# ERP Training Strategies: Conceptual Training And The Formation Of Accurate Mental Models


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## Abstract

Enterprise Resource Planning (ERP) systems are large, complex integrated software applications that often take years to implement. This study examined a major determinant of successful ERP implementation, end-user training. Specifically, this study advances research in the area of ERP software through examining end-user training strategies that may impact the effective use of these complex systems. The Sein, Bostrom, and Olfman [19] Hierarchical Knowledge-Level model is applied in an experiment to develop more effective ERP training strategies. The experiment was a non-equivalent quasi-experimental design involving two groups of approximately 35 senior business students: one group was given the introduction of ERP workflow concepts as an advance organizer (TCT Group); the other received traditional, procedurally-oriented (PT Group) ERP training over the same 5 week time period. A series of post-test measures were administered after each training treatment, and ten days after all treatments concluded. The study finds that a workflow conceptual advanced organizer strategy (TCT group) improves end-users' mental model accuracy over time as demonstrated by the subjects' ability to recall ERP specific concepts. Results indicate that a conceptual advance organizer is an important component of ERP training and should be incorporated into an organization's training strategy.




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## 1. INTRODUCTION

Enterprise Resource Planning (ERP) systems are complex integrated software applications that frequently take years to implement. Unfortunately, as noted in the popular press, a significant number of implementations fail, lacking the benefits expected upon "go-live." This study seeks to advance research in the area of ERP software through examining end-user training methods that may impact the effective use of these complex systems. Ultimately we seek to develop training strategies that can improve ERP system implementations.

The preponderance of training research serves as a basis for studying the effects of end-user training in ERP usage. The training literature has successfully examined training methods in an effort to determine elements that may enhance training results and subsequent performance. In 1999, Sein, Bostrom and Olfman, introduced a training strategy framework (Figure 1). This framework seeks to develop specific training approaches and methods to impart specific levels of knowledge ultimately into the end-user's mental model. In particular, given a tool, such as an ERP system, and a specific type of end-user, training methods can be developed to teach the levels of knowledge required to effectively understand and operate the tool.

As Figure 1 shows, training strategies should consider the types of trainees and IT tools on which to be trained (inputs). The training methods should be designed using these inputs with the goal of achieving high levels of knowledge (training outcomes). The general problem with IT training is that it is often focused on skills and procedures rather than a complete strategy considering the trainees and tools, and maximizing the levels of knowledge acquired by training [19]. This training strategy framework (Figure 1) seeks to offer a re-conceptualization of training as a means to offer a specific range of knowledge-levels, as summarized in Table 1, to maximize learning outcomes.

This study applies the training strategy framework to ERP training with the hope of improving training outcomes.[25]. Commercially available end-user training provided by the ERP vendors is typically classroom based; designed for a general audience; and focused on the interface, procedures to complete transactions, and sometimes tasks required to complete a business process (i.e., procurement) [25]. In terms of the knowledge-level outcomes (Table 1), typical ERP training focuses on a small portion of potential knowledge-levels (training outcomes), specifically: the syntax and semantics of the command-based knowledge-level; the combination of commands to complete tasks in the tool-procedural knowledge-level; and sometimes the application of tools to a given business process in the business-procedural level [14, 19, 25].

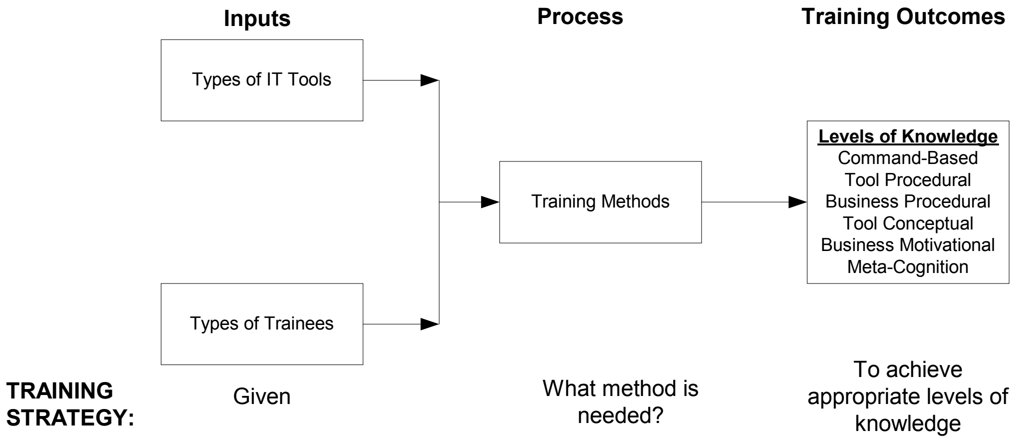


**Figure 1. Training strategy framework [19].**

**Table 1. Knowledge-Level Outcomes for Training (Adapted from Sein, Bostrom, and Olfman [19])**

| Knowledge Level | Focus | ERP System Focus |
|---|---|---|
| Command Based | Syntax and semantics | Learning the nuances of the system interface |
| Tool Procedural | Combining commands to complete tasks | Learning the steps to enter and recall transaction data |
| Business Procedural | Application of tool procedures to a task | Learning to complete an entire business process (i.e., procurement) |
| Tool Conceptual | The big picture of what to do with the tool | Understanding workflow of the whole process and the organizational impacts |
| Business Motivational | Reason to use | Business purpose of the system (i.e., integration, competitive necessity) |
| Meta-Cognition | Learning to learn | Continuous learning cycle- ways to approach learning the system |

This study leveraged Sein, Bostrom and Olfman's [19] training strategy framework to evaluate the end-user impact of existing ERP training methods versus a new training strategy that encompasses a broader range of knowledge-levels. As shown in Figure 2, this study provided one group of subjects with traditional ERP training covering the first three knowledge-levels (command-based, tool procedural, and business procedural), and the other group with a new training method that expanded the knowledge-levels to include tool conceptual training.

The specific research question surrounding end-users' learning of ERP software was investigated as follows:

Would end-users who received a tool conceptual advance organizer, as part of their ERP training, develop more accurate mental models over time when compared to those who received traditional ERP training?

In the following sections, the major constructs, their impacts and respective hypotheses related to the ERP study are discussed further.

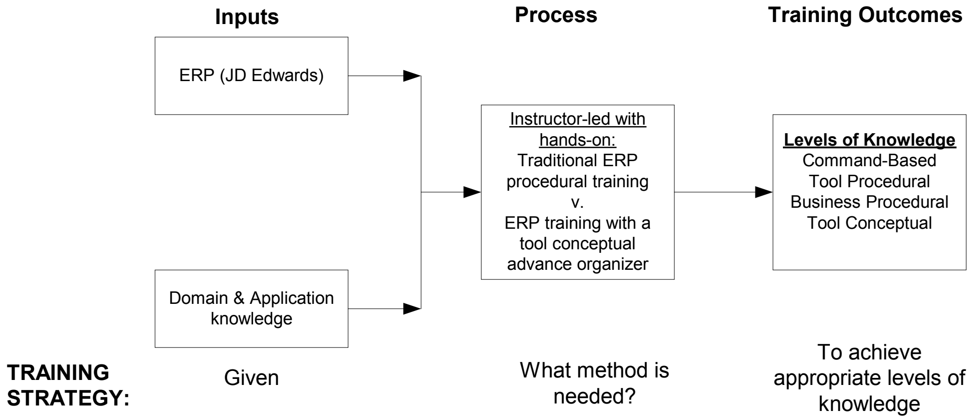


**Figure 2. ERP training strategy for this study (adapted from Sein, Bostrom, and Olfman [19])**

# 2. RESEARCH FRAMEWORK AND CONSTRUCTS

There is a preponderance of research surrounding end-user training and learning outcomes. The training and learning literature has examined many facets surrounding mental models, end-user knowledge and training strategies in an effort to determine elements that may enhance training results. This section examines mental models, the variables associated with Figure 1 (training strategy), and their applicability to the study at hand.

## 2.1 Mental Models

The concept of mental models has been a point of research within the field of cognitive psychology for many decades [11]. As a construct, mental models are a central element to this study because it examines how mental representations derived from end-users' application and domain knowledge, and training methods influence the successful use of an ERP system.

### *2.1.1 Mental Model Definition*

A definition of mental models developed by Wilson and Rutherford [26] incorporates research from many fields of study and provides a good overall definition of mental models:

> A mental model is a representation formed by a user of a system and/or task, based on previous experience as well as current observation, which provides most (if not all) of their subsequent system understanding and consequently dictates the level of task performance (p. 619).

An accurate mental model of the target system is an important component to any training research because it is the desired outcome of training [23]. Studies have found that end-users with accurate mental models, as measured by pre and post mental model transfer affect measures, do better quality work [4, 10], take less time to perform tasks [5, 16, 20], and produce a smaller variety of error types [1, 16]. Therefore, the study of the development of accurate mental models is important to this ERP training study because, as research suggests, end-user performance can be improved [5, 20]. Furthermore, the understanding of how appropriate ERP training strategies are linked to mental model accuracy can lead to improved implementations.

## 2.2 Training Strategies and Mental Models

As stated earlier in the definition of mental models, system understanding and prior knowledge are important elements that influence the formation of mental models [26]. Researchers have sought to determine effective training strategies to convey appropriate content, resulting in accurate mental models [15]. Of particular interest to this study is the effectiveness of traditional ERP procedural training in conveying system understanding and knowledge, as it is the most common ERP training technique. In terms of the training strategy framework, typical vendor-supplied ERP training focuses on three knowledge-levels: command-based, tool procedural, and business procedural. Procedural training is focused on carrying out tasks, the content often being a sequence of action steps [2]. By introducing procedural training to end-users, they may internalize the "how to" steps, creating a collection of rules in their mental model from which to draw upon [2, 12, 15, 17]. The end-user is left to abstract the conceptual understanding of the broader system from the procedures given [2]. However, given the complex, integrated nature of ERP systems, this method of training may be inappropriate. This study proposes that another training method, one that conveys more knowledge-levels, such as the addition of conceptual content, may be more suitable for ERP. As previously discussed, end-user understanding of the greater ERP system may provide for a more accurate mental model of the system as a whole, leading to more effective system usage.

Unlike an end-user mental model, a conceptual model is an external representation of a system. Norman [13] describes a conceptual model as a consistent and complete representation of a system to facilitate understanding or teaching. Training is the mechanism by which external representations (conceptual models) are introduced to end-users [13]. By introducing a conceptual model to end-users through training, they may internalize the conceptual models into their mental model, therefore updating and filling in experience and understanding gaps [6, 11, 13, 17, 18, 23]. Conceptual training uses metaphorical techniques to convey the workings of a system. This may take the form of describing the overall structure and integrated workflow of the system and instructing end-users on a new system by drawing analogies in terms of a system they are already familiar with (i.e., database software). In terms of the training strategy framework, this approach would increase the knowledge-levels of ERP training to add a tool conceptual component.

A competing theory suggests that procedural training and conceptual training lead to similar outcomes and that the learning styles of the subjects are often the stronger determinant of success [5, 15]. However, the existing research focuses on narrow applications, such as library database searches [5], e-mail [17], graphical interfaces [15], and database [22]. ERP systems contain elements of all the aforementioned applications *and* require business domain knowledge. The complex nature of ERP systems may be more suited to a training technique that draws upon elements of end-user's existing knowledge, rather than one that potentially requires the learning of hundreds of specific procedures and tasks. Therefore, those end-users exposed to the additional tool conceptual ERP training are expected to have more accurate mental models surrounding an ERP system than those receiving traditional procedural training.

An understanding of the relationship between training strategies and the development of accurate mental models is relevant to the investigation of factors that influence the use of ERP systems. Understanding training strategies and how they may impact the accuracy of mental models can lead to improved ERP training outcomes. Based on the literature, this study proposes that end-users receiving training in four knowledge-levels (command based, tool procedural, business procedural, tool conceptual training) are expected to have more accurate mental models over time when compared with those receiving training in three knowledge-levels (command based, tool procedural, business procedural).

# 3. METHOD

## 3.1 Research Design

A laboratory experiment using a nonequivalent quasi-experimental design was used in this study (see Figure 3). Two training treatment groups (procedural (PT) vs. tool conceptual (TCT)), one in each of two undergraduate classes, were used. A quasi-experimental design was chosen for the current study because it was not possible to randomly assign subjects to treatment groups. However, it was expected that subjects assigned to different treatment groups would be comparable because: 1) there is no reason to believe that subjects from various classrooms will differ on application knowledge, and 2) the treatments were randomly assigned to the classrooms [21].

Thus, one classroom of subjects was randomly assigned as a procedural treatment group ($X_i$ – PT), and the other to the tool conceptual treatment group ($Y_i$ - TCT). Training took place over a four-week period of eight class sessions. Each subject's mental model was assessed using a pre-test ($O_{m1}$) gathered prior to the experimental manipulation (training treatments). Immediately following each experimental treatment, the dependent variable (end-user mental model) was measured ($O_{m2}$-$O_{m5}$). Ten days after all treatments were completed, a final measurement of the dependent variable (end-user mental model) occurred ($O_{m6}$).

As noted above, the independent variable, the experimental manipulation of training, had two levels (procedural training and tool conceptual training). The dependent variable (end-user mental model) was a continuous measure.

## 3.2 Hypotheses

### *3.2.1 Proposition*

**End-users receiving training in four knowledge-levels (command based, tool procedural, business procedural, tool conceptual training) are expected to have more accurate mental models over time when compared with those receiving training in three knowledge-levels (command based, tool procedural, business procedural).**

H1: The mean scores on the mental model post-tests starting in session 2 ($O_{m3}$, $O_{m4}$, $O_{m5}$) will be higher for end-users who received TCT than those who received PT.

H2: The mean scores on the mental model test after all treatments ($O_{m6}$) will be higher for end-users who received TCT than those who received PT.

| | Week 1 | | Week 2 | | Week 3 | | Week 4 | | |
|---|---|---|---|---|---|---|---|---|---|
| Before | $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $S_7$ | $S_8$ | After |
| $O_{m1}$ | $X_1$ $O_{m2}$ | $X_2$ $O_{m3}$ | $X_3$ $O_{m4}$ | $X_4$ ... | | | | $O_{m5}$ | $O_{m6}$ |
| $O_{m1}$ | $X_1$ $O_{m2}$ | $Y_1$ $O_{m5a}$ | $Y_2$ $O_{m3}$ | $Y_3$ $O_{m4}$ | $Y_4$ ... | | | $O_{m5b}$ | $O_{m6}$ |

where
$O_{mi}$ = Mental model assessments (measures $_a$ & $_b$ are the same test taken at different times)
$S_i$ = Session

Procedural Training ($X_i$) Treatment
$X_1$ = Command Based Training
$X_2$ = Tool Procedural Training
$X_3$ = Business Procedural Training
$X_4$ = Tool/Business Procedural (complete workflow: $S_4$ - $S_8$)

Tool Conceptual Training ($Y_i$) Treatment
$Y_1$ = Tool Conceptual Training (workflow concept)
$Y_2$ = Tool Procedural Training
$Y_3$ = Business Procedural Training
$Y_4$= Tool/Business Procedural (complete workflow: $S_5$ - $S_8$)

**Figure 3. Research design.**

## 3.3 Subjects

A total of 77 subjects participated in this study. The subjects were senior undergraduate business students from a state university. Data was gathered during two separate class sections of a senior-level information management course; each class section receiving different treatments (PT and TCT). Subjects were advised of the research prior to its beginning. They were identified for the purpose of grading, but their responses for the study were not associated with identifying information. Subjects were also advised of course section differences and not to work with others. During treatments the subjects were allowed to take notes, but not to share them nor use them during mental model measurements ($O_{m2}$-$O_{m6}$). All subjects signed an "honor code" that stated the above controls.

## 3.4 Procedure

The study involved training students on an ERP application (J.D. Edwards® OneWorld® demo version). The training was included as part of the class syllabus. The key difference was that one course section (the TCT group) was treated with a tool conceptual advance organizer about the system; the other section (the PT group) was not. The PT group received training as if they had gone to a commercially available ERP training center. The TCT group also included similar procedural training, with the addition of a tool conceptual advanced organizer. Both groups were treated with five weeks of training, and an equalizing session was conducted at the end. The training sessions and content are summarized in Table 2.

**Table 2. Summary of Treatment Content and Hours for PT and TCT groups**

| | PT ($X_i$) | | TCT ($Y_i$) | |
|---|---|---|---|---|
| | Treatment | Hours/Classes | Treatment | Hours/Classes |
| **Command-Based** | Intro to OneWorld; navigation | 2/1 | Intro to OneWorld; navigation | 2/1 |
| **Tool Conceptual** | | | System integration and workflow concepts | 2/1 |
| **Tool Procedural** | Data entry; choosing records; creating records | 2/1 | Data entry; choosing records; creating records; "Integration/Data Entry relations" | 2/1 |
| **Business Procedural** | Advanced record location; reports; work with customer records | 2/1 | Advanced record location; reports; work with customer records; "workflow" | 2/1 |
| **Tool/Business Procedural** | Procure to pay: A/P, distribution, inventory | 10/5 | Procure to pay: A/P, distribution, inventory; "Workflow references" | 8/4 |

Both treatment groups (PT and TCT) were only permitted to ask questions related to the ERP interface and the specific procedures. Treatments occurred immediately prior to the administration of the mental model measures (with the exception of $O_{m6}$) so as to avoid time-lapse effects.

Following each treatment, a teach-back short answer test was given to assess the accuracy of a subject's mental model.

Both course sections were taught by the same trainer, over the same five week period. The trainer, who was one of the authors, was experienced with the target software and ERP application training. To reduce the risk of experimenter expectancy, the training sessions were scripted to mimic content found in commercially available training. As stated earlier, the trainer also limited the responses to questions directly related to the material.

J.D. Edwards OneWorld demo version is commonly used by software vendors for training purposes. This version is a fully functional ERP system including demo data consisting of a bicycle manufacturing operation. The demo data was refreshed after each class to reduce cross-contamination between course sections and to ensure a consistent software environment.

## 3.5 Measures

The measures and variables are summarized in Table 3.

### *3.5.1 Control Variables and Measures*

Preliminary Quiz: The purpose of the preliminary quiz was to provide a mental model equivalency test of the treatment groups ($O_{m1}$). The measure was developed by the author following question formats similar to those used in previous studies (e.g., Shayo [21]).

#### *3.5.1.1 Dependent Variables and Measures*

Mental model was assessed using a "teach-back" short answer quiz. With the "teach-back" instruments ($O_{m2}$-$O_{m6}$), participants were asked four questions to explain operations and concepts surrounding the target software (ERP) as if they were teaching it to someone who had not worked with the system before.

**Table 3. Variables and Measures**

| Variable Type | Variable Name | Measures of Variable | Measurement Method | Scoring |
|---|---|---|---|---|
| **Dependent Variable:** | End-user Mental Model | Mental model accuracy | Teach-back quiz. | Teach Back: score range 4 to 28 |
| **Independent Variable:** | Training | Treatment of traditional ERP procedural training OR ERP training with a tool conceptual advance organizer | Non-equivalent groups were treated with either PT or TCT | |

Content analysis similar to that of Shayo and Olfman [22] was used to code participants' answers to determine the extent of their mental model development surrounding the ERP. Inter-rater reliability was assessed by two independent raters (the experimenter and a faculty member familiar with ERP systems) using a predetermined scoring criterion. Sampling 15% of the total of each instrument ($O_{m1}$ to $O_{m6}$), the level of agreement between the raters was: 90% for $O_{m1}$, 93% for $O_{m2}$, 93% for $O_{m3}$, 95% for $O_{m5a}$, 93% for $O_{m4}$, 97% for $O_{m5/5b}$, and 96% for $O_{m6}$. Disagreements between raters were resolved by: 1) the first rater (trainer) reviewing the subject response; and 2) re-scoring or confirming the original score. Maximum possible score for a teach-back instrument was 28 (7 points for each response) and the minimum 4 (1 point for each response).

#### *3.5.1.2 Independent Variables and Measures*

Training was conducted for the PT and TCT groups via a combination of instructor-led lecture (using Microsoft® PowerPoint®) and hands-on exercises. The treatments for both groups started with the same command-based overview of the user interface ($X_1$). As described below, the two groups received different treatments.

PT group sessions $S_2$ and $S_3$ consisted of tool-procedural ($X_2$) and business procedural ($X_3$) treatments (see Figure 3). The tool procedural treatment ($X_2$) featured procedural steps for the data entry and recall of address book records. These techniques included query-by-example (QBE) record lookup and proper steps for entering information. The business procedural ($X_3$) treatment featured procedural steps for locating report data and expansion of address book information required for other modules. The final treatment ($X_4$) was built over five sessions ($S_4$-$S_8$). This treatment covered the procedures and tasks required to complete an entire procurement of inventory items including: supplier address book, purchase order details, receiving, and voucher payment.

TCT group session $S_2$ consisted of a tool conceptual advanced organizer ($Y_1$). Topics included business process workflow (using a procurement example) and ERP system integration. Sessions $S_3$

and $S_4$ consisted of tool-procedural ($Y_2$) and business procedural ($Y_3$) treatments similar to PT group sessions $X_2$ and $X_3$. However, the TCT $Y_2$ and $Y_3$ sessions drew upon analogies to other database products (MS Access) to facilitate understanding of the QBE procedures. The final treatment ($Y_4$) was built over the four remaining sessions ($S_5$-$S_8$). Similar to the PT group, this treatment covered the procedures and tasks required to complete an entire procurement process. TCT group treatments also included examples relating back to the tool conceptual advance organizer ($Y_1$).

## 3.6 Data Analyses

All analyses were conducted using SPSS v11 using an alpha level of .05 ($p<.05$).

For the hypotheses, one-way ANCOVA's were run to determine mean score differences between the TCT and PT groups, using $O_{m1}$ as a covariate.

# 4. RESULTS

## 4.1 Overview of the Analyses

Correlations were used as a preliminary analysis to investigate the relations between mental model measures and training groups. To reduce the number of analyses to be conducted, only those measures of the dependent variable (mental model measures) that are significantly related to the independent variable (training groups) were included in subsequent analyses.

The results presented follow the general order of the hypotheses. All analyses used ANCOVA designs where the covariate was a preliminary measure of a subject's mental model ($O_{m1}$). The sample size (N) for each treatment sample is also given as subject population varied slightly between treatments.

All data were screened to identify univariate outliers. One outlier (more than 3 standard deviations from the mean) was winsorized[13] to the closest score within the normal range (from 16 to 15). Reliability analyses for each of the teach-back measures were: $O_{m1}$ = 0.69, $O_{m2}$ = 0.71, $O_{m3}$ = 0.84, $O_{m5a}$ = 0.76, $O_{m4}$ = 0.78, $O_{m5b}$ = 0.71, $O_{m6}$ = 0.82.

The means, standard deviations and significance for all variables are presented in Table 4. Table 5 shows correlations used to determine those measures that were significantly related to the independent variables (PT and TCT group) or the covariate ($O_{m1}$).

### *4.1.1 Preliminary Analyses*

Prior to all analyses, data were screened to meet homogeneity of variance requirements for ANCOVA [24]. The overall analysis procedures are summarized in Table 6. Results are summarized in Table 7.

#### *4.1.1.1 Hypothesis 1 (H1)*

A one-way ANCOVA was used with PT and TCT groups as the independent variables, mental model measures ($O_{m3}$ and $O_{m4}$) as the dependent variables, and $O_{m1}$ as the covariate. Analyses were run using only $O_{m3}$ and $O_{m4}$ as they showed significant correlations (see Table 5).

$\underline{O}_{m3}$: The first ANCOVA was performed to determine significant differences between PT (N = 31) and TCT (N = 44) groups using $O_{m3}$ (teach-back) as the dependent variable and $O_{m1}$ as the covariate ($F_{1, 72}$ = 27.56, p = .000).

[13] Winsorizing data is an established statistical technique that involves resetting extreme observations to less extreme values, usually a selected percentile at both tails[9].

**Table 4. Means, Standard Deviations and Significance for Subject Groups**

| | PT Group (*N*=32) | | TCT Group (*N*=45) | | Whole Sample (*N*=77) | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Teach-Back Scores | | | | | | |
| $O_{m1}$ | 7.09 | 3.11 | 6.35 | 2.46 | 6.66 | 2.75 |
| $O_{m2}$ | 8.94 | 2.83 | 8.16 | 2.32 | 8.48 | 2.55 |
| $O_{m3}$ | ***12.87*** | ***3.16*** | ***14.86*** | ***4.63*** | 14.04 | 4.18 |
| $O_{m5a}$ | | | 11.64 | 3.30 | 11.64 | 3.30 |
| $O_{m4}$ | ***12.69*** | ***3.11*** | ***15.68*** | ***4.39*** | 14.42 | 4.15 |
| $O_{m5b}$ | 20.00 | 3.61 | 20.49 | 4.73 | 20.29 | 4.28 |
| $O_{m6}$ | ***17.50*** | ***4.44*** | ***20.07*** | ***6.09*** | 18.99 | 5.57 |

*Note*:

**Bold** denotes p < .05; ***italic bold*** denotes p < .01.

**Table 5. Significant Correlations: Mental Model Measures and Independent Variables**

| | Group[a] |
|---|---|
| Teach-Back Scores | |
| $O_{m1}$ | |
| $O_{m2}$ | |
| $O_{m3}$ | 0.24 |
| $O_{m5a}$ | |
| $O_{m4}$ | ***0.36*** |
| $O_{m5b}$ | |
| $O_{m6}$ | 0.23 |

*Note*:

***Italic bold*** denotes p < .01.

This analysis revealed a significant difference between the PT and TCT groups ($F_{1, 72}$ = 9.73, p = .003, effect size (eta square) = .119, observed power .868). Resulting mean score differences showed the TCT group (mean = 14.86, adjusted mean = 15.11) had higher mean scores than the PT group (mean = 12.87, adjusted mean = 12.52). With this mental model observation ($O_{m3}$), the hypothesis is confirmed.

$O_{m4}$: An ANCOVA was performed to determine significant differences between PT (N = 32) and TCT (N = 44) groups using $O_{m4}$ (teach-back) as the dependent variable and $O_{m1}$ as the covariate ($F_{1, 73}$ = 8.70, p = .004). This analysis revealed a significant difference between the PT and TCT groups ($F_{1,73}$ = 14.61, p = .000, effect size (eta square) = .167, observed power .965). The results indicate that the TCT group (mean = 15.68, adjusted mean = 15.82) had higher mean scores than the PT group (mean = 12.69, adjusted mean = 12.49). With $O_{m4}$, the hypothesis is also confirmed.

#### *4.1.1.2 Hypothesis 2 (H2)*

$O_{m6}$: A one-way ANCOVA was used with PT (N = 32) and TCT (N = 44) groups as the independent variable, mental model measure $O_{m6}$ teach-back (r = .23) as the dependent variable, and $O_{m1}$ as the covariate ($F_{1, 73}$ = 27.17, p = .000).

**Table 6. Hypotheses Analyses**

| Main Effect Hypothesis | Variables | Analysis |
|---|---|---|
| 1. The mean scores on the mental model post-tests starting in session 2 ($O_{m3}$, $O_{m4}$, $O_{m5}$) will be higher for end-users who received TCT than those who received PT. | IV: Groups (TCT, PT); DV: Mental Model measures ($O_{m3}$, $O_{m4}$, $O_{m5}$) | One-way ANCOVA with $O_{m1}$ as the covariate |
| 2. The mean scores on the mental model test after all treatments ($O_{m6}$) will be higher for end-users who received TCT than those who received PT. | IV: Groups (TCT, PT); DV: Mental Model measure ($O_{m6}$) | One-way ANCOVA with $O_{m1}$ as the covariate |

**Table 7. Hypothesis Results**

| Hypothesis | Instrument | F | df | P | eta | power | Reject / Confirm |
|---|---|---|---|---|---|---|---|
| 1. | $O_{m3}$ | 9.73 | 1, 72 | 0.00 | 0.12 | 0.87 | Confirm |
| | *$O_{m1}$ Covariate* | *27.56* | *1, 72* | *0.00* | *0.27* | *0.99* | |
| | $O_{m4}$ | 14.61 | 1, 73 | 0.00 | 0.17 | 0.97 | Confirm |
| | *$O_{m1}$ Covariate* | *8.70* | *1, 73* | *0.00* | *0.11* | *0.83* | |
| 2. | $O_{m6}$ Teach-back | 9.71 | 1, 73 | 0.00 | 0.12 | 0.87 | Confirm |
| | *$O_{m1}$ Covariate* | *27.17* | *1, 73* | *0.00* | *0.27* | *0.99* | |

This analysis revealed a significant difference between the PT and TCT groups ($F_{1, 73} = 9.71$, $p = .003$, effect size (eta square) = .117, observed power .868). Resulting mean score differences, with $O_{m1}$ as the covariate showed the TCT group (mean = 20.07, adjusted mean = 20.43) had higher mean scores than the PT group (mean = 17.50, adjusted mean = 17). For $O_{m6}$, the hypothesis is confirmed; the TCT group showed a significantly higher score after all training tasks than the PT group.

## 5. DISCUSSION

The study proposed that end-users receiving training in four knowledge-levels (command based, tool procedural, business procedural, tool conceptual training) are expected to have more accurate mental models over time when compared with those receiving training in three knowledge-levels (command based, tool procedural, business procedural).

Most subjects came into the study with little knowledge of ERP software. Scores on the $O_{m1}$ pretest averaged around 30 percent. By the end of the ERP training session, scores on $O_{m6}$ averaged around 70 percent.

Overall mental model scores increased for both training groups (PT and TCT). Significant differences were found with most of the instruments. Specifically, in support of Hypothesis 1, $O_{m3}$ and $O_{m4}$ measures reveal that subjects in the TCT group demonstrated a significantly more accurate mental model than subjects in the PT group. In support of hypothesis 2, $O_{m6}$ revealed similarly significant results.

The teach-back measures attempt to model real-world training expectations. Specifically, when companies train their staff for an ERP implementation, it is costly and unfeasible to send everyone. Rather, companies typically send a select group of individuals to training with the expectation that they will train others when they return [7]. The teach-back method focuses on subjects' ability to recall information from their mental model and communicate it in their own words (e.g., $O_{m2}$, question 2 "How would you describe the workings of ERP (i.e. J.D. Edwards OneWorld) to her/him?"). Therefore, assessing subjects' ability to recall and communicate information they have learned is an important trait, as the subjects will make use of it when they are expected to train others. Any training method that leverages this skill is important for improving ERP training strategies.

With respect to hypotheses 1 and 2, TCT subjects showed significantly higher levels of mental model accuracy. In other words, end-users are able to describe system concepts more effectively having had the TCT training; the only exception being the $O_{m5/5b}$ teach-back measure. $O_{m5/5b}$ was taken four sessions after $O_{m4}$ for the TCT group and five sessions after $O_{m4}$ for the PT group (approximately two weeks). The time taken to train and the quantity of material presented appear to have equalized the groups' mental model accuracy with the teach-back (recall) measure. However, ten days after the $O_{m5/5b}$ measure, and no further training, $O_{m6}$ re-confirmed the previous significant findings of $O_{m3}$ and $O_{m4}$.

One explanation for the difference between the $O_{m5/5b}$ and $O_{m6}$ results could be the complexity of the questions. Business procurement operations were the focus throughout the sessions leading up to $O_{m5/5b}$. Questions in measure $O_{m5/5b}$ focused on the procurement process that had been learned over two weeks. However, in $O_{m6}$, the measure asked questions related to the sales process. The objective of the $O_{m6}$ sales process questions was to test the strength of the subjects' learning as the sales process is a change in perspective (you are selling, versus buying) rather than a change in process. The $O_{m6}$ measure reveals that subjects in the TCT group had significantly higher mental model scores than the PT group. In other words, the TCT group appeared to have a deeper understanding than the PT group. Therefore, both groups were able to assimilate learning into their mental models over time as shown by $O_{m5/5b}$, however the type of training may impact the depth of that learning.

This result is consistent with mental model research involving computer applications [8]. Santhanam and Sein [17] use assimilation theory to describe mental model formation through the induction of new schema or knowledge structures. Specifically, assimilation theory describes learning in terms of three steps: 1) reception; 2) availability; and 3) activation [3]. Reception refers to a subject's willingness to learn and attend to the teachings. The availability step refers to the subject's existing knowledge or concepts that can be used to aid in the assimilation of information. Lastly, the activation step refers to the subject's ability to make connections between the new information and existing knowledge. Assimilation theory research suggests that in cases where pre-existing knowledge is unavailable within the subject's mental model, the introduction of conceptual information as an advance organizer can improve learning results [3, 8, 17]. In this study, as demonstrated by the subject's low scores on the initial mental model measure ($O_{m1}$), it is evident that they did not have strong pre-existing ERP knowledge available to them to aid in the assimilation process. The TCT group was explicitly taught ERP conceptual models whereas the PT group had to construct their own based on their minimal pre-existing understanding of ERP. It seems reasonable that the conceptual models that were taught to the TCT group improved the assimilation learning process by providing accurate information to be integrated into the subjects' mental models. The depth of learning for the TCT group was also improved as evidenced when the degree of far-transfer difficulty was increased in $O_{m6}$. The TCT group was able to draw upon their integrated mental models more effectively than the PT group.

# 6. CONCLUSION

## 6.1 Implications for ERP Training Strategies

This study was based on the Sein, Bostrom, and Olfman [19] training strategy framework. In general, the study supported the framework and found that by adding a tool conceptual knowledge-level to the training the end-users developed more accurate mental models. Specifically, it was found that conceptual training improves the end-user's ability to recall and articulate ERP concepts. By using the knowledge-level framework and incorporating tool conceptual knowledge into an organization's training design, organizations may see an improvement in overall ERP implementation results. For example, because ERP training is very expensive, those within an organization that attend ERP training are often asked to train others in the organization when they return. This study shows that adding a tool conceptual knowledge-level to their training improves their ability to recall and re-articulate their understanding of the system. By building the knowledge-levels that enable more effective understanding and communication of concepts learned could be an invaluable asset to any company's training and implementation strategy.

Time also plays a role in the success of ERP training strategies. In this study the training results became stronger as time progressed. Even ten days after no training was given, end-users who received conceptual training continued to evolve their mental models. This is not to say that lack of system use improves training, rather one could speculate that given time and practice after training, end-users can solidify their learning. This is often forgotten in the push to implement an ERP system. ERP, like other systems, requires time and practice to master.

## 6.2 Limitations

### *6.2.1 Internal Validity*

In general, the internal validity of this study is strong. The study had extremely low levels of mortality (2 subjects) and did not appear to suffer from maturation or instrumentation difficulties.

One threat to internal validity was experimenter expectancy. One of the authors was also the trainer, thereby having the power to influence results. To mitigate this risk, the training sessions were scripted based on actual training materials used in commercial training. The "trainer" only varied from the scripts to answer subject questions. Only questions directly related to the target system procedures were answered.

### *6.2.2 External Validity*

To improve external validity, the study was designed to replicate real world ERP training. Presentations, documentation and the actual ERP system were similar to those found in commercially available classes. The main threats to external validity are the timing, pace, and context of the training sessions.

In real world ERP training, end-users often travel to the training center and receive all their training over a short period of time. For example, a procurement class might be five straight days, eight hours per day. The training in the study occurred over five weeks, with two-hour sessions each time.

To mitigate this particular threat, the instructor attempted to mimic the proportion of hands-on and lecture time that the subjects would experience in typical training. After class practice sessions were limited so as to not allow subjects a disproportionate amount of practice time.

Another threat to external validity is the subject pool. This study was incorporated into a university course curriculum. The subjects are not necessarily representative of a true ERP training session. Specifically, the subjects had limited business experience and different motivations to participate than one may find in commercially available ERP training.

## 6.3 Directions for Future Research

This study provides some interesting insights into the difficult task of training end-users on complex applications. Future research should include an evaluation of hands-on learning. In this study the subjects were given a proportional amount of hands-on practice with the system, similar to what they would have in a commercially available ERP class. However, while the measures sought to assess their mental model accuracy, no attempts were made to evaluate the subject's ability to perform the tasks.

Prior research suggests that mental model accuracy leads to better performance as measured by time and errors [5, 16, 20]. Exploring hands-on results could provide some interesting findings pertaining to the accuracy of the mental models and training strategies. Specifically, this could enable evaluation of the appropriateness of prior hands-on performance research in different types of applications (Windows, database) and determine if those results are compatible with the complex ERP environment.

Overall this study provides a strong case for ERP vendors, implementers, and trainers to provide ERP conceptual training prior to the typical procedural training. A conceptual advance organizer provides a platform to develop further ERP understanding. Adapting conceptual models into ERP training strategies could improve the propagation of training and ultimately save an organization time and money.

# 7. REFERENCES


[1] Allwood, C. Learning and using text-editors and other application programs. in Falzon, P. ed. Cognitive ergonomics: Understanding, learning, and designing human computer interaction, Academic Press, New York, NY, 1990, 85-105.

[2] Anderson, J.R. A theory of human knowledge. Artificial Intelligence, 40. 313-351.

[3] Ausubel, D.P. Educational Psychology: A Cognitive View. Holt, Reinhart and Winston, New York, NY, 1968.

[4] Bayman, P. and Mayer, R.E. A diagnosis of beginning programmers misconceptions of BASIC programming statements. Communications of the ACM, 26. 677-679.

[5] Borgman, C. The user's mental model of an information retrieval system: An experiment on prototype online retrieval catalog. International Journal of Man-Machine Studies, 10. 625-637.

[6] Bostrom, R.P., Olfman, L. and Sein, M.K. The importance of learning style in end-user training. MIS Quarterly, 14 (1). 101-119.

[7] Davenport, T.H. Mission critical: Realizing the promise of Enterprise Systems. Harvard Business School Press, Boston, MA, 2001.

[8] Davis, S.A. and Bostrom, R.P. Training end users: An experimental investigation of the roles of computer interface and training methods. MIS Quarterly, 17 (1). 61-85.

[9] Dixon, W.J. and Tukey, J.W. Approximate behavior of the distribution of winsorized t (Trimming/Winsorization 2). Technometrics (10). 83-98.

[10] Gist, M.E., Schwoerer, C. and Rosen, B. Effects of alternative training methods on self-efficacy and performance in computer software training. Journal of Applied Psychology, 74 (6). 884-891.

[11] Johnson-Laird, P.N. Mental models: Towards a cognitive science of language, inference, and consciousness. Harvard University Press, Cambridge, MA, 1983.

[12] Kieras, D.E. and Polson, P.G. An approach to the formal analysis of user complexity. International Journal of Man-Machine Studies, 22. 365-394.

[13] Norman, D.A. Some observations on mental models. in Gentner, D. and Stevens, A.L. eds. Mental Models, Lawrence Erlbaum Associates, Hillsdale, NJ, 1983, 15-35.

[14] Olfman, L., Bostrom, R.P. and Sein, M.K., Training with a business focus: A best practice. in Bitworld 2001, (2001).

[15] Olfman, L. and Mandviwalla, M. Conceptual versus procedural software training for graphical user interfaces: A longitudinal field experiment. MIS Quarterly, December. 405-426.

[16] Panko, R.R. and Sprague, R. Experiments in spreadsheet development: Task difficulty, level of expertise, and error rate Manuscript in preparation, http://www/cba.hawaii.edu/panko/papers//ss/Imexpert.htm, 1997.

[17] Santhanam, R. and Sein, M.K. Improving end-user proficiency: Effects of conceptual training and nature of interaction. Information Systems Research, 5 (4). 378-399.

[18] Sein, M.K. and Bostrom, R.P. Individual Differences and Conceptual Models in Training Novice End-Users. Human Computer Interaction, 4 (3). 197-229.

[19] Sein, M.K., Bostrom, R.P. and Olfman, L. Rethinking end-user training strategy: Applying a hierarchical knowledge-level model. Journal of End User Computing, 11 (1). 32-39.

[20] Sein, M.K., Bostrom, R.P. and Olfman, L. Training end users to compute: cognitive, motivational and social issues. INFOR, 25. 236-255.

[21] Shayo, C. Role of conceptual and mental models in motivating end users to learn new but related software packages Information Science, Claremont Graduate School, Claremont ,CA, 1995, 419.

[22] Shayo, C. and Olfman, L. The role of training in preparing end users to learn related software. Journal of End User Computing, 12 (1). 3-13.

[23] Staggers, N. and Norcio, A.F. Mental models: Concepts for human-computer interaction research. International Journal of Man-Machine Studies, 38. 587-605.

[24] Tabachnick, B.G. and Fidell, L.S. Using Multivariate Statistics. Harper Collins, New York, NY, 1989.

[25] Wheatley, M. ERP training stinks CIO, 2000.

[26] Wilson, J.R. and Rutherford, A. Mental models: Theory and application in human factors. Human Factors, 31 (6). 617-634.

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