Learning word processing: effects of techniques, preferences, and attitudes

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Learning word processing: Effects of techniques, preferences, and attitudes

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Learning word processing: Effects of techniques, preferences, and attitudes

by

Amiram Raban

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INTRODUCTION

The primary purpose of this study was to conduct a preliminary investigation into possible interactions among different types of computer-aided training techniques and the individual-difference variables of learning preferences and computer attitudes, as they relate to novice computer users. A secondary purpose was to determine the effectiveness of guided exploration when learning to use a word processing system.

This investigation was guided by the following premises about learning preferences, computer-based instruction, and attitudes toward computers. First, individuals differ in the type of learning environments they desire (e.g., exploratory versus instruction-based). Second, computer-based learning provides a unique means for individualizing instruction by accommodating specific characteristics of the learners. Third, novices' attitudes toward computers have an impact on their behavior and performance when being trained on a computer system.

The hypotheses tested in the present study are in accord with the considerations outlined above, and with previous research which will be described in the next chapter. They are as follows:

1. Students trained on the word processor by guided exploration will perform better than those receiving instruction-based training.
2. There will be an interaction between learning preferences and training techniques.

3. Students holding more positive computer attitudes will outperform those with less favorable ones, after word processing training.

4. There will be an interaction between learning preferences and/or training techniques, and computer attitudes.

The Plight of the Novice User

The importance of training the novice (or naive) computer user has already been stressed by Mayer (1967; see also Gist, Rosen, & Schwoerer, 1988). Lack of efficient and effective training techniques was claimed to be one difficulty of the novice user in learning how to interact with the computer.

The present investigation is relevant to numerous computer users. These people have only minimal (or no) experience with computers, and they will not be computer professionals. Nevertheless, they constitute the large potential market for computing services in the coming years. The naive computer user is usually characterized by the following attributes (cf., Chapanis, 1982; Eason & Damodaran, 1981):

- is not an expert in computer technology.
- is an occasional user; uses a computer system to assist him/her in the performance of his/her real work.
• is not interested in computers per se; evaluates the system as a tool by virtue of its ability to service his/her task.

• seeks to minimize the time and effort needed for studying the system; not willing to undergo extensive training to learn how to use a computer.

The identification of relationships among training techniques, learning preferences and computer attitudes of novice users would provide useful information for designers of word processing systems (and possibly of other computer applications as well), and for designers of training materials. Development of training materials (especially exploratory ones) which would be flexible so as to fit the preferences of new users, potentially would result in higher overall performance.

Scope of the Study

Through the use of computer-based training techniques for a commercial word processing program this study investigated the problems outlined above. For each of two treatment conditions the computer served as an instructional/training system.

The instruction-based treatment forced learners to work step-by-step through the commercially available tutorial disk, permitting them to repeat sections of it as many times as they wished. The guided exploration treatment allowed
learners to explore the actual word processing system and to take advantage of the system's built-in Help facilities. These subjects received a brief introductory guidance as to the capabilities of the system and directions for using the Help features.

It was hoped that the results of this study would be useful in assessing the impact of exploration, and of novices' preferences and attitudes, on word processing training outcomes, and that the findings would provide directions for future research.

Summary

This chapter has presented an outline of the purpose for the investigation and the nature of the problem investigated. Potential benefits to be gained from this research have also been described.

In the next chapter a review of the literature relevant to this experiment is presented. The review provides focus for the problem statement and additional rationale for the study.

The third chapter reports the methodology employed throughout the investigation.

The fourth chapter presents the findings as they relate to the hypotheses of the present study.
The last chapter discusses implications of the results, limitations of the study, suggestions for future research, and final conclusions.
The goal of this chapter is to describe, through a review of the relevant literature, the rationale behind the investigation of the variables in this study. To accomplish this goal, theory and research relating to human factors in word processing, exploration-based learning, learning preferences, and computer attitudes have been reviewed.

In these reviews the following specific questions related to the design of computer-based training for word processing will be addressed:

1. Is guided exploration training more effective than conventional instruction-based training, when learning to use a word processor?

2. Does matching of training techniques to learning preferences have a positive effect on achievement in word processing training?

3. Can positive attitudes toward computers lead to greater benefits from word processing training?

4. What is the role of attitudes toward computers in combination with other task-related factors?

Human Factors in Word Processing

This study concerned itself with the use of a word processing system as an instance of the more general area of human-computer interaction. The purpose of this section is to provide an introduction to this relatively new area. The specific topics covered in this section include (a) Human-
Introduction

Computer systems are a new technology in the early stages of dissemination and refinement. The opportunities for system designers are substantial since only a fraction of the potential functions and market has been explored (Shneiderman, 1987). Computers used to be like early automobiles - accessible to users only through people who devoted extensive effort to mastering the technology. It has become clear, however, in light of the drastic reduction in hardware price and increase in systems' performance, that the speed and effectiveness with which people could learn to use computers was of primary importance.

The emergence of microcomputers has brought computers into our living rooms, kitchens, game rooms, as well as our workplaces. Computers play an important role in the lives of a rapidly growing number of people. A major challenge facing the computer industry is, therefore, making computers that are easy to learn and easy to use. Differently stated, the question is, how can we make computer systems with good human factors (Thomas, 1984)? While much is known about the physical aspects of human factors (e.g., Hutchingson, 1981), relatively little is known about software human factors.
Human-computer interaction

Human performance in the use of computer systems is a rapidly expanding research and development topic and is predicted to remain so in the coming decades (Shneiderman, 1987). This active new research area is often referred to as the field of human-computer interaction. Carroll (1987) defines it as the study of computers as experienced and manipulated by human users. Its principal goal is to provide an understanding of how human motivation, action, and experience place constraints on the usability of computer equipment. Human-computer interaction may be considered a subset of the field of human factors, with a special focus on cognition as an important factor in the ease of use of the user interface. While previous efforts directed at the ease of computer use concentrated on physical factors, such as the design of keyboards, and to some extent on perceptual factors, such as the size of letters on a display screen, current work is more concerned with such issues as understandability, memorability, and ease of learning how to use a system (Reisner, 1987).

The interdisciplinary area of human-computer interaction combines theoretical frameworks, experimental methods, and tools developed by cognitive and educational psychologists, computer science specialists, instructional
designers, technical writers, and traditional human factors experts (Shneiderman, 1987).

There is a growing interest in the human factors of computer use with systems such as:

- text editors and word processors.
- expert systems.
- personal, home, and educational computing.
- programming environments and tools.
- computer-assisted design and manufacturing.

The issues being investigated are as diverse as the types of systems involved. They range from software and hardware aspects, to the broader questions of organizational impact, job redesign, and long-term societal changes (e.g., Salvendy, 1987).

**Word processors: A behavioral perspective**

Word processors, referred to also as manuscript editors, are text editors intended primarily for manuscript preparation. Of the various office automation technologies, word processing has been the first computer-based tool in widespread use in the general office (Curley, 1983). Rafaeli and Sutton (1986) report almost thirteen million electronic information processors to have been introduced into American offices.
Card, Moran, and Newell (1983) suggested that studies of computer text editing were a natural starting point in the study of human-computer interaction, since the use of a computer for editing text was a paradigmatic example of human-computer interaction. The following reasons were specified to support their claim:

1. The interaction is usually rapid: A user completes several transactions a minute for sustained periods.

2. The interaction is intimate: A text editor becomes an unconscious extension of its user, a device to operate with rather than operate on.

3. Text editors are the single most heavily-used computer programs.

4. Text editors are similar to, and can therefore be representative of, other systems for human-computer interaction: Like most other systems, they have a discrete command language and provide ways to input, modify, and search for data. Also, the physical details of their interface are not unique.

The publication of Gerald Weinberg's influential book, The Psychology of Computer Programming (1971), may be considered as marking the beginning of the behavioral approach to computer science. In the arena of text editors, past behavioral studies have focused on editing time, on the methods actually used by users, users' errors, and learning. For example, Embley, Lan, Leinbaugh, and Nagy (1978) analyzed editors in terms of the number of commands and number of keystrokes required to perform benchmark tasks.
In another study, Card, Moran and Newell (1980) videotaped users of text editors to determine their methods and predict, using cognitively-oriented models, their editing time. In the next few paragraphs the available research methods for studying editors and the editing process will be reviewed, starting with the most subjective.

The simplest form of research in human-computer interaction is introspection, our own intuition and experience. The subjects simply reflect on how they edit files, write programs, or use terminals. A variant of introspection is protocol analysis. Here, the subject (or the experimenter) keeps a written or tape recorded record of his/her perceived thought processes. This permanent record can be analyzed for frequency counts of specific behaviors or words, or clusters of behavioral patterns (Shneiderman, 1980). Conclusions reached by one individual may, however, not be shared by others. Furthermore, conducting protocol analysis for large numbers of subjects is time-consuming and expensive.

Case or field studies collect information on computer usage at one or more sites without substantial interference with the system or phenomenon under study. They range in scope from anecdotal evidence to carefully planned and recorded systematic observations. Worthwhile insights may
be gained on how people actually use computer systems. Nevertheless, the lack of experimental controls limits the generalizability of the results.

Controlled experiments restrict the number of variables to be manipulated and observed and attempt to minimize the effects of all other factors. Using statistical analyses, it is possible to test hypotheses within stated confidence levels (Embley & Nagy, 1981).

Learning word processing

Over the last ten years more emphasis has been given to investigating learning of real-life skills, as opposed to traditional laboratory studies of learning and problem solving. Computer use is now attracting attention from both academic and industrial research groups, who explore the process of learning (Lewis, 1987). These efforts are in line with the awareness in recent cognitive science research that particular task domains have their own distinctive structure. There is increasing evidence that the structure of cognition changes from domain to domain (Carroll, 1987; Anderson, 1987). This view, therefore, sees the need to augment general studies of learning with studies of particular domains within which learning takes place.

The importance of goals and plans to human behavior is stressed by modern cognitive psychology, and was first pointed out by Miller, Galanter, and Pribram (1960).
Recently, the goal-plan approach has proven valuable in the study of human-computer interaction - both for interactive command language systems like text editors and for programming language systems (e.g., Card, Moran, & Newell, 1983; Black, Kay, & Soloway, 1987). According to this approach, almost all of human behavior can be characterized in terms of devising plans of action and performing them in order to accomplish a goal. Thus, most of what people know about how to operate in the world is stored in memory as plan and goal knowledge representations.

Card, Moran, and Newell (1983) applied goal-plan analysis to investigate expert use of text editors. A GOMS model was proposed, in which the expert knowledge representation consists of four components: goals, operators, methods, and selection rules. Goals are what the expert user is trying to accomplish (e.g., change a word). Operators are the actions the system allows to accomplish the goals (e.g., using the backspace key). Methods are the sequences of actions that will accomplish a goal (e.g., a repetition of three backspace operators). Selection rules are the conditions under which a given method is chosen to accomplish a given goal (e.g., use the backspace when the word to be deleted is short). In order to validate their model, Card et al. (1980, 1983) conducted in-depth studies
of a limited number of highly-trained individuals. Subjects performed manuscript editing tasks with a variety of line and display editors while precise timing measurements were made automatically. The researchers found that the GOMS model could account for both the sequence of operators experts use and the amount of time it takes them to accomplish routine tasks.

Goal-plan analysis has also been applied to study how novices learn to use text editors and become expert with them (e.g., Kay & Black, 1984, 1985). Kay and Black (1985) had their subjects rate the similarity of pairs of systems commands. They found that the basis for such similarity judgments shifted drastically from one experience level to another, and that this method could be used to map out the changes in knowledge representation that occur as users become experienced with a system. Based on such experiments, Black, Kay, and Soloway (1987) concluded that learning to use a text editing system progressed through four phases: (1) preconceptions, (2) initial learning, (3) plan development, and (4) increasing expertise.

The first phase (Black et al., 1987) refers to the user who has had no experience using a text editor, but comes to the text editing domain with a knowledge representation that may or may not correspond to the knowledge representations that will develop as text editing experience increases.
During the second phase, the user needs to overcome the prior knowledge bias, by (a) learning the goals relevant to text editing, and (b) learning the commands that can be used to accomplish these goals. This stage may correspond to the goals and operators of the GOMS model discussed above. In phase three, users develop the ability to form plans by combining the actions that were organized separately in the previous phase. These plans correspond to the methods of the GOMS model. Phase four represents the completion of the learning process. Users are now able to (a) combine simple plans into more compound plans to accomplish more advanced tasks, and (b) develop rules for selecting the best plan to achieve a given goal in a given situation. Naturally, this stage corresponds to the selection rules of the GOMS model.

As described above, most of the earlier studies of human-computer interaction grew out of cognitive science theories concerning the information processing involved when individuals solve problems, learn, and remember. Furthermore, computer users are usually studied as a homogeneous group, with knowledge, experience, and age being the major individual differences factors considered. Carroll (1987) emphasizes the need for broadening the scope of the conventional cognitive science analysis by explicitly considering the role of motivation, which may be - according
to Carroll - at least as important as any purely cognitive factor. Carroll asserts that "A motivated learner often cannot be stopped - even by rather poorly designed user interface facilities. And a poorly motivated learner often cannot be helped" (p. xiii).

In a similar manner, traditional cognitive psychology has been criticized for treating the learning process as passive with respect to the initiative of the learner, and for its methodological orientation that focuses analysis on highly constrained laboratory situations (cf., Norman, 1981; Carroll & Mack, 1984). Adopting this approach in the context of learning to use word processors, a long series of studies have been conducted in the last few years, many of which at the IBM Thomas J. Watson Research Center (cf., Mack, Lewis, & Carroll, 1983; Rosson, 1983; Mantei & Haskell, 1983; Carroll & Rosson, 1987). These research efforts will be discussed in the following paragraphs.

Designers of office systems face the challenge of how to develop word processing systems that are easy to learn and easy to use. The first step toward answering this question is to have a better understanding of how people learn to use such systems and what problems they have. The method often used to study the learning process is called the "thinking-aloud" protocol. This method has proved to be
a useful tool in cognitive psychology for studying in depth a new task domain without imposing the limitations of more traditional experimental methods (Mack, Lewis, & Carroll, 1983).

Thinking-aloud protocols produce qualitative data that can provide a broad picture of phenomena and problems in a task domain (cf., Ericsson & Simon, 1980). In a typical study, naive computer users are brought into a laboratory and are asked to "think aloud" as they go about learning to use text processing equipment, and as they go through the training materials. Specifically, learners are asked to verbalize as they work, describing questions that are raised in their minds, plans and strategies they feel they might be considering, and inferences and knowledge they are currently aware of (e.g., Carroll & Mack, 1984). These comments are tape-recorded, and the computer screen is video-recorded for later analysis. Based on the analysis, the researcher's goal is to form a picture of the typical experience of a learner.

A general finding from investigations of computer use is that people have considerable trouble learning to use computers. In a large exploratory study employing the thinking-aloud technique, ten office temporaries with varied work and educational backgrounds spent four half-days in a
laboratory setting to learn a text processing system (Mack, Lewis, & Carroll, 1983). Only a self-study manual was available to the subjects. The researchers were able to identify a broad range of problems encountered by learners (adopted from the authors' summary table, p. 259):

1. Learning is difficult.
   - Learners experience frustration and blame themselves.
   - Learning takes longer than expected, and learners have trouble applying what they know after training.

2. Learners lack basic knowledge.
   - Learners are naive about how computers work (e.g., do not understand computer jargon).
   - Learners do not know what is relevant to understanding and solving problems.

3. Learners make ad hoc interpretations.
   - Learners try to construct interpretations for what they do or for what happens to them.
   - Learners' interpretations can prevent them from seeing that they have a problem.

4. Learners generalize from what they know.
   - Learners assume that some aspects of text editors will work like typewriting (especially functions that simply move the typing point on a typewriter).
   - Learners assume that text editing operations will work consistently.

5. Learners have trouble following directions.
   - Learners do not always read or follow directions.
• Learners do not always understand or correctly follow directions even when they do try.

6. Problems interact.
• Learners have trouble understanding that one problem can create another.

7. Interface features may not be obvious.
• Learners can be confused by prerequisites and side effects of procedures.
• Learners can be confused by feedback messages and the outcome of procedures.

8. Help facilities do not always help.
• Learners do not always know what to ask for.
• Help information is not always focused on the learner's specific problem.

A phrase often used to describe the world of the new user of a word processor is that of William James: "a bloomin' buzzin' confusion". People in this situation see many things going on, but they do not know which of these are relevant to their current concerns. They don't even know whether their current concerns are the appropriate concerns for them to have. Novice users have, naturally, very little basis on which to act. Yet, the typical pattern that have been observed is that they simply "strike out into the unknown" (Carroll & Mack, 1983). They try to learn with energy and intelligence. In other words, they are active learners (cf., Carroll & Mack, 1984). They work hard to
make sense out of what they are seeing. They build on what they know about typing (if they have such knowledge), and they try to understand why the system does what it does and what patterns connect various parts of the interface. "Ad hoc theories are hastily assembled out of ... partially relevant and partially extraneous generalization. And these "theories" are used for further prediction. Whatever initial confusions get into such a process, it is easy to see that they are at the mercy of an at least partially negative feedback loop: things quite often get worse before they get better" (Carroll & Mack, 1984, p. 16).

Carroll and Rosson (1987) argue that the learning difficulties just described derive, at least in part, from two fundamental paradoxes, reflecting two conflicting motivational and cognitive strategies. A motivational paradox originates from the "production bias" people bring to the learning situation. Their primary goal is throughput. On the positive side, it directs their activities with the system, and it increases the likelihood of their receiving concrete reinforcement from their work. At the same time, however, it reduces their motivation to spend any time just learning about the system. As a consequence, they are likely to stick with the procedures they already know, even in situations where new and more
effective procedures should be used. Also, the resistance to follow structured instructions and explanations often causes learners to accidentally or deliberately get off track and to end up in lengthy and complex tangles of error recovery or self-initiated exploration (e.g., Carroll & Mazur, 1986).

The second paradox argued by Carroll and Rosson (1987) is a cognitive one. It arises from an "assimilation bias": People apply what they already know to interpret new situations. It is known, for example, that new users of word processors often try to understand their systems by reference to what they already know about typewriters. The metaphor of a typewriter is sometimes useful, but it breaks down at other occasions (Douglas & Moran, 1983). Irrelevant and misleading similarities between new and old information might blind learners to what they are actually seeing and doing, resulting in erroneous conclusions, or preventing the users from recognizing possibilities for new functions.

Carroll and Rosson (1987) further propose that the motivational and cognitive paradoxes are mutually reinforcing, thereby increasing their otherwise separate effects on the learning process and outcomes. The researchers conclude that these conflicts are fundamental, unavoidable properties of learning. If learning were not as
complex, they add, then designing learning environments would be a trivial design issue (see also Thomas & Carroll, 1979).

Exploration-Based Learning

This study compared the effectiveness of an exploration-based training technique with the more common instruction-based method, for the purpose of learning to use a word processing system. In this section the roots of exploratory learning will be examined as well as its modern application in computer-based training. The topics covered here will include (a) Discovery learning approach, (b) Computer-based learning, and (c) Exploration-based training for word processing.

Introduction

Exploration-based learning is defined as the acquisition of new information through activities initiated and controlled by the learner, which may include hypothesis testing and generation of positive examples. Exploration has been an intuitively appealing training method to researchers because it is believed to coincide with both the learners' intrinsic interest in exploring and the learners' behaviors spontaneously exhibited during structured training (e.g., Lepper, 1985). Exploratory learning originated from the discovery learning approach delineated below.
**Discovery learning approach**

An important and controversial issue in the educational world is the debate of teaching/learning by discovery versus teaching in the traditional, structured and didactic approach. Two sharply contrasting educational philosophies are reflected in this conflict (Shulman & Keislar, 1966).

In discovery learning, students explore the environment to discover the relationships that exist among the concepts presented. The student uses intuition, trial and error, or guided instruction to assimilate/accommodate the information. This is an inductive, Piagetian, self-directed learning, which is claimed to increase students' motivation as well as to produce deeper and more meaningful learning (e.g., Bruner, 1961). The opponents of the exploratory approach claim that learning is more efficient and effective with a more directive and structured strategy of instruction (e.g., Skinner, 1968).

Discovery-based learning environments may differ in the extent to which they provide guidance (Gagne, 1966). Bruner (1966) contends that discovery learning should be guided and not entirely trial and error. It is also recognized that discovery learning is not best for all learners in all situations. Factors that should be taken into account may include the subject matter, student history, previous
knowledge, timing of instruction, and learning outcome desired (Bruner, 1966).

Many studies examined the effectiveness of discovery learning. For example, Luehrmann (1980) found that students who were able to formulate a problem for solution by computer always had a better understanding of the problem than if given a verbal or a mathematical description. Mayer, Stiehl, and Greeno (1975) showed that traditional rule learning produced better performance on near transfer (transfer from one school learned event to another school learned event) and discovery learning produced better performance on far transfer (transfer from information learned in school to a real-life out-of-school situation). Egan and Greeno (1973) found that discovery learning formed a well-integrated cognitive structure, while rule learning added new components to structure, reorganizing existing components. They also found that rule learning was more effective for low ability students.

Overall, in those and other studies the benefits of exploration have included greater retention of information over longer periods of time, greater transfer of learning to novel situations, and heightened motivation (Herman, 1969; Lepper, 1985).
**Computer-based learning**

Computer-based learning (CBL) or computer assisted instruction (CAI) can be divided into two types of instructional uses, which show similarities to the exploration-instruction dichotomy. They are those in which the "computer teaches the student" and those in which the "student teaches the computer" (Papert, 1980).

The "computer teach student" approach means the computer is in control of the information presented and the sequence of instruction. "Computer teach student" environments are based on traditional instructional designs. The "student teach computer" environment enables the student to control the computer and the learning process.

The most common types of computer-based learning (CBL) applications that have been researched are currently classified as drill and practice, tutorial, simulation, and problem solving. Drill and practice and tutorials are considered "computer teach student" environments. Simulation and problem solving are closely related to "student teach computer" environments, depending on the way that they are implemented. The major outcomes that have been measured are initial learning, retention of material, time on task, and change in attitude toward subject matter, instruction, and computers.
Simulations and problem solving can be "student teach computer" environments, but most CBL studies use them as "computer teach student" environments. Therefore, the majority of CBL studies have been based on "computer teach student" environments. Research has focused on comparing "computer teach student" environments to traditional classroom instruction. A typical CBL study measured the difference in learning between students who received drill and practice CBL and students who received traditional worksheet instruction.

Reviewers of CBL research generally support CBL as a supplement to conventional instruction (e.g., Kulik, Kulik, & Cohen, 1980). Kulik and his colleagues conducted meta-analyses of the effectiveness of CBL, which covered a wide range of subject matters and grade levels. In one study, a meta-analysis of fifty-nine CBL studies in the college level, Kulik, Kulik, and Cohen (1980) found that CBL produced small contributions toward course learning and attitudes toward instruction. However, in studies with the same teacher conducting the experimental and control class, differences between CBL and traditional instruction decreased.

A few researchers have recently criticized the CBL versus conventional instruction comparisons (Salomon &
Gardner, 1986; Clark, 1985). In broader terms, these researchers oppose the question "Does it teach better than ...?", which dominated the field of media (e.g., television) research for decades. This question assumed that the medium, rather than some specific attribute or quality of it, affects learning. As examplified by Kulik et al.'s (1980) findings described above, those researchers assert that when everything else is indeed held constant, save the medium, not much of an effect can be observed. In the CBL context, they call for a focus on the computer's essential characteristics (e.g., interaction, afforded control), and for an investigation of how those attributes interact with learners' characteristics. Aspects assumed to be of potential value include learners' ability and prior knowledge, motivation, perception of task, and preferred learning strategy (cf., Salomon & Leigh, 1984).

Little research has been conducted on outcomes derived from "student teach computer" environments. The "student teach computer" approach is promoted by Seymour Papert (e.g., Papert, 1980). The basis of this approach is that the student controls the learning process. Goals are chosen, learners associate new information to existing knowledge and then formulate a strategy that will accomplish the goal. This provides cognitive links which facilitate transfer.
Papert developed LOGO to serve as a discovery "student control computer" environment. LOGO is a "Mathland" where students use turtle graphics to draw lined geometric shapes. Students drive the turtle around the screen by determining the angle and distance the turtle should travel to make the particular geometric shape. This experience provides students with a concrete form of representing abstract concepts. The turtle geometry helps learners develop heuristic knowledge procedures that the learner can use to solve future problems (Papert, 1980).

Papert's approach is closely related to that of discovery learning. Just as in discovery learning, students are given a chance to figure out the concept before they are told the concept. The learner is provided with opportunities to interact with concrete material, and with time to find links between previously learned material and newly acquired information, and to explore and discover strategies to use in solving problems.

The medium of computer-based learning is recognized to offer potentially novel possibilities for the creation of rich and responsive learning environments in which questions about the relative strengths of the exploratory versus the traditional instruction-based approaches may be more systematically defined and studied (Brown, 1983; Lepper,
Nevertheless, exploration has been researched mostly in non-computer-based educational settings (Kamouri, Kamouri, & Smith, 1986).

**Exploration-based training for word processing**

Exploration is believed to facilitate the use of existing knowledge in the solution of new problems (cf., Brown, 1983; Shrager & Klahr, 1983). Since this is a very desirable training outcome, exploration has been advocated as a training method by many researchers (e.g., Carroll & Mack, 1984; Shrager & Klahr, 1983). However, despite its potential to be an effective training technique, its effects have not been investigated empirically in many applied situations, and it is rarely employed for job skills training (Kamouri, Kamouri, & Smith, 1986).

A possible reason for the slow incorporation of exploration as a training method is the expense and physical harm that can result from inexperienced hands-on learning. The design of computer-based training systems for exploration may make this a viable alternative to traditional training because these systems can be designed to facilitate learning by relating new information to existing knowledge, reducing the consequences of errors and accidents, and providing system feedback that encourages insightful problem solving. Furthermore, by providing
guidance in the exploratory environment, exploration-based training times can be made as efficient as more traditional methods (Herman, 1969).

Kamouri, Kamouri, and Smith (1986) compared exploration-based and instruction-based training techniques as methods of learning the procedural buttonpress sequences that operate three analogous computer-simulated devices: a programmable alarm-clock, a computerized checkbook, and a digital radio controller. The exploration trainees learned by interacting with the devices without being given any instructions or hints about how to arrive at solutions. The instruction group also interacted with the computer in their training, but were presented with a manual of device buttonpress procedures, and could only perform the procedural examples contained in the manual. The groups were subsequently compared on performance on a novel transfer device (an electronic notepad) which was either analogous or disanalogous with respect to the procedures of the original training devices. Although exploration trainees took longer than instructed trainees to learn an initial device, their training times for subsequent analogous devices were significantly reduced. In general, the results of the study suggested that exploration-based training can be effective where learning outcomes such as transfer, possible later application of training information
(retraining), and an abstract understanding of information are considered important.

A different pattern, however, was found in an early study comparing trouble shooting training techniques for Navy maintenance technicians (Bryan & Schuster, 1959). A tutorial approach proved to be more effective than an unstructured, exploratory training environment.

In the context of learning to use word processing systems, a few researchers have emphasized the importance of encouraging learners to take an active role by allowing them to learn the new information by exploration (cf., Carroll & Mack, 1984; Brown, 1983; Douglas & Moran, 1983). Such an approach was adopted by Carroll and his colleagues (e.g., Carroll, Mack, Lewis, Grischkowsky, & Robertson, 1985). Carroll et al. (1985) used Guided Exploration cards, challenging the assumption that a linearly structured training manual format is the most appropriate training tool. These Guided Exploration (GE) materials were modular, task oriented, procedurally incomplete, and addressed error recognition and recovery. Twelve subjects, who were relatively computer-naive office temporaries, were asked to learn the basic functions of a state-of-the-art commercial word processing system. Half used the self-study training manual that was part of the commercial system, and half used
the experimental GE cards. Participants were asked to "think aloud" as they used the materials.

Qualitative analysis of these thinking-aloud protocols, as well as quantitative assessment of performance on a transfer of learning performance test (including typing, revising, and printing out a letter) were conducted. Learners using the GE cards spent substantially less time, yet still performed better on the posttest than learners using the commercially developed self-study manual. Moreover, the qualitative analysis suggested that the Guided Exploration cards worked as they were designed to work; they increased attention to the task, they encouraged learners to explore, they helped learners recognize and recover from errors, and they provided a better understanding of learning goals (see also Carroll & Rosson, 1987).

Another effort to support the novice explorer and his/her active learning strategies resulted in the design of the Minimal Manual and the Training Wheels Word Processor (see Carroll, 1985; Carroll, 1984; Carroll & Rosson, 1987). Both the training manual and the training interface were designed in direct response to the empirical studies of people trying to learn to use commercial word processors.

The Minimal Manual attempted to support active learning by providing concise instruction focused on easy-to-
understand goals. This manual was less than a quarter as massive as typical manuals. This was achieved by eliminating all repetition, all summaries, reviews and most practice exercises. Also, all material not related to actually doing things was eliminated or radically cut down. Its step-by-step exercises gave only abbreviated specifications of procedures, leaving some of the detail for the learner to discover or infer. In an evaluation study, forty-nine subjects used one of five training methods, including two variations of the Minimal Manual, for up to seven working days. The Minimal Manual proved to be forty percent faster than the other manuals for the basic topic areas it covered, and to produce learning achievement at least as good as the other methods (Carroll, 1985). The Minimal Manual only covered basic topics, where the commercial manuals covered advanced topics as well. In a later phase of the experiment, Minimal Manual learners were transferred to the advanced topics sections of a commercial manual. In this comparison they learned faster and also performed better than the others.

The Training Wheels Word Processor was intended to encourage exploration of basic functions by disabling the more advanced functions that can distract and confuse novices. The interface still displayed all of the function
choices of a full function system. Making an incorrect (i.e., too advanced) choice merely elicited a message indicating that the selected function was not available during training. Hence, while the learner was allowed to make an "error", the consequences of the error were minimized. In two experimental studies, twenty-four subjects were asked to use either the Training Wheels System or the complete commercial system to learn to type and print out a simple document. Learners using the Training Wheels System got started faster, produced better work, and spent less time on errors. Furthermore, the magnitude of these advantages increased over the course of the experiment. Lastly, the Training Wheels learners performed better on a system concepts test administered after the experiment (Carroll & Carrithers, 1984).

Learning Preferences

Learner preferences for various forms of word processing training, and the effectiveness of those forms for increasing performance, were central to this investigation. The purpose of this section is to provide a review of the literature related to research on learning preferences. The following topics will be covered in this review: (a) Classification of constructs, (b) Measures of
learning styles/preferences, and (c) Matching learning preferences and instruction.

**Introduction**

Learning preferences are defined as individuals' favored methods of acquiring information. Within teaching-learning interactions, an effort to assess learning preferences reflects a receiver orientation and recognizes that learners differ in their preference for various kinds of instructional messages (Gorham, 1986). The construct of learning preferences is closely related to that of cognitive style and learning style, as will be elaborated next.

**Classification of constructs**

Prior to the mid-'70s researchers experimented with cognitive style. Their definitions were different, but all were concerned with how the mind actually processed information or was affected by each individual's perceptions (cf., Coop & Brown, 1970; Witkin, 1975). The most comprehensive line of cognitive style research is that which has investigated information processing in terms of the field dependence-independence continuum proposed by Witkin (e.g., Witkin, Moore, Goodenough, & Cox, 1977): Individuals who use predominantly internal cues when making judgments on perceptual tasks are considered field-independent. Those
who use predominantly external cues are considered field-dependent.

In the early seventies the emergence of the concept of learning style was facilitated by the publication of Kolb's (1971) and Dunn and Dunn's (1972) books. During the following decade a few other researchers developed varied definitions, models, and techniques for assessing students' learning style (e.g., Schmeck, Ribich, & Ramanaiah, 1977). Despite their differences, those models revealed essential similarities (Dunn, DeBello, Brennan, & Murrain, 1981). All looked at learning style as the way in which an individual absorbs and retains information and/or skills. A wide variety of aspects were covered by different models, among them environmental (e.g., light, temperature), sociological (e.g., team, authority), and cognitive (e.g., analytic/global, reflective/impulsive).

In a review and analysis of twenty-one cognitive/learning style models, Curry (1983) arrived at a three-level reorganization: (1) The most stable constructs are classified as "Cognitive Personality" elements and include Witkin's field dependence-independence model discussed above; (2) The middle level, "Information Processing Style", represents a person's intellectual approach to assimilating information, an interaction between
fundamental personality traits and environmentally offered learning choices which may be modifiable; (3) The third, and least stable, layer is labeled "Instructional Preferences" and refers to the individual's preferences in a specific learning environment. Curry (1983) further suggested that one of the main difficulties preventing significant progress in the application of learning styles to educational practice was the confusion of definitions and wide scope of behaviors claimed to be predicted by learning style models.

Measures of learning styles/preferences

Following is a brief review of three commonly used learning style/preference self-report inventories:

(1) Kolb's Learning Style Inventory.
(2) Dunn, Dunn and Price Learning Style Inventory.
(3) Grasha-Riechmann Student Learning Styles Questionnaire.

Kolb's LSI (Kolb, 1978) contains nine sets of four words. The respondent is asked to rank order the words according to how well each characterizes himself or herself. For example, one set consists of the words "feeling", "watching", "thinking", and "doing". The inventory classifies people into one of four quadrants differentiated by a concrete experience-abstract conceptualization axis and an active experimentation-reflective observation axis. Four learning "types" are, thus, revealed: accommodators,
assimilators, convergers, and divergers. Accommodators are strong in concrete experience and active experimentation. They like to do things and involve themselves in new experiences. Assimilators favor abstract conceptualization and reflective observation. They excel in creating new theoretical models through inductive reasoning. Convergers' dominant learning abilities are abstract conceptualization and active experimentation. They are best at applying ideas to practical problems. Divergers are the opposite of the convergers. They are strong in concrete experience and reflective observation, and they are good at viewing concrete situations from many perspectives.

Dunn/Price LSI (Dunn & Dunn, 1978) includes statements such as "I study best when it is quiet", and "I like to study by myself", which are intended for eliciting agree-disagree responses. The inventory provides a profile of the conditions under which students prefer to learn, by assessing individual preferences in the following areas: (a) immediate environment (sound, light, temperature); (b) emotionality needs (motivation, responsibility, persistence, structure); (c) sociological preferences (self-, peer-, or authority-oriented); and (d) physical needs (perceptual modality, time of day, intake, mobility).
Grasha-Riechmann's Student Learning Styles Questionnaire (Riechmann & Grasha, 1974) consists of items such as "I never ask questions in my classes"; and "If I do not understand the course material, I just forget it". Items are rated on a five-point scale, from strongly disagree to strongly agree. Respondents are assessed on six learning style scales, labeled Independent, Avoidant, Collaborative, Dependent, Competitive, and Participant.

Matching learning preferences and instruction

Only a limited amount of research has been conducted to study the interactions of learning style/preference and modes of instruction. Most of these efforts focused on the classroom and student-teacher interaction as their main targets of investigation.

In a study using Kolb's learning style categories, Carrier, Newell, and Lange (1982) found a significant difference in preference for group-oriented activities. The subjects in the study, 163 dental hygiene students, were required to indicate their degree of preference (from 1 to 5, with five being high) for thirteen instructional activities. The activities being rated included such common instructional techniques as lectures, group discussions, and independent study. The activities on the list represented three categories, namely traditional classroom, self-
instructional, and group-oriented. An analysis of the responses from 70 accommodators and 67 divergers, 84 percent of the sample, revealed a significant difference in preference for the group-oriented activities only. The results of the study suggested that it might be useful to consider the effects of different learning styles when designing instruction.

Several unpublished research studies have tested populations for learning style preferences and then placed the subjects in instructional settings that were matched or mismatched to the indicated learning style (Dunn, 1984). These studies have investigated whether learners can identify their own learning styles, and if matching teaching styles to accommodate learning styles results in improved performance. The populations involved included 64 sixth grade students (Pizzo, 1981), 72 high school students (Copenhaver, 1979), 100 college students (Farr, 1971), and 1,689 student-teacher pairs (Cafferty, 1980). The results of the research consistently indicated that if learning style preferences were strong, then learners could identify them and that when matched with their preferred style learners performed better. These findings support the use of self-report inventories for determining learning styles and attempts to match learning style with instructional designs.
Learning (or instructional) preferences may not be as stable as cognitive style elements like Cognitive Personality, or Information Processing Style (using Curry's classification). Their potential, however, lies in their concern with aspects of instructional design which are immediately modifiable by the instructor (Gorham, 1986).

Computer Attitudes

The role of novice users' attitudes toward computers when they learn to use a word processing system was examined in this study. This section will look at the construct of computer attitudes in general, and will explore its relationship to novice users' learning and performance. Also, gender differences will be discussed. Topics included in this part are (a) Measurement of the construct, and (b) Computer attitudes and performance.

Introduction

A major psychological factor which may affect the way novices interact with a computer is user attitudes toward computers. A strong negative attitude may turn minor problems in using a system into major obstacles, examples for the user of what he/she had been expecting. At the other end, a strong positive attitude may give a user the will to overcome minor problems without difficulty. Attitudes, therefore, provide motivational inputs to the
task-user-tool triad of factors, which is central to the success of human-computer interaction (see Eason & Damodaran, 1981).

Computers are so widespread in today's society that most people cannot ignore them, and many have strong attitudes toward them (Eason & Damodaran, 1981). Some individuals are excited and intrigued by computers' technological innovation; yet others view the computer as a complex and threatening device. The possible consequences of such attitudes emphasize the merit of their investigation.

**Measurement of the construct**

In spite of the potentially important role the construct may play, only a few computer-based instruction studies have incorporated and assessed the learners' attitudes toward computers. At least in part this is due to the very few efforts made at developing psychometrically sound instruments for measuring the construct. Furthermore, much of these efforts were directed at only a limited population of school children, rather than at older and more diversified populations. The following paragraphs outline those endeavors.

Bannon, Marshall, and Fluegal (1985) developed a Likert-type scale to determine computer attitudes among
students, teachers, educational administrators, and other educators. Most of their respondents were either under nineteen or over thirty years of age. The researchers started out with only seventeen items. Their factor analysis identified two 7-item scales; a cognitive scale, with all items positively stated (e.g., Computers will improve education), and an affective scale, with items stated negatively (e.g., Computers will dehumanize teaching). Internal consistency estimates of reliability (alpha coefficients) were 0.93 and 0.90 for the cognitive and affective scales, respectively. The intercorrelation between the factors (scales) was not reported; nor was there any indication of the external validity of the instrument.

Another computer attitudes scale was developed by Loyd and Gressard (1984), and was tested on students in grades eight through twelve. Thirty items were selected by a panel of judges from an original pool of 78 items, to represent three attitude domains: (a) anxiety or fear of computers (e.g., Computers usually make me feel nervous and uncomfortable); (b) liking of computers or enjoying working with computers (e.g., Once I start working on the computer, I find it hard to stop); and (c) confidence in ability to use or learn about computers (e.g., I'm not the type to do well with computers). A factor analysis with a three-factor
solution supported the a priori groupings. Coefficient alpha reliabilities were 0.89, 0.91, 0.91, and 0.95 for the Computer Anxiety, Computer Liking, Computer Confidence subscales, and the Total Score, respectively. In light of large intercorrelations between the subscales, the authors suggested that the total score based on the three subscales might represent a general attitude toward working with computers.

A computer attitude scale to be useful for university students rather than only for school children or teachers was constructed by Dambrot and his colleagues (Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985). Twenty items (5-point Likert-type) were reported to be derived from previous research and observations. Some representative items were "I think computers are fascinating", "All computer people talk in a strange and technical language", and "Given a little time and training anybody could learn to use computers". All twenty items were retained after an item analysis. No factor analysis was reported. Alpha coefficients for two samples of college students were 0.84 and 0.79. Based on a regression analysis, computer attitude was found to be significantly related to computer experience, computer aptitude, and math anxiety. The resulting multiple R and adjusted R square, however, were very low.
Bear, Richards and Lancaster (1987) conducted a more comprehensive study in order to develop and validate a measure of student attitudes toward computers held by students in elementary through high school. The initial version of the instrument consisted of thirty-eight three-choice (agree, don't know, disagree) Likert items. The items were designed to assess attitudes toward five areas: general computer use, computer assisted instruction, programming and technical concepts, social issues surrounding computer use, and computer history. Items included statements such as "I enjoy learning about how computers are used in our daily life", and "People who use computers in their jobs are the only people who need to study about computers".

Based on a factor analysis, the instrument was judged to be unidimensional rather than multi-dimensional as originally expected. After an item analysis, the number of items was reduced to twenty-six. Alpha reliability for the revised questionnaire, labeled BCCAS (Bath County Computer Attitude Survey), was 0.94. For validation purposes, the researchers investigated the relationship of computer attitudes to computer experience and use, educational and career plans, choice of favorite subject area, and attitudes toward mathematics, reading and science. The BCCAS scores
were found to be related to those variables, thus supporting the validity of the instrument.

The narrower construct of computer anxiety has been the center of some other psychometric efforts (for example, see Lin, 1985). These studies will not be elaborated on here.

Computer attitudes and performance

Investigations of trainee characteristics influencing training effectiveness have usually focused on the ability level necessary to learn the program material. Motivational influences have received minimal attention, despite the fact that their significance has long been recognized (Wexley & Latham, 1981; Maier, 1973). For example, Noe and Schmitt (1986) tested an exploratory model describing the impact of trainee career and job attitudes on training outcomes. Job involvement and career planning were positively related to the acquisition of the key behaviors emphasized in the training program.

Attitudes toward computers are believed to affect users' learning and performance with interactive computer systems (Paxton & Turner, 1984; Shneiderman, 1979). Novices with negative attitudes toward computers were found to learn editing tasks more slowly, and to make more errors (Walther & O'Neil, 1974).
Little research has focused on the relationship of computer attitudes and performance in general, and in the particular context of computer-aided learning and microcomputer word processing. The few studies published in the last few years may raise some doubts as to the validity of the belief in a simple, first-order relationship between attitudes and performance, for today's computer systems and users.

The effects of computer attitudes on performance were examined as a part of a larger study conducted by Erwin and Nelson (1986). They developed a causal model to test the effects of the individual difference variables of scholastic ability, computing background, and computer attitudes, on the following outcome variables: use of a specific computer assisted instruction system, attitudes about the system, computer attitudes (a post-test), and course grade. Initial computer attitudes had no effect on either course grade or on the amount of the CAI system usage.

Jackson, Vollmer and Stuurman (1985) studied the effects of computer attitudes and task complexity on word processing performance. Forty computer-naive women were assigned to one of two computer-based instructional text editors, high versus low user-friendly. An attitudinal measure assessed the subjects' self-perceived enjoyment in a
wide variety of computer related tasks. In contrast to the expectations, subjects having favorable attitudinal scores did not perform better on the text editing tasks. Nevertheless, a three-way interaction of attitudes X editor type X time proved significant. Specifically, only participants with positive attitudes (high enjoyment) improved over time when using the more complex editor. This study emphasizes the need to look for combined effects of computer attitudes and other relevant variables, rather than compare simple mean differences for subjects expressing negative versus positive attitudes.

An issue that has received special attention within the area of computer attitudes is that of gender differences. Females usually have been found to hold less favorable attitudes than males (cf., Chen, 1986; Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Lockheed, Nielsen, & Stone, 1983). The same studies also found women to have, in general, less computer experience. It may be, however, that experience is the major factor responsible for the gender differences in attitudes. This specific hypothesis was tested and supported in a recent investigation by Chen (1986). Controlling for the amount of computer experience, males and females exhibited similar levels of attitudes toward computers.
Implications of the Literature

The literature review resulted in several implications of importance to the study. In an effort to relate the literature review to the study, the hypotheses, research questions, and related implications are presented below.

Hypotheses, research questions, and implications

**Hypothesis I**
Students trained on the word processor by guided exploration will perform better than those receiving instruction-based training.

**Research question**
Is guided exploration training more effective than conventional instruction-based training, when learning to use a word processor?

**Implications**
This prediction is directly implied from previous research. Yet, the relevant studies - as described earlier - were very few, employed only small samples of subjects, and operationalized 'exploration-based' and 'instruction-based' training in some specific, limited ways. This investigation broadens the scope of training techniques examined, and employs a larger sample size, thus permitting for more elaborate statistical analyses.

**Hypothesis II**
There will be an interaction between learning preferences and training techniques (or learning modes).
Research question  Does matching training techniques to learning preferences have a positive effect on achievement in word processing training?

Implications  While no research addressed this question in the context of word processing systems, the literature from traditional educational settings and subject matters did suggest that teaching styles should accommodate students' learning preferences.

Hypothesis III  Students holding more positive computer attitudes will outperform those with less favorable ones, after word processing training.

Research question  Can favorable attitudes toward computers lead to greater benefits from word processing training?

Implications  Recent research revealed findings which were mixed and inconsistent with earlier beliefs. Overall, however, the incorporation of attitudinal factors into the study of computer-based instruction and of word processing has been rare. This investigation serves to explore the role these factors may play in determining the effectiveness of word processing training techniques.

Hypothesis IV  There will be an interaction between learning preferences and/or training techniques, and computer attitudes.
Research question What is the role of attitudes toward computers in combination with other task-related factors? For example, do favorable attitudes lead to higher performance only when training techniques and learning preferences are matched?

Implications Though never addressing this specific question, previous research suggested that computer attitudes may interact with other task-relevant factors, to produce a combined effect on performance. The present study examines training techniques and learning preferences as two such factors.
METHODOLOGY

The main purpose of this study was to investigate possible interactions between different types of computer-aided training techniques and the individual-difference variables of learning preferences and computer attitudes. A secondary purpose was to determine the effectiveness of guided exploration when computer novices learn to use a word processor.

To accomplish this task a sample was selected from an undergraduate population, instruments measuring learning preferences and attitudes toward computers were constructed and administered, computer-aided training materials were designed and delivered, and achievement tests were administered. This chapter provides a description of the methods and instruments used in this study.

Subjects

The subjects in this study were seventy-five undergraduate students (37 males and 38 females) at Iowa State University. Seventy-nine undergraduates volunteered to participate in the study and received extra-credit points for their participation. Four subjects were excluded from the analyses; two did not come to the second experimental session due to personal reasons; the other two had previous
word processing experience. Students with minimal or no previous experience with computers and no word processing experience were asked to participate. The final sample included thirty-eight subjects in the Guided Exploration condition and thirty-seven in the Instruction-Based condition.

Research Instruments

A three-part self-report inventory was employed in order to assess the subjects' previous experience with computers, learning preferences, and attitudes toward computers. Two types of training materials were used, guided exploration and instruction-based. Performance and knowledge tests were administered after training. These instruments are described below.

Computer Background

In order to control for previous experience (in addition to the prerequisite of minimal computer experience), computer background was assessed (see Part 1 in Appendix A).

Subjects reported whether they had ever used a word processor. Then, they responded to four multiple-choice questions regarding the total number of hours they had ever worked with a computer for the purpose of:

(1) playing computer games (PLAY);
(2) entering data for research or business (ENTR);
(3) running computer applications such as spread sheets, 
data management, statistical packages (APPL); and
(4) developing computer programs (PROG).

Possible scores on PLAY are from 1 ("not at all") to 4 
("over 40 hours"). For the other three variables (ENTR, 
APPL, PROG), scores could range from 1 ("not at all") to 6 
("over 40 hours").

Learning Preferences (LP)

Subjects rated their relative preference (on a 99-point 
scale) for either a guided exploration or an instruction-
based method for the task of learning to use a word 
processor. The rating was based on a short description of 
the specific learning methods employed in the present 
investigation (see part 2 in Appendix A). Anchors for this 
scale were "Strongly prefer onscreen tutorial" (1), 
"Undecided" (50), and "Strongly prefer guided exploration" 
(99).

Computer Attitudes Scale (CAS)

The twenty-six item Bath County Computer Attitude 
Survey (Bear, Richards, & Lancaster, 1987) was modified for 
this investigation (see Part 3 in Appendix A). A 99-point 
Likert scale replaced the original three-point (agree, don't
know, disagree) scale. Subjects were asked to indicate the degree to which they agreed or disagreed with statements such as "I enjoy learning about how computers are used in our daily life", and "People who use computers in their jobs are the only people who need to study about computers". Higher CAS scores represent more positive attitudes toward computers.

**Instruction-Based Training (INST)**

Materials were based on an existing, state-of-the-art, onscreen tutorial for a commercial word processing system (WordStar Professional 4.0; WordStar is a registered trademark of MicroPro International Corporation). For the research purposes (to avoid unnecessary confusion on the part of the learners), the system was customized so that the function keys labels, appearing at the bottom of the editing screen, were turned off.

The tutorial is a controlled, step-by-step, hands-on introduction to the keyboard and to the word processing program. It explains and demonstrates the basic functions of the system, and lets the learner repeat lessons as needed. Two printed instruction sheets oriented the subjects to their task and provided them with a checklist of the tutorial topics (see Appendix B).
Guided Exploration Training (EXPL)

The same word processing system was used as in the instruction-based condition. Training was based on exploring the system, utilizing the built-in Help facilities while working on the actual word processing program. An initial guidance included four printed instruction sheets (see Appendix C) introducing:

1. special keys on the keyboard;
2. basic word processing terms (e.g., word wrap, menu);
3. how to get onscreen help;
4. the experimental task; and
5. a checklist of basic WordStar commands (the same as those covered by the onscreen tutorial).

Performance Test (PERF)

For this test (see Appendices D and E for the test and the scoring key, respectively), a three-paragraph passage was stored on a floppy diskette. Each subject was given a printed copy of the passage, with editing tasks. The tasks included substituting words, inserting letters, centering lines, moving a paragraph, and saving the edited file.

The test was a modified version of a word processing examination given in a computer applications course in the College of Education at Iowa State University. The maximum possible score on the test was 25.
Knowledge Test (KNOW)

Ten multiple-choice questions assessed the subjects' memory and understanding of basic word processing commands/functions (see Appendix F). Questions were adopted, with modifications, from Stultz (1983). The maximum possible score on this test was 10.

Procedure

Subjects signed up to participate in two experimental sessions of approximately an hour and a half each, with a two-day interval between sessions. Participants worked individually, though a few of them (a maximum of eight) occupied the laboratory at the same time.

The computer laboratory contained nine Zenith 150 computers (IBM compatible), each equipped with two five and one-quarter inch floppy disk drives.

Subjects were randomly assigned to the two training conditions, with the restriction that only one training method would be employed by all trainees at a given session. Each subject sat in front of a word processing system consisting of a monitor, disk drives, and a keyboard. Printers were not available, and subjects were told they should not use the print command. Diskettes were inserted into the disk drives by the experimenter.
At the beginning of the first session, subjects filled out the computer background, learning preferences, and computer attitudes questionnaires. Then, they individually worked through the training materials for a period of approximately 65 minutes. They were instructed to work on their own, and to ask the experimenter for help only if they were absolutely unable to proceed. Subjects were informed of the performance and knowledge tests that awaited them at the end of the second session.

The next session started with approximately 35 minutes of continued training. Subjects received the same instructions as in the first session (see Appendix G).

After training, participants took the performance and knowledge tests, which were limited to thirty and ten minutes, respectively. The knowledge test was administered only after the performance test in order that performance on the system (i.e., during the performance test) would not be contaminated by the information and possible cues provided by the multiple-choice items.

Pilot Study

Eight subjects, four in each training condition, served to test the training materials and the experimental procedure. There was only one participant in each pilot
session. The pilot subjects provided the basis for some wording changes and for deciding on the times allotted to the various phases of the experiment.

Analyses

The Likert-type items' scores ranging from 1 to 99 (that is, the scores for the preferences and for the attitudinal items) were divided by 100 and transformed to probit scores ranging from about -2.33 to about +2.33. This was done in order to enhance the discriminability of scores in both extremes of the original scale.

Internal-consistency reliability coefficients were computed and resulted in the following coefficients:
- Computer Attitudes Scale: .90
- Performance Test: .58
- Knowledge Test: .45

For each subject, scores were derived for each independent and dependent variable. Scores for the Computer Attitudes Scale, Performance Test, and Knowledge Test were computed by summing the scores for the items making up each scale/test. In the case of the Computer Attitudes Scale, scoring was reversed for items phrased in the "negative" direction ("positive" direction being one in which a high score on an item reflects a high level of the measured
variable). The independent variable of Training Method was coded as +1 (Guided Exploration) or -1 (Instruction-Based).

Thus, nine scores relevant to the hypotheses of the study were derived for each subject, namely:

1. Previous experience in playing computer games: PLAY.
2. Previous experience in entering data: ENTR.
3. Previous experience in running computer applications: APPL.
4. Previous experience in developing computer programs: PROG.
5. Training Method: TM.
6. Learning Preferences: LP.
7. Computer Attitudes Scale: CAS.
8. Performance Test: PERF.
9. Knowledge Test: KNOW.

Pearson Product-Moment correlations were calculated between all pairs of measures. Then, a Multivariate Analysis of Covariance (MANCOVA) was performed to determine the effects of training method, learning preferences, and computer attitudes on performance and knowledge scores. The four computer background variables served as covariates in this analysis.
The purpose of this study was to investigate relationships among learning methods, learning preferences, computer attitudes, and training outcomes, when computer-naive people learn to use a word processing system. Several research questions (presented in the Introduction chapter) were generated to guide the investigation. Data relevant to these questions are presented in this chapter.

Presentation of the data analyses is organized in the following manner. First, descriptive statistics related to all of the measured variables are presented. These statistics include means, standard deviations, and intercorrelations. Second, results of the MANCOVA and ANCOVA tests are described. Finally, formal tests of the research hypotheses are reviewed.

Descriptive Statistics

Means and standard deviations

Table 1 lists the means and standard deviations of all the variables measured in this study. As evident in this table, subjects had — as initially required — only minimal previous experience with computers. Playing computer games was, not surprisingly, the dominant one among these experiences.
### TABLE 1. Means and standard deviations of measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Maximum Possible Score</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer Background</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing Games (PLAY)</td>
<td>4.00</td>
<td>2.40</td>
<td>0.77</td>
</tr>
<tr>
<td>Entering Data (ENTR)</td>
<td>6.00</td>
<td>1.73</td>
<td>1.29</td>
</tr>
<tr>
<td>Running Applications (APPL)</td>
<td>6.00</td>
<td>1.20</td>
<td>0.64</td>
</tr>
<tr>
<td>Developing Programs (PROG)</td>
<td>6.00</td>
<td>1.79</td>
<td>1.21</td>
</tr>
<tr>
<td><strong>Preferences &amp; Attitudes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Preferences (LP)</td>
<td>2.33</td>
<td>-0.47</td>
<td>1.03</td>
</tr>
<tr>
<td>Computer Attitudes (CAS)</td>
<td>60.50</td>
<td>13.05</td>
<td>10.92</td>
</tr>
<tr>
<td><strong>Training Outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Test (PERF)</td>
<td>25.00</td>
<td>18.60</td>
<td>3.68</td>
</tr>
<tr>
<td>Knowledge Test (KNOW)</td>
<td>10.00</td>
<td>6.20</td>
<td>1.92</td>
</tr>
</tbody>
</table>

The negative value for Learning Preferences (-0.47, where zero represents no preference) indicates that on the average, subjects had a slight preference toward the instruction-based method. Also, the positive value for the Computer Attitudes Scale (13.05) reveals relatively positive attitudes toward computers.

Subjects, as a group, performed well on the posttests. They were 74.4% correct on the Performance Test (18.6 out of 25). Performance was somewhat poorer on the Knowledge Test, with 62.0% correct (6.2 out of 10).
**Intercorrelations**

The correlation coefficients between all measures are shown in Table 2. Only five intercorrelations are statistically significant, all of which are in the positive direction. Especially noteworthy is the high correlation between Training Method and the Performance Test \((r=0.50)\). Training Method is nonsignificantly correlated with the other training outcome variable, the Knowledge Test \((r=0.12)\).

**TABLE 2. Correlations between all measures**

<table>
<thead>
<tr>
<th></th>
<th>PLAY</th>
<th>ENTR</th>
<th>APPL</th>
<th>PROG</th>
<th>TM</th>
<th>LP</th>
<th>CAS</th>
<th>PERF</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLAY</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTR</td>
<td>.11</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPL</td>
<td>.14</td>
<td>.35**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROG</td>
<td>.14</td>
<td>.08</td>
<td>.27*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TM</td>
<td>-.01</td>
<td>-.04</td>
<td>-.07</td>
<td>.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP</td>
<td>.09</td>
<td>.05</td>
<td>.04</td>
<td>.05</td>
<td>-.16</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAS</td>
<td>.02</td>
<td>.12</td>
<td>.01</td>
<td>-.11</td>
<td>-.07</td>
<td>.06</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>PERF</td>
<td>.16</td>
<td>-.03</td>
<td>.04</td>
<td>.23*</td>
<td>.50***</td>
<td>.06</td>
<td>-.09</td>
<td>1.00</td>
</tr>
<tr>
<td>KNOW</td>
<td>.01</td>
<td>-.08</td>
<td>.03</td>
<td>.20</td>
<td>.12</td>
<td>-.11</td>
<td>-.04</td>
<td>.34**</td>
</tr>
</tbody>
</table>

* \( p < .05 \).

** ** \( p < .01 \).

*** \( p < .001 \).

The two training outcomes are moderately correlated \((r=0.34)\). The other significant correlations are:

- Performance Test with programming experience \((0.23)\);
- Previous experience in running computer applications with programming experience (0.27); and
- Previous experience in running computer applications with data entry experience (0.35).

Overall Training Outcomes

The effects of training method, learning preferences, computer attitudes, and possible interactions among them were analyzed using a Multivariate Analysis of Covariance (MANCOVA) on two training outcome measures: performance and knowledge tests. The four computer background variables served as covariates in this analysis, in order to control for their effects.

The MANCOVA results indicated an overall significance for the training method (TM) main effect ($F(2,62)=18.51, p<.0001$) and for the training method by learning preferences (TM x LP) interaction ($F(2,62)=11.95, p<.0001$). Computer attitudes and their interactions with training method and with learning preferences were statistically nonsignificant.

Univariate Analyses

The nature of the individual group differences was investigated by univariate analyses. Results of the univariate ANCOVAs were significant only for the performance
test. Group differences were nonsignificant for the knowledge test, with mean scores of 6.4 versus 6.0 (out of 10) for the guided exploration and the instruction-based conditions, respectively.

Performance test results

Table 3 summarizes the findings of the Analysis of Covariance for the performance test. This analysis produced two statistically significant results: main effect for training method ($F(1,63)=36.53, p<.0001$); and training method by learning preferences interaction ($F(1,63)=21.04, p<.0001$).

**TABLE 3. ANCOVA results for Performance Test**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>MS</th>
<th>$F(1,63)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training Method (TM)</td>
<td>261.80</td>
<td>36.53</td>
<td>0.0001</td>
</tr>
<tr>
<td>Learning Preferences (LP)</td>
<td>14.60</td>
<td>2.04</td>
<td>0.1585</td>
</tr>
<tr>
<td>Computer Attitudes (CAS)</td>
<td>0.13</td>
<td>0.02</td>
<td>0.8951</td>
</tr>
<tr>
<td>TM x LP</td>
<td>150.81</td>
<td>21.04</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>7.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mean score for the guided exploration trainees on the performance test was 20.4 out of 25. The respective mean for the instruction-based group was 16.8. This difference was statistically significant, as indicated by the ANCOVA results (see Table 3).
To simplify the interpretation of the significant Training Method by Learning Preferences interaction, learning preferences scores were categorized as IP (instruction-based method preferred), NP (no strong preference), and EP (guided exploration method preferred). These three subgroups were based on approximately the lower, middle, and upper 33 percentiles on the original Learning Preferences scale. Table 4 presents the relevant group means and cell sizes.

TABLE 4. Means and cell sizes for the interaction TM x LP on the performance test

<table>
<thead>
<tr>
<th>Learning Preferences (LP)</th>
<th>Training Method (TM)</th>
<th>Instruction</th>
<th>Guided Exploration</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP</td>
<td>Mean</td>
<td>18.3</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>NP</td>
<td>Mean</td>
<td>16.7</td>
<td>22.1</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>EP</td>
<td>Mean</td>
<td>15.9</td>
<td>22.2</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>16</td>
<td>13</td>
</tr>
</tbody>
</table>

Subjects performed better when using their preferred learning method (see Table 4). The greatest benefit was achieved by the EP subjects (those preferring the guided
exploration method). Their average performance was 22.2 when using their preferred method, versus 15.9 when using the other method. Note also that subjects with no strong preference toward any of the training methods did better with guided exploration compared to the instruction-based method.

Formal Tests of Hypotheses

This section provides a second review of the present findings. The emphasis here, however, is on the results as they relate to 1) effects of training method, 2) interactive effects of training method and learning preferences, 3) effects of computer attitudes and their interactions with learning preferences and training method.

Effects of training method on training outcomes

The findings supported the first research hypothesis. That is, learning by guided exploration led to training outcomes which were better than those resulting from instruction-based learning. This is indicated by the significant training method main effect in the MANCOVA analysis and the significant training method main effect in the ANCOVA for the performance test, as reported above. ANCOVA results for the knowledge test were nonsignificant, meaning that the advantage of guided exploration over instruction was evident only in the performance test.
Interactive effects of training method and learning preferences

The second research hypothesis received large support, as indicated by the significant interaction effect of training method by learning preferences in the MANCOVA and ANCOVA analyses reported earlier. As with the training method main effect, this interaction was significant for the training outcomes combined, and for the performance test as a single dependent variable. Table 4 shows the substantial improvement in performance which occurred when subjects were assigned to the training method they preferred.

Effects of computer attitudes and their interactions with learning preferences and training method

The MANCOVA results for computer attitudes main effect and for the interactions of computer attitudes with learning preferences and with training method all turned out nonsignificant. In other words, computer attitudes had no impact on training outcomes, whether alone or in combination with the other variables. The third and fourth research hypotheses, thus, did not receive support from the present findings.
DISCUSSION

This study was concerned with training novice computer users on a word processor. Its purpose was to investigate the relationships between training effectiveness, training techniques, and trainees' learning preferences and computer attitudes. The study also compared two different computer-aided approaches to word processing training: (1) an instruction-based technique, using an onscreen tutorial, (2) a guided exploration technique, using the word processor's online Help facilities with brief preliminary guidelines.

This chapter starts with a summary of the findings and a discussion of their implications. Limitations of the present investigation will then be addressed, as well as suggestions for future research. Finally, concluding remarks for this dissertation will be presented.

Summary of Findings and Discussions of their Implications

Learning methods

Guided exploration proved to be a superior training technique compared to the more traditional, instruction-based approach. While both training techniques provided opportunities for hands-on practice of word processing skills, the freedom to experiment and to create one's own
training activities and sequences appears to improve learning.

Exploratory learning such as that employed in the guided exploration condition is believed to better fit the motivational state of the novice user, which is often characterized by a "production bias" (Carroll & Rosson, 1987) and by an active and exploratory orientation.

Possibly the lower performance exhibited by the instruction-based trainees was due in part to boredom from their task. These subjects might have just gone through the motions from one tutorial lesson to the next, without making the necessary efforts to maximize their learning. Nevertheless, the instruction-based trainees did gain substantial word processing skills, as evidenced by their scores on the performance and knowledge tests.

Previous research has demonstrated the effectiveness of guided exploration in the acquisition of word processing skills. The current findings extend this line of research and enhance its generalizability. Specifically, this study focused on the use of onscreen learning-aids, while earlier studies emphasized the use of hard-copy training materials such as manuals and cards. The results here attest to the potential value of onscreen Help as an initial training tool. Like other types of software documentation, Help
scripts often are inaccurate, inconsistent, or incomplete (Houghton, 1984). In addition to correcting or avoiding such failings, designers of Help systems and training materials should devote special attention to the way Help facilities are incorporated into the overall training and documentation systems. Past experience has already shown that a completely free exploration will often lead the computer-naive trainee to long and frustrating sequences of error recovery. Initial training guidelines, which specify the correct use of onscreen Help, can greatly remedy these unfavorable consequences.

In addition to the motivational aspect, guided exploration techniques for learning a software application are usually very economic, since often no human instructor and no special equipment are needed. These techniques also have other advantages of self- (as opposed to group or classroom) learning, such as privacy and self-pacing.

Before concluding the section comparing the two training approaches, a note concerning the knowledge test is in place. It has been indicated above that the superiority of guided exploration over instruction did not appear in the results for the knowledge test. The suggestion that a pencil and paper test may not be able to capture the knowledge of a new user and that interaction with the system
may be required (Catrambone & Carroll, 1987) is consistent with these findings. The relatively low reliability of the knowledge test may also have contributed to the lack of significant results for this test. These explanations notwithstanding, one cannot rule out the possibility that the two training conditions differed only in their post-training performance, while their "theoretical" knowledge of the word processing system was comparable.

**Learning preferences, and matching training techniques to learning preferences**

Matching learning techniques to trainees' learning preferences proved to be of significant benefit in this study. As evident in Table 4, the best post-training performance was attained by the EP subjects when assigned to the guided exploration condition, which employed their preferred learning method. In contrast, the poorest performance belonged to those subjects preferring guided exploration yet assigned to the instruction-based method. Within the IP trainees (that is, those preferring the instruction-based method), people assigned to their preferred method outperformed those using their nonpreferred method. The difference here, however, was less impressive, and was apparently constrained by the relatively low overall mean for the instruction-based condition (16.8, compared to 20.4 for the guided exploration condition).
Two other observations can be made with respect to learning preferences. First, subjects as a group tended to slightly prefer the instruction-based training method (see Table 1). This tendency is understandable and could be expected among people who have had either minimal or no previous experience with computers. Such novices probably do not have the confidence to initiate self-experimentation on the computer, and are likely to feel more secure with traditional instruction.

Second, subjects with no strong preference toward either method benefited more from the guided exploration than from the instruction-based technique (see Table 4). This finding further demonstrates the relative superiority of guided exploration among the training approaches investigated in the study.

In general, this study provides evidence for the potential value of matching word processing training techniques to people's learning preferences. A similar approach has proven effective in the more traditional instructional settings and subject matters, and has now shown promise in the context of learning basic word processing skills. The same may be true for other computer applications as well. Empirical testing is obviously needed to corroborate that claim.
The study attests to the capability of computer-naive people to identify their computer-related learning preferences based on a brief description of the relevant learning techniques. Granted, these preferences are neither refined nor optimal; yet, they do seem to merit the attention and consideration of researchers as well as designers of software systems.

**Computer attitudes and training outcomes**

Attitudes toward computers had no effect on training outcomes in this study. Positive attitudes did not lead to higher performance. Furthermore, there were no significant joint effects of computer attitudes with either learning preferences or training techniques. These findings did not come as a major surprise and should not be regarded as such, especially in light of the inconsistencies found in recent research. At the same time, it is felt that the issue is not settled yet. Further investigation is needed into the role of computer attitudes in computer-aided learning in general, and in the learning of computer applications in particular.

**Limitations of the Study**

There may be variables other than those analyzed that have an important impact on training effectiveness. Two
such variables are a person's age and ability (see, for example, Egan & Gomez, 1985; Gomez, Egan, & Bowers, 1986). The nature of the sample, however, implied substantial restriction of range on these personal characteristics. A much more heterogeneous sample would be needed to include them in the analysis.

Inherent in the design of this experiment was the inability to explore any of the cognitive processes which operated when subjects were learning. A tough choice had been made in this regard, which resulted in a preference for a larger sample, better control over treatment conditions, and a more rigorous assessment of training outcomes. It was felt that considerable in-depth, protocol-type research of word processing learning had already been conducted, and that the gains from the present study would compensate for the sacrifice.

A specific type of "demand characteristics" of the experiment cannot be ruled out as a partial explanation for some of the findings obtained in this investigation. Demand characteristics of an experiment are cues that control the subjects' perception of their roles in the experiment and of the experimenter's expectations (Orne, 1969). As such, they represent a threat to internal validity.
Specifically, the demand characteristics factor, as elaborated below, may have contributed to the interaction effect of learning preferences by training technique. A self-report learning preferences questionnaire was filled out by the subjects at the beginning of the first experimental session. Later, subjects were assigned (randomly) to one of two treatment conditions. Subjects were not given the slightest "promise" that they would use the learning method they preferred. Moreover, there was even no explicit indication that the same methods as described in the learning preferences questionnaire would actually be employed throughout the training sessions. Still, trainees might have developed their private expectations and perceptions of the experimental task, which could serve as self-fulfilling prophecies as well as a basis for frustration among individuals assigned to their nonpreferred learning method. The fact that the difference between performance with the preferred versus nonpreferred method was substantially smaller for trainees preferring the instruction-based technique compared to trainees preferring the guided exploration technique reduces the power of the demand characteristics factor discussed here as a major alternative explanation for the pattern of results described in this dissertation.
Reliabilities of the performance and knowledge tests were relatively low. Efforts to increase these reliabilities, by improving and possibly also adding psychometrically good test items will enhance the overall validity of this type of research. An obstacle toward achieving this goal is that published research in this area often does not describe the test items and the psychometric features of computer user performance tests. A related problem is the uniqueness and incompatibility of many of today's computers, operating systems, and software applications. Till a reasonable degree of hardware/software standardization and compatibility is reached, chances for "psychometric collaboration" look slim.

Suggestions for Future Research

Ample evidence has accumulated by now which encourages the use of guided exploration strategies for the acquisition of word processing skills. Yet, guided exploration could be operationalized (or implemented) in many different ways, as exemplified in this and previous research. For this line of research to have a sizable and justified impact on the development and design of real computer training systems, numerous questions still await answers (that is, further investigation), for example:
- What is the most effective guided exploration technique?
Do certain techniques better accommodate certain types of users?
- Are different techniques more effective with different software applications (other than word processing)?

Guided exploration has typically been contrasted with instruction-based techniques (e.g., Carroll, Mack, Lewis, Grischkowsky, & Robertson, 1985). It is recommended that future comparative studies will employ a broader scope of training approaches. One such approach, though more expensive than those used in the present study, could be the behavioral modeling method which involves videotape presentations (Gist, Rosen, & Schwoerer, 1988). Another recommended route would be to create a combination of the two techniques employed here. Within such a "hybrid" system, the user would be able to switch back and forth between a tutorial mode and an exploration mode. It is possible that the flexibility provided by the system would effectively accommodate trainees' preferences at various levels of knowledge and expertise.

Learning preferences proved to be of significant consequences in computer-aided training. Clearly this study constitutes merely an exploratory investigation of this issue, but the results are encouraging. The construction of sound measures of learning preferences in the context of computer-based applications will require substantial
research efforts; so will the continued search for effective ways to accommodate these preferences.

Attitudes toward computers did not have an influence on post-training performance. Future research may benefit from focusing on a narrower aspect rather than looking at general computer attitudes. A construct that has received recent attention is that of computer self-efficacy. Perceived self-efficacy is concerned with judgments of how well one can execute a certain course of behavior. Bandura (1982) has proposed that perceptions of self-efficacy regarding a task can influence the choice to engage in that task, the effort that will be expended in performing it, and the persistence that will be shown in accomplishing it.

The construct of computer self-efficacy refers to people's expectations of being able to use and control computers. Miura (1987) investigated gender differences in perceptions of computer self-efficacy among undergraduate students. Men rated themselves higher than did women on the self-efficacy scale. In addition, computer self-efficacy correlated positively with current and past enrollment in computer science classes, interest in knowing more about computers, and plans to take a computer science class. In another study, Hill, Smith, and Mann (1987) found that the sense of efficacy with respect to computers exerted an
influence on the decision to use computers. This influence was independent of people's beliefs regarding the instrumental value of such use. Hill et al. also showed that previous experience with computers was related to computer self-efficacy, but it (previous computer experience) did not exert a direct independent influence on the decision to use computers.

Computer self-efficacy may play a role in determining individuals' success in word processing training as well as in computer-aided training for other types of software applications.

Trainees' perceptions of their tasks, and user satisfaction with the training materials were not assessed in this study. Especially in an experimental investigation where thinking-aloud protocols are not available, these additional measures have the potential value of shedding some light on people's thoughts and feelings while in the process of learning. Knowledge regarding the degree of satisfaction with a training tool and with its specific qualities is important for the system designer because of the possible consequences for the marketability and acceptance of the product among new computer users.
Conclusions

The nature and quality of the specific training techniques employed by novice computer users when they learn a software application determine, to a large extent, the outcome of their learning. Nevertheless, the effectiveness of training depends also on factors that originate from individuals rather than from hardware or software systems. Individual differences have often been overlooked when computer systems were researched and developed. This study undertook the task of investigating a few of these personal characteristics in the context of learning to use a word processing program.

Guided exploration was compared to an instruction-based learning technique. The effects of learning techniques and individuals' learning preferences and attitudes toward computers were assessed on two post-training outcome variables: performance and knowledge. The relationships among all variables were examined.

Guided exploration subjects outperformed those who used the instruction-based technique. It is demonstrated that onscreen Help messages, accompanied by concise, introductory training guidelines, can turn a word processing program into an effective training system. The findings are in line with the view that providing trainees with only brief
documentation and encouraging active learning can promote training outcomes (e.g., Carroll & Carrithers, 1984). It is suggested here that special care should be directed toward the design of on-line Help facilities and to their integration within the overall framework of the training and documentation systems.

As in the more traditional instructional settings, this study provides evidence for the potential value of matching word processing training techniques to individuals' learning preferences. Individuals performed substantially better if assigned to their preferred learning method. It is therefore suggested that future research will further investigate the role of learning preferences in the computer-aided learning arena, and will also focus on the design of instruments to measure these preferences.

Results related to computer attitudes were disappointing (that is, not significant), though not surprising, in light of the unclear picture from previous research. Trainees' attitudes toward computers did not affect their post-training performance. Considering the potential importance of attitudinal factors, their continued investigation is recommended. At the same time, a shift in focus is also suggested. A construct that seems to deserve greater attention is that of computer self-efficacy.
Perceptions of efficacy with regard to the use of computers may prove to be meaningful contributors to people's success in learning and using computer systems.

In conclusion, the results of the present investigation call for deeper consideration of individual differences and of motivational factors in the research and development of computer systems. Catering to users' preferences and other individual characteristics is gradually becoming more feasible and effective, with the development of advanced, intelligent software systems in general, and tutoring systems in particular. Furthermore, the significance of accommodating user needs is greater than ever, with the increasing dissemination of microcomputers among wide and diverse user populations, the growing number of software applications, and the continuous decline in prices of hardware and software equipment.

Similarities exist between a word processing system and other software applications such as spreadsheets (for example, in respect to the cognitive complexity of the tasks involved). Therefore, the findings discussed in this dissertation are likely to bear implications for the training of computer-naive people on these other computer systems as well.
BIBLIOGRAPHY


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I wish to thank my parents for their encouragement during these last four years. Most of all, thanks to my wife, Daphne. She has been an invaluable source of love and support for me.
APPENDIX A. SELF-REPORT INVENTORY
### COMPUTER ATTITUDES QUESTIONNAIRE

This questionnaire is designed to examine your feelings toward computers. There are no right or wrong answers, so do not hesitate to respond to the statements frankly. The questionnaire consists of three parts.

#### Part 1. Computer Background

1. A word processor is a special computer application that lets you type in text, edit it, and have it printed out.

   Have you ever used a word processor?  
   - Yes  
   - No

Items 2 through 5 refer to the TOTAL number of hours you have ever worked with a computer for various purposes. Please circle the letter corresponding to your answer.

2. Playing computer games.
   - A. not at all
   - B. 1-10 hours
   - C. 11-40 hours
   - D. over 40 hours

3. Entering data for research or business.
   - A. not at all
   - B. 1-5 hours
   - C. 6-10 hours
   - D. 11-20 hours
   - E. 21-40 hours
   - F. over 40 hours

4. Running computer applications such as spread sheets, database management, statistical packages.
   - A. not at all
   - B. 1-5 hours
   - C. 6-10 hours
   - D. 11-20 hours
   - E. 21-40 hours
   - F. over 40 hours

5. Developing computer programs.
   - A. not at all
   - B. 1-5 hours
   - C. 6-10 hours
   - D. 11-20 hours
   - E. 21-40 hours
   - F. over 40 hours
Part 2. Preference for Learning Word Processing

Based on a 99-points scale, please indicate the degree of your personal preference between the following two methods for learning to use a word processor:

a) Onscreen Tutorial.
   The learner who uses this method goes through a series of onscreen lessons about the keyboard and the word processor by following step-by-step instructions given on the screen. Lessons can be repeated as necessary. A person is available to answer questions, if the learner is unable to proceed.

b) Guided Exploration.
   Here, the learner receives an introduction to the keyboard and the word processor. Then, the learner is free to explore the actual word-processing program by using onscreen Help explanations. A person is available to answer questions, if the learner is unable to proceed.

   
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<td>Strongly prefer</td>
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<td>Onscreen Tutorial</td>
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6. Respond by writing a number from 1 to 99, to indicate your preference ____
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These consist of pages:

97 Feelings and Attitudes toward Computers
APPENDIX B. INSTRUCTIONS FOR INSTRUCTION-BASED TRAINEES
During the next 65 minutes and the first part of our next meeting you will learn the basics of a word processing program called WordStar. You will use an onscreen tutorial for this purpose.

Please go through all the lessons and topics at least once. You can repeat the lessons as often as you like. You will be tested on your knowledge of WordStar at the end of the next session. The test will include onscreen exercises on the actual WordStar program as well as multiple-choice questions.

As you read the lessons, keep in mind the following:
- There is no printer available. DO NOT TRY TO PRINT A FILE.
- It is not needed for your initial learning.
- Ignore the Function keys (F1 through F10) on the left side of the keyboard.
- IF YOU ARE ABSOLUTELY UNABLE TO PROCEED, ASK THE EXPERIMENTER FOR HELP.
- Page 7 is a scratch paper, in case you would like to use one.
- PLEASE DO YOUR OWN WORK. DO NOT SPEAK WITH OTHERS.

At the end of this session, return the Tutor disk and these pages to the experimenter. The disk and Pages 5-7 will be given to you again at the beginning of the next session. For the research purposes, you are asked NOT to learn or practice anything related to word-processing in between the two training sessions.

TO START THE TUTORIAL, follow these steps:

1. Type TEACHME WORDSTAR and press Return.

2. Start going through the lessons (You will continue next time).
   PLEASE USE THE LIST ON THE NEXT PAGE, and place a checkmark by each topic after you have completed it for the first time.
   You may skip topics 5 (Starting a new page) and 7 (checking your spelling) within the Explore Lesson (see checklist).
Tutorial Topics: A Checklist

___ FEARNOT
___ Your keyboard
___ Cursor movement keys
___ Parts of your screen
___ Files
___ Answering onscreen questions

___ TUTOR GUIDE (optional)
___ QUICK LESSON (optional)
___ Starting WordStar and creating a document (optional)
___ Erasing text/unerasing text
___ Inserting text and aligning paragraphs
___ Getting help
___ Saving and printing your document and quitting WordStar

___ EXPLORE LESSON
___ Getting to know the menus
___ Moving quickly through your document
___ Emphasizing your point-centering and boldfacing
___ Moving a paragraph
___ Finding and replacing text (optional) (Checking your spelling)
APPENDIX C. INSTRUCTIONS FOR GUIDED EXPLORATION TRAINEES
Machine # _____

LEARNING TO USE WORDSTAR

During the next 65 minutes and the first part of our next meeting you will learn the basics of a word processing program called WordStar. You will learn WordStar by using WordStar's onscreen Help explanations and by free experimentation.

The following are introductory guidelines about the keyboard and on how to use the Help explanations. Please read them CAREFULLY.

The Keyboard

Special KEYS have been added on both sides of the alphabetic keys:

**Ctrl** or the Control key, has a unique function. You can give special instructions/commands to WordStar by holding down Ctrl while you press another key (to "press" a key, push down the key ONCE and let it go). For example, the combination of "holding down Ctrl and pressing S" is pronounced "Control S", and is usually abbreviated to the symbol ^S

**Del** or the Delete key, erases a character at your place in the text.

**Backspace** erases to the left of your place in the text.

**Esc** or the Escape key. You'll use Esc to escape from WordStar Help screens.

**Return** is usually used for ending a paragraph, for creating an empty line, or to send a response to a WordStar prompt/question. Return is NOT needed when typing a command.

**Shift key.** Allows you to type uppercase letters and the upper set of characters on other keys.

Ignore the following keys: Alt, Ins, and the Function keys (F1 through F10). They are not needed for your initial learning.

The Screen and WordStar

In WordStar, the screen is your personal workplace. By using various commands, you control what happens on this "blank page". You can type letters, papers, memos, etc. When you type, you can see your text on the screen. WordStar enables you to change your text or rearrange it in many different ways; and you can learn the necessary commands by asking WordStar for help.

Here are a few TERMS you should know:

**CURSOR:** A blinking dash (_) which marks your place on the screen. Whatever you type next will appear right where the cursor is.
WORD WRAP: Word Wrap is a useful word-processing feature. It means that you don't need to press Return at the end of each line. When a word runs over the end of a line, WordStar automatically moves the whole word down to the next line. You just keep typing.

FILE: In word-processing, documents you type are kept on a disk in a file. Each time you write a document (a memo or letter, for example), you give it a name, or filename (from one to eight characters, with no spaces between characters). When you finish typing or editing a document, you need to SAVE it, so that the computer will store it on the disk until the next time you need it.

MENU: Throughout WordStar you'll find your choices listed on Menus. A Menu is a list of commands from which you select the task you want WordStar to do. WordStar has seven major Menus.

The OPENING MENU is displayed when you start WordStar. This is where you will find the command to open a document. After you open a document, the EDIT MENU is displayed. It contains basic editing commands and the commands to display the rest of the Menus. Commands are grouped under five headings, CURSOR, SCROLL, ERASE, OTHER, and MENUS.

Getting Onscreen Help

As you're learning WordStar, remember that onscreen help is always available. When you want to learn exactly what a command does, just call for Help. Help gives you information about each command right on the screen when you need it (It temporarily overlays your file). Read it THOROUGHLY.

To get help while typing or editing (when the Edit Menu is displayed), press ^J (hold down Ctrl and press J; no need to press Return). WordStar displays the Edit Menu and the first help message. The message explains how to call up help messages for every Menu and command: Hold down the Ctrl key and press the letter of the command you want help with. You can also press ^J? for help with screen layout.

After you read a help message, press Esc to go back to your file. If the help message takes up more than one screen, you must press Esc to display the next screen or ^U to cancel the help.

Help Levels: For learning, you should NOT change the current help level (3), which means that all Menus are displayed.

MISTAKES ARE NO BIG DEAL!

Making errors is a part of learning, and it doesn't mean the end of the world. Most errors are really misunderstandings. REMEMBER: You can't harm the computer by pressing its keys.
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How to Learn WordStar?

You are free to experiment with WordStar. Type a short letter to a friend, or even type a part of this page (Give the filename: Explore). Then, use the onscreen Help explanations to learn basic WordStar commands, and try them out on the text you have typed.

As you explore and experiment with WordStar, keep in mind the following:

- There is no printer available.
- Ignore the Function keys (F1 through F10).
- Reread relevant parts of the explanations on Pages 5-7 as needed.
- Read EVERY WORD of the onscreen Help explanations.
- Always read carefully ALL the information displayed on the screen.
- IF YOU ARE ABSOLUTELY UNABLE TO PROCEED, ASK THE EXPERIMENTER FOR HELP.
- Page 9 is a scratch paper, in case you would like to use one.
- PLEASE DO YOUR OWN WORK. DO NOT SPEAK WITH OTHERS.

At the end of this session, return the disks and these pages to the experimenter. They will be given to you again at the beginning of the next session. For the research purposes you are asked NOT TO LEARN OR PRACTICE anything related to word-processing in between the two training sessions.

You will be tested on your knowledge of WordStar at the end of the next session. The test will include onscreen exercises on the actual WordStar program as well as multiple-choice questions.

TO START WORDSTAR, follow these steps:

(Ask the experimenter to place the disks)

1. Program disk in the upper drive (drive A). (Placed by experimenter)
2. Training disk in the lower drive (drive B). (Placed by experimenter)
3. Type b: and press Return. (To type the colon (:), use the Shift key)
5. Press D to open a document. Give the filename: Explore. (It is a new file you are creating).
6. FIRST, type a few sentences in your new document file (e.g., a paragraph from this page, or a very short letter). Don't worry now about typing errors. THEN, USE THE CHECKLIST ON THE NEXT PAGE as a guide for learning WordStar. FOR LEARNING EACH COMMAND, do the following: (1) Read its Onscreen Help explanations (see "Getting Onscreen Help" on Page 6); (2) Try it out on your text; (3) Place a CHECKMARK by that command. (You may explore other commands as well, but you won't be tested on them).
WORDSTAR COMMANDS: A CHECKLIST

At the Edit Menu
(please read left to right)

___ ^J (REMEMBER: "^" means holding down the Ctrl key)
    ___ ^E  ___ ^X
    ___ ^S  ___ ^D
    ___ ^A  ___ ^F
    ___ ^C  ___ ^R
    ___ ^Y

___ Del (Del key, NOT the letters D,e,l)
    ___ ^V
    ___ ^B
    ___ ^O  ___ ^OC
    ___ ^K  ___ ^KD  ___ ^KB  ___ ^KK
    ___ ^KV  ___ ^KM
    ___ ^P  ___ ^PB
    ___ ^Q  ___ ^QA
    ___ ^U
APPENDIX D. PERFORMANCE TEST
WORD-PROCESSING EXERCISE

The exercise consists of two parts. First, you will perform a few editing tasks on a WordStar file. After exiting WordStar, you will be asked to answer several multiple-choice questions about WordStar.

Part 1. Onscreen Exercise (30 minutes).

To do the exercise, follow these steps:

1. Program disk in the upper drive (drive A). (Placed by experimenter)
2. Exercise disk in the lower drive (drive B). (Placed by experimenter)
3. Type b: and press Return.
4. At the B> prompt, type a:ws and press Return to start WordStar.

You will find the following paragraph on your Exercise disk in the file called EXERCISE. Open this file, and perform the following corrections on it. When you have completed the corrections up to step 6, call the experimenter over so you can save your work.

Winter
by
(your name)

It certainly does appear that Winter is sneaking up on us again. The changes are always subtle, but before you know it, it is time to start shoveling the white stuff again.

Last Monday morning, that old Winter feeling came over me again. The alarm went off and I could feel that it was oh, so nice and warm in my bed and oh, so cold outside my bed.

I did the only thing a sensible person could possibly do when he realizes Winter is coming: I turned right over and went back to sleep, waiting for things to get warmer!

1. Open the EXERCISE file.
2. Put your name in where indicated.
3. Center lines 1, 3, and 5 (Winter, by, and your name).
   What command did you use?  

4. Make the following changes:
   make the w in Winter lower case in the entire paper.
   What command did you use? 
   change apear to appear.
   change no to know.
   put a space between sensible and person.

5. Move the last paragraph so it is the first paragraph.
   What command did you use?

STOP--Call the experimenter over.

6. With the experimenter watching, save the file.
   What command did you use?

7. Part 2 of the exercise will be handed to you at this point.
APPENDIX E. SCORING KEY FOR THE PERFORMANCE TEST
### Scoring Key for the Performance Test

<table>
<thead>
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<th>Task #</th>
<th>Points for correct solution</th>
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<td>1.</td>
<td>2</td>
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<td>2.</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>3 (1 for each line)</td>
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<tr>
<td>4a.</td>
<td>2</td>
</tr>
<tr>
<td>b.</td>
<td>2</td>
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<td>c.</td>
<td>2</td>
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<td>d.</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>2</td>
</tr>
</tbody>
</table>

**Alignment**

3 (1 per paragraph)

**Extra/missing characters**

2 (no such characters) 1 (within one paragraph)

Maximum possible total score: 25
APPENDIX F. KNOWLEDGE TEST
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These consist of pages:

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APPENDIX G. INSTRUCTIONS FOR SECOND TRAINING SESSION
LEARNING TO USE WORDSTAR: SECOND SESSION

Machine # __

During the first 35 minutes of this session you will continue your WordStar learning. Attached here are the instructions you received last time. Go over them again, and continue learning.

Approximately 35 minutes from now the experimenter will take these pages from you and will give you the test, which includes onscreen exercises on the actual WordStar program as well as multiple-choice questions.