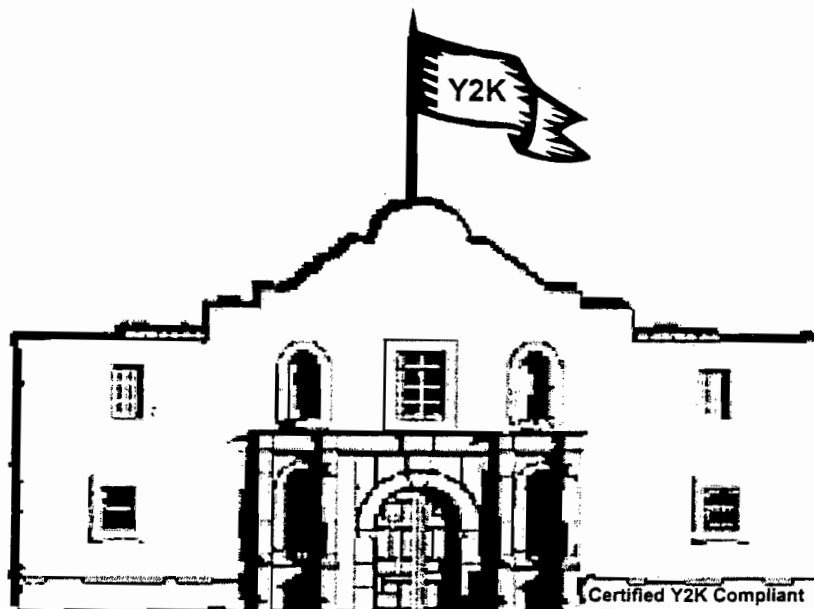


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A FRAMEWORK FOR TRAINING NOVICE USERS IN APPROPRIATE RESPONSES TO ERRORS

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ABSTRACT

When performing computer tasks, users frequently make errors. These errors can frustrate users and keep them from reaching their task goals. Errors occur even more frequently with novice users. It is important therefore to train novice users in appropriate responses to errors. However, traditional approaches to training (also called procedural training) focus on instructing users that errors are bad, and do not train users in how to respond to errors. This paper describes three approaches for training novice users to respond to errors. A framework for analysis of the research literature and future research needs is also presented.

INTRODUCTION

As users learn to use a new application of computer technology, they frequently make errors (11, 14, 16). Systems and interfaces should be designed to minimize the chance of making an error. In his book, *The Psychology of Everyday Things*, Norman discusses three goals for system design: 1) minimize the causes of error, 2) make it possible to reverse actions easily and make it hard to perform actions that cannot be reversed, and 3) make it easy to discover errors when they occur, and make it easy to correct the errors (18). Researchers emphasize factors such as the screen location of the error message (14), error messages that are clearly worded and provide meaning (8, 24), and giving users different alternatives on responding to the error (1).

Even if a system is designed to follow these design principles, it is virtually impossible for users, especially novice users, to avoid making errors, because novice users are especially prone to committing errors (1, 3, 11, 14). This is especially true in the networked environment, where there are more opportunities for users to get frustrated and make errors (13, 20).

Since it is impossible for novice users to avoid making errors, it is important to train novice users in appropriate strategies for responding to errors. Traditional methods for training novice users, called "*procedural training*," focus on avoiding errors. In traditional training methods, errors are considered to be counter-productive, and novice users are not instructed in how to respond to errors. Since novice users tend to make errors frequently, this approach is unrealistic. To assist novice users in responding to errors, three training methods have been presented in the literature. These methods are error management, exploration, and conceptual models. The purpose of this paper is to introduce and describe these three training methods, describe how these methods train novice users to respond to errors, and present a framework within which to study user responses to errors.

Traditional Training

Traditional training methods, also called *procedural training*, typically involve giving users a list of specific steps to follow in order to learn a task (2, 21, 26). Users are expected to

follow the directions exactly as written or presented to them (2). In traditional training methodologies, no information about the structure of the system is given (21). Procedural training has also been described as a deductive approach to learning tasks (6).

Traditional or procedural methodologies for teaching novice users how to use computer applications focus on avoiding errors (3, 9). Frese and Altmann believe that this is based on behaviorist traditions, in which errors are considered to be punishment (9, 10). The assumption of training methodologies that focus on avoiding errors is that users never make errors when performing tasks (3). This is unrealistic, since it is virtually impossible to avoid errors when learning new tasks. (1, 3, 11, 14). In their study of novice users learning to use a word processor, Carroll and Mack found that novice users may make errors as soon as they begin their task (5). Carroll goes as far as saying, "In the [traditional] training, one step just followed another. If the learner could pretend to be a robot, no errors would occur" (3, p. 41). However, it is unlikely that a typical user can behave as a robot. Frese and Altmann also state that errors will occur in the real work situation, since all of the features of a computer system can not be taught in training sessions (9).

Regardless of why the errors occur, the fact is that errors do occur frequently with novice users. Typically, novice users make insignificant errors, but in traditional procedural training, they are not instructed on how to recover from these errors (2, 3, 5, 14). Carroll and Carrithers found that a few insignificant errors may combine to form more significant errors, which frustrate users, who are not able to recover from the error sequence (4). Due to the errors, users may not be able to reach their task goals, and simply may give up. Because novice users frequently make errors, it is important to train them in appropriate responses to errors.

Error Training

A new methodology for training, called **Error Training**, has been presented in the literature (7, 10, 15). Although Frese et. al., Dormann and Frese, and Nordstrom, Wendland, and Williams present error training as one training method, it is actually a combination of two different training approaches - *error management* and *exploration*.

Error Management

When learning a new task on a computer, it is inevitable that at some point, users make mistakes. When novice users make errors, they become frustrated, and many times, they give up (9, 10). Error management highlights the positive aspects of errors (9). For instance, novice users are provided with statements such as "Make Errors! You can learn from your errors!" and "I have made an error. Great!" (10, 11). The cornerstone of error management is to train users that errors are not bad. Users are taught that errors are good, because errors are opportunities for learning (9).

Another aspect of error management is warning users of potential problem areas in a system, where errors are more likely to occur (9, 10). Users may then pay extra attention to these areas, which might increase the likelihood that users can avoid making errors in those areas. On the other hand, if users do make errors in these areas, they are paying special attention, so they are more likely to notice the occurrence of an error. By warning users of these potential error areas, users are both less likely to make an error, and more likely to be able to respond if they do make an error.

There are other positive aspects of making errors. Errors might keep incorrect sequences from becoming automated (9). By making errors, users should be able to correct their actions before a procedure becomes habitual. Users might also learn new procedures as a result of making an error (10). Also, in the real-world work environment, errors occur on a frequent basis (10). In the work environment, there is not always someone (a trainer) there to assist the user. Users should be prepared for how to handle errors when errors occur on the job.

These error management strategies assist the users in viewing errors as a learning experience and becoming less frustrated by errors (9). Greif and Keller agree with this assessment, saying that "...it is important to redefine errors as learning situations for which emotional and cognitive coping strategies have to be developed" (11, p. 242).

Exploration

Exploration has been defined as encountering objects and situations with a certain degree of uncertainty (11). Exploratory training has also been described as an inductive approach to learning tasks (6). In exploration, users are encouraged to explore their task environment (7). Instead of giving users a step-by-step list of how to perform a task, a more general overview of the environment is provided (7). Users are instructed in techniques for navigating through their task environment.

In traditional training, to instruct the user in moving from a home directory to the "www" subdirectory, the user would be told to type `<cd www>`. In exploratory training, the user would receive a description of the `<cd>` command, and how to implement it. The user would not, however, be told exactly what to type. The user would be encouraged to attempt the correct command based on their knowledge of the command.

Carroll believes that exploration is a more appropriate methodology for training novice users, because they are not overloaded with too much information (2). Furthermore, exploration more closely models how novice users naturally tend to approach new tasks (26). Greif and Keller state that when interacting with a computer, users usually do not plan their actions in advance. Instead, users follow something akin to trial-and-error (11). Therefore, Wendel and Frese suggest modeling the training on the users' behavior, and encouraging users to explore (26). Payne and Howes also note that exploration might be considered "more fun", and less like work, than procedural methods, for novice users (12, 19).

There are other advantages to exploration. Through exploration, users possibly can find a better way to perform the task (9, 23). Exploration can benefit users because it has "...the additional effect of eliciting positive emotional feelings and self-evaluations of competence and efficacy" (11, p.236). Users can feel more confident when they explore.

Experimental Findings

There are currently three published studies on the effects of error training. These studies are the Frese, et. al. (1991) study, the Dormann and Frese (1994) study, and the Nordstrom, Wendland, and Williams (1998) study. The 1991 and 1998 studies focused on the task environment of word processing, and the 1994 study focused on the task environment of statistical software. In all three of these studies, subjects who received error training had higher levels of performance than those who received traditional training. In addition, satisfaction levels were measured in the 1991 and 1998 studies, and in both studies, subjects who received error

training were more satisfied with their experiences than subjects who received traditional training.

Error training is the combination of two other training methods - error management and exploration. Although the experimental effects of error management alone are unknown, there are studies published on exploration: Carroll and Mack (1984), Carroll and Mazur (1986), and Frese and Altmann (1989). In all three of these studies, researchers found that users preferred using the exploratory approach. It is important to note that there has also been related work done on user manuals using the exploratory approach (2, 3, 26).

Conceptual Models

Another method that has been presented to assist novice users in responding to errors is conceptual models (21). A conceptual model is an "accurate, consistent and complete representation of the target system" (25, p. 588). These models are useful when teaching human users about computer systems (17, 25). A conceptual model of a computer system could consist of a basic description of the components of a computer system, along with how those components work together (21). The human users, when given a conceptual model, compare it to what is happening in their world (25).

There are two types of conceptual models: *analog* and *abstract* models (21). An analog conceptual model compares the target system (the system that the user is learning about) to another type of system (21). For instance, a computer network could be compared to a system with two cans and a string. An abstract conceptual model describes a system using charts, diagrams, and mathematical expressions (21). In a study of 48 novice users learning to use an electronic mail package, Sein et. al. found that abstract conceptual models were more effective than analog conceptual models, in training novice users (22). In a study of 66 subjects learning to use an electronic mail package, subjects who received conceptual models had a higher level of performance than subjects who received procedural training, although the difference was not statistically significant (21). In the commentary on their experiment, Santhanam and Sein note that conceptual models might be helpful in explaining errors to users (21).

Research Framework

To assist in understanding the development of the research in this area, the following research framework has been developed. This research framework presents the current state and possible future directions of research related to error management, exploration, and conceptual models in training.

Main Effects			Named Training Method?	Published Studies
Conceptual Model	Error Management	Exploratory Training		
Yes	Yes	Yes		
Yes	Yes	No		
Yes	No	Yes		
Yes	No	No	Conceptual Training	Sein, Bostrom, and Olfman, 1987 Santhanam and Sein, 1994
No	Yes	Yes	Error Training	Frese et. al., 1991 Dormann and Frese, 1994 Nordstrom, Wendland, and Williams, 1998
No	Yes	No		
No	No	Yes	Exploratory Training	Frese and Altmann, 1989 Carroll and Mazur, 1986 Carroll and Mack, 1984
No	No	No	Traditional Training	Many studies

The research framework shows that there are many areas of training that have yet to be explored. For instance, error management has been combined with exploratory training, as "error training." However, the effects of error management, by itself, have yet to be tested. The combination of error management, exploratory training, and conceptual models used together in training has not been tested. Several other examples exist. Furthermore, a majority of the published studies (including 5, 9, 10, 15) focus on the task environment of word processing. Only two of the studies focused on network-based tasks. Sein, Bostrom, and Olfman, 1987 and Santhanam and Sein, 1994 both focus on the task environment of e-mail. None of the published studies focus on the task environment of web browsing. This is especially important since users tend to make more errors in the networked environment (13). The research needs to be expanded to other task domains, such as spreadsheets, databases, and web browsing.

CONCLUSION

This paper presents different approaches for training novice users in responding to errors. A research framework for these different methods is presented. In the increasingly networked environment in which users find themselves, the opportunities for error increase. Because of this, well-designed error messages are not enough. Users need to receive training in how to respond to errors.

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