End User IT Training Outcomes – The Role of Application Interfaces and Training Approaches

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Abstract

Prior research into the question of how to train end users reveals an important lesson. To provide insights, researchers must study training approaches and their influence on end user learning preference styles. Further, the impact of application software needs to be investigated. The experiment reported here illustrates this lesson. The end user training outcomes are measured in terms of efficiency and effectiveness. The end users who participated in this study were first year tertiary students learning to use a project management software application. Results indicate that icon interfaces lead to the usage of minimal set of keystrokes and menu interfaces lead to higher scores in completing a task. In addition to this, the level of knowledge helps to determine the choice of keystrokes.

Keywords: End User Training, Computer Interface, Learning, Learning Preference Styles.

MISQ: IB03; IB0301; IB0301.01

Introduction

IT training is a big business today. In a recent survey, it was found that over US $5 billion were spent on IT training in the US alone. It is reported that over 10% of an SAP implementation cost was spent just on training. With burgeoning costs come attempts to devise innovative methods for cost minimization. Most of the current operations in an application software domain depend upon either a menu access, or an icon operation or a dialogue box interaction at end user level. However, to be efficient, one should know how to interpret the meaning of these interfaces. IT training plays an important role in providing various concepts associated with these interfaces to end users who may not possess sufficient conceptual knowledge. This study investigates the influences of application software interfaces in determining end user training outcomes.

For the purpose of this study, two training approaches are used namely, instruction based approach and exploration based approach. Participants of this study are commencing students in a tertiary course. They have very limited knowledge in the area of IT. Based on their knowledge, they are classified into Basic and Advanced. The participants use iconic and menu interfaces to complete a given task in a hands-on experiment. The influence of training approaches and application interfaces on training outcomes is then determined.

Instructional Design

The framework for instructional design proposed by Reigeluth [22] is widely used in end user IT training. This framework is called Methods – Conditions – Outcomes or simply MCO. The framework consists of three major components. The first component METHODS are the means of instructions used. The second component CONDITIONS are the items that cannot be changed. For example, an individual characteristic such as an individual's preferred learning style is a condition that cannot be manipulated in a given situation. The component conditions are further defined as factors, which interact with the methods and cannot be manipulated in a given situation. The third component OUTCOMES are in terms of effectiveness, efficiency and appeal. The concept is that the conditions interact with the methods to affect the outcomes.

A special case of Reigeluth's MCO framework is the Aptitude – Treatment – Interaction (ATI) model proposed by Cronbash and Snow [10]. The Aptitude is the condition, the Treatment is the method and the Interaction is the interaction of the method and the condition.

A number of end user training frameworks fall under this MCO type. For instance, the Bostrom et al. [5] framework is an MCO/ATI framework. This framework suggests that training methods, individual characteristics and the interaction between individual characteristics and training methods influence learning outcomes. The framework suggested by Bohlen [3] is also an MCO type. In this framework the instruction type and learning styles determine training outcomes.

Training Approaches

Davis & Bostrom [12] describe the elements of exploration and instruction-based training to include process and structural features. The exploration-based process features include induction, trial and error, and high learner control. On the other hand, the structural features include incomplete learning materials and task focus (such as analyzing a document). The instruction-based process features include complete learning materials, and features focus (such as deleting text strings). End user training includes elements of both of these training methods.

Interfaces

Interfaces are central to user-dialogue system in any application environment. Interfaces are used to communicate with applications. They are used to convey various commands to an application in order to get a job done quickly and efficiently. Interfaces are simple to use.

There are three common styles available in user interfaces. They are WYSIWYG (What You See Is What You Get), direct manipulation and iconic. WYSIWYG is fundamental to interactive systems. The direct manipulation uses objects represented visually. The operations are conducted using a mouse. Iconic interfaces are a pictorial representation of an action. Menus are a special case of dialogue forms, combining text strings and in certain cases, an additional dialogue box.

Key Lessons Learned

The Bostrom [6] framework suggests that two categories of training outcomes – learner attitudes and learning performances – are the criteria for answering the question of how end users should be taught. This framework identifies individual differences as a variable affecting the effectiveness and efficiency of training methods. Based on the results of four studies they conclude that individual learning style affects training outcomes and, moreover, that training method should be matched with individual learning style for the best outcomes.

Ignoring individual differences, Davis & Bostrom [12] examined the training outcomes associated with the two primary independent variables. They are (1) training methods and (2) target systems. Target systems are systems for which the training is being conducted, e.g., electronic mail, word processing, etc. They applied exploration and instruction-based training methods on the target systems which were differentiated on the basis of interface, specifically, direct manipulation interface and command-based interface. They found no difference between training methods but did find that a direct manipulation interface resulted in higher learning performance, regardless of training methods.

In three of four studies [5], training methods are differentiated based on the use of analogical versus abstract conceptual models for describing an electronic mail system in terms of an office filing cabinet versus a schematic diagram. What is important to note is that the interfaces yielded significant differences in outcomes in the study conducted by Bostrom [5]. This finding is important in training end users.

The second key lesson is inferred from the Davis & Bostrom's [12] finding that the target system having the direct manipulation interface yielded substantial learning performance advantages over the target system characterised as having the command-based interface. Davis & Bostrom [12] note that their results “provide strong evidence to support the use of a direct manipulation interface for training novice computer users in basic concepts of operating system structure and function” (p.73).

This Study

The primary objective of this research is to develop insights to answer the question regarding how to train end users. In the context of the first lesson noticed earlier, this research studies two training approaches based on instruction and exploration. Further, the studies in the area of end user computing have indicated that individuals have a preferred learning style and the training outcomes are dependent on the preferences. However, very little research has been done to verify the outcomes of training and their dependence on instruction and learning styles. If this is the case, then there is a need to study the resultant effect.

It has become an essential component in a student's life to use computers outside classrooms to perform a variety of activities. The usage of various computing activities should be effective in order to accomplish a given task. This research aims to provide some insights as to the effectiveness of two methods of providing instructions for students. This study should also increase the body of knowledge concerning the effect of learning style preferences and the method of instruction on the learning outcomes of end users in general.

Research Framework

The following diagram (Fig. 1) depicts the research framework.

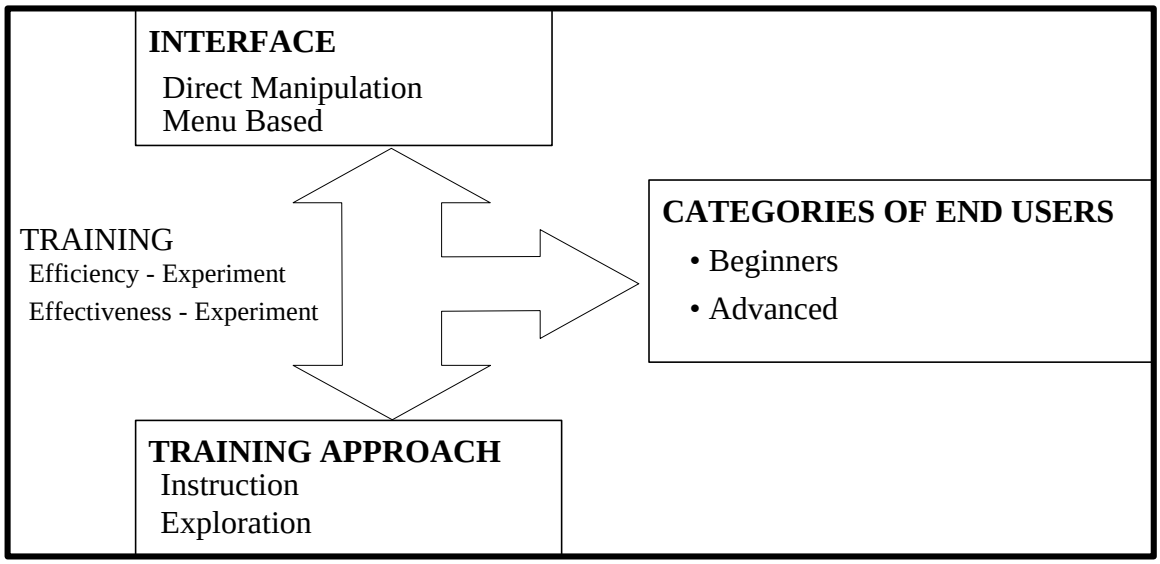

Figure 1 Research

The model is anchored on Bostrom et al. [5] framework. The original model suggests training outcomes are (user attitude and learning performances) determined by three important factors: characteristics of the target system, training approaches and the trainee characteristics. Fig. 1 suggests that focus is only on the target system and training approaches. The target system is based on two types of interfaces - Direct manipulation and menu based. The training approaches are based on instruction and exploration. The target system and the training approaches interact with two types of end users, beginners and advanced users. The interface and training variables and their linkages to training outcomes are shown in the diagram and discussed below.

Computer Interfaces

In today's computing environment, there are three types of interfaces - command based, direct manipulation and menu based. Command based interfaces use a conversational metaphor that requires users to enter and read English like commands. Direct manipulation interfaces (DMI) allow users to enter commands by pointing to icons, objects, words, or cells on the screen, and reading output as the effects of these commands on these objects. Finally, menu based interfaces require users to select command options from lists or menus. Each of these interfaces presents a model of a computer system either directly - in the form of objects to be manipulated, or indirectly - through the conventions of its command language or menu systems. The interfaces as models suggest that individuals learn systems by actually using them.

This study focuses on DMI and menu based interfaces because they represent radically different views of how users should interact with systems. There is sufficient material available to highlight the superiority of DMI in the literature [12, 25, 26]. However, very few studies have compared the influence of DMI with menu-based interfaces. The few studies that have made such comparisons have been criticized for their lack of theory in explaining their outcomes. Due to the lack of explanation, the studies do not measure in terms of merit. To avoid any such criticism, this study would use Assimilation Theory [1] as a basis for explaining the differences between the interfaces DMI and Menu.

Training Approaches

The research framework in Fig. 1 suggests that the training can facilitate learning through a mapping via training. This encourages individuals to reason from prior referent experiences and promotes the integration of new knowledge with prior or existing knowledge. Previous studies suggest that exploration based training is best suited for such a learning [2, 8, 17]. This issue has never been examined in detail. One of the problem encountered was the classification of different knowledge levels of users and hence the validity of such an outcome. To alleviate this problem, this study would examine the impact of exploration and instruction based training.

The literature reviewed in the area of end user training and general learning styles provides information about the way in which instructional design should be developed for such a learning activity. The literature highlights the need for process features and structural features in the training activity. Process features describe the mechanisms by which individuals carry out learning activities and include reasoning process, level of knowledge, and control of learning. On the other hand, the structural features refer to the organization of training materials. The features include level of completeness and learning orientation. There is evidence that these features are essential while developing the instructional materials for training.

Instruction based training features, on the other hand, promotes a more passive approach to learning. In this case, learners follow an inductive approach and very strictly adhere to the rules and instructions provided. Since rules are provided, there may be little need or incentive to discover them by actively working with them. Previous studies have been criticized for the subjective nature of the author in preparing training materials and hence forcing participants to follow either instruction or exploration approach. Instruction based training materials are highly structures leaving little room to learners to explore but to follow the instructions methodically to arrive at completion of tasks. Further, the instruction-based materials provide information in "packets" without proper links to various topics in completing a task.

However, it should be noted that the study conducted by Olfman [20] found that there was little difference in the performance of the two groups, instruction and exploration. This shows that researchers are not in complete agreement. The study by Bohlen [3] shows that the training method has very little significance in the final output. The lack of agreement could be attributed to the way in which the tasks are defined. Therefore, a careful construction of tasks is essential to arrive at an accurate measurement.

End Users

This study uses the definition of end users provided by Panko [21]:

> *End users are individuals who are not systems professionals and who make direct use of a computer in the performance of their job.*

The lack of definition of samples in the previous studies leads to the inaccurate measurement and hence the contradiction in outcomes. This study makes an attempt to alleviate this problem by providing a classification on end users derived from the Rockart and Flanney [23] classification. The classification provides 6 levels based on the type of activities performed. The two levels are non-programming end users and command level end users. The first level, non-programming end users use various menu based applications developed by others. In this study, this could be mapped to application software packages. Even though the classification makes a mention of "non-programming", the implied meaning is users who predominantly use the available tools such as menus, icons etc to perform their jobs. The second level "command level" refers to users who perform simple queries and generate reports. These users are able to perform various interactions with the "system" to get their job done.

This framework is chosen because there are references to this framework in other classification typologies. The typology developed by Davis [11] maps these classes as "indirect users" and "direct users". Indirect users use interface available to interact with systems while direct users use command level prompts.

The end user classes are further partitioned into two broad categories, beginners and advanced. For the purpose of this study, beginners are users who have minimum experience with PC applications and are aware of only a few computing terms. On the other hand advanced users have a sound knowledge of various concepts, working experience of a few application software packages and capable of producing documents for their daily jobs.

Research Questions

The research focuses on the following four questions:

1. Do interfaces affect end user training outcomes?

2. Do training approaches affect end user training outcomes?

3. Do prior knowledge of users affect end user training outcomes?

4. Is there any significant interaction between training approaches, interfaces and user knowledge in determining training outcomes?

Hypotheses

Interfaces

The results reported in the literature merely indicate that the learning preferences and styles have an impact on outcomes. There is no evidence in the literature as to how the learning preferences influence outcomes of end user computer training and relative strengths have not been identified.

It has already been mentioned that there are two types of interfaces used by end users in learning. The preferred choice of interfaces helps end users to learn through either rote or meaningful learning. The process of meaningful learning is described by Mayer [18] as a combination of reception, availability and assimilation. Ausubel [1] suggests that meaningful learning can occur only if all three of the foregoing conditions are met.

This theory thus provides a basis for understanding why a given type of interface may be more effective than another in training novice users. The first point that should be noted is that in order to achieve meaningful learning, individuals must search long term memory to retrieve appropriate anchoring ideas. Gentner and Gentner [14], Gick and Holyoak [15] suggest that unless learners are provided with clues to help them retrieve appropriate concepts, they will often be unable to do so. This is particularly true of learners, such as computer novices, who have no prior experience in a given learning domain.

The testing conducted by Mayer on this proposition appears to be supporting this idea. This, in turn, suggests that DMI may be more effective than other interfaces in promoting meaningful learning because they provide models, or contexts, with which to assimilate new information.

The second point worth noting from Assimilation theory is that certain types of interfaces are advantageous to help learners to integrate existing knowledge with new knowledge. In other words, the static paper based models need to be extended to dynamic mental models. These dynamic models allow learners to search the long-term memory to get the necessary knowledge for the purpose of integration. DMI interfaces provide such advantages. On the other hand, menu based interfaces would be expected to play a less significant role because of the rigor in the set of instructions and the availability of choices.

Further, menu based systems introduce the concept of 'abstraction'. Users need to translate the menu commands into a form that is recognized by the system and then interpret the system's response. This forces the user to view the system through a collection of abstractions that constitute the command syntax. In this approach, users have to depend on the verbal feedback given through various dialogue boxes.

Based on these propositions, one would expect trainees using DMI to experience a higher level of meaningful learning than trainees using a menu based commands. The fact that DMI allows users to work directly with icons or symbols, suggest that they have a unique capacity to reinforce and clarify relationships between existing knowledge and required knowledge. In other words, one could conclude that DMI would be more effective in performing basic, straightforward tasks. This is stated in the form of null hypotheses as follows:

H1: There will be no difference in effectiveness due to choice of interfaces.

H2: There will be no difference in efficiency due to choice of interfaces.

Training Approaches

It has already been highlighted that training features consist of process and structural features. To facilitate a training environment, which is going to be successful, one should allow learners with enough controls to create and experiment with a variety of examples. In other words, the training materials should accommodate both novices and learners with experience. This will allow learners to learn through step-by-step instructions as well as learn through "fill in the gaps" methods. The training methods, in other words, would provide both instruction approach and exploration approach to facilitate both type of features mentioned in the earlier sections.

The propositions of Assimilation Theory would enable one to predict that the participants with exploration training would perform better in far-transfer tasks than those who receive instruction-based training. On the other hand, instruction based training would yield better results in a situation where participants need to retain the instructions presented during a training sessions. In such cases, instruction training would be effective. These outcomes are expressed in the form of null hypotheses in H3 and H4.

H3: There will be no difference in effectiveness due to training approaches.

H4: There will be no difference in efficiency due to training approaches.

Interaction between Interfaces and Training Approaches

Assimilation Theory suggests that there may be a combined learning effect between the computer interface and the training method. It is safe to assume that encouraging a learner to work with the knowledge facilitates the assimilation of new knowledge. Interfaces such as DMI provide direct representations of appropriate assimilative contexts and encourage learners to work with these models by reducing the need to interpret input and output [16] should have distinct advantages over menu based interfaces. Also, because of the reduced cognitive demands of DMI and because operations, particularly errors could be easily reversed, learners should be encouraged to work with newly acquired information by exploring the computer system. The expected outcome would be better performance in far-transfer tasks by the DMI/exploration group than by all other interface/training groups. This also suggests that by matching DMI with the type of learning that it supports, trainers could provide users with multiplicative enhancements to ease of use. This extends the propositions by Davis et al. [13] that certain individual external factors can be used to influence ease of use. In particular, synergistic relationships exist between an interface and the training method. Hypotheses H5 and H6 state these propositions in the null form.

H5: There will be no difference between the direct manipulation subjects given exploration training and other interface/training subjects in effectiveness.

H6: There will be no difference between the direct manipulation subjects given exploration training and other interface/training subjects in efficiency.

Research Methodology

The research was conducted in a classroom setting. A total of 169 end users participated in the study. The participants were administered with a set of two questionnaires to assess their level and experience in the IT.

The experiment was organized into 5 sessions of about 30 minutes each. The first session was a briefing session and the first two questionnaires were administered. The second session was used for the Learning style preference. The third session was used for training. The fourth session was used for an 11 task hands-on exercise.

The hands-on task was recorded using Lotus ScreenCam software. The recording of the entire hands-on task was saved on a file with the average file size of about 4 MB. The responses were noted by replaying the file, which took about 45 minutes per participant.

The research design is a two factor experimental design. Interface is one factor, while the training approach is the other. Subjects are randomly assigned to one of the two methods of teaching as described below.

Participants

The participants of the research are tertiary end user computing students enrolled in a computer science program. The participants possess limited IT knowledge. They range from 18 years to 40 years in age. Participants have sufficient knowledge of PC operations.

The participants are then randomly assigned to two groups of training. The first group is provided with training materials based on instruction based approach. These participants are provided with limited freedom to explore. The second group is provided with exploration based training materials and they are given a lot of freedom to explore. Both teams work on their own with limited interaction with the tutor.

Training Manual

The training manual is produced in order to encourage either an inductive or deductive approach to learning. This is essential because the instruction-based learning facilitates an inductive approach to learning while the exploration-based learning facilitates a deductive based approach to learning. The training manual provides an overview of the software application, and then gives the rules for performing menu commands or icon based actions. Once the generic rules are covered, specific set of examples are given to participants to reinforce and reiterate the knowledge and concepts. While the instruction-based sequences provide little control to learners, exploration based sequences give greater freedom to participants. The manual is prepared by providing specific tasks and tasks related activities rather than the overall tasks. This is deliberately done in order to test the hypotheses on near and far-transfer tasks.

The manual consists of commands for each type of interfaces. Due to the complexity of the commands and their sequences, the manuals supply graphical representations of the actions and responses. This is done in order to provide visual or imagery part of cognition as described in the previous studies in cognitive dimension of learning styles. The effect of imagery part of cognition is not measured in this study as this is beyond the scope of this research.

This study uses some of the suggestions provided by Carrol et al. [9] and Olfman [19] in preparing the manuals. The manuals, as described earlier, consist of both exploration and instruction based instructions to facilitate training.

The manual is structured as tutorials. It consists of specific instruction on how to perform specific commands or operations. The concepts are explained and elaborated as and when there is a necessity. Further, the manual also contains actions to recover when things go wrong. The tasks pertaining to instruction and exploration approaches are as close as possible. In addition, a participant is not prohibited from jumping from one form of training approach to another form. In other words, participants can learn either from instruction approach or exploration approach or both. They will be classified based upon their own preferences at a later point of time.

Training Outcomes

The training outcomes are effectiveness and efficiency. They are measured in terms of total steps and total key pressed to accomplish the steps in completing a given task. The hands on exercise consists of 11 tasks in a package. Participants should complete the 11 tasks in order to complete the exercise. To be effective, participants need to complete a 54-step process. Anything less would indicate that the task is not complete. Anything more would indicate that the task is not completed in an effective way. A step in a task consists of key stokes, access to icons, menus and interaction with dialogue boxes. Every time a user presses a key, an interaction with the system takes place. The measurements of effectiveness and efficiency are defined below.

Effectiveness is defined as a function of completion of basic operations in completing a step in a task. Each step in a task is provided with a score. To be effective, one would obtain a maximum score. The scores range between 0 and 100.

Efficiency is defined as a function of total keys used in completing a given step in a task. The key press could comprise of access to icons, menus, dialogue boxes, and any response to errors. The key presses do not include alpha or numeric keys used to type in information.

Data Analysis

The following two graphs (Fig. 2) provide pictorial data for the factors effectiveness and efficiency. It can be seen from the first graph that the mean value for the two training approaches is almost equal for the icon interface. However, exploration training approach scores a higher mean for the menu interface. For the factor efficiency, exploration scores a higher mean.

The residual plot on the data provides a perfect diagonal on the square box indicating the data is normal. In addition to this, Levene's test performed on the data confirms that the data is reliable. This confirmation has prompted the MANOVA.

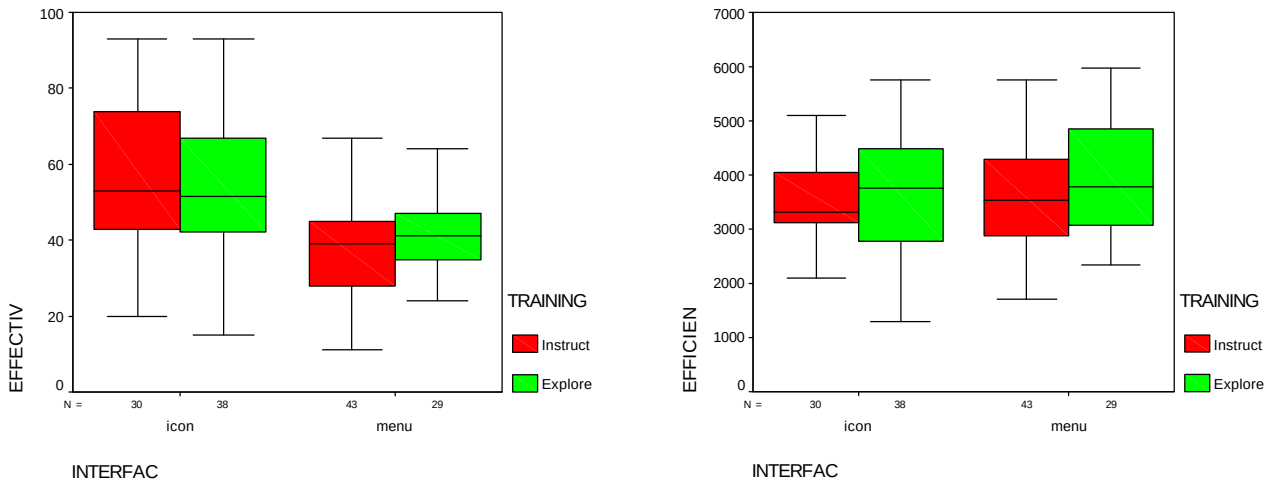

Fig. 2 Effectiveness & Efficiency for different Interface Types / Training Approaches

The MANAVO was conducted using SPSS. The details are provided in Table 1. It can be seen that the interface is significant among groups at 0.05 level of alpha. The value is consistently lower than this critical region for both effectiveness and efficiency. Therefore, hypotheses 1 and 2 are clearly rejected. The rejection signifies that there is a significant difference in effectiveness and efficiency due to the choice of interfaces.

The second factor training scores a value higher than the critical region at 0.05 level of alpha. Therefore, the factor training is not significant in determining the outcomes. Therefore, hypotheses 3 and 4 are not rejected.

Hypothesis 5 and 6 deal with the interaction effect. Hypothesis 5 deals with effectiveness and hypothesis 6 deals with efficiency. It can be noted from the table that the training and level of knowledge play a significant role in determining the training outcomes. No other interface is significant at the 2-way level.

When tested for the three-way effect, the test provides lower values than the critical region for the factors interface, training and level of knowledge. For both outcomes efficiency and effectiveness, the p-value is significant. Therefore, it is safe to conclude from the data that the three factors are significant in determining training outcomes.

Table 1 Effectiveness & Efficiency for various factors

		EFFECTIVENESS		*EFFICIENCY*	
Source	**df**	**F**	**Sig.**	***F***	***Sig.***
INTERFACE	1	48.981	.000	*3.428*	*.066*
TRAINING	1	.007	.936	*1.566*	*.213*
LEVEL	1	.792	.375	*.078*	*.781*
INTERFACE * TRAINING	1	1.885	.172	*.054*	*.817*
INTERFACE * LEVEL	1	.784	.377	*.001*	*.982*
TRAINING * LEVEL	1	10.219	.002	*.640*	*.425*
INTERFACE * TRAINING * LEVEL	1	4.001	.048	*9.293*	*.003*

Discussion

The statistical analysis clearly reveals that an icon interface helps to complete a given task using minimal set of keys. The reason for such a trend is the meaning portrayed by the icon in understanding the functions of a given system. One would be efficient if they use minimal keys to complete a task. This also translates into the minimal time usage.

However, the same cannot be said when it comes to scores, which determine effectiveness. One would be effective if they score higher. While icon interfaces yield a higher score for instruction training, the exploration training realizes higher score for menu interfaces. The reason for such a trend is, when difficulties are encountered, icons alone will not be sufficient to complete a task. Knowledge of menus, and how to access them would be useful in scoring higher scores. In addition to this, menus also open-up dialogue boxes, and if one is able to understand the 'communication' methods, then it is possible to explore in novel situations or difficult situation to complete a task. The explore-menu group demonstrates this trend.

This also supports the proposition of Assimilation Theory. Subjects use their previous knowledge to derive new knowledge in order to achieve meaningful learning. In DMI interfaces, the meaning of new knowledge is apparent. However, the same cannot be said with menu interfaces. Due to the level of hierarchy and the complexity in interpretation, menu interfaces are difficult to comprehend and hence the assimilation of knowledge is slow. This is shown in the outcome efficiency. Subjects have taken considerable time to absorb the new knowledge when it comes to menu interfaces. The average points are higher for menu interfaces in efficiency than icon interfaces, once again asserting the results from previous studies that DMI is advantageous in training novice users in basic concepts.

DMI provides conceptual models to subjects whilst the conceptual models provide a context in which thinking is facilitated for reasoning purposes. In the case of DMIs, subjects are provided with assimilative contexts with on-screen icons, reflecting the functions of the application. Previous studies [4, 7, 18, 24] confirm this trend.

The icon interfaces allow users to carry out a task based on the semantic distance. In other words, the semantic distance, which is the relationship between a user's conceptualization of an operation and the mechanisms that the interface provides to carry it out, is facilitated through the icons. This study shows that the icon interfaces closely represent the user's conceptual model. Menu based subjects are not able to do this due to the number of steps involved and the complex conceptual model provided by the menus. The icon interfaces also provide articulatory distance, which is the relationship between the meaning of an expression in the interface language and its form. Icons provide such directness by providing operations that mimic user's intention. Menu interfaces are not able to provide such directness.

Conclusion

In this research, experiments and investigations are carried out to determine whether end user training outcomes are affected by method of training instructions, the users preferred learning style, the application interfaces and the level of prior knowledge. The results clearly indicate that the methods of instruction and the application interfaces play an important role in determining the outcomes. The results are indicative only and not conclusive due to the limited sample size. In effect, end users perform better if the type of instruction is constructed carefully.

It should be noted that the factors of outcome need further consideration. The factors, scores, steps and keys imply the actual operations in performing a task without considering the underlying cognitive aspects. The factor time is important in establishing the way in which the information provided is processed. Further, the sample size is limited. The experiment was conducted by one tutor and with single application software. Therefore, the experiment needs to be replicated before any broad conclusion can be drawn.

The experiment did not address any motivational factors. The experiment concentrated only on the hands-on operations and there is a need and necessity to consider motivational factors to address issues such as how users use the tool etc. This is an area for future research.

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