DEVELOPING EXPLORATORY STRATEGIES IN TRAINING: THE GENERAL APPROACH AND A SPECIFIC EXAMPLE FOR MANUAL USE

Rigas WENDEL   Michael FRESE

Dept. of Psychology, University of Munich, Leopoldstr. 13,
8000 München 40, Federal Republic of Germany

Exploration is an important factor in learning how to use a computer. In manual construction, exploratory behaviors can be supported (e.g., by modularity and task orientation) and necessitated (e.g., by presenting a random sequence of information modules). In an experiment with 21 subjects, it was shown that the principles of manual construction advanced here led to better performance in comparison to a commercial manual. The exploratory manual was successful in inducing exploratory behavior.

1. INTRODUCTION

There are essentially two efficient strategies in training: Giving the best possible outside structure for teaching the most important concepts and skills or allowing the individual to use exploratory tactics when dealing with new material (Ausubel, 1974). We conceptualize exploratory strategies to consist of trying out new ideas, learning from experiences, and being in control of the learning process. There is evidence in the human-computer area that exploratory strategies may be of higher importance in training computer related skills than in other areas, because people do not follow neat instructions when learning a new system but use active, exploratory strategies even when conditions actually do not support them (Carroll et al., 1985; Frese, in press). For example, people tend not to use manuals even when they have grave problems dealing with a system (Scharer, 1983;). This behavior may be rational, however, when the manuals are not easy to understand or when they actually interfere with exploration.

In this chapter, we discuss aids for exploration in human-computer interaction in general and, specifically, we look into the following questions: How can manual construction further or hinder exploratory behavior and do manuals that support such behavior, lead to better performance.

2. HOW TO ADVANCE EXPLORATORY STRATEGIES?

Table 1 describes various influences on exploratory behavior. They are differentiated into external (mainly information) and internal (cognitive and motivational) factors (of course, there is always an interaction of the internal variables and the external information that a person gets).

Tab 1: Factors That Support Exploration

External Information	Internal cognitive	motivational
- structured	- making	- interest
- moderately new	sense	- activation
	- analogies	
- incomplete	- metaphors	- no anxiety of errors & overload
- no sequence		
		- goal-oriented

External information that is structured, moderately new and that supports needs for help leads to exploratory behavior. Similarly, this is true of incomplete information and information that does not provide a given sequence for proceeding, so that the person has to develop his or her own sequences.

Internally, in terms of cognitive factors that support exploratory behavior, a person has to make sense of the information provided and has to use metaphors and analogies to be able to explore (Carroll & Thomas, 1982). Furthermore, there has to be some interest and little fear of making errors or of being overburdened. A general active approach (in contrast to the feeling of helplessness) is required as well. Trial and error should not be equated with exploratory behavior. Trial and error is not goal-oriented and it is not guided by a mental model. On the other hand exploratory behavior is goal-oriented in the sense of getting to know certain aspects of the environment and it is guided by some kind of mental model (even if the mental model is not fully developed).

Exploratory behavior has been studied in the context of procedures that a trainer explained to the trainees (Frese et al., 1987, Greif & Janikowski, in press). It has also been researched in relation to written materials that the trainees used for getting to know a system (Carroll et al, 1984). The latter is related to our issue of exploratory behavior as a result of the type of manuals.

3. MANUAL CHARACTERISTICS FOR EXPLORATORY BEHAVIORS

One can differentiate between manual features that underline support and those that necessitate exploratory behaviors.

3.1. Supporting exploratory strategies

The following features are helpful for exploratory behavior but can also be used profitably in traditional non-exploratory manuals that are organized to be worked through step by step:

(1) Task-orientation: Since exploration is always goal-oriented, task-orientation helps the reader to know in which direction he or she can explore; it also structures novelty and reduces potential fears of the unknown. For example, a headline "How to correct an error" is better (more task-oriented) in this sense than one called "The first steps in WordStar".

(2) Modularity: A manual that prescribes how to proceed interferes with exploration. Modularity implies that task oriented units are separately understandable, e.g. units on "writing", "deleting", or "printing" (Carroll et al., 1986). Thus, modularity makes it possible, to jump from one part of the book to another one and explore the system. Many commercial manuals break this rule by throwing functionally unrelated commands together into any one chapter.

(3) Structuredness: Structuredness helps readers to use the text with their own purpose in mind. One aspect of this may be the differentiation of declarative (what is something needed for?) and procedural information (how is it done?).

(4) Giving an overview: Terse overviews provoke interest and curiosity, thus supporting exploratory behavior. These overviews may be in the form of overviews of commands in the manual or in the form of help systems or menus. In the latter case, the manual has to teach, how to use the help system and how to understand the menus.

(5) Error anticipation and error correction: Novices spend as much as 50% of their time with trying to leave a situation that they erroneously stumbled into (Carroll, et al., 1986), e.g. getting into a mode that does not allow the continued writing of one's text. The main reason that proponents of traditional manuals give for their rigid sequence in manual use is that trainees may get themselves into trouble when exploring. This view has a rational basis. However, this does not necessarily mean that one should be against exploratory manuals. Rather it means, that a manual supporting exploratory behavior has to anticipate errors and provide help for undoing them. Thus, it makes it possible to cope with errors, it reduces anxiety and, it increases the motivation to explore. Furthermore, it is an important aspect of mastering a system to be able to undo error states.

Extending this principle, it is necessary that the manual - and of course the system - make it easy to revoke any kind of command that a person uses (not only erroneously used commands).

(6) Encouragement for exploration:
Some people are not prone to explore
except when encouraged. Therefore,
such an encouragement should be inclu-
ded in manuals and potential anxiety
should be alleviated by emphasizing
that the hardware cannot break when
exploring with the keyboard.

3.2. Forcing exploratory strategies

All the manual characteristics discus-
sed so far support but do not necessi-
tate exploratory behavior. There are
two manual characteristics that force
the user to explore:

(1) Random sequence: Traditional manu-
als instigate the reader to work from
the first chapter to the last. If the
reader is given a set of cards that he
knows are in a random order, he or she
is forced to put an own order into the
material. This gives an incentive to
explore.

(2) Incomplete information: Trainees
are forced to explore, if the informa-
tion provided is not sufficient for
actually using the system. Carroll et
al (1984) did this with some success
but a variety of problems evolved as a
consequence of this (e.g. people get-
ting lost in some errors).

4. THE EXPERIMENT

To use the toughest and most difficult
test for exploratory procedures in ma-
nuals, we have developed an experiment
in which an optimally designed tradi-
tional manual for the text processing
system WordStar was compared to a ma-
nual supporting exploratory behaviors.
Both were compared to a typical com-
mercially available manual.

The optimal traditional manual was
constructed to include the first five
of the six characteristics stated
above (3.1) that encourage but do not
necessitate exploratory strategies.
Although the commercial manual was
(like other such manuals) sequentially
organized and didactically well done,
it did not systematically conform to
the 6 principles stated above. The
exploratory manual included those 6
characteristics of the optimal tradi-
tional manual. Additionally, it was

given to the subjects as a set of in-
dividual modules ordered in a random
sequence. This forced the subjects to
bring order into the the exploratory
manual before being able to work with
it. One would think, that this
actually makes it harder to use it
than the optimal traditional manual
because of the time and effort re-
quired to develop some order in this
random material. Thus, from this argu-
mentation, one would suppose that the
exploratory manual would actually lead
to a lower performance than the other
two. However, we hypothesize that the
exploratory manual is at least as good
as the optimal traditional manual and
better than the commercial one. If the
exploratory manual would turn out to
be as good or even better than the op-
timal traditional manual, this would
be an indication for the usefulness of
an exploratory manual. In any case, we
hypothesized that the optimal tradi-
tional manual and the exploratory ma-
nual lead to better training results
than the commercial manual.

4.1. Methods

4.1.1. Experimental Procedure

There were three groups, each working
with one manual for two sessions (each
two hours long) on two consecutive
days. The subjects were asked to be-
have as if they had just bought a new
computer and would now work alone with
it for the first time. They were sup-
posed to use the manuals (presented by
the experimenter) but could work ac-
cording to their own speed and they
were not required to learn all the
functions presented in the manuals.
Most subjects, however, did practice
all the functions described in the ma-
nuals (with the exception of two sub-
jects in the commercial manual group).

The subjects were asked to think aloud
in these sessions. The experimenter
sat with them quietly. When he was as-
ked for help he encouraged the sub-
jects to find their solution and wai-
ted five minutes to see, whether they
succeeded on their own before he ac-
tually provided help. The help consi-
sted only of bringing the system into
a mode that the subjects were familiar
with or to show where the needed in-
formation was in the manual.

In the third session (on the third day), the subjects were tested how well they recalled commands and whether they could solve editing tasks. Additionally, they were interviewed and filled out questionnaires.

4.1.2. Subjects

Twenty-one students of a secretarial school were randomly assigned to the three manual groups. All of them volunteered; all were well-educated, between 20 and 25 years old; they were highly skilled typists, but complete computer novices.

4.1.3. Instruments

The following variables were ascertained:

(1) Frequency of exploration: The experimenter kept a protocol on how many commands were used that were not included in the manuals.

(2) Editing skills: Four tasks of variable difficulty tested whether the subjects could correct, delete, and insert characters, blanks, and paragraphs (number of correct solutions divided by the number of tasks).

(3) Helps required: The number of times (with the 5 minute rule of attempting to solve the problem on their own) that the subjects required assistance from the experimenter was counted.

(4) Time: The time to finish the book was recorded (it was not possible to do this in the exploratory manual group because the subjects did not work from cover to cover but had long periods of exploration in between).

(5) Free recall of manual-commands and explored-commands: The experimenter counted all those commands that the subjects could recall correctly. A separate count of those commands was kept that were not in the manual ("explored commands").

Thus, we have four performance variables (editing skills, helps required, time and free recall of manual commands), two exploration variables (frequency of exploration and free recall of explored commands) and one satisfaction variable.

4.2. Results and Discussion

The results are presented in Table 2. There are two kinds of results that are interesting: (1) The performance differences between all three groups (analyzed with analysis of variance and presented in column 4); (2) the differences between the two manuals constructed for this experiment taken together (exploratory manual and optimal traditional manual collapsed) versus the commercial manual (one-tailed t-test, column 5).

As hypothesized, the exploratory manual turned out to be superior in all of the variables except satisfaction (however, not always significantly so). Additionally, the two manuals that were constructed for this experiment according to the recommendations discussed in paragraph 3 of this article were not much different from each other in the performance variables like editing skills, helps required, and free recall of manual commands, as well as in satisfaction.

Furthermore, the exploratory manual was in fact superior to the optimal traditional manual in producing exploratory behavior as shown in the significant difference in frequency of exploration ($t=2.92, p<.01$). The same tendency can be seen in "recall for explored commands" ($t=1.75, p=.06$). The optimal traditional manual did not lead to a high degree of exploration (it is not much different from the commercial manual on the exploration variables). In our sample, it seemed not to be enough to only make it possible to explore; but it was essential to encourage and to necessitate exploration in order to get the subjects to explore. One reason for this result may have been that the subjects did not have specific goals in mind for participating in the experiment but were rather interested in a general overview of word processing. The results may have turned out to be different in a situation where employees just received a computer and are forced to work with it. With respect to the points discussed in paragraph 3 of this article on how to construct a manual, they worked well in any case. The manuals constructed for this experiment (the exploratory and the optimal traditional manual) were both much better than the commercial manual (as presented in column 5 of Table 2).

Tabelle 2: Comparison of the 3 Manual Groups

	Means			Significance (P)	
	Exploratory (1)	Optimal, traditional (2)	Commercial (3)	Anova (4)	t-Test (5)
Frequency of exploration	5.28	1.14	0.57	.01	.01
Editing skills	.82	.71	0.36	.01	.01
Helps required	2.29	2.00	4.00	n.s.	.05
Time (min)	X	*125*	200	X	.05
Free recall (a) manual commands	13.14	12.29	9.14	n.s.	.05
(b) explored commands	1.14	0.14	0.0	.05	p = .08
Satisfaction (5 item questionnaire) (1 - 5)	4.31	4.54	3.17	.01	.01

The commercial manual proved to be the worst in all of the parameters (it also took longer to complete). Thus, there is evidence that psychologically derived principles of manual construction make an immediate difference in the performance of computer novices.

This is also shown in the subjective satisfaction questionnaire. Subjects in the two experimental groups are much more satisfied than the ones in the commercial manual group.

₂e problems, subjects had with the commercial manual are also corroborated by the experimenter's qualitative observations of subjects' behavior. For example, the commercial manual assumed that a person would turn off the computer after finishing a chapter; therefore, starting procedures were explained in the beginning of each chapter. Some subjects rigidly conformed to these procedures and started again with every new chapter even though they were still in the system.

Some subjects of the commercial manual group had difficulties in deriving a general principle from the examples that were given. For example, the text suggested a special file name when opening a file. Later, some subjects of this group had problems understanding that one could use different file names as well. Problems like this did not appear in the other two groups. Apparently, not giving a chance to explore (as in the commercial manual) leads to a higher rigidity in thought and behavior.

From the experimenter's qualitative impressions, two of the most important factors that were wrong with the commercial book were, first, that it did not provide safeguards against subjects' potential rigidity in following instructions. Sometimes the procedures suggested were not optimal or downright nonsensical but subjects still followed them rigidly. Thus, the lack of modularity of the commercial manual may have helped to produce effects as discussed above. Second, it did not anticipate potential errors and did not give advice how to cope with errors (thus, the principle of error anticipation and error correction was violated).

In summary, the recommendations on manual construction based on the concept of exploratory behavior that were presented in this article produce better performance, more exploration and higher satisfaction. It is useful and possible to encourage subjects to explore through an instrument like manuals. This is so, even though manuals seem to be an unlikely and difficult candidate for providing support to exploratory behavior.

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