DOCUMENT RESUME

ED 383 347 IR 017 202

AUTHOR Yang, Fu-mei
TITLE The Effects of Elaboration on Self-Learning Procedures from Text.
PUB DATE 95
NOTE 20p.; In: Proceedings of the 1995 Annual National Convention of the Association for Educational Communications and Technology (AECT), (17th, Anaheim, CA, 1995); see IR 017 139.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Software; Guides; Higher Education; *Programmed Instructional Materials; *Student Attitudes; *Text Structure; Undergraduate Students
IDENTIFIERS Computer Manuals; *Elaboration; Microsoft Works

ABSTRACT

This study investigated the effects of augmenting and deleting elaborations in an existing self-instructional text for a micro-computer database application, "Microsoft Works User's Manual." A total of 60 undergraduate students were randomly assigned to the original, elaborated, or unelaborated text versions. The elaborated version included: (1) reorganizing content by separating conceptual and procedural information; (2) adding examples, restatements, explanations, an introduction and summary; (3) adding text-to-graphic references to support both conceptual and procedural information; (4) adding several examples of using different combinations of connectors to link selection rules; and (5) removing side-margin headings. Changes in the unelaborated version included: (1) identifying statements of procures and rules; (2) deleting all elaboration such as examples, restatements, and descriptions of what the software does as a result of procedures; (3) deleting unnecessary words; (4) deleting introductory text; and (5) deleting side-margin subheadings. Students completed six tasks using one of the three instructional texts, and then completed a six-item attitude survey. The absence of a significant difference in the task performance under the three text versions suggests that not all people require elaborations to develop a good understanding of procedural learning. Background information on elaboration includes a discussion of learner-generated versus author-provided elaboration, and the minimalist versus maximalist approach to training users in the use of computer programs. Six tables summarize findings. (Contains 67 references.) (MAS)

Title:

The Effects of Elaboration on Self-Learning Procedures From Text

Author:

Fu-mei Yang
University of Minnesota

No. 34 Aly. 53 Tung-men Rd.
Tainan, Taiwan, R.O.C.

Abstract

This study investigated the effects of augmenting and deleting elaborations in an existing self-instructional text for a micro-computer database application. A total of 60 undergraduate students were randomly assigned to the original, elaborated or unelaborated text versions. Students completed six tasks using one of the three instructional texts and then completed a six-item attitude survey. The absence of a significant difference in the task performance under the three text versions by a repeated measures ANOVA suggests that not all people require elaborations to develop a good understanding of procedural learning.

The Effects of Elaboration on Self-Learning Procedures From Text

Reading from text is one way in which people acquire knowledge or skills. An effective instructional text makes learners become active participants in the learning process rather than passive absorbers of information. In an age of independent, self-directed study, learning from texts is a common strategy, particularly in the computer industry. With the spread of personal computer systems, the issue of how to design effective self-instructional texts that facilitate the acquisition of knowledge and skills has become a very important one.

It is not uncommon to hear students complain about technical textbooks such as computer manuals. Obviously, if an instructional text designed for self-directed learning is too difficult to read or has confusing terminology, learners will become frustrated, and the negative experience would lower their motivation for learning. Pepper (1981) reported that students were looking for easy-to-read texts supported by many examples. Unfortunately, many computer textbooks and manuals don't use examples.

Documentation

Duin (1990) argued that computer documentation should center on the learner's goals, instead of on the system or on the concepts that are being taught. The learner's primary goal of reading computer manuals is to learn how to use the computer programs (skill learning), not only to know what the programs are (fact learning). In cognitive science literature, a similar distinction between fact learning and skill learning has been considered under the label of declarative versus procedural learning. Since learning to use a computer is a kind of procedural (skill) learning, learners want to extract information for immediate action rather than absorb knowledge for future recall.

Developers of computer documentation should also consider the cost of ineffective instructional texts. When instruction is inefficient, the costs incurred by both learners and business are extremely high (Carroll, 1990). Thus, the importance of designing an effective instructional text that facilitates procedural learning cannot be overemphasized.

Text-Based Elaboration

One variable that may increase the effectiveness of learning (particularly self-directed learning) from text is *elaboration*. According to Gagne "Elaboration is the process of adding related knowledge to the information being learned. The addition can be a logical inference, a continuation, an example, a detail, or anything else that serves to connect information" (Gagne, 1985, p.83). A common goal of elaboration is to attempt to make learning more meaningful by forming a relationship between the new, unfamiliar material and the older, already learned information. There has been ample research that indicates elaborations could help subjects learn and remember the main ideas of a text, because elaborations provide multiple retrieval routes to the essential information by creating more connections to the learner's prior knowledge (Reder, Charney, & Morgan, 1986). Elaborations also provide extra, useful information for constructing an answer (Reder, 1982). That is, elaborations can lead to better memory by increasing the redundancy of interconnections among the to-be-remembered information, and by imposing an organization on the information that can be used to guide the retrieval process.

Levin (1988), in his research review of elaborated-based learning strategies, indicated that elaboration can facilitate one's memory in learning because people's memory for nonmeaningful or arbitrary stimulus materials can be substantially improved through the addition of relevant connections or "mediators" (p.191). Over the last quarter of a century, there has been a great deal of evidence that shows elaboration-based strategies to facilitate students' performances in a variety of school-learning content areas

and tasks. These range from memory for simple factual material to the processing of complex prose passages (see Levin, 1988, for a review). In addition, elaborations are beneficial for individuals with diverse characteristics and at all levels of ability, including wide variations in their age, ethnicity, intelligence, academic achievement, and specific abilities and aptitudes.

Reder and colleagues (1984, 1986) studied the informational content of manuals and the role of text-based elaborations. They defined text-based elaborations as "any information that supports, clarifies, or further specifies the main point of a text, including examples, details, analogies, restatements, and deductions" (Reder, Charney, & Morgan, 1986, p.64). Results from a large body of research consistently show that text-based elaboration facilitates learning in the acquisition and recall of declarative knowledge. In certain cases, such as for children with mental retardation, the more elaboration, the better (Levin, 1988). The reason is elaborations that relate to more than one part of the new knowledge are more effective in enhancing retrieval than are elaborations that relate to only one part of the new information. However, elaborations do not benefit all performance outcomes. For example, Mayer (1980) pointed out that the research indicates that elaboration in the form of artificially constructed verbal learning materials increased learner efficiency and recall.

By contrast, elaborations can also interfere with recall. There is ample evidence for the existence of retrieval interference both on recall and on response times to verification (Reder, Charney, & Morgan, 1986). Although elaborations help people remember relational information as well as specific information about the key concepts involved in the relationship, the results of Stein et al. (1984) showed that elaborations that enhance both relational and item-specific information do not require the activation of associatively related concepts that learners have previously acquired.

Learner-Generated vs Author-Provided Elaboration

The definition by Reder, Charney, & Morgan in 1986 includes two sources of elaborations: (1) those generated by learners while reading, and (2) those contained within the text provided by the author. Ideally, given a reading text, students would elaborate on new information by thinking of related ideas, examples, images, or logical inferences as they read. Thus, learner-generated elaborations are likely to be more relevant to his or her prior knowledge and purpose for reading the text. On the other hand, author-provided elaborations, such as examples, details, or embellishments, may be more accurate than those generated by the learner because the author is more knowledgeable and more familiar with the topic.

Elaborations either generated by the learner or provided by the author have their merits and drawbacks. For example, learner-generated elaborations have been found in several research studies to facilitate memory and retention. By elaborating on the presented material with their relevant prior knowledge, the subjects in these studies reviewed by Reder, Charney, and Morgan in 1986 show better retention of the material and better understanding of it. However, Reder et al.(1986) also indicated that not all author-provided elaborations supply similar benefits on retention of the central ideas in all learning situations, although they reported that both sources of elaborations do facilitate skill performance. Moreover, Levin reviewed several studies and suggested that with inefficient learners, it is better for an instructor to provide elaborations than to have the students generate them on their own (Levin, 1988). Carroll (1984) also argued that learner-generated elaboration such as "thinking," according to their prior knowledge, can often lead to mistakes while they are acquiring knowledge and skill in the computer domain. Therefore, in some situations learner-generated elaborations may be most effective, while in others author-provided elaborations may be best.

A number of factors contribute to which type of elaboration is most appropriate for a given situation. These include individual differences such as prior knowledge, age, ability, and the learner's own performance objective. Although Weinstein (1982) provided evidence that students can be trained to use elaboration to enhance learning, it remains to be determined whether generalized skills can be taught that would enable students to generate their own elaborators for a variety of procedural learning tasks.

Different Forms of Elaborations

Considerable research has been done in the area of author-provided elaborations to examine the effects of different forms of elaborations including examples, details, and embellishments on fact as well as on skill learning. In fact, not all research on author-provided elaborations has found to impair both kinds of learning. Generally speaking, the research suggests that author-provided elaborations may facilitate memory performance if they are constructed in view of the specific processes operating during testing. For example, an embellishing detail is expected to facilitate access to a super ordinate major idea during free recall while it is accessible itself and possesses sufficiently strong relations to the relevant major idea (van Dam & Brinkerink-Carlier, 1989). Some findings regarding the use of author-provided elaborations have shown the

addition of embellishing details may facilitate future access to the embellished main ideas of a text during learning. For example, Bradshaw and Anderson (1982) found that recall performance for a central fact was better when it was supported by elaborated condition than when it was studied along with unelaborated condition. In addition, recall increases as the number of related details increases and the number of unrelated details decreases (Mohr, Glover, & Ronning, 1984). The results of van Dam & Brinkerink-Carlier's study (1989) indicated that embellishing information supplied in one paragraph may actually increase the accessibility of another paragraph if elaborations allow the plot-irrelevant information to be related to the story. However, Reder (1982) concluded that author-provided elaborations appear to help retention of the main ideas of a text only when subjects are allowed to reconstruct those main ideas during the retention test. Mandl et al. (1984) also argued that elaborated texts facilitated recall and comprehension only when the subjects were very familiar with the topic; otherwise, elaborated texts performed worse than unelaborated ones.

These findings are contrary to those of Reder and J. R. Anderson (1980, 1982), who examined the function of details and the effects of embellishment on memory for the main points of a text. They found, surprisingly, that subjects performed better after studying an abridged or summarized version of the original text than after studying a full, elaborated text. The advantages for summaries were maintained at retention intervals (from 20 minutes to 12 months) as well as in reaction times (subjects answered faster); were superior both for questions directly taken from the text and for inferences that required the subjects to combine facts that had been studied; and yielded better transfer, too. The advantages for summaries were found under a variety of study conditions including a non laboratory setting (Reder, 1982). Performance was superior even on new material when related material had previously been studied in summary form. Two possible causes concluded by Reder and J. R. Anderson (1982) are that (1) reading summaries allows the subject to reread the main points at spaced intervals, and (2) the presence of details distracts the subject's attention away from the critical ideas that should be attended to. In other words, details hurt retention of central ideas within a text when the study time is fixed, although they do increase interest and credibility. Moreover, Reder et al. (1986) found that when people already know what tasks they must perform, they benefit very little from seeing examples and other elaborations in the text.

Despite the assertion that author-provided elaborations may impede fact learning with a fixed study time, Reder, Charney and Morgan (1986) argued that author-provided elaborations may facilitate the domain of skill acquisition. Elaborations in computer documentation, according to Duin (1990), may expand on what the basic concepts are, when these concepts are relevant, and how users apply these to their immediate goals. In fact, elaborations seem most important for subjects learning to select and execute procedures correctly. To facilitate skill-performance, Reder et al. (1986) demonstrated author-provided elaborations for a personal computer that provided the learner with explanations and concrete illustrations of how the skill is performed. They found that these elaborations helped learners solve problems more quickly than minimal manuals without such elaborations. They also reported that only syntactic elaborations that illustrated how correct commands should look helped experienced and novice computer users determine exactly how to implement a procedure. A possible reason why the syntax examples facilitated performance, to the exclusion of the concept elaborations, is that perhaps the syntax examples more closely matched what the subject needed to do.

Consistent with this point of view, in their study to teach writing recursive functions, Pirolli and J. R. Anderson (1985) found that the subjects whose text included examples and explanations of correct syntax performed more efficiently. They suggested that it is the example, which is used to illustrate how to do the task rather than to simply clarify what happens during a skill learning procedure, helps performance. Their protocol data indicated that subjects do rely heavily on examples to guide their solutions to novel and difficult problems. Ross (1984) has shown that performance in a domain of new skill learning is affected by prior examples when these examples match on superficial features. Pepper (1981) reported the surprising findings that the subjects overwhelmingly preferred a verbose and poorly written text (conversational-style) over a concise and well written one (outline-style) because they attempted to look for explanations and examples for help. In a sense, one indicator of good text is the degree to which writers elaborate on a topic with explanations, supporting ideas, and examples (Benton & Blohm, 1986). Pepper (1981) claimed that a technical text, such as a computer documentation, will be more readable and more effective by avoiding technical jargon, writing in a clear and unpretentious style, and incorporating various graphical and textual aids into the body of the text. Thus, a new experimental chapter was written by Pepper according to his guidelines (see Pepper, 1981, p. 263 for a review), and the results showed that the subjects who read the new chapter performed substantially better in their comprehension, and rated the new chapter more favorable than any of the others. Two conclusions that Pepper (1981) suggested for the field of document design are: (1) examples should be used as a tool for bridging the gap between the expert and

the novice; and (2) textbooks should be written for the student, at the student's level, and with the active guidance of the student.

Summing up the findings of previous research, text-based elaborations facilitate in the domain of declarative fact learning and skill performance. To some degree, a useful and important form of elaboration is the example, particularly for helping people learn a procedure. However, several studies have noted that not all types of examples provide the same help. Examples that were found to facilitate performance are those that address syntactic information, and those that clarify how to execute commands in computer-related procedures. For the sake of learners' needs in a procedure learning, providing concrete examples of "how to do" rather than giving concept elaborations dealing with "what they are" can reduce initial learning time. In addition, increasing elaborations in the forms of graphical aids, textual aids, examples, and explanations is effective and preferred by students while learning a computer-related skill.

However, findings on the role of text-based elaborations in learning a procedure are inconsistent. Although the studies previously described indicate that text-based elaboration facilitates learning a procedure from text, other studies provide evidence that unelaborated texts are better for adult learners who are learning new procedures. For instance, some studies in the computer-related domain indicate that text-based elaborations facilitate learning declarative information when the performance measure is either free recall or recall of the main points of the text (Reder, Charney, & Morgan, 1986; Pirolli & Anderson, 1985; Pepper, 1981; Mayer, 1980). In contrast, Carroll (1984, 1990) argues that self-learning procedures from text are more efficient when the text contains no elaboration, or at least very few elaborations, and his findings from several studies have indeed shown an advantage for learning procedures from unelaborated text.

Training

During the 1980's, the problem of training users in the use of computer programs has been the focus of considerable research. Carroll and colleagues (1984, 1987-88) at IBM pointed out several problems that novice computer users had while learning a word processing program. They found novice learners are apt to:

- Be overwhelmed by learning tasks;
- "Jump the gun" to act instead of reading explicit warnings or suggestions;
- Skip the information that cannot be executed;
- Trust their own reason to act instead of reading the instruction;
- Sometimes ignore the screen when following a tutorial step-by-step;
- Have trouble recovering from errors;
- Want to do real work right away and understand "why" and "what" they are doing.

Minimalist Approach. Most computer learners do not want to read through a thick manual or work through an on-line tutorial if they are not interested primarily in the to-be-learned program or system. Impressed by the frustration and failure the trainers observed when novices attempted to learn to use commercial word processing systems by means of the commercial self-study books that accompany them, Carroll et al. (1984) developed and tested the Minimalist Training Model, a model that accommodates and capitalizes on user learning styles and strategies. This is what Carroll called the *Minimalist Approach* which attempts to support active learning by providing concise instruction focused on easy-to-understand goals. According to Carroll, "the key idea in the minimalist approach is to present the smallest possible obstacle to the learner's efforts" (Carroll, 1990, p.77) to learn and acquire competency.

In an earlier set of studies, Carroll et al. (1984, 1985) created the "Minimal Manual" that incorporates elements of the Guided Exploration approach (Carroll, 1984), in order to meet the needs of computer learners in learning a word processing system with "training wheels." By training wheels, Carroll provided new users with a real but easier system with regard to learning to recognize and avoid errors. The training wheels subjects were better able to transfer their skills to perform advanced full-system editing functions and spent less time in error recovery than full system subjects.

Carroll (1984, p.130) outlined five premises for developing computer documentation according to the Minimalist model:

- "slash the verbiage" by eliminating all repetition, summaries, reviews, practice exercises, the index, and the troubleshooting appendix;
- to force coordination of the system and the training;
- to expect every possible error;
- to focus on real tasks and activities; and
- to support error recognition and recovery.

After a series of studies, Carroll et al. (1984, 1985, 1987-88) found that minimal manuals do help learners better coordinate their attention between the system and the manual, better recognize and recover from errors, and better support reference use after training.

Carroll et al.(1984, 1985) advocated a Guided Exploration approach to provide learners with brief training materials that encourage and support learning by exploration. Guided Exploration, based on the principle of Minimal Manual, is a set of brief cards that replace a commercial self-instruction manual. In helping people to use a word processor, Carroll et al. found that brief "guided exploration" cards are more effective than a commercial manual in many respects. Subjects using the cards accomplished more tasks, made fewer errors, spent less time reading and doing the tasks, and recovered more often from errors. Brief guided exploration materials focus users on the steps needed to accomplish basic tasks by encouraging and supporting exploration through easy-to-find procedural information and timely error recognition and recovery advice (Catrambone and Carroll, 1987, p. 170) Recently, Duin (1990) designed a study that investigated the effects of a minimal manual version versus a guided exploration card version of documentation for learning to use a telecommunication system. The results showed that both forms of documentation--the minimal manual and the guided exploration card-- are viable forms for the design and development of computer-related documentation because they both center on the learner by seeking to delete extraneous text. Duin also suggested that while designing documentation, designers should (1) center on functions rather than concepts, (2) think in terms of tasks rather than terms, and (3) develop syntactic rather than conceptual elaborations.

Effective computer documentation should not only allow learners to understand how to perform specific tasks, but should also allow them to create, explore, and integrate knowledge when they use a computer program in the system. While computer programs as a whole are improving, the documentation that accompanies the programs, should improve along with it to better meet learners' needs. Toward this end, we might re-introduce the structure of a manual based on learners' needs by codifying some of the principles which were helpful to the guided exploration learners. Summing up the results of a series of studies, Carroll (1990) concluded and developed the following nine principles of the minimalist approach (see p. 78-93 for a review):

1. Training on real tasks--allow the user select meaningful tasks to work on.
2. Getting started fast--urge getting learners started doing tasks as quickly as possible.
3. Reasoning and improvising--permit self-directed reasoning and improvising in learning process to enrich their own training experience.
4. Reading in any order--eliminate sequence and design materials allowed learners to read and use in any order.
5. Coordination system and training--impel the learners to attend the system during the course of training.
6. Supporting error recognition and recovery--support the recognition of and recovery from errors so that errors will not block the learners.
7. Exploiting prior knowledge--concrete schemes from learner's prior knowledge may motivate and facilitate learning and skill development.
8. Using the situation--let the situation occur naturally rather than protect the learners from experiencing difficulties or errors.
9. Developing optimal training designs--minimize instructional materials that obstruct learning and design the materials to support learner-directed activity and accomplishment.

According to the principle of the minimalist approach, the role of elaboration that Carroll emphasizes is learner-generated elaboration against author-provided elaboration. He encourages learners to engage in active self-elaboration (prompted by incomplete materials for learning, such as summaries from the full text) in order to make information more robust and accessible in memory (Carroll 1990, p. 81). It appears that a main reason the performance in the minimal manual is superior to the commercial self-instruction manual is that it forces learners to make inferences. Actually, Black, Carroll, and McGuigan (1987) found that the Inferential version of the Minimal Instruction Manual yielded better learning than did the Skeletal, the Rehearsal and the Lengthy versions. In particular, they noted that the Lengthy Manual consistently yielded worse performance than the other versions. Thus, continuing research is investigating how different types of inference, such as analogy, proceduralization, and instantiation, affect learning.

In addition, Carroll (1984) stated that "forget the preview and review; studies indicate users can learn more, given less information" (p.125). He strongly recommends eliminating orientational material, including introduction, overview, preview, review, and conceptual elaborations because they obstruct the learner's desire to do something instead of reading about how to do something. He continues, "the minimalist approach urges getting learners started doing projects as quickly as possible, allowing

meaningful and concrete activity to provide intrinsic learning guidance--rather than relying on the extrinsic guidance of conceptual elaboration and practice with numbered steps, techniques that too often become obstacles to learning" (Carroll, 1990, p.81). That is, the Minimalist design presumes that if you give the learner *less* (less to read, less overhead, less to get tangled in), the learner will achieve *more*.

However, a truly minimalist approach--with no previews, with no explanations or elaborations--may not be best in all situations. For example, Reder, Charney, and Morgan (1986) found the evidence that performance in the elaboration-after condition was significantly better than performance in the unelaborated-after condition, where no source of elaborations was available. But in the same study, they also indicated that when subjects already knew what tasks they would perform, they benefited very little from seeing examples and other elaborations in the text. By contrast, Charney and Reder (1987) provided the value of preview that learners who were given a problem first, asked to try to solve it, and shown a solution at the end, learned best.

Therefore, despite its brevity, Wendt (1991) argued that the Minimal Manual (Carroll, 1990) should not be thought of as simply an unelaborated version of the original text for several reasons: (1) information was eliminated that was not task-oriented(e.g., descriptions of the system); (2) information was added to address error recognition and recovery procedures; (3) information was rearranged to support topics of interest to learners; and (4) sometimes procedural details were deliberately specified incompletely or introduced with an invitation to try them and see what would happen.

In conclusion, the effects of minimalist approach cannot separate from the effects of the guided exploration (discovery) approach as well as the emphasis on error recognition and recovery. Nevertheless, using a minimalist approach, people learning a procedure from text are able to acquire competence and perform well on transfer tasks without benefit of many author-provided elaborations. Besides author-provided elaborations, the minimalist approach allows learners to generate their own elaborations during the learning process. That is, author-provided elaborations may facilitate skill learning in some situations, but not others. Therefore, for developing an effective text, it is very important to establish guidelines for determining what types of elaborations are optimal in what situations and when to use them in order to facilitate fact or skill learning.

Minimalist vs Maximalist Approach. To answer the question whether computer manuals should be minimalist and contain only information that is absolutely necessary, or should be maximalist and fully explain unfamiliar concepts and procedures, Wendt (1991) directly compared three versions of texts in order to examine the effects of an original version, as well as an Elaborated and an Unelaborated revisions of an excerpt from a commercial system user's manual on the self-learning procedures from text. First, she summarized the issues that support an extensively elaborated text and those that support a minimally elaborated self-instructional text, and then provided contrasting guidelines for developing an effective text (Wendt 1991, p.36).

The guidelines for supporting an extensively elaborated text to produce an effective, readable text for the learners (at least in the short run) are the following:

- Use concrete examples to support every major and most minor points.
- Use graphical aids such as illustrations and diagrams.
- Use textual aids such as introductions, summaries, and glossaries.
- Use explanations for all definitions, technical terms, solution rules, and procedures.
- Use syntactic elaboration instead of conceptual elaboration to clarify how to perform the to-be-learned procedures.

Guidelines for supporting a minimally elaborated text to help learners get started faster, perform better, make fewer errors, and recover from errors more successfully, are the following:

- Do not embed examples which may be obstructive for the learners.
- Do not include explanations but urge the learners to discover their own.
- Do not provide materials that give the learners a model of correctness; but encourage exploration and support error recovery.
- Do not increase text by adding elaboration but reduce text by eliminating elaboration and instruction for the purpose of requiring the learners to make inferences from the incompletely remaining text.

Wendt (1991) offered a new perspective for evaluating the role of text-based elaboration in the process of self-learning a new procedure by directly comparing the effects of these two approaches on learning the same procedure and performing the same tasks in one study.

According to the guidelines mentioned above, the Elaborated version in Wendt's study included changes, such as (1) reorganizing the content by separating conceptual and procedural information; (2)

adding elaboration in the form of examples, restatements, explanations, an introduction, a summary; (3) adding text-to-graphic references to support both conceptual information and procedural information, (4) adding several examples of using different combinations of connectors to link selection rules; and (5) removing side-margin subheadings. By following the principles of designing minimalist instructions, changes in the Unelaborated version included (1) identifying statements of procedures and rules; (2) deleting all elaboration such as examples, restatements, and descriptions of what the software does as a result of procedures; (3) deleting unnecessary words; (4) deleting introductory text; and (5) deleting side-margin subheadings (Wendt, 1991).

Changes from the Original User's Manual in Wendt's Study

Elaborated Text version	Unelaborated Text version
(1) reorganizing the content by separating conceptual and procedural information	(1) identifying statements of procedures and rules
(2) **adding elaboration--** • examples • restatements • explanations • an introduction • a summary	(2) **deleting all elaboration--** • examples • restatements (actually included three) • explanations • descriptions of what a procedure goes • an introduction • a summary
(3) adding text-to-graphic references to support both conceptual information and procedural information	(3) deleting unnecessary words
(4) adding several examples of using different combinations of connectors to link selection rules	(4) deleting introductory text
(5) removing side-margin subheadings	(5) deleting side-margin subheadings

Consistent with the idea that text-based elaborations facilitate learning declarative information when the performance measure is either free recall or recall of the main points of the text, Wendt indicated in her study that the performance of the Elaborated text on the given tasks was equal or superior to the Original text and the Unelaborated text versions. She found that those who read the Elaborated text achieved a higher percentage of elements correct, more correct solutions, committed fewer errors, did not spend significantly more time reading their text but spent less time working on the application tasks, and rated their text more positively and more consistently. She also indicated that the subjects who studied the Elaborated text continued to perform well as task difficulty increased because the Elaborated text in her design separated conceptual and procedural information and elaborated both types of information that served an important factor in facilitating their understanding. However, she reported that not all subjects who read the Elaborated text performed well. In other words, not all people need elaboration to develop a good understanding in a procedure learning.

While Wendt wanted her subjects to read the instructional text first and then complete the application tasks 'without' the text, however, it belongs to an immediate posttest to test subjects' memory for information acquired via text after study. It occurred to me, that in a real world setting, learners may not need recall text from their memory in order to learn a new computer program. On the one hand, Carroll (1984) argued that if learners go along nose-in-the-book, they will not learn to use the system (p.126). On the other hand, focusing on the learner's primary goal to complete a specific task, learners want to attempt tasks immediately rather than read and remember information for future recall. Therefore, the idea of coordination of the system and the training at the same time should be concerned for further studies.

The Current Study

The purpose of study in this paper is to investigate the effects of augmenting and deleting elaborations in an existing self-instructional text from a computer automated database file. The intent here is to replicate and extend Wendt's (1991) study by asking students to read one of the three self-instructional

texts and complete several given tasks accompanied with the copy of materials in the same period of time instead of an immediate posttest. To increase the power of the analysis, the present study increases the sample size from 21 to 60. The study attempts to discover whether students who learned to use a computer database program from an elaborated text did better than students who learned from an unelaborated one.

Learner-generated elaborations were not included in the texts, since it is too difficult to control for differences in learner's prior knowledge. The present study will exclude all types of learner-generated elaborations in favor of author-provided elaborations. The types of elaborations provided by the experienced author in the study are those directly included in the material to-be-learned for the purpose of facilitating a more complete and accurate understanding of the material itself, and appropriate application to individual tasks. Specially, the research questions asked here are: (1) will author-provided elaborations facilitate the learners' performance on given tasks in a self-learning procedure from text? (2) will the elaborated text be more effective than the unelaborated text during the self-learning procedure? (3) will the amount of text-based elaboration differentially affect performance on the given tasks while the difficulty of the tasks increases?

Method

The present study sought to extend the previous investigation by Wendt (1991) to examine whether students who learn from an elaborated text do better on performance of a computer database application than students who learn from an unelaborated text. A purpose of this study was to replicate previous findings reported by Wendt (1991), so the materials used here are similar, with the exception of the number of the subjects and the way of the procedures.

Subjects

Sixty undergraduate students from the Department of Psychology at the University of Minnesota completed the study. Students received research participation points as well as five dollars for participating. The subjects varied widely in their prior general experience with computers; however, they had no prior experience with the Microsoft Works Database application.

Materials

The database. Subjects used a database file of 25 records created in the Microsoft Works Database program in conjunction with the six application tasks Although all 25 records contained the same 15 fields, data in each field were different from one record to another. The contents of the 15 fields within each record, including name, title, company, and desired sessions, consisted of fictitious information from a registration form requested for a training workshop.

The Original text. The text was adapted from the Microsoft Works User's Manual (1989), an instructional text provided for the learners to use and apply the computer software--Microsoft Works. In this study, the six pages that explain how to use the *Selection Rules* to locate and retrieve desired information from the database file were excerpted from the User's Manual. Two versions were created from the Original Text by Wendt (1991) according to the guidelines she set (discussed in the previous section). One was an Elaborated Text version that was developed using the guidelines for an extensive Elaboration approach. The other was an Unelaborated Text version developed using the guidelines for designing minimalist instructions.

Elaborated text version. The Elaborated Text version was extended to twenty-two pages long. According to the guidelines established by Wendt (1991), the Elaborated Text version was developed from the Original Text in three steps:

First, the content from the Original Text was analyzed and outlined. There were four major areas identified: (1) deciding selection rules; (2) entering selection rules; (3) connecting selection rules; and (4) making changes.

Second, a terminal performance objective was identified and a learning hierarchy was constructed. Since the terminal performance objective in the learning procedure was to retrieve records from a database file by using selection rules, a learning hierarchy that showed the prerequisite relationships among the skills to-be-learned played an important role. As a result, the Elaborated Text version was constructed with the following components: (1) an introduction; (2) how to create a single selection rule; (3) how to enter a single selection rule; (4) how to use combinations of selection rules; (5) how to enter multiple selection rules, (6) how to make changes; and (7) a summary.

Third, syntactic elaborations (rather than conceptual elaborations) were created and extensive elaborations were provided to support the explanations of procedures (such as how to create a single

selection rule and how to link selection rules using connectors). The most frequently used type of elaboration was examples (e.g., create the pairs of correct and incorrect examples in terms of supplementing the explanation of why the incorrect examples were not right).

There were some elaborations that provided additional content which dealt with how to use the connectors in these ways. To begin with, some examples were given to explain the use of connector "And." Ther, some examples were given to explain the use of connector "Or." Finally, several examples using a combination of the two connectors were given and explained.

Unelaborated text version. The Unelaborated Text version was six pages long. Working from the Original Text, this version was created according to the principles of designing minimalist instructions: (1) identify statements of procedures and rules; (2)delete all elaborations including examples, restatements, explanations, and descriptions of what a procedure goes; (3) delete introductory text; (4) delete unnecessary words; and (5) delete side margin subheadings.

As a result, 114 lines of text in the Original Text were reduced to 75 lines of text. However, the format of the original text was maintained in the Unelaborated Text version. After a pilot study, the Unelaborated Text was revised by adding three restatements (1) to explain the definition of "record comparison information"; (2) a step in the procedure for entering a selection rule on the computer screen; and (3) how the connectors interacted when they were used together. In spite of these additions, it was consistent with the principle of minimalist approach advocated by Carroll (1990), including error recognition and recovery procedures.

A comparison of frequencies of different types of elaboration across the three different types of texts is listed in the following table. Three illustrations that provided important navigation information were included in all three versions .

Comparison of Frequencies of Different Types of Elaboration

Types of Elaborations	Original Text (6 pages)	Elaborated Text (22 pages)	Unelaborated Text (6 pages)
Boldface Types	2 items	all items	all items
Italics	yes	yes, with some single and double underline	yes, with only 1 single underline
Graphical Illustrations	3	3	3
Textual Examples	6	31	0
Marginal Comments	6	0	0
Paraphrases and Restatements	0	10	3
Headings	4	7	5
Summaries	0	1	0
Overviews	1	7	5
Intertextual References	1	1	1
Text-to-Graphic References	2	18	3

Background information and prior experience questionnaire. This questionnaire contained six questions asking the participants to provide (1) academic major, (2) year in school, (3) status (full or part-time student), (4) prior experience with computer hardware,(5) prior experience with computer software for what purpose, and (6) prior experience with the Microsoft Works database application.

Background information about these materials preface. A three-page supplement to the text was created to demonstrate what a database is, how it works, and to explain the contents of the database file that would be used in the study. The same three-page supplement was placed directly above each text and marked as pages 1, 2 and 3. Initially, page 1 established a context both for the reading of text and the given application tasks in order to provide a general overview of this study. Page 2 explained how information is organized in a database file, and provided an example for subjects to distinguish two key terms: records and fields. Page 3 listed the 15 fields with their definitions. Therefore, the text that described the use of selection rules always started on page 4.

Application tasks. There were six application tasks designed to test subjects' understanding of the information, procedures provided in the text, and their ability to apply the information in the computer setting. For example, task 1 asked: "Who is coming from IBM?" which required subjects to retrieve the records of the persons who were coming from IBM. Since IBM belongs to a "company" (its corresponding *field*), subjects should have selected "company" from the *field* first, chosen "equals to" from the *comparison phrases*, and then typed "IBM" in the box of *record comparison information*. This task was the simplest one, which used only one selection rule without any logical connectors. Task 2 asked: "Which companies are sending either the President or the CEO?" which required retrieving the records of companies that were sending the persons whose title was either President or CEO. Since the box for *record comparison information* can only hold one instruction at a time, subjects were required to use a *logical connector* "Or" to link the person whose "title" "equals to" "President" and whose "title" "equals to" "CEO". Therefore, two selection rules were used in this task.

The difficulty level of the tasks on the list increased by (1) increasing the number of selection rules required to complete a task; and (2) increasing the correct use of logical connectors to combine the selection rules. The following table (adapted from Wendt 1991, p.48) shows the increase in difficulty by task. To clarify, when rules are linked with a combination of 'And' and 'Or', the program will locate only those records that satisfy all the Selection Rules continuously linked by 'And'. When it sees the Connector 'Or', it will begin a new and separate search for these records.

Dimensions of Difficulty in the Application Tasks

Task Number	Selection Rules	Logical Connectors
1	1	0
2	2	1 - Or
3	3	2 - And, And
4	4	3 - And, Or, And
5	5	4 - And, Or, And, And
6	6	5 - And, And, And, And, And

Attitude survey. The attitude survey was composed of six questions. Responses were recorded by subjects using a six-point scale. Four of the questions used by Pepper (1981) were adapted in order to compare the results. These four questions asked the subjects (1) how easy the text was to understand, (2) how well the material was "taught" by the text, (3) how well reader's questions were answered, and (4) asked for an "overall" rating. In addition, two questions were added to obtain feedback on the examples and text-to-graphic illustrations, since many of them were added to the Elaborated Text version.

Design

This study involved a single independent variable with three levels: *Original Text version, Elaborated Text version* and *Unelaborated Text version.* The dependent measures within the study were (1) percentage scores of elements correct on each of six application tasks, (2) number of correct solutions across all application tasks, (3) total time spent on reading the text and working with the application tasks, and (4) results on an attitude survey. The results of each of the six performance tasks were analyzed in a repeated measures fashion with one between-subjects factor ("Version" with three levels) and one within-subjects factor ("Task" with six levels). One-way ANOVAs were used to analyze the results for each of the other measures, with Version as the independent variable. Results of mean scores across the three versions from attitude survey were also analyzed with one-way ANOVA and presented in simple descriptive format.

Procedures

The study was conducted individually in one session approximately 60 - 90 minutes in length. Sixty copies of materials, including 20 of the Original Text, 20 of the Elaborated Text, and 20 of the Unelaborated Text versions, were prepared prior to the study and placed in unmarked, brown envelopes. To achieve random distribution, all envelopes were repeatedly shuffled so that subjects studied one text in each of the three conditions: Original, Elaborated or Unelaborated Text version.

After completing a Consent Form, a Background Information Questionnaire, and an Experience Questionnaire, each participant was asked to read the first three pages of materials (that provided information about what a database is and how to perform the procedures in the study). No time limitation was imposed as subjects familiarized themselves with the content of these three pages. When a subjects was ready, a list of tasks was given and he/she was directed to read either an Original, an Elaborated or an Unelaborated

instructional text of Microsoft Works Database application, and to complete the six given tasks within an hour. The instructional texts were available at the same time that the subjects were completing the tasks. Subjects were allowed to mark or underline the text while reading if they so desired, but they could not ask any questions. When the hour was up, subjects were told to stop working, whether they completed all the application tasks or not. Subjects could stop at any time during the session if they finished the tasks earlier. Then, the six-item attitude survey was given. Participants were asked to rate each question with "1" being the most negative reaction and "6" being the most positive reaction. Finally, each subject received research participation points, as well as five dollars, for participating,. Subjects were also given a copy of the Education Debriefing Form that briefly summarized the rationale of this research on the role of elaboration, and provided references and additional sources of information on this research topic.

Results

Mean Percentage of Elements Correct on Each Application Task

Table 1 presents the mean percentage of elements correct for each text version and application task. Results of a repeated measures ANOVA using Versions (Original, Elaborated, and Unelaborated) as the between-subjects factor and Task (1 to 6) as the within-subjects factor was shown in Table 2 as follows: the between-subjects factor of Version was not significant [$F(2, 57) = .36$, $p = .701$, $MS_e = 2597.28$]; the within-subjects factor of Task was significant [$F(5, 285) = 22.22$, $p < .001$, $MS_e = 421.05$], while the Version by Task interaction effect was not [$F(10, 285) = .90$, $p = .530$, $MS_e = 421.05$].

Table 1: Mean Percent of Elements Correct for Each Version and Task

Text Version	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task Mean
Original (n=20)	100%	91.45%	85.45%	66.60%	70.80%	60.75%	78.800%
Elaborated (n=20)	100%	91.45%	77.30%	72.95%	82.45%	72.10%	82.708%
Unelaborated (n=20)	95.05%	87.15%	73.60%	63.30%	77.15%	67.10%	78.342%
Total Mean (n=60)	98.35%	90.02%	78.78%	67.62%	76.80%	66.65%	79.703%

Table 2: Analysis of Variance for Percentage of Elements Correct

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	P
Between Subjects					
Version	1854.16	2	927.08	.36	.701
Subjects Within Groups	148044.88	57	2597.28		
Within Subjects					
Task	46788.95	5	9357.79	22.22	.000*
Version x Task	3806.74	10	380.67	.90	.530
Task x Subjects Within Groups	120000.48	285	421.05		

A follow-up series of t-tests was run pairwise across the six tasks. A Bonferroni procedure was used to control Type I error resulting in alpha = .01. Results of the follow-up t-tests to the "Task" repeated measures effect are shown in Table 3. To summarize Table 3, there were significant difference between Task 1 and Tasks 2, 3, 4, 5, and 6; similarly, Task 2 was different from Tasks 3, 4, 5, and 6. Moreover, Task 4 was significantly different from Tasks 3 and 5.

Table 3: Pairwise t-tests (df = 59) Among the Six Tasks
(alpha = .01, using Bonferroni adjustment)

Task	Task 2	3	4	5	6
1	t = 4.11 p = .000*	t = 5.68 p = .000*	t = 8.97 p = .000*	t = 5.80 p = .000*	t = 6.63 p = .000*
2		t = 3.28 p = .002*	t = 6.88 p = .000*	t = 4.06 p = .000*	t = 5.71 p = .000*
3			t = 3.29 p = .002*	t = .54 p = .594	t = 2.44 p = .018
4				t = -2.85 p = .006*	t = .22 p = .824
5					t = 2.47 p = .016

Number of Correct Solutions

"Number of Correct Solutions" means the number of subjects who achieved 100% elements correct for each task in each text version group. Table 4 shows the number of correct solutions for each version and task. However, there was no difference between tasks in terms of the total number of correct solutions [$F(2,57) = .573$, $p = .567$, $MS_e = 3.227$].

Table 4: Number of Correct Solutions for Each Version and Task

Text Version	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Total
Original (n=20)	20	15	14	5	7	9	70
Elaborated (n=20)	20	14	10	6	8	13	71
Unelaborated (n=20)	17	12	9	4	9	9	60

Total Time Spent Reading and Working on Tasks

Table 5 presents the mean time spent for each text version group. The result shows no differences for total time on reading and working the tasks among the three Text Versions [$F = .175$, $p = .840$, $MS_e = 125.507$].

Table 5: Mean Time Spent Reading and Working on Tasks

Text Version	Time
Original	46.15 min.
Elaborated	48.15 min.
Unelaborated	46.60 min.

Attitude Survey

Table 6 presents the results of the attitude survey ("1" was the least favorable reaction and "6" was the most positive reaction). The data seems to indicate that not all subjects needed examples or illustrations for help among the three conditions. Although on average subjects in all three groups rated the texts in a positive way, the ANOVA on mean attitude score across the three versions was non-significant [$F(2, 57) = .224$, $p = .800$, $MS_e = 1.024$]. No differences are on each question among the three versions, either.

Table 6: Ratings of the Three Text Versions

Questions of Attitude Survey	Text Version: Original Mean	Original Range	Elaborated Mean	Elaborated Range	Unelaborated Mean	Unelaborated Range
1. Easy to Understand	3.65	1-6	3.85	2-6	3.55	1-5
2. Taught Material Well	4.10	2-6	4.10	2-6	3.85	1-6
3. Answered Questions	3.65	1-6	3.95	2-6	3.85	1-6
4. Illustrations Helpful	4.05	1-6	4.15	2-6	4.35	3-6
5. Examples Helpful	4.05	1-6	4.20	2-6	3.75	2-6
6. Overall	3.90	2-6	4.15	2-6	3.85	1-6
Group Mean of Attitude	**3.90**		**4.07**		**3.87**	

Discussion

The present study examined the effect of varying degrees of text elaborations on self-directed student learning, to learn to use a computer database application. Using guidelines from Wendt's (1991) study, an Elaborated Text and an Unelaborated Text were developed from an original commercial system user's manual. Subjects completed six applied tasks by reading one of the three instructional text versions, and completed an attitude survey at the end.

The results of the current study not only deviate from Wendt's findings (which supported the effects of elaboration on self-directed learning from text), but also differ from Carroll's approach, which suggests the minimalist manual's superiority to the commercial self-instruction manual. The effects of task in a 3(Version) x 6(Task) repeated-measures ANOVA was significant, while both the Version and the Version x Task interaction were not. No differences among conditions were found for treatment with the following dependent variables: (a) percentage of elements correct on each of six performance tasks, (b) number of

correct solutions across all performance tasks, (c) total time spent reading and working on the application tasks, and (d) results on attitude survey. It seems that the advantages of elaborations on computer documentation do not produce the same effect when subjects can complete the application tasks accompanied by the instructional text. That is, unlike Wendt's results, subjects who read manuals containing extensive elaborations in the present study did not out-perform subjects who read manuals with less elaboration. And, unlike Caroll's findings (1984, 1985, 1987-88, 1990), subjects who read the unelaborated manual did not perform better than subjects who read the longer, elaborated manual.

A possible reason for the differences in results reported by Wendt (1991) is that the present study involved simultaneously completing the tasks and reading the text in order to simulate goal-oriented learning in a real-world setting. Subjects in the current study attempted the application tasks accompanied by the text instead of reading the text first and then working on the tasks without using reading materials. This was done to maximize the external validity of the study, because few people learn to navigate a new computer program by memorizing an instructional text. In Wendt's study, results focused on the effectiveness of elaborations on recall and retrieval of the main points of the text. In the current study, the investigation focused on whether text-based elaborations facilitate procedural learning while learning a new computer program in a real-world setting.

An analysis of subjects' performance on the easier versus the more difficult tasks gives additional information. The six application tasks were created based on a learning hierarchy for the procedural learning, and most subjects correctly completed the easiest task, which required the use of only one single selection rule. As task difficulty increased, subjects were required to construct and input more rules, as well as combine those rules by using the correct connectors.

Results show that each of the six tasks seemed successively more difficult, but Task 4 appeared the most difficult. The reason for this might be not attributed to subjects' understanding of the logical concepts of the connectors 'And' and 'Or', rather than how to select and input the rules. Task 4 asked "Who is coming from Texas and California that is attending the Session on Topic C?" It required retrieving the records of the persons who come from the states of either the Texas or California, but they should attending Topic C. Many subjects used the following rules:

the persons whose	"state" "equals to" "Texas"
'Or'	"state" "equals to" "California",
'And'	"attending Topic C" "equals to" "yes".

Using these rules, the answer obtained shows the persons who come from Texas but not attending the session on Topic C, because the connector 'And' only linked with the last two rules: "state equals to California" and "attending Topic C". The correct rules are the following:

the persons whose	"state" "equals to" "Texas"
'And'	"attending Topic C" "equals to" "yes".
'Or'	"state" "equals to" "California",
'And'	"attending Topic C" "equals to" "yes".

Four selection rules with three connectors should have been used in this task.

There were six examples given in the Elaborated text, three examples in the Original Text, and none in the Unelaborated text. The investigator expected that the subjects using the Elaborated text would perform better because more examples were provided that supported the solution. As a result, subjects who read the Elaborated Text version scored 72.95% of elements correct in Task 4, compared with a score of 66.60% of elements correct for subjects who read the Original Text version and 63.30% of elements correct for subjects who read the Unelaborated Text version. However, these differences were not statistically significant. When looking at the number of correct solutions on the same task, only 6 out of 20 subjects got every item correct in the Elaborated Text group, only 5 of them got every item correct in the Original Text group, and 4 of them got every item correct in the Unelaborated group. The performance on Task 4 was poor across all three conditions. This finding did not support the view that using examples is an important tool for bridging the gap between the expert and the novice.

Regarding the number correct across the three conditions, the Elaborated and Original Texts produced fairly similar performances, but performance wasn't significantly better than those in the Unelaborated Text condition. In addition, when looking at the total time subjects spent reading and working on the tasks, the investigator assumed that subjects who studied the 22-page Elaborated Text would spend more time reading than those who had the Unelaborated Text and the 6-page Original Text. The results show that subjects who had the Elaborated Text spent, on average, only 1-1/2 to 2 minutes more time reading than subjects who had the Unelaborated Text and the Original Text. However, comparing the combined times of reading and working on tasks for each group in Wendt's study, on average, subjects in the Original Text group spent the most total time (58.13 min.), while subjects in the Unelaborated Text

group spent the least total time (37.22 min.) and subjects in the Elaborated Text group spent the second least total time (41.57 min.). Wendt reported that as compared to those who read the other text versions, those who read the Elaborated Text performed better than the other versions but did not spend significantly more time reading their text (26.57 min. while 28.28 min. in the Original group) and spent less time (15.00 min.) working on the application tasks (when 20.57 min. in Unelaborated group and 29.85 min. in the Original group). To compare the learning efficiency of the performance among the three groups in the current study, the data, calculated from the mean percentage of elements correct for tasks of each subject divided by the total time he or she spent, shows that, on average, the Original Text group achieved 1.98% elements correct per minute, while the Elaborated Text group achieved 1.80%, and the Unelaborated Text group achieved 1.83% elements correct per minute. The result, differs from Wendt's, indicates that people who read the elaborated text did not demonstrate better learning efficiency.

Subjects' overall ratings of the Text on the attitude survey showed no differences among the three versions. However, subjects who read the Elaborated Text rated a positive score of 4.20 to '*examples helpful*' on a 6.00 scale, but this was not statistically significant. This result suggests that not all examples facilitate procedural learning. On the other hand, subjects who read the Unelaborated Text rated a positive score of 4.35 to '*illustrations helpful*' on a 6.00 scale, but this was not of higher statistical significance than subjects who read the other text versions (even though all the three text versions had the same illustrations). It is interesting to note that examples may not always be necessary because when subjects cannot locate relevant examples, they tend to use rules from the illustrations. That is, examples and illustrations of elaborations may be helpful in some situations, but not all. Moreover, the wide spread in Attitude ratings of the three text versions indicate that both Elaborated and Unelaborated Text versions have room for improvement Since attitude ratings indicated that there were positive and negative aspects of the texts, it would be useful to identify these features and create new texts that more adequately address learner needs.

Conclusion

In conclusion, the absence of a significant difference in the task performance across the three text versions suggests that not all people require elaborations to develop a good understanding of procedural learning. A possible reason for this finding is that the advanced use of logical connectors became too complex for some subjects since all groups had a consistently low performance on Task 4. Alternatively, some of the tasks might have been so simple that they did not require elaboration. This assertion is supported by the finding that subjects who read the Unelaborated Text without any examples did not perform worse than other groups.

The absence of differences across the three versions may also be affected by the fact that all subjects were college students. Generally speaking, younger subjects may need more elaborations than adults because, in the absence of elaborations, adults may try to find other ways to solve their problems. In addition, it's possible that, in general, adults may have had more computer experience than children. According to the background information provided by subjects for this study, at least 90% of them had some experience with other computer software applications (which may have used similar navigational tools). Obviously, the more prior computer experience individuals have, the easier it is for them to navigate throughout a new computer application. Therefore, conducting further research with younger subjects and/or individuals with less computer experience may produce different results on the effect of the elaborations.

It would also be useful to conduct a study in which additional versions of the text were created in order to isolate specific types of changes. For example, it would be interesting to add a combination version of the use of elaborations with more examples and the use of a minimal approach with less statements to see what kinds of instructional text would successfully facilitate skill learning. Another idea for a future study was suggested by Redish in 1987. She suggested that on-line tutorials that display instructional texts directly on the computer screen would be a fascinating area for research on a document that combines aspects of reading to learn and reading to do. Moreover, additional questions could be added to the Attitude Survey and the responses used to improve the texts.

It would also be interesting to conduct a study in which an additional posttest or delayed posttest was administered to examine the effects of elaborations on transferring a skill. Additional factors (such as age) should be considered while designing a new study. It would be useful to determine which features of the extensive elaboration approach and the minimalist approach work best for different types of users, different types of computer programs, and different types of procedural learning.

References

Anderson, J. R. (1976). *Language, memory, and thought.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Anderson, J. R. (1982). Acquisition of cognitive skill. *Psychological Review*, **89**(4) 369-406.

Anderson, J. R., & Reder, L. M. (1979). An elaborative processing explanation of depth of processing. In L. S. Cermak & F. I. M. Craik (Eds.), *Levels of processing in human memory.* Hillsdale, NJ: Erlbaum. 385-403.

Blohm, P. J., & Benton, S. L. (1986, April). *Effect of composing condition and level of question on measures of conceptual elaboration in informational writing.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Benton, S. L., & Blohm, P. J. (1988). Elaboration of ideas in prose production. *Journal of Experimental Education*, **56**(2), 60-66.

Beuhring, T., & Kee, D. W. (1987). Developmental relationships among metamemory, elaborative strategy use, and associative memory. *Journal of Experimental Child Psychology*, **44**, 377-400.

Black, J. B., Carroll, J. M., & McGuigan, S. M.(1987). What kind of minimal instruction manual is the most effective. *CHI + GI*, **1987**, 159-162.

Bradshaw, G. L., & Anderson, J. R. (1982). Elaborative encoding as an explanation of levels of processing. *Journal of Verbal Learning & Verbal Behavior*, **21**, 165-174.

Catrambone, R. & Carroll, J. M. (1987) Learning a word processing system with training wheels and guided exploration. *CHI + GI*, **1987**, 169-174.

Carroll, J. M. (1984). Minimalist training. *Datamation, 30,* 125-136.

Carroll, J. M. (1985). Minimalist design for active users. *Human-Computer Interaction - INTERACT '84* / B. Shackel (Eds.), Elsevier Science Publishers B. V. (North-Holland).

Carroll, J. M. (1990). *The nurnberg funnel: Designing minimalist instruction for practical computer skill.* Cambridge, Massachusetts: The MIT Press.

Carroll, J. M., Smith-Kerker, P. L., Ford, J, R., & Mazur-Rimetz, S. A. (1987-88). The minimal manual. *Human Computer Interaction*, **3**, 123-155.

Charney, D., & Reder, L. (1987). Current research in technical communication. *Technical Communication*, **34**, 52-53.

Duin, A. H. (1990). Computer documentation--centering on the learner. *Journal of Computer-Based Instruction*, **17**(2), 73-78.

Fisher, R. P., & Craik, F. I. M. (1980). The effects of elaboration on recognition memory. *Memory & Cognition*, **8**(5), 400-404.

Gagne, E. (1985) *The cognitive psychology of school learning.* Boston, Massachusetts: Leiile, Brown and Company.

Gagne, R. M., & Briggs, L. J. (1979). *Principles of instructional design.* New York, New York: Holt, Rinehart and Winston.

Glover, J. A., & Burning, R. H. (1990). *Educational psychology: Principles and applications.* Glenview, Illinois: Scott, Foresman and Company.

Goetz, E. T., Alexander, P., & Burns, C. W. (1988). Elaborative strategies: Promises and dilemmas for instruction in large college classes. *Reading Research and Instruction*, **27**(2), 62-69.

Lewis, M. W., & Anderson, J. R. (1985). Discrimination of operator schemata in problem solving: Learning from examples. *Cognitive Psychology*, **17**, 26-65.

Klein, S. B., & Kihlstrom, J. F. (1986). Elaboration, organization, and the self-reference effect in memory. *Journal of Experimental Psychology: General*, **115**(1), 26-38.

Larson, C. O., Dansereau, D. F., O'Donnell, A. M., Hythecker, V. I., Lambiotte, J. G., & Rocklin, T. R. (1985). Effects of metacognitive and elaborative activity on cooperative learning and transfer. *Contemporary Educational Psychology*, **10**, 342-348.

Levin, J. R. (1988). Elaboration-based learning strategies: Powerful theory = powerful application. *Contemporary Educational Psychology*, **13**(3), 191-205.

Lockhart, R, S. & Craik, F. I. M. (1990). Levels of processing: A retrospective commentary on a framework for memory research. *Canadian Journal of Psychology*, **44**(1), 87-112.

Lynch, S., & Rohwer, Jr. W. D. (1971). Effects of verbal and pictorial elaborations on associative learning and response learning in a children's paired associate task. *Journal of Educational Psychology*, **62**(4), 339-344.

Mandl, H., Schnotz, W., & Tergan, S. (1984, April). *On the function of examples in instructional texts.* Paper presented at AERA meeting, New Orleans.

Mayer, R. E. (1980). Elaboration techniques that increase the meaningfulness of technical text: An experimental test of the learning strategy hypothesis. *Journal of Educational Psychology*, **72**(6), 770-784.

McDaniel, M. A. (1984). The role of elaborative and schema processes in story memory. *Memory & Cognition*, **12**(1), 46-51.

Merrill, M. D., Tenneyson, R. D., & Posey, L. O. (1992) *Teaching concepts: An instructional design guide. Second edition.* Educational Technology Publications, Inc., Englewood Cliffs, New Jersey.

Miller, R. B., & McCown, R. R. (1986). Effects of text coherence and elaboration on recall of sentences within paragraphs. *Contemporary Educational Psychology*, **11**(3), 127-138.

Mohr, P. M., Glover, J. A., & Ronning, R. R. (1984). The effect of related and unrelated details on the recall of major ideas in prose. *Journal of Reading Behavior*, **16**(2), 97-108.

O'Donnel, A. M., Dansereau, D. F., Rocklin, T. R., Hythecker, V. I., Lambiotte, J. G., Larson, C. O., & Young, M. D. (1985). Effects of elaboration frequency on cooperative learning. *Journal of Educational Psychology*, **77**(5), 572-580.

Palmere, M., Benton, S. L., Glover, J. A., & Ronning, R. R. (1983). Elaboration and recall of main ideas in prose. *Journal of Educational Psychology*, **75**(6), 898-907.

Pepper, J. (1981). Following students suggestions for rewriting a computer programming textbook. *American Educational Research Journal*, **18**(3), 259-269.

Phifer, S. J., McNickle, B., Ronning, R. R., & Glover, J. A. (1983). The effects of details on the recall of major ideas in text. *Journal of Reading Behavior*, **15**(1), 19-30.

Pirolli, P. L., & Anderson, J. R. (1985). The role of learning from examples in the acquisition of recursive programming skills. *Canadian Journal of Psychology*, **39**(2), 240-272.

Pressley, M. (1982). Elaboration and memory development. *Child Development*, **53**, 296-309.

Pressley, M., McDaniel, M. A., Turnure, J. E., Wood, E., & Ahmad, M. (1987). Generation and precision of elaboration: Effects on intentional and incidental learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **13**(2), 291-300.

Pressley, M., Symons, S., McDaniel, M. A., Snyder, B. L., & Turnure, J. E. (1988). Elaboration interrogation facilitates acquisition of confusing facts. *Journal of Educational Psychology*, **80**(3), 268-278.

Reder, L. M. (1979). The role of elaborations in memory for prose. *Cognitive Psychology*, **11**, 221-234.

Reder, L. M. (1980). Elaboration techniques that increase the meaningfulness of technical text: An experimental test of the learning strategy hypothesis. *Journal of Educational Psychology*, **72**(6), 770-784.

Reder, L. M. (1980). The role of elaboration in the comprehension and retention of prose: A critical review. *Review of Educational Research*, **50**(1), 5-53.

Reder, L. M. (1982). Elaborations: What do they help and when do they hurt? *Text*, **2**, 211-224.

Reder, L. M., & Anderson, J. R. (1980). A comparison of texts and their summaries: Memorial consequences. *Journal of Verbal Learning & Verbal Behavior*, **19**, 121-134.

Reder, L. M., & Anderson, J. R. (1982). Effects of spacing and embellishment on memory for the main points of a text. *Memory & Cognition*, **10**(2), 97-102.

Reder, L. M., Charney, D. H. & Morgan, K. I. (1984). The role of elaborations in learning a skill from an instructional text (Tech. Rep. No. 1). *Pittsburgh: Carnegie-Mellon University.*

Reder, L. M., Charney, D. H. & Morgan, K. I. (1986). The role of elaborations in learning a skill from an instructional text. *Memory & Cognition*, **14**(10), 64-78.

Redish, J. C. (1988). Reading to learn to do. *The Technical Writing Teacher*, **15**(3), 223-233.

Rohwer, W. D., Jr., & Ammon, M. S. (1971). Elaboration training and paired -associate learning efficiency in children. *Journal of Experimental Psychology*, **62**, 376-383.

Rohwer, W. D., Jr., & Rabinowitz, M., & Dronkers, N. F. (1982). Event knowledge, elaborative propensity, and the development of learning proficiency. *Journal of Experimental Child Psychology*, **33**, 492-503.

Ross, B. H. (1984). Remindings and their effects in learning a cognitive skill. *Cognitive Psychology*, **16**, 371-416.

Shallert, D. L., Alexander, P. A., & Goetz, E. T. (1988). Implicit instruction of strategies for learning from text. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.) *Learning and study strategies: Issues in assessment, instructions, and evaluation.* New York, New York: Academic Press, 193-214.

Shuell, T. J. (1988). The role of the student in learning from instruction. *Contemporary Educational Psychology*, **13**, 276-295.

Stein, B. S., Morris, C. D., & Bransford, J. D. (1978). Constraints on effective elaboration. *Journal of Verbal Learning & Verbal Behavior*, **17**, 707-714.

Stein, B. S., & Bransford, J. D. (1979). Constraints on effective elaboration: Effects of precision and subject generation. *Journal of Verbal Learning & Verbal Behavior*, **18**, 769-777.

Stein, B. S., Littlefield, J., Bransford, J. D. & Persampieri, M. (1984). Elaboration and knowledge acquisition. *Memory & Cognition*, **12**(5), 522-529.

Suzuki-slakter, N. S. (1988). Elaboration and metamemory during adolescence. *Contemporary Educational Psychology*, **13**, 206-220.

Taylor, A. M. & Turnure, J. E. (1979). Imagery and verbal elaboration with retarded children: Effects on learning and memory. In N. R. Ellis (Eds.), *Handbook of mental deficiency, psychological theory and research* , 659-697. Hillsdale, NJ: Erlbaum.

Turnure, J. E. (1971). Types of verbal elaboration in the paired-associate performance of educable mentally retarded. *American Journal of Mental Deficiency*, **76**(3), 306-312.

Using Microsoft Works: Version 2.0. (1988). Redmond, Washington: Microsoft Corporation.

van Dam, G., & Brinkerink-Carlier, M. (1989). The influence of self-cueing on recall of a text containing both plot-relevant and plot-irrelevant materials. *The Journal of General Psychology*, **116**(1), 109-119.

van Dam, G., & Brinkerink-Carlier, M. (1990). The influence of experimenter-provided elaborations on recall of plot-irrelevant paragraphs from a text. *The Journal of General Psychology*, **117**(1), 15-25.

Weinstein, C. E. (1978). Elaboration skills as a learning strategy. In H. F. O'Neil, Jr. (Eds.), *Learning strategies*. New York: Academic Press. 31-55.

Weinstein, C. E. (1982). Training students to use elaboration learning strategies. *Contemporary Educational Psychology*, **7**, 301-311

Wendt, K. K. (1991). The effect of elaboration on self-learning procedures from text. An unpublished Master thesis from University of Minnesota.

Whitney, P. (1987). Psychological theories of elaborative inferences; implications for schema-theoretic views of comprehension. *Reading Research Quarterly*, **22**(3), 299-310.