaction as a result of hands-on experience? The answer to this question may well be explained based on the experiential learning theory utilized in this study.

Traditionally, the approach to instruction consists of the delivery of one or two hours of standard lecture augmented by an assignment (i.e., textbook assignment). In the
standard lecture, a student’s day in the classroom is spent listening, taking notes, and preparing to recapitulate the material back to the instructor at some later date. Then, students are given an assignment to complete in a week, which is related to the domain being studied in class. A significant problem with conventional lectures is that the student’s attention and learning decrease significantly over the first twenty minutes (Sankar, et al., 1997). Thus, an alternative to the traditional lecture approach is the experiential learning model (Kolb, 1984).

In the Experiential Learning format, a student engages in some activity, reflects on what happened in a critical manner, and abstracts some useful insight from the analysis. This form of learning was first translated into an educational tool in the late 1940s by a behavioral scientist involved with a program for change agents at the National Training Laboratories (NTL) in Bethel, Maine (Kolb, 1984). Today, this pedagogical approach is used routinely by a number of educators, especially those in the fields of management and organizational behavior.

Kolb’s experiential learning theory (Kolb, 1984) was used to develop the structure for an Enterprise Systems/business process lecture. The learning mechanism consist of a transition from declarative knowledge (knowing what) to proceduralized use-oriented knowledge (knowing how). Declarative knowledge encoded in memory (such as the steps of a business process) is assumed to be available for the development of skill. One assumes that the knowledge is deposited in memory as a product of language comprehension through reading a text or through oral instruction and lecture. Procedural knowledge consists of sets of production rules that define the skill in each domain. The
theory holds that effective and conditionalized knowledge of procedures can be acquired only through actual use of the declarative knowledge in solving problems.

Thus, based on the application of the experiential learning theory and previous studies (Kolb, 1984; Gattiker and Paulson, 1987), it was expected that hands-on would provide superior performance results when compared to traditional instruction or simulated hands-on.

7.2.1.2. Self-Efficacy

Bandura's (1977) self-efficacy theory suggests that individuals must feel confident in using computer technologies that are important tools for learning and communication. One could predict that by providing students with real-life interaction with a system, it may help to increase his/her level of self-efficacy perception. Previous research with university students have suggested that positive affect can be encouraged through educational experiences with computers (Gilroy and Desai, 1986; Lambert and Lenthall, 1989).

Thus, it is anticipated that hands-on experience exercises will increase self-efficacy in students toward new computer technologies. Individuals who exhibit a low self-efficacy perception with technological innovations are more apt to be resistant to them. Furthermore, perceived ability to perform a new task or behavior is a strong determinant of willingness and openness to change (Hill, et al., 1987).

7.2.1.3. Subjects' Satisfaction

Satisfaction has been found to be a key factor in the positive attitudes by students toward the new technology (Alavi, 1994; Alavi, et al., 1995; Kulik, et al., 1980). The research in this study found that satisfaction of students with the system as well as lecture
presentation were not significant. Overall, the level of satisfaction was higher in the hands-on experimental group than in the simulated hands-on group, though the results were not significant. Thus, these studies indicate that satisfaction has an important influence on the extent to which subjects actually learn the material presented to them during a lecture program.

7.2.2. Effect of Learning Style on Learning Outcomes

Individual differences, such as gender, age, motivation, and learning style have been addressed by several researchers (Bostrom, et al., 1990; Gattiker, 1992; Cazja, et al., 1989). These variables, with emphasis on learning styles, were examined in this study.

This study indicates that learning style does not significantly influence the subjects' learning. Even though Sein and Bostrom (1989) indicated that learning style has important implications for the effectiveness of end-user training, this research did not find the direct impact of learning style on performance. Furthermore, its interaction with instructional method was not significant. Thus, it seems that use of the SAP R/3 System does not appear to be biased toward students with a particular learning style; rather it provides students an equal opportunity for success. Overall, analysis of performance scores in various categories indicate that assimilators had better learning retention compared to accommodators, convergers, and divergers, though the results were not significant.

However, the Kolb's learning style instrument has been criticized by researchers, particularly with regard to its forced-choice scoring format, poor construct and face validity, poor reliability, and an abnormal distribution (Atkinson, 1991; Ruble and Stout, 1993). Atkinson (1991) evaluated the Kolb Learning Style Inventory (LSI) and reviewed
studies of the inventory's design, reliability, and validity. Findings suggest that the inventory has weak internal consistency and weak stability. The 1985 revision of the Kolb Learning Style Inventory seems to have improved internal consistency, but stability and classification reliability were unchanged. Although this study used the revised form of the LSI, it is recommended that an alternative (Allinson and Hayes, 1988) learning style questionnaire be administered (or adopted) instead.

7.3. Conclusions

Enterprise systems are emerging as useful tools for enhancing student learning of business concepts. Specifically, they provide a way to transport the classroom to the real world of business.

Reasons for using the SAP R/3 System are related not only to the enhancement of learning, but also to students' increasing awareness of developments in information technology and its applications in information practice.

Many different universities are using the SAP R/3 System in similar ways, for similar reasons, and with similar anxieties: that is what makes this study significant. A number of possibilities exist for the integration of Enterprise Systems such as the SAP R/3 System into business schools (Watson and Schneider, 1999). As a support tool to facilitate the knowledge and understanding of business concepts, SAP R/3 can be integrated in different forms of education as lectures, courses, project work, and masters’ theses. The focus of this study was on the use of the SAP R/3 System as a complement to a lecture in Business Processes Education. Thus, this study was driven by the need to determine the effectiveness of using an Enterprise System to facilitate the learning of business processes in business education.
In this study, effectiveness was defined as the extent to which a given instructional method actually contributes to enhancements in student performance, self-efficacy, and satisfaction. Thus, the present study was designed to examine the effects of a number of factors on performance, self-efficacy, and satisfaction. Based on previous research in this area (e.g., Kulik, et al., 1980; Bowman, et al., 1995), it was hypothesized that there would be no difference in performance scores, self-efficacy, and satisfaction between the group that receives hands-on experience with the SAP R/3 System and all other groups. In addition, it was hypothesized that the subjects’ learning style will not influence the performance, self-efficacy, and satisfaction of subjects (Bostrom, et al., 1988).

A two-way ANOVA design was performed based upon these hypotheses. With respect to the between group effect, no significant differences were found between the hands-on group and the other groups on the multiple-choice/true-false pre-test/post-test scores, self-efficacy or satisfaction. One must note that lack of statistical-significant differences between the control group, the simulated hands-on, and the hands-on experimental groups in this study do not automatically or uniformly apply to all other disciplines or all types of computer tasks. Thus, the present study results demonstrated that technology-enhanced instruction can assist the learning of business concepts by students in business majors at least as well as, and possibly somewhat better than, a more traditional instructional format.

In conclusion, the results of this study provide interesting insights into the variables related to student performance, self-efficacy, and satisfaction when learning about enterprise systems. However, the findings together with others in the literature, as
discussed in previous chapters, suggest that with respect to performance, self-efficacy, and satisfaction, the added value of the technology is questionable.

The data suggest that the teaching of the business processes topic to college students can be done effectively with hands-on when it is used as a supplement tool, or as effective as simulated hands-on. Thus, the evidence clearly indicates that the hands-on experience group performed as well as the simulated hands-on and control groups. On the other hand, a general conclusion is that a SAP-based course is much more laborious and demanding than that of a conventional course.
8. CONTRIBUTIONS, LIMITATIONS, AND FUTURE RESEARCH

This chapter discusses the theoretical and methodological limitations of the study. Based on this discussion, potential future research directions are outlined.

8.1. Contribution of the Study

Given the significance of providing business students with knowledge and skills in Enterprise Information Systems to effectively lead organizational integration and process reengineering efforts, it is imperative that business schools design and implement instruction in the most effective manner, and that they understand the factors that contribute to teaching effectiveness.

Perhaps the greatest challenge facing business schools is to distinguish the activities that can take best advantage of the new learning information technology from those that cannot be replaced in the foreseeable future. To date, the educational benefits (i.e., enhanced student’s business functional knowledge/skills through hands-on experience) of instructional uses of the SAP R/3 System are established on the basis of anecdotal statements from faculty and students rather than on empirical and objectively measured data secured by educational research methods. On the other hand, there is no single research effort that focuses on the question related to the effectiveness of using a commercial ERP system such the SAP R/3 System to facilitate knowledge/skills and understanding of contemporary business processes at the undergraduate or graduate levels.

From both IS practitioners and academicians’ research standpoint, the information collected on this study can be used to build a body of knowledge about student learning processes when learning about Enterprise Resource Planning Systems such the SAP R/3
System. It answers an important question that still need to be asked: How does the use of the SAP R/3 System improve student learning of particular concepts/skills and help overcome particular misconceptions about IS? For example, what kind of hands-on R/3 exercises work best in developing the idea of particular concepts such as distributed client/server systems and business process reengineering. Results of this research study, along with the base of knowledge already existent on the use of information technology to enhance education, will help universities rethink what in business education/information systems is most important to learn, how it should be taught, and what evidence of success should be anticipated.

The results of this study should have important theoretical and methodological significance. From the theoretical perspective, this research builds upon the exciting Information Technology literature on learning models (e.g., Kolbs, 1984; Leidner and Jarvenpaa, 1993; Bostrom, et al., 1988), by adapting the Social Cognitive Theory to the Information Technology field (Compeau and Higgins, 1995a; Bandura, 1977, Gist, et al., 1989), and on the educational literature on Instructional Design (Rothwell and Kazanas, 1998). Furthermore, it provides an initial working model to examine instructional effectiveness of using the SAP R/3 System to enhance business education. In addition, the study explores whether the various moderator variables (i.e., attitude, experience, etc.) differentially affect instruction effectiveness.

The study also has methodological implications. Often the measure of effectiveness of instruction using information technology is based on one process outcome variable, final grade. In this study, two perceptual measures were included (self-efficacy and satisfaction) to help in the understanding of the learning environment.
8.2. Limitations of the Study

No research is without limitations and this study is no exception. This section identifies and discusses some of the theoretical and methodological limitations of the study so that they can be addressed and improved in future research studies.

8.2.1. Theoretical Limitations

Previous educational studies provide evidence of the power of providing conceptual models or organizing constructs to assist in student learning (Mayer, 1989). In the present study, all subjects received the same lecture; however, half the subjects were given a simulated hands-on exercise, and half were given a hands-on assignment exercise. An important question not included on this study is whether providing students with a conceptual model would enhance their understanding of Enterprise Information Systems concepts, in addition to their interaction with the real-time system.

Borgman (1986) states that “mental models is a general concept used to describe a cognitive mechanism for representing and making inferences about a system or problem which the user builds as he or she interacts with and learns about the system.” An important question related to the application of mental models in training is whether a user will build a mental model spontaneously or whether it is necessary to provide a conceptual model on which a mental model can be based.

Thus, a theoretical limitation of the present study was the not consideration of the mental model theory. It will be necessary to evaluate Kolb’s experiential learning theory based on mental model change. One would expect that as individuals move through the cycle, their mental model is either maintained or changed.
8.2.2. Methodological Limitations

This study uses a two-phase methodology for investigating the effectiveness of integrating SAP R/3 into the business curriculum. A preliminary field experiment (Experiment I) was conducted to ensure an appropriate research design (i.e., choice of variables, techniques for reducing error, and randomization of subjects). The pilot testing was carried out in consultation with faculty, industry, and students for critical evaluation of possible limitations, internal/external validity issues, cost, logistics, etc.

A number of control measures were taken: a) all subjects were given similar set of activities to perform (reading/writing exercises), b) pre-test and post-test measures as well as selection of significant levels where established, c) data were collected on a number of variables to be used as covariates if applicable (i.e., learning style, attitude toward computers, age, GPA, Major, etc.), and d) a multiple-choice test was developed to measure performance. The test was provided to Information Systems faculty knowledgeable of the domain (ERP and core Business Processes such as Order-to-Cash Cycle and Manufacturing Planning and Execution) to be revised for further use. In addition, previous developed and validated instruments were used to measure self-efficacy and satisfaction.

Even though a number of measures were undertaken to avoid significant limitations, there were still a number of limitations incurred in the study. First, unequal cell sizes represented a potential limitation although analysis of variance is quite robust to unequal cell sizes. Second, experiments should have been based on a longer time frame (semester) or longitudinal to capture mental model formation/change. Third, this study
focused on leaning style as a key individual difference between subjects. However, subjects were not grouped according to their learning style. Assigning individuals to treatment within learning style may offer more insight into the effect of learning style on subject performance. Thus, the above stated limitations must be resolved in future research.

8.3. Future Research

The accelerated use of the R/3 system to support instruction demands sound research on the effectiveness of the innovation. Thus, this research project addressed an issue that had existed in the literature with respect to the use of information technology in education, how effective is it? However, a number of unresolved issues and future research opportunities also remained after the study.

There seems to be a general agreement about the benefits of using the SAP R/3 System in business education. However, when it comes to investigating the question of its effectiveness to enhance student performance, self-efficacy, and satisfaction, this study does not support it. On the other hand, research should examine some other important questions such as ‘how do educators create curriculum content for the effective use of the R/3 system’?

8.3.1. Theoretical Extension of the Research Model

Future studies should include mental model formation as part of the research model used in this investigation. Sein and Bostrom (1989) provide conclusive evidence of the effectiveness of using conceptual models in aiding users to build mental models of computer systems. Furthermore, The Kolb (1984) and Simon, et al. (1996) learning
models provide an important platform for future research concerning education/training effectiveness.

8.3.2. Methodological Improved Research Design

Longitudinal studies should be conducted to investigate the learning process and user-behavior when utilizing the R/3 system, especially from a cognitive perspective. These type of studies would be conclusive to track user-behavior over a period of time. Perhaps it could be expected that as students become more familiar with the system, they could concentrate more on relating the system model with the lecture material and thus improving their level of knowledge and understanding of the domain. Therefore, in future studies, it would be valuable to examine the long-term learning effect of instruction using the R/3 system.

A follow-up study is recommended, but also many left for others to attempt. In addition to gathering more data on the research model, future research is aimed at addressing other factors that are believed to influence learning outcomes.

The assessment of the overall effectiveness of a particular instructional method involves two main questions: 1) Does using the SAP R/3 System lead to higher levels of learning or knowledge than some other instructional method? 2) What practices within the use of the SAP R/3 System lead to the highest learning levels? To answer the first question, a substantive study could be conducted, which concentrates on the results produced by the method compared with other methodologies. On the other hand, a procedural study is performed to answer the second question. A procedural study concentrates on what usages and procedures are associated with superior results. This study concentrated on the first question and, thus it is suggested that the research effort
should be put into answering the second question. No hypotheses were rigorously posed as to why the use of the SAP R/3 System would enhance learning of business processes. An intent was made by including outcome variables such as self-efficacy and satisfaction.

The present study was not designed to examine what usage of the SAP R/3 System lead to the highest learning levels. It is known that other SAP Alliance universities are utilizing the system in different ways besides the one adopted in this study (Gable, et al., 1997). However, other techniques being used go more toward the training of students on the software rather than educating on the subject of Enterprise Systems. Thus, it is recommended that studies be conducted to examine the second question as well as the first.

Finally, although the instructional program closely followed suggested instructional models and prescriptions, the quality of instruction and instructional material have a significant impact on the outcome of any educational program. Thus, additional empirical research is needed in the area of instructional design related to Enterprise Information Systems.
REFERENCES


APPENDIX A - PRELIMINARY SURVEY

Demographic Characteristics

Name: ____________________________ ISDS 3115 –Sec: ___

Please answer the following questions to the best of your knowledge. The information provided in this questionnaire will remain strictly confidential and will not affect your grade in this course.

PLEASE PUT AN “X” ON ANY OF THE FOLLOWING THAT APPLY

1. What is your major?
   □ Female □ 20-22 years
   □ Male □ < 19 years
   □ Sophomore □ Junior □ Freshman
   Please Specify______________

2. Age
   □ 3.0-3.5 □ 2.5-3.0 □ > 3.5 □ Senior

3. Gender
   □ No □ < 2.5

4. What is your academic level
   □ Yes □ No □ Yes □ Senior

5. Overall GPA
   □ < 2.5 □ 2.5-3.0 □ 3.0-3.5 □ > 3.5

6. Do you have access to a Computer at home?
   □ Yes □ No

7. Do you have access to an Internet Connection at home?
   □ Yes □ No
**Learning Style Inventory**

**Example:**

<table>
<thead>
<tr>
<th>When I learn</th>
<th>2</th>
<th>4</th>
<th>1</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am happy</td>
<td>I am careful</td>
<td>I am fast</td>
<td>I am logical</td>
<td></td>
</tr>
</tbody>
</table>

1. When I learn

| I like to deal with my feelings | I like to think about ideas | I like to be doing things | I like to watch and listen |

2. I learn best when

| I listen and watch carefully | I rely on logical thinking | I trust my hunches and feelings | I work hard to get things done |

3. When I am learning

| I tend to reason things out | I am responsible about things | I am quiet and reserved | I have strong feelings and reactions |

4. I learn by

| feeling | doing | watching | thinking |

5. When I learn

| I am open to new experiences | I look at all sides of issues | I like to analyze things, break them down into their parts | I like to try things out |

6. When I am learning

| I am an observing person | I am an active person | I am an intuitive person | I am a logical person |

7. I learn best from

| observation | personal relationships | rational theories | a chance to try out and practice |

8. When I learn

| I like to see results from my work | I like ideas and theories | I take my time before acting | I feel personally involved in things |

9. I learn best when

| I rely on my observations | I rely on my feelings | I can try things out for myself | I rely on my ideas |

10. When I am learning

| I am a reserved person | I am an accepting person | I am a responsible person | I am a rational person |

11. When I learn

| I get involved | I like to observe | I evaluate things | I like to be active |

12. I learn best when

| I analyze ideas | I am receptive and open-minded | I am careful | I am practical |
APPENDIX C - INITIAL KNOWLEDGE/SKILLS ASSESSMENT

Previous Experience With, and Current Use of Computer Technologies

Name: ----------------------------------- ISDS 3115 -Sec: ___

Please answer the following questions about your previous experience with, and current use of computer technologies (i.e., word processing, electronic mail, spreadsheets, database programs, statistical packages, and CD-ROM databases).

8. How would you describe your previous experience with computers? (Circle number)
   1  No experience
   2  Somewhat
   3  Occasional
   4  Frequent user
   5  Professional user

   Please circle a number from 1 to 5 of the following that apply
   where:
   1 = Several Times a Day
   2 = About Once a Day
   3 = A Few Times a Week
   4 = A Few Times a Month
   5 = Once a Month

9. If you have computer at home, how frequently do you use it?  
   1 2 3 4 5

10. If you have computer at work, how frequently do you use it?  
    1 2 3 4 5

11. How frequently do you use Electronic Mail?  
    1 2 3 4 5

12. How frequently do you use Search the World Wide Web?  
    1 2 3 4 5

13. How frequently do you participate in Chat or Discussion Groups?  
    1 2 3 4 5

14. For each of the following types of software, rate your familiarity with it.
   0 = Not at all  3 = To some extent
   1 = To a very little extent  4 = To a great extent
   2 = To a little extent  5 = To a very great extent
   - Word Processors (e.g. MS Word)  
     0 1 2 3 4 5
   - Spread Sheets (e.g. MS Excel)  
     0 1 2 3 4 5
   - Presentation Software (e.g. MS PowerPoint)  
     0 1 2 3 4 5
   - Database Management Systems (e.g. Access)  
     0 1 2 3 4 5
   - Statistical Packages  
     0 1 2 3 4 5
   - Electronic Mail  
     0 1 2 3 4 5

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Attitudes Toward Computer Technologies

Please answer the following questions about your attitude toward computer technologies (i.e., word processing, electronic mail, spreadsheets, database programs, statistical packages, and CD-ROM databases).

Please circle a number from 1 to 5 of the following that apply where:

1 = Strongly Disagree
2 = Disagree
3 = Undecided
4 = Agree
5 = Strongly Agree

15. I am confident about my ability to do well in a course that requires me to use computer technologies.

16. I feel at ease learning about computer technologies.

17. I am not the type to do well with computer technologies.

18. The thought of using computer technologies frightens me.

19. Computer technologies are confusing to me.

20. I do not feel threatened by the impact of computer technologies.

21. I am anxious about computers because I don’t know what to do if something goes wrong.

22. I enjoy working with computers

23. I feel comfortable about my ability to work with computer technologies.
Background Knowledge Assessment

ISDS 3115 – SEC___ SPRING 1999

NAME ________________________________ SS#: ____________________________

This is a basic background knowledge assessment. The objective is to determine your prior knowledge of the class material. Please answer to the best of your knowledge. This assessment will not affect your grade in the course in any way.

MULTIPLE CHOICE

1. A legacy system might be defined as
   a. a series of disparate mainframe based software applications.
   b. a group of systems that support a company business needs.
   c. a system that provides information support to business processes.
   d. a system that provides information support to different functional areas within a company but it is not fully integrated.

2. A company should be concern about having a Legacy System because
   a. such as system does not provides support to compete in the current dynamic market.
   b. the system does not support the cross-functional models of a business.
   c. the system creates data redundancy within the organization.
   d. All of the above

3. An Enterprise System can be defined as
   a. a group of software packages connected together.
   b. a Manufacturing and Logistics application software.
   c. an application package that supports core-business operational functions.
   d. a and c

4. Companies should integrate systems because
   a. system integration allows a company to lower operating cost, decreases quality, and facilitates cross-functional integration.
   b. it increases inefficiencies inherent in the functional model supported by legacy systems, and links business processes.
   c. it provides competitive advantage, low customer satisfaction, and eliminates redundancy of data.
   d. an integrated system facilitates cross-functional integration, eliminates redundancy of data, links business processes.
5. How would you define the SAP R/3 System?
   a. It is an application software.
   b. It is an application software that supports different functional areas of an organization.
   c. It is a modular integrated system built around best practices in a particular industry.
   d. All of the above

6. An SAP R/3 System module is
   a. a group of related business processes.
   b. the level of functionality in the SAP R/3 system.
   c. a group of related business transactions.
   d. a business application within SAP R/3 System.

7. The supply chain extends from
   a. supplier to manufacturer.
   b. supplier to supplier.
   c. dealer to customer.
   d. supplier to customer.

8. SAP three-tier client/server architecture is
   a. a system divided into presentation, application, and database layers interconnected.
   b. A system with three different servers, application, database, and tools.
   c. A system made up of three computers.
   d. All of the above

9. What is a Client/Server system?
   a. A system where a Client computer accesses a Server computer over a network.
   b. A system where a Server computer accesses a Client computer over a network.
   c. A group of computers interconnected on a network.
   d. A single-user workstation connected over a network to a server (s) that contains database. (s)

10. The following are examples of a business process except:
    a. order fulfillment
    b. payroll
    c. sales
    d. production scheduling
11. A bill of material specifies all of the following except:
   a. a brief description of each component in the product
   b. when a component is needed in the assembly process
   c. lot sizes and lead times
   d. how many of each component is needed
   e. all of the statements above are specified on the BOM

12. The Manufacturing Planning and Execution Cycle includes
   a. Forecasting, Demand Management, Material Master
   b. Customer Master, Forecasting, Sales and Operations Planning
   c. Material Requirement Planning, Forecasting, Bill of Material
   d. Forecasting, Demand Management, Material Requirement Planning
   e. None of the above

13. Material Requirements Planning (MRP) is a system for
   a. computing economic order quantities.
   b. determining when to release orders.
   c. computing safety stocks.
   d. determining service levels.

14. All of the following are major inputs to the MRP process except:
   a. work orders.
   b. the master production schedule.
   c. the inventory master file.
   d. the product structure file.
   e. All of the above are major input to MRP.

15. The Master Production Schedule (MPS) specifies
   a. which components a firm is to produce.
   b. how many components are needed.
   c. when the finished product is needed.
   d. None of the above statements are true.
APPENDIX D - MEASUREMENT PERFORMANCE

Post Knowledge Assessment

ISDS 3115 – SEC___

NAME ___________________________ SS#: ___________________________

MULTIPLE CHOICE
1. A legacy system might be defined as
   e. a series of disparate mainframe based software applications.
   f. a group of systems that support a company business needs.
   g. a system that provides information support to business processes.
   h. a system that provides information support to different functional areas within
      a company but it is not fully integrated.

2. A company should be concern about having a Legacy System because
   e. such as system does not provides support to compete in the current dynamic
      market.
   f. the system does not support the cross-functional models of a business.
   g. the system creates data redundancy within the organization.
   h. All of the above

3. An Enterprise System can be defined as
   e. a group of software packages connected together.
   f. a Manufacturing and Logistics application software.
   g. an application package that supports core-business operational functions.
   h. a and c

4. Companies should integrate systems because
   e. system integration allows a company to lower operating cost, decreases
      quality, and facilitates cross-functional integration.
   f. it increases inefficiencies inherent in the functional model supported by legacy
      systems, and links business processes.
   g. it provides competitive advantage, low customer satisfaction, and eliminates
      redundancy of data.
   h. an integrated system facilitates cross-functional integration, eliminates
      redundancy of data, links business processes.

5. How would you define the SAP R/3 System?
   e. It is an application software.
   f. It is an application software that supports different functional areas of an
      organization.
   g. It is a modular integrated system build around best practices in a particular
      industry.
   h. All of the above
6. A module is
   e. a group of related business processes.
   f. the level of functionality in the SAP R/3 system.
   g. a group of related business transactions.
   h. a business application within SAP R/3 System.

7. The supply chain extends from
   e. supplier to manufacturer.
   f. supplier to supplier.
   g. dealer to customer.
   h. supplier to customer.

8. What is a Client/Server system?
   e. A system where a Client computer accesses a Server computer over a network
   f. A system where a Server computer accesses a Client computer over a network
   g. A group of computers interconnected on a network
   h. A single-user workstation interconnected on a network to a server(s) that
      contains database(s)

9. The SAP R/3 System three-tier client/server architecture is
   e. A system divided into presentation, application, and database layers
      interconnected.
   f. A system with three different servers, application, database, and tools.
   g. A system made up of three computers.
   h. All of the above

10. The following is an example of a business process:
    e. Order fulfillment
    f. Material Requirements Planning
    g. Pricing
    h. Goods Receipt

11. Production Master Data includes all of the following except
    a. Bill of Material
    b. Customer Master
    c. Material Master
    d. Cost Center

12. The list of quantities of components, ingredients, and materials required to produce a
    product is the
    a. bill-of-material
    b. engineering change notice
    c. purchase order
    d. all of the above
    e. none of the above

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13. The Manufacturing Planning and Execution Cycle includes
   f. Forecasting, Demand Management, Material Master
   g. Customer Master, Forecasting, Sales and Operations Planning
   h. Material Requirement Planning, Forecasting, Bill of Material
   i. Forecasting, Demand Management, Material Requirement Planning
   j. None of the above

14. Material Requirements Planning (MRP) is a system for
   e. computing economic order quantities.
   f. determining when to release orders.
   g. computing safety stocks.
   h. determining service levels.

15. The Master Production Schedule
   a. drives the MRP process.
   b. provides a schedule for all component items.
   c. represents customer demand.
   d. All of the above

16. MRP can
   a. calculate demand for component items.
   b. keep track of when component items are needed.
   c. generate work orders.
   d. generate purchase orders which incorporate lead time.
   e. All of the above

17. All of the following statements concerning MRP are true except:
   a. MRP is useful for assemble-to-order environments.
   b. MRP is useful for discrete demand items.
   c. MRP is useful when lead time is uncertain.
   d. MRP is designed primarily for repetitive and continuous manufacturing.
   e. All of the above are true

18. All of the following are major inputs to the MRP process except
   f. work orders.
   g. the master production schedule.
   h. the inventory master file.
   i. the product structure file.
   j. All of the above are major input to MRP.

19. The Master Production Schedule (MPS) specifies
   e. which components a firm is to produce.
   f. how many components are needed.
   g. when the finished product is needed.
   h. None of the above statements are true
20. All of the following statements concerning the Master Production Schedule are true except:
   a. the MPS does not consider specific resource needs and may actually produce a
      infeasible schedule.
   b. the quantities on the MPS represent demand forecasts, not production plans.
   c. the quantities on the MPS may only be predictions, not actual customer orders.
   d. the quantities on the MPS may undergo many revisions before the schedule is
      completed.
   e. All of the statements above are true

21. Which of the following is the input that is said to “drive” the MRP system?
   a. Inventory master file
   b. Capacity requirements plan
   c. Master production schedule
   d. Product structure file
   e. None of the above

22. Business transactions that are included in the Manufacturing Planning and Execution process are
   a. Goods Issue
   b. Production Order Receipt
   c. Purchasing Requisition
   d. Production Order
   e. All of the above

23. In the Sales and Operations Planning Table, the four lines of the table that can be maintained (changed) are
   a. Sales, Stock Level, Production, and Days’ supply.
   b. Sales, Production, Target Stock Level, and Target days’ supply.
   c. Sales, Days’ supply, Production, and Target days’ supply
   d. Sales, Production, Stock Level, and days’ supply

24. The Production Order Execution Process involves
   b. Planned Order, Order Release, Goods Issue, Completion Confirmation, Goods, and Order Settlement.
TRUE/FALSE

25. All SAP R/3 system application modules share data through the R/3 database which contains the data for all modules.
   a. True
   b. False

26. When you enter data in the SAP R/3 System for any of the modules, the data is placed in the R/3 database and is immediately available to all other R/3 application modules.
   a. True
   b. False

27. A key advantage of the SAP R/3 system is that it is both integrated using a common database and it consists of a single robust business process.
   a. True
   b. False

28. Motor Sports International (MSI) receives an order for 50 of its 1200cc motorcycles from its wholesale customer, Cycle Concepts in Philadelphia, with a request for delivery in one month. By running a Master Production schedule (MPS), MIS determines how many and which components they need for its production plan.
   a. True
   b. False

29. Independent Requirements are created by using the Sales and Operations Planning Table or by entering them directly through demand management.
   a. True
   b. False

30. A production plan can be generated via target stock level. As a result of changing the target stock level, the R/3 system calculates the production quantities needed to achieve target stock levels.
   a. True
   b. False

31. The quantities listed in the Stock/Requirement List (Received/required quantity field) correspond to the production plan values displayed in the planning table.
   a. True
   b. False

32. Updating the entries on the SOP planning table will automatically update the entries on the Stock/requirements list.
   a. True
   b. False
33. Master Production Scheduling (MPS) generates planned orders that satisfy the independent requirement for each master schedule material. These planned orders contain the dependent requirements for the first-level components in each product's bill of material.
   a. True
   b. False

34. The difference between the stock/requirement list and the MRP list is that the Stock/requirement list displays all current stock, expected receipts, and requirements. The MRP list displays only the results of the last planning run.
   a. True
   b. False

35. Following the MPS run, the MRP list displays the independent requirements from the SOP and the planned orders that were generated in MPS to satisfy these requirements.
   a. True
   b. False

36. The primary purpose of the MRP planning run is to schedule material availability and prevents excessive inventory of component materials.
   a. True
   b. False

37. The Multi-level MRP determines the required quantity of each component material by exploding the entire bill of material using the quantity per to calculate the necessary quantities.
   a. True
   b. False

38. The dependent requirements (Figure 1) for the MRP item (i.e., frame assembly) are generated during the MPS run of the MPS item (i.e., Bicycle).
   a. True
   b. False

Figure 1
39. The Manufacturing Execution process is started by releasing each production order to the Shop floor.
   a. True
   b. False

40. After being converted from a planned order, a production order must be released to the Shop floor before any component material is issued or any finished product is received.
   a. True
   b. False
APPENDIX E - MEASUREMENT SELF-EFFICACY

Self-Efficacy Instrument

Name: ___________________________ ISDS 3115 - Sec: _____

Please take your time and answer to the best of your judgment. The information you give on this survey will remain strictly confidential and will not affect your grades in any way.

Often in the real work environments we are told about software packages that are available to make work easier. For the following questions, imagine that you were given a new software package for some aspect of your work. It doesn’t matter specifically what this software does, only that it is intended to make your job easier and that you have never used it before.

The first ten questions ask you to indicate whether you could use this unfamiliar software package under a variety of conditions. For each condition, please indicate whether you think you would be able to complete the job using the software package. Then, for each condition that you answer "yes," please rate your confidence about your first judgment, by circling a number from 1 to 10, where 1 indicates "Not at all confident," 5 indicates "Moderately confident," and 10 indicates "Totally confident."

For example, consider the following sample item:

<table>
<thead>
<tr>
<th>I COULD COMPLETE THE JOB USING THE SOFTWARE PACKAGE...</th>
<th>Not Confident</th>
<th>Moderately Confident</th>
<th>Totally Confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>1....if there was no one around to tell me what to do as I go.</td>
<td>YES: 1 2 3 4 5 6 7 8 9 10</td>
<td>YES: 1 2 3 4 5 6 7 8 9 10</td>
<td>NO:</td>
</tr>
</tbody>
</table>

The questionnaire is on the next page...
I COULD COMPLETE THE JOB USING THE SOFTWARE PACKAGE ...

1. ...if there was no one around to tell me what to do as I go.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

2. ...if I had never used a package like it before.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

3. ...if I had only the software manuals for reference.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

4. ...if I had seen someone else using it before trying it myself.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

5. ...if I could call someone for help if I got stuck.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

6. ...if someone else had helped me get started.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

7. ...if I had a lot of time to complete the job for which the software was provided.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

8. ...if I had just the built-in help facility for assistance.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

9. ...if someone showed me how to do it first.
   1 2 3 4 5 6 7 8 9 10
   YES... NO

10. ...if I had used similar packages before this one to do the same job
    1 2 3 4 5 6 7 8 9 10
    YES... NO
# APPENDIX F - END-USER COMPUTING SATISFACTION

**Please circle the response below which best describes your feeling about the Manufacturing Planning and Execution Exercises (Assignment) with the SAP R/3 System.**

where:

1 = Very Low  
2 = Low  
3 = Medium  
4 = High  
5 = very High

<p>| | | | | | |</p>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

1. The clarity and understanding of the exercise documentation was

2. The assistance gained from the exercise documentation was

3. The match between the exercises outcome and my expectation about the exercises outcome was

4. The usefulness of the exercises to understand the lecture material is

5. The benefits of the exercises to understanding the lecture material are

6. The time provided to complete the exercises was

7. Overall rating for the Assignment exercises content and documentation is

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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

*Please circle the response below which best describes your feeling about the System you worked with to perform the Manufacturing Planning and Execution Exercise.*

where:

1 = Almost Never  
2 = Some of the Time  
3 = About Half of the Time  
4 = Most of the Time  
5 = Almost Always

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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

8. Is the system user friendly?

9. Is the system easy to use?

10. Is the Information clear?
APPENDIX G - USER LECTURE SATISFACTION

Please circle the response below which best describes your feeling about the Enterprise Resource Planning and Manufacturing Planning and Execution lectures.

where:
1 = Very Low
2 = Low
3 = Medium
4 = High
5 = very High

1. The clarity and understanding of the lecture documentation was

2. The assistance gained from the lecture documentation was

3. The match between the lecture outcome and my expectation about the lecture outcome was

4. The usefulness of the lecture to my job is

5. The benefits of the lecture to my job are

6. The duration of the lecture for all the topics covered in the class was

7. The consistency between the amount of time spent on a topic and the importance of the topic was

8. Lecture consistency (presentation, contents, exercises) for various topics throughout the lecture period was

9. The organization and arrangement of lecture topics relative to my expectation was

10. Overall rating for the lecture material and documentation is
APPENDIX H - LECTURE SESSION EVALUATION

Please circle a number from 1 to 5 of the following that apply
where:

1 = Strongly Disagree
2 = Disagree
3 = Undecided
4 = Agree
5 = Strongly Agree

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The instructor showed a genuine interest in the students.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. The instructor was well informed about the subject matter.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. The instructor made the subject matter more meaningful to me through the use of examples and applications.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. Explanations of the material were clear and to the point.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. The instructor aroused my interest in the subject matter.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. The session was paced effectively.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. Overall, I would rate the instructor as outstanding.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
VITA

The author, Jose, was born in the Pacific Coast of Costa Rica, Golfito. He grew up in a rural area enjoying what nature can offer.

He came to LSU in Fall 1991, to pursue graduate studies at The Department of Oceanography and Coastal Sciences. He graduated in 1994 with a Master of Science degree in Oceanography. He continued graduate studies at LSU and obtained a Master of Science degree in Information Systems and Decision Sciences in 1996.

Today the author is a candidate for the degree of Doctor of Philosophy in Business Administration (Information Systems and Decisions Sciences). He is an assistant professor at Florida International University, Miami. He is currently involve on research and teaching in the areas of Enterprise Information Systems, Analysis and Design of Information Systems, Business Process Reengineering, and Supply Chain Management.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Jose H. Noguera

Major Field: Business Administration

Title of Dissertation: Effectiveness of Using an Enterprise System to Facilitate Process-Centered Learning in Business Education

Approved:

[Signatures]

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

November 29, 1999