Effectiveness of using an enterprise system to teach process-centered concepts in business education

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Keywords

Business performance, Education, Management training, Teaching methods

Abstract

This study investigates whether or not student's performance, self-efficacy, and satisfaction are enhanced by the use of an enterprise system as a support tool for learning business process and enterprise systems concepts. The study compares three instructional delivery methods. A traditional instruction method (lecture format plus reading/exercises) serves as the control. The second and third instructional methods are computer-based methods. In the second method, students receive traditional lecture format with full access to hands-on an enterprise system transaction exercise. In the third method, students receive traditional lecture format, but also have full access to simulated hands-on an enterprise system via Web transaction exercises (i.e. ScreenCam movies). A statistically significant difference between-instructional methods effect is found. *Post hoc* analysis showed that the simulated hands-on instruction group's performance score was significantly higher than that of the control group. There were no other statistically significant differences found, but practical considerations at this learning environment are discussed.

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Emerald

Journal of Enterprise Information Management
Volume 17 · Number 1 · 2004 · pp. 56-74
© Emerald Group Publishing Limited · ISSN 1741-0398
DOI 10.1108/09576050410510953

Introduction

Business education, in particular IS education, must constantly change in order to stay on top of key business and business systems concepts. How enterprise resource planning (ERP) systems support the process-centered organization (Hammer, 1996) is a relatively new concept being taught today.

ERP systems support the need for enterprises to move from functional-oriented to process-oriented structures by taking a very process-oriented view of the organization:

> 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 ERP system is an integrated enterprise software system 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).

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 ERP systems. Thus, business schools are expected to graduate students with

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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.*, 1995). 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 provided by alliances among ERP industry market leaders and universities across the world.

Basically, these alliance programs provide an academic entity (e.g. a university, college, school, or department) with a completely functional ERP system for teaching and research. The program can provide significant learning opportunities in the classroom. Students can develop a deeper and broader understanding of both the role that ERP systems play 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. Thus, a significant challenge facing business school educators is to identify how best to deploy a commercial ERP system in their academic environment.

To date, there is not an effective model for how to integrate an ERP system into the business curriculum. However, current integration efforts in several institutions provide evidence 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 tend to resolve around the implications of such system on business education (i.e. curriculum development, delivery, and assessment). 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.

On the other hand, the educational benefits of instructional uses of ERP systems is established on the basis of anecdotal statements from faculty and students rather than on empirical and objectively measured data secured by educational research methods. Furthermore, there is no known single research effort that focuses on questions related to the effectiveness of using ERP systems at the undergraduate or graduate level.

Thus, the main objective of this study is to determine whether or not student performance, self-efficacy, and satisfaction are enhanced by the deployment of a real system in the curriculum. Specifically, the question is whether using an ERP system as a support tool for instruction facilitates the knowledge and understanding of business processes, focusing on how enterprise information is processed. A secondary objective is to determine whether or not learning styles, as assessed by a learning style inventory (Kolb, 1985), affects learning outcomes within the instructional methods.

This paper is organized into six sections. Following presentation of the theoretical framework, the research model and hypotheses are presented and discussed in section two. The third and fourth sections report the research design and data analysis and results. Section five presents the discussion and conclusions. The article concludes with the limitations and future research suggestions.

Theoretical framework

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 *et al.*, 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 and Dickson, 1985).

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Thus, this research uses the experiential learning theory (Kolb, 1984) and instructional design methods (Rothwell and Kazanas, 1998) as platforms to investigate learning effectiveness of ERP system-supported instruction.

The experiential learning theory (Kolb, 1984; Simon *et al.*, 1996) conceptualizes learning in such a way that it provides two fundamental dimensions to the learning process:

(1) concrete experience (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 (Figure 1).

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 1). Divergers 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.

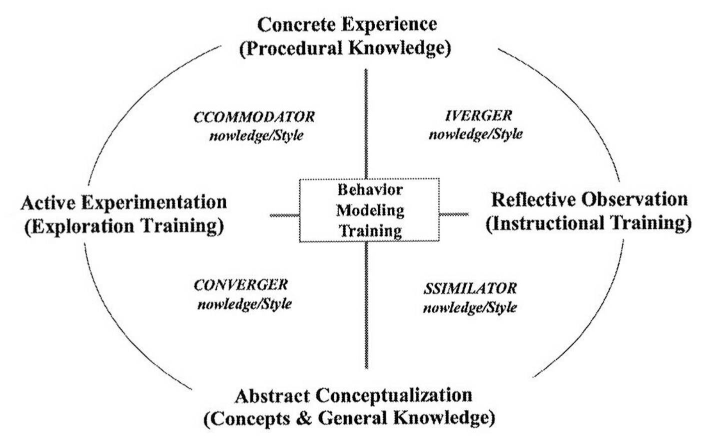
Kolb's experiential learning theory and learning styles (Kolb, 1984; Simon *et al.*, 1996) provide an approach to learning that emphasizes the fact that individuals perceive and process information in very different ways. The theory implies that the amount of learning by an individual is a function of 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.

Instructional design

Instructional design in education is analogous to how architecture is in the building industry. 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 various (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).

Figure 1 Comprehensive experimental training model



Research model and hypothesis

The research model used in this study is shown in Figure 2. The model focuses only on the influences of instructional method and individual differences on education outcomes. Instructional method refers to the actual delivery of instruction. Several researchers agree that the instruction method influences an individual's performance (Bostrom *et al.*, 1990; Leidner and Jarvenpaa, 1993). The types of instruction method used in this study are:

- a traditional instruction method that acts as the control (lecture plus reading/exercises);

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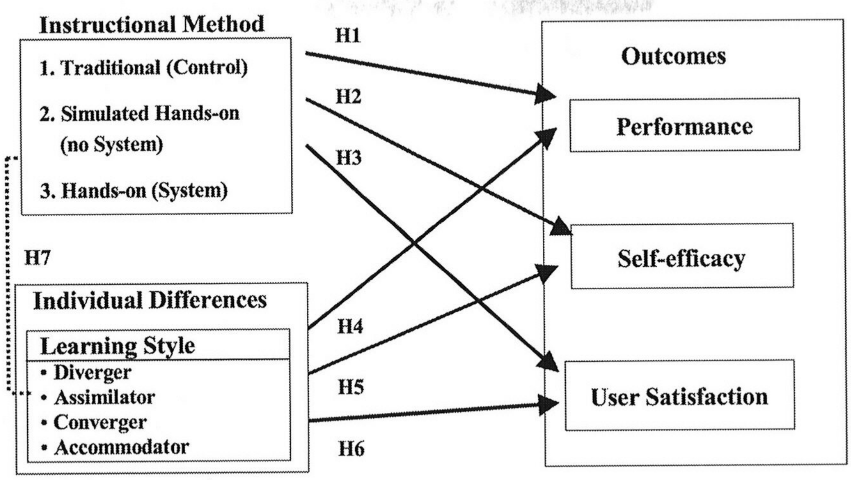
Figure 2 Research model



- a computer-based method with hands-on ERP system; and
- a computer-based method with simulated hands-on ERP system.

Individual differences are defined based on Kolb's Experiential learning theory/learning styles (Kolb, 1984). Previous research studies have emphasized the importance of considering individual differences in information systems effectiveness studies (Bostrom *et al.*, 1988, 1990, 1993; Todd and Benbasat, 1987).

Educational outcomes include performance, self-efficacy, and user satisfaction. 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, 1995). 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. In Figure 2, 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.

Hypotheses

The relationship between the constructs on the research model (Figure 2) are expressed as a set of hypotheses (*H1* to *H7*) to be tested. 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 ERP system and all other groups (control group, and simulated hands-on the ERP system group). Previous studies have reported mixed results about the outcomes of traditional instruction versus computer-based instruction (Bowman *et al.*, 1995). Accordingly, *H1* is as follows:

H1. There will be no difference in performance scores between the group that receives hands-on experience with the ERP 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, *H2* is as follows:

H2. There will be no difference in self-efficacy between the hands-on ERP system instruction group and the simulated hands-on ERP 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. 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 program 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, *H3* is as follows:

H3. There will be no difference in user satisfaction between the hands-on ERP system instruction group and the simulated hands-on ERP system instruction group.

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). The objective of incorporating this variable in the study is to examine the role of the learning style on learning about business processes and ERP 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, *H4*, *H5* and *H6* are as follows:

H4. Subjects' learning style does not influence the performance of subjects.

H5. Subjects' learning style does not influence the self-efficacy of subjects.

H6. Subjects' learning style does not influence the satisfaction of subjects.

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, *H7* is as follows:

H7. There is no significant interaction effect between learning style and

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instruction method on the performance, self-efficacy, and satisfaction of subjects.

Research design

Subjects

Subjects ($n = 284$) consisted of undergraduate students enrolled in five sections of an operations management course. Subjects came from various programs (finance, accounting, marketing, management information systems, operations management, general business, and others). Most students were at the junior or senior level. More than 70 per cent of the subjects were between 20-22 years of age. Sample involved equal number of females and males. Subjects were randomly assigned to the treatment groups.

Content

The content was a set of two 50-minute lectures on ERP systems and a lecture on manufacturing planning and execution (MPE) designed and taught by the same instructor.

The MPE cycle was chosen as the domain area to be used in the experiment. Briefly, the manufacturing process involves seven major operational steps:

(1) forecasting;
(2) sales and operations planning;
(3) demand management;
(4) master production scheduling;
(5) material requirements planning;
(6) manufacturing execution; and
(7) order settlement.

None of the students enrolled in the operations management class would have been exposed to this topic before encountering it in this course.

The two lectures were complemented with an assignment. There were three types of assignments:

(1) reading and exercises, this is a traditional text/book reading and homework exercise that is given to students to support in class lecture;
(2) simulated hands-on the ERP system via Web, this is similar to the hands-on ERP system 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; and
(3) hands-on ERP system, this is a hands-on experience exercise that ask students to perform a series of business transactions using the ERP systems.

For the simulated hands-on and hands-on assignments, a combination of exploration and instruction-based manual was operationalized by following the minimalist theory (Carroll *et al.*, 1987; Lazonder and Meij, 1993).

Research variables

Independent variables

The two independent variables are the instructional method and learning style (Table I). The types of instruction methods used in this study are:

- a traditional instruction method that acts as the control (lecture plus reading/exercises);
- a computer-based method with hands-on system (lecture plus hands-on ERP system); and
- a computer-based simulated hands-on (lecture plus simulated hands-on ERP system via Web/ScreenCam demonstrations).

A learning style instrument (Kolb, 1985) was administered to measure subject's learning style.

Dependent variables

The dependent variables (Table I) are:

- student performance, which will be measured by student grades on a test given at the end of the experiments; and
- self-efficacy, which will be measured by a survey instrument developed by Compeau and Higgins (1995); Allinson and Hayes (1988), and satisfaction, which will be measured by a survey instrument developed by Doll and Torkzadeh (1988).

Performance (knowledge and understanding of business process and the ERP system) 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

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Table I Variables to be considered in the study

Independent	Dependent
Instructional method	Performance
Traditional (control)	Self-efficacy
Computer-based hands-on (system)	User satisfaction
Computer-based simulated hands-on (no system) via Web	
Learning style	***Other variables***
Diverger	Demographic characteristics
Assimilator	Knowledge/skills assessment
Converger	Previous experience with computers
Accommodator	Attitude toward computers
	Technology

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 ERP system exercises and simulated computer-based hands-on ERP system exercises). The test was graded on a scale of 1-100.

Self-efficacy is measured by administering a ten-item scale instrument developed by (Compeau and Higgins, 1995). The instrument has proven to have a high reliability (Cronbach's alpha = 0.94). In the instrument, students are asked 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 one to ten.

User satisfaction is measured by administering an instrument based on Doll and Torkzadeh's (1988) end-user satisfaction instrument. The Doll and Torkzadeh instrument measures the end-user computing satisfaction construct and uses three major factors:

(1) content/format;
(2) accuracy/timeliness; and
(3) 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 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.

Other variables

Information on a number of other variables was measured to be used in the analysis as covariates (Table I): demographic characteristics, knowledge/skills assessment, previous experience with computers, and attitude toward computer technology (Kinzie *et al.*, 1994).

The basic knowledge/skills initial assessment is a 15 multiple-choice quiz that tests basic concepts about ERP systems and the manufacturing planning and execution cycle. The quiz is graded on a scale of one to ten.

Experimental design structure

The research design for this study follows a true experimental design. Experimental units (students) were randomly assigned the treatment groups 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).

The experiment involved a two-factor design, where the instructional method is the independent variable and learning style is the moderating independent variable. The result is a 3×4 factorial design (Table II). The main dependent variable is performance as measured by the scores on a post-test. The test was identical for the three experimental groups.

Experimental procedure

The experimental procedure included four main phases (Figure 3). 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. Then, subjects were given enough time to complete an in-class background knowledge/skills assessment and the learning style inventory. 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 in to the next class session. The same script was followed in every section.

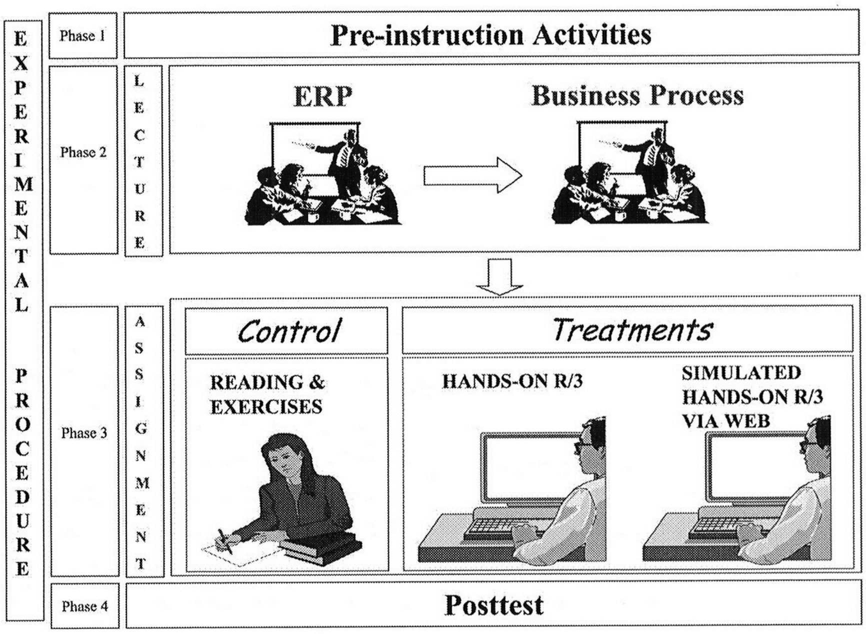
During phase 2, the content, a set of two 50-minute lectures on ERP systems and MPE process was delivered. Following the lectures, an assignment was provided to the students (phase 3).

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 and end-user computing satisfaction). Then, a comprehension test was administered.

Table II Experimental design structure for the experiment

	Learning style (B)			
Instructional method (A)	**Diverger $k=1$**	**Assimilator $k=2$**	**Converger $k=3$**	**Accommodator $k=4$**
Control ($j=1$)	A_1B_1	A_1B_2	A_1B_3	A_1B_4
Hands-on system ($j=2$)	A_2B_1	A_2B_2	A_2B_3	A_2B_4
Simulated hands-on system ($j=3$)	A_3B_1	A_3B_2	A_3B_3	A_3B_4

Figure 3 Experimental research procedure



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Data analysis and results

Validity and reliability analysis

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. Thus, content validity was established by using previous validated instruments and "expert judgement".

Construct validity refers to the extent to which the instrument is in fact measuring. It is, in fact, an operational issue. 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 III presents the results from factor analysis for each research variable consisting of more than three questionnaire items.

Only the first component (factor I) displayed eigenvalues greater than one (Table III) 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.

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 on repeated administration, on administration by alternate forms, and so forth. A variety of methods of estimating scale reliability are actually used in practice.

Cronbach's (1951) coefficient alpha was used to assess the internal consistency reliability of the scales. Internal consistency is the extent to which the individual items that constitute a test correlate with one another or with the test total. Coefficient alpha reliability estimates all exceeded 0.8. The Cronbach alphas were 0.94 for self-efficacy, 0.87 for computer user satisfaction, and 0.89 for attitudes toward computers (Table III). These high values of alpha coefficients indicate that the items under these constructs adequately measure the constructs.

Descriptive statistics

Distribution of subjects

A total sample of 284 subjects participated in the experiment. The distribution of the subjects' learning style by experimental group is presented in Table IV. Numbers in parentheses are percentages.

The proportion of participants according to instructional method were 23.59 per cent, 39.44 per cent, and 36.97 per cent for the control, simulated hands-on, and hands-on experimental group, respectively. On the other hand, overall, there were 17.25 per cent divergers, 35.91 per cent assimilators, 29.23 per cent convergers, and 17.61 per cent accommodators.

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 ($\chi^2 = 3.493$, $p = 0.745$) in the proportion of the subject's learning style by experimental group. Thus, the subject's learning style was similar among experimental groups.

Summary of the mean of other variables

Overall, of the subjects sampled ($n = 284$), responses to the preliminary survey on the

Table III Factor analysis and coefficient alpha reliability estimates for the study's variables

	Factor I		Coefficient alpha reliability		
Variable	Eigenvalue	Variance explained (%)	Number of items	Alpha	*n*
Self-efficacy	6.79	68	10	0.94	217
Computer user satisfaction	4.05	68	7	0.87	217
Attitude toward computers	4.67	58	8	0.89	284

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Table IV Distribution of subjects by experimental group and learning style mode

Experimental group	Learning style mode: Diverger	Assimilator	Converger	Accommodator	Total
Control	9 (3.17%)	21 (7.39%)	24 (8.45%)	13 (4.58%)	67 (23.59%)
Simulated hands-on	21 (7.39%)	42 (14.79%)	28 (9.86%)	21 (7.40%)	112 (39.44%)
Hands-on	19 (6.69%)	39 (13.73%)	31 (10.92%)	16 (5.63%)	105 (36.97%)
Total	49 (17.25%)	102 (35.91%)	83 (29.23%)	50 (17.61%)	284 (100%)

subject's demographic characteristics indicates that participants were mostly marketing and finance majors (19.0 per cent, respectively), senior academic level (79.23 per cent), with an overall GPA between 2.5-3.00 (40.2 per cent), age between 20-22 (75 per cent), and 52.8 per cent males and 47.2 per cent females. In general, data indicate that groups were equivalent at the beginning of the study.

The average knowledge/skills assessment scores was 36.96 ± 12.19, 44.25 ± 10.67, and 44.00 ± 12.60 for the control, simulated hands-on, and hands-on experimental groups, respectively.

The results of the previous experience with computer instruments indicated that approximately 83 per cent of the subjects had access to computers at home and 73 per cent had access to the Internet at home. On the average, subjects were frequent users of computers, using computers at home and several times a week at work. Furthermore, subjects reported using electronic mail and the World Wide Web search about once a day. Overall, subjects had familiarity with software to some extent.

The mean of the attitude measurement scale fluctuated from 4.18 ± 0.50 to 3.66 ± 0.76 (where one indicates "strongly disagree", three indicates "undecided", and five indicates "strongly agree"). Overall, students have a positive attitute toward the use of computer technologies.

Dependent variables

The mean, standard deviations (SD), and sample sizes (n) for each dependent variable (outcomes) by experimental group and learning style are provided in Table V.

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 one indicates "not at all confident", five indicates "moderately confident", and ten indicates "totally confident"). 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 V).

Hypotheses test

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 ($\chi^2 = 1.4976$, Prob. $> \chi^2 = 0.4729$).

The test on background knowledge/skills assessment indicated that there is significant statistical difference ($\chi^2 = 17.571$, Prob. $> \chi^2 = 0.0002$) 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 ANOVA statistical method since the data conformed with the assumptions of the F-test previously indicated.

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Table V Descriptive statistics for dependent variables by experimental group and learning style

		Outcomes (mean ± SD)			
Experimental group	**Learning style**	**Performance**	**Self-efficacy**	**User satisfaction**	***n***
Control	Diverger	61.22 ± 10.06	–	–	9
	Assimilator	62.62 ± 8.30	–	–	21
	Converger	60.21 ± 11.09	–	–	24
	Accommodator	59.15 ± 10.98	–	–	13
Experimental group mean ± SD		60.89 ± 9.99			67
Simulated hands-on	Diverger	64.20 ± 6.30	6.51 ± 1.65	2.77 ± 0.70	21
	Assimilator	67.07 ± 7.88	6.33 ± 1.80	2.66 ± 0.71	42
	Converger	64.30 ± 7.01	6.85 ± 1.63	2.42 ± 0.73	28
	Accommodator	66.52 ± 6.67	6.61 ± 1.65	2.75 ± 1.07	21
Experimental group mean ± SD		65.53 ± 7.37	6.54 ± 1.69	2.64 ± 0.79	112
Hands-on	Diverger	62.21 ± 8.14	6.11 ± 2.06	2.92 ± 0.76	19
	Assimilator	66.26 ± 8.90	6.47 ± 1.73	2.93 ± 0.72	39
	Converger	64.45 ± 9.13	7.14 ± 1.63	2.61 ± 0.75	31
	Accommodator	62.69 ± 8.08	6.40 ± 1.87	2.82 ± 0.63	16
Experimental group mean ± SD		64.44 ± 8.74	6.59 ± 1.80	2.82 ± 0.73	105

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 ($p > 0.05$).

Differences between experimental groups after treatment

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 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 VI.

Student's performance (H1, H4, H7)

Table VII reports the results of the analysis. The *F*-value for the experimental group was 5.11, 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, *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 0.35 and was not statistically significant, indicating that there is no significant relationship between learning instructional method and learning style. Thus, *H4* and *H7* were not rejected. 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 12 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 ERP 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.

Self-efficacy (H2, H5, H7)

H2, *H5* and *H7* could not be rejected since there were not significant main effects (instructional methods and learning style) or

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Table VI Hypotheses to be tested

Hypothesis	Statement
H1	There will be no difference in performance scores between the group that receives hands-on experience with the ERP system and all other groups
H2	There will be no difference in self-efficacy between the hands-on ERP system instruction group and the simulated hands-on ERP system instruction group
H3	There will be no difference in user satisfaction between the hands-on ERP system instruction group and the simulated hands-on ERP system instruction group
H4	Subjects' learning style does not influence the performance of subjects
H5	Subjects' learning style does not influence the self-efficacy of subjects
H6	Subjects' learning style does not influence the satisfaction of subjects
H7	There is no significant interaction effect of learning style and instruction method on the performance scores, self-efficacy, and satisfaction of subjects

Table VII ANOVA table for student's performance

Source of variation	Type III sum of squares	DF	Mean square	*F* value	Prob. > *F*
Experimental group (A)	748.657	2	374.328	5.115	0.007
Learning style (B)	416.520	3	138.840	1.897	0.130
AB interaction	181.214	6	30.202	0.413	0.870
Error	19906.379	272	73.185		

Notes: Normality test: W: normal = 0.9813, Pr < W = 0.3136; Homogeneity of variance Bartlett's test: $\chi^2 = 13.77$, alpha = 0.246

interaction effect when evaluating the student's self-efficacy. Results of the statistical analysis are reported in Table VIII.

User satisfaction (H3, H6, H7)

The regression approach to ANOVA did not reveal a significant main effect for the instructional method, learning style or an interaction effect between instructional method and learning style. The results of the data analysis are provided in Table IX. Thus, *H3*, *H6* and *H7* could not be rejected when using user satisfaction as a dependent variable.

Power analysis

A *post-hoc* power evaluation was performed on the statistical tests computed previously. 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. The results of the power analyses are reported in Table X.

Power depends on three parameters:

(1) the significance level (alpha);
(2) the sample size (n); and

Table VIII ANOVA table for student's self-efficacy

Source of variation	Type III sum of squares	DF	Mean square	*F* value	Prob. > *F*
Experimental group (A)	0.103	1	0.103	0.034	0.854
Learning style (B)	15.665	3	5.222	1.719	0.164
AB interaction	3.608	3	1.203	0.396	0.756
Error	634.69	209	3.037		

Notes: Normality test: W: normal = 0.9613, Pr < W = 0.0002; Homogeneity of variance Bartlett's test: $\chi^2 = 2.03$, alpha = 0.958

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Table IX ANOVA table for student's satisfaction

Source of variation	Type III sum of squares	DF	Mean square	*F* value	Prob. > *F*
Experimental group (A)	1.456	1	1.456	2.522	0.114
Learning style (B)	3.713	3	1.238	2.144	0.096
AB interaction	0.282	3	0.093	0.163	0.921
Error	120.669	209	0.577		

Notes: Normality test: *W*: normal = 0.9772, Pr < *W* = 0.1506; Homogeneity of variance Bartlett's test: $\chi^2 = 7.87$, alpha = 0.344

Table X Power calculations for tested hypotheses

Effect	Dependent variable	Test	Decision	Effect size	Noncentrality parameter (λ)	Power*
Experimental group (A)	Performance	*H1*	Reject	0.1900	10.230	0.820
	Self-efficacy	*H2*	Not reject	0.0125	0.034	0.054
	Satisfaction	*H3*	Not reject	0.1078	2.522	0.353
Learning style (B)	Performance	*H4*	Not reject	0.1415	5.691	0.488
	Self-efficacy	*H5*	Not reject	0.1540	5.158	0.446
	Satisfaction	*H6*	Not reject	0.1722	6.431	0.541
AB interaction	Performance	*H7*	Not reject	0.0930	2.476	0.171
	Self-efficacy	*H7*	Not reject	0.0740	1.188	0.128
	Satisfaction	*H7*	Not reject	0.0149	0.488	0.080

Notes: * Observed power computed using alpha = 0.05, *n* = 284

(3) the "effect size" or degree to which the phenomenon exists.

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 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. Overall, effect sizes for this study were relatively small, based on Cohen's (1988) criteria. On the other hand, in general, power was relatively low.

Discussion and conclusions

The primary goal of the present study was to assess the effectiveness of using an ERP system to facilitate the understanding of business processes and ERP systems concepts. Effectiveness was measured as a function of subjects' performance scores, self-efficacy perceptions, and level of computer satisfaction. The results reported in this study provide some interesting discussion and conclusions.

Discussion

Experimental studies have shown that information technology 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). 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 ERP 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

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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 20 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. Today, this pedagogical approach is used routinely by a number of educators, especially those in the fields of management and organizational behavior.

Kolb's (1984) experiential learning theory was used to develop the structure for an enterprise systems/business process lecture. The learning mechanism consists 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.

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).

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.

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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; Czaja *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 an ERP 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 indicates 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 styles 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. Although this study used the revised form of the learning styles inventory, it is recommended that an alternative (Allinson and Hayes, 1988) learning style questionnaire be administered (or adopted) instead.

Conclusions

Enterprise systems are emerging as useful tools for enhancing student learning of business/IS concepts. Specifically, they provide a way to transport the classroom to the real world of business. Many different universities are using ERP systems in similar ways, for similar reasons, and with similar anxieties: that is what makes this study significant.

This research builds on the exciting information technology literature on learning models (e.g. Kolb, 1984; Leidner and Jarvenpaa, 1993; Bostrom *et al.*, 1988), by adapting the experiential learning model to a modern ERP system learning environment and on the educational literature on instructional design (Rothwell and Kazanas, 1998). Thus, it provides an initial working experimental model to examine instructional effectiveness of using ERP systems to enhance business education/IS. In addition, the study explores whether the various moderator variables (i.e. attitude, experience, etc.) differentially affect instructional effectiveness.

The results of this study provides evidence that the teaching of business process topics to undergraduate college students can be done effectively with hands-on when it is used as a supplement tool, or as effective as simulated hands-on. Furthermore, one concludes that the hands-on experience group performed as well as the simulated hands-on and control groups. Thus, with respect to performance, self-efficacy, and satisfaction, the value-add associated with the use of the ERP system could not be measured by our instrument.

The information collected in this study can be used to build a body of student-learning process knowledge in the context of operational decision making involving manufacturing planning and execution while utilizing an ERP system. 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/skills and help overcome particular misconceptions about the role of information technology on the modern process-centered organization?". For example, what kind of hands-on ERP system exercises work best in developing the idea of a business process and ERP systems concepts such as distributed client/server systems, business process reengineering, and supply chain management? 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.

Limitations and future research

Limitations

Previous educational studies provide evidence of the power of providing conceptual models or organizing constructs to assist in student learning (Sein and Bostrom, 1989; Santhanam and Sein, 1994). 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 in 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 that it did not consider 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.

A preliminary field experiment 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:

- all subjects were given similar set of activities to perform (reading/writing exercises);
- pre-test and post-test measures as well as selection of significant levels were established;
- 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
- a multiple-choice test was developed to measure performance.

The test was provided to information systems faculty knowledgeable of the domain (manufacturing planning and execution and ERP systems) 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 ANOVA 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.

Future research

The accelerated use of ERP systems 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

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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 ERP systems 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 an ERP system?".

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.

Longitudinal studies should be conducted to investigate the learning process and user-behavior when utilizing an ERP 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 improve 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 an ERP 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 an ERP system lead to higher levels of learning or knowledge than some other instructional method?
(2) What practices within the use of an ERP 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 an ERP 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 an ERP system lead to the highest learning levels. It is known that many faculty involved in university alliance programs utilize the ERP 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 business processes and ERP 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 ERP systems.

References

Alavi, M. (1994), "Computer-mediated collaborative learning: an empirical evaluation", *MIS Quarterly*, Vol. 18, pp. 159-74.
Alavi, M., Wheeler, B.C. and Valacich, J.S. (1995), "Using IT to reengineer business education: an exploratory investigation of collaborative telelearning", *MIS Quarterly*, Vol. 19 No. 3, pp. 293-312.
Allinson, C.W. and Hayes, J. (1988), "The learning styles questionnaire: an alternative to Kolb's inventory?", *Journal of Management Studies*, Vol. 25 No. 3, pp. 269-81.
Atkinson, G. (1991), "Kolb's learning style inventory: a practitioner's perspective", *Measurement and*

Evaluation in Counseling and Development, Vol. 23, pp. 149-61.

Bandura, A. (1977), "Self-efficacy: toward a unifying theory of behavior change", *Psychology Review*, Vol. 84, pp. 191-215.

Bandura, A. (1986), *Social Foundation for Thought and Action*, Prentice-Hall, Englewood Cliffs, NJ.

Bandura, A. and Cervone, D. (1986), "Differential engagement of self-reactive influences in cognitive motivation", *Organizational Behavior and Human Decision Processes*, Vol. 38 No. 1, pp. 92-113.

Borgman, C. (1986), "The user's mental model of an information retrieval system: an experiment on a prototype online catalog", *International Journal Man-Machine Studies*, Vol. 24, pp. 47-64.

Bostrom, R.P., Olfman, L. and Sein, M.K. (1990), "The importance of learning style in end-user training", *MIS Quarterly*, Vol. 14 No. 1, pp. 101-19.

Bostrom, R.P., Olfman, L. and Sein, M.K. (1988), "End user computing: a framework to investigate the training/learning process", in Carey, J.M. (Ed.), *Human Factors in Management Information Systems*, Ablex Publishing Corporation, Norwood, NJ.

Bostrom, R.P., Olfman, L. and Sein, M.K. (1993), "Learning styles and end-user training: a first step", *MIS Quarterly*, Vol. 17, pp. 118-20.

Bowman, B.J., Grupe, F.H. and Simkin, M.G. (1995), "Teaching end-user applications with computer-based training: theory and an empirical investigation", *Journal of End-User Computing*, Vol. 7, pp. 12-18.

Carroll, J.R., Smith-Kerker, P.L., Ford, J.R. and Mazur-Rimetz, S.A.(1987), "The minimal manual", *Human-Computer Interaction*, Vol. 3 No. 2, pp. 123-53.

Cohen, J. (1988), *Statistical Power Analysis of the Behavioral Sciences*, Lawrence Erlbaum Associates, Hillsdale, NJ.

Compeau, D.R. and Higgins, C.A. (1995), "Application of social cognitive theory to training for computer skills", *Information Systems Research*, Vol. 6 No. 2, pp. 118-43.

Compeau, D.R. and Higgins, C.A. (1995), "Computer self-efficacy: development of a measure and initial test", *MIS Quarterly*, Vol. 19 No. 2, pp. 189-211.

Cronan, T.P. and Douglas, D.E. (1990), "End-user training and computing effectiveness in public agencies: an empirical study", *Journal of Management Information Systems*, Vol. 6 No. 4, pp. 21-39.

Cronbach, L.J. (1951), "Coefficient alpha and the internal consistency of tests", *Psychometrika*, Vol. 16, pp. 297-334.

Czaja, S.J., Hammond, K., Blascovich, J.J. and Swede, H. (1989), "Age related differences in learning to use a text-editing system", *Behavior and Information Technology*, Vol. 8, pp. 309-19.

Davenport, T.H. and Short, J.E. (1990), "The new industrial engineering: information technology and business process redesign", *Sloan Management Review*, Vol. 31 No. 4, pp. 11-27.

Doll, W.J. and Torkzadeh, G. (1988), "The measurement of end-user computing satisfaction", *MIS Quarterly*, pp. 258-74.

Duchastel, P. (1986), "Intelligent computer-assisted instructional systems: the nature of learner control", *Journal of Educational Computing Research*, Vol. 2 No. 3, pp. 373-93.

Farmer, D.F. (1987), "Good managers are hard to find", *ComputerWorld*, Vol. 21 No. 27, p. 70.

Gable, G., Heever, R., Scott, J. and Erlank, S. (1997), "Large packaged software: the need for research", *Proceedings of the 3rd Pacific Asia Conference of Information Systems, Brisbane*, pp. 381-8.

Gattiker, U. (1992), "Computer skills acquisition: a review and future directions for research", *Journal of Management*, Vol. 18, pp. 547-74.

Gattiker, U., and Paulson, D. (1987), "The quest for effective teaching methods: achieving computer literacy for end-users", *Information Systems and Operations Research*, Vol. 25 No. 3, pp. 256-71.

Gilroy, F.D. and Desai, H.B. (1986), "Computer anxiety: sex, race, and age", *International Journal of Man-Machine Studies*, Vol. 25, pp. 711-19.

Hammer, M. (1990), "Reengineering work: don't automate, obliterate", *Harvard Business Review*, Vol. 68 No. 4, pp. 104-12.

Hammer, M. (1996), *Beyond Reengineering: How the Process-Centered Organization is Changing Our Work and Our Lives*, Harper Business, New York, NY.

Hill, T., Smith N.D. and Mann, M.F. (1987), "Role of self-efficacy expectations in predicting the decision to use advanced technologies: the case of computers", *Journal of Applied Psychology*, Vol. 72 No. 2, pp. 307-13.

Horgan, B. (1998), "Faculty, instruction, and information technology", *The Technology Source*, World Wide Web, available at: http://horizon.unc.edu/TS/development/1998-0808.asp (accessed 6 April 1999).

Ives, B., Olson, M.H. and Baroudi, J.J. (1983), "The measurement of user information satisfaction", *Communications of the ACM*, Vol. 26 No. 10, pp. 785-93.

Jarvenpaa, S.L. and Dickson, G. (1985), "Methodological issues in experimental IS research: experiences and recommendations", *MIS Quarterly*, Vol. 9 No. 2, pp. 141-56.

Jegede, O.J., Walkington, J. and Naidu, S. (1995), "An investigation into students' disposition to the use of objectives in distance learning materials", *Educational Research*, Vol. 37 No. 3, pp. 293-304.

Kinzie, M.B., Delcourt, A.B. and Powers, S.M. (1994), "Computer technologies: attitudes and self-efficacy across undergraduate disciplines", *Research in Higher Education*, Vol. 35 No. 6, pp. 745-68.

Kolb, D.A. (1984), *Experimental Learning: Experience as The Source of Learning and Development*, Prentice-Hall, Englewood Cliffs, NJ.

Kolb, D.A. (1985), *Learning Style Inventory Technical Manual*, McBer & Co., Boston, MA.

Kolb, D.A., Rubin, I.M. and McIntyre, J.M. (1974), "Learning and problem solving: on the management and learning process", in Simon, H.A. (Ed.), *Organizational Psychology: A Book of Readings*, Prentice-Hall, Englewood Cliffs, NJ.

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Kulik, J.A., Kulik, C.C. and Cohen, P.A. (1980), "Effectiveness of computer-based college teaching: a meta-analysis of findings", *Review of Educational Research*, Vol. 50 No. 4, pp. 525-44.

Lambert, M.E. and Lenthall, G. (1989), "Effects of psychology courseware use on computer anxiety in students", *Computers in Human Behavior*, Vol. 5, pp. 207-14.

Lazonder, A.W. and Van Der Meij, H. (1993), "The minimal manual: is less really more?", *International Journal of Man-Machine Studies*, Vol. 39, pp. 729-52.

Lee, D.M.S., Trauth, E.M. and Farwell, D. (1995), "Critical skills and knowledge requirements of IS professionals: a joint academic/industry investigation", *MIS Quarterly*, Vol. 19 No. 3, pp. 313-40.

Leidner, D.E. and Jarvenpaa, S.L. (1993), "The information age confronts education: case studies on electronic classrooms", *Information Systems Research*, Vol. 4 No. 1, pp. 24-54.

Leidner, D.E. and Jarvenpaa, S.L. (1995) "The use of information to enhance management school education: a theoretical view", *MIS Quarterly*, Vol. 19 No. 3, pp. 265-91.

Lengnick-Hall, C.A. and Sanders, M.M. (1997), "Designing effective learning systems for management education: student roles, requisite variety, and practicing what we teach", *The Academy of Management Journal*, Vol. 40 No. 6, pp. 1334-68.

Nelson, R.R. (1991), "Educational needs as perceived by IS and end-user personnel: a survey of knowledge and skill requirements", *MIS Quarterly*, Vol. 15 No. 4, pp. 503-25.

Neter, J., Wasserman, W. and Kutner, M.H. (1990), *Applied Linear Statistical Models*, 3rd ed., Richard D. Irwin, Homewood, IL.

Niemiec, R. and Walberg, H.J. (1987), "Comparative effect of computer-assisted instruction: a synthesis of review", *Journal of Educational Computing Research*, Vol. 3 No. 1, pp. 19-37.

Rothwell, W.J. and Kazanas, H.C. (1998), *Mastering the Instructional Design Process*, 2nd ed., Jossey-Bass, San Francisco, CA.

Ruble, T.L. and Stout, D.E. (1993), "Learning styles and end-user training: an unwanted leap of faith", *MIS Quarterly*, Vol. 17, pp. 115-18.

Sankar, C.S., Ford, N.F. and Terase, N. (1997), "Impact of videoconferencing in teaching an introductory MIS course", *Journal of Educational Technology Systems*, Vol. 26 No. 1, pp. 67-85.

Santhanam, R. and Sein, M. (1994), "Improving end-user proficiency: effects of conceptual training and nature of interaction", *Information Systems Research*, Vol. 5 No. 4, pp. 378-99.

Sein, M.K. and Bostrom, R.P. (1989), "Individual differences and conceptual models in training novice users", *Human-Computer Interaction*, Vol. 4, pp. 197-229.

Sein, M.K. and Robey, D. (1991), "Learning style and the efficacy of computer training methods", *Perceptual and Motor Skills*, Vol. 72, pp. 243-8.

Simon, S.J., Grover, V., Teng, J.T.C. and Whitcomb, K. (1996), "The relationship of information system training methods and cognitive ability to end-user satisfaction, comprehension, and skill transfer: a longitudinal field study", *Information Systems Research*, Vol. 7 No. 4, pp. 466-90.

Straub, D.W. (1989), "Validating instruments in MIS research", *MIS Quarterly*, pp. 147-70.

Sullivan-Trainor, M. (1988), "MIS stares at skills crunch", *ComputerWorld*, Vol. 22 No. 10, p. 1.

Todd, P. and Benbasat, I. (1987), "Process tracing methods in decision support systems research: exploring the black box", *MIS Quarterly*, Vol. 11, pp. 494-514.

Watson, E.F. and Schneider, H. (1999), "Using ERP systems in education", *Communication of the Association for Information Systems*, Vol. 1 No. 9.

White, M.J. and White, B.R. (1997), "The effect of using a computer authoring system on student achievement", *Journal of Business and Training Education*, Vol. 6, pp. 87-99.