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ABSTRACT

The effectiveness of mapping for middle school students was tested, using 11 eighth graders who were taught to map short expository prose passages during approximately 12 hours of instruction. Mapping is an innovative reading comprehension strategy in which students identify the important relationships defining the text structure and re-represent the interconnected ideas symbolically, thereby producing a diagrammatic representation of text meaning. In a static group comparison, the subjects who mapped two passages recalled a greater proportion of idea units than did the control subjects, who used their own preferred reading strategy. The differences in recall were statistically significant for the 24-hour delayed recall following one passage, and approached significance for the immediate recall following the second passage. For both passages, the probability of recalling mapped idea units was significantly greater than the probability of recalling unmapped idea units. These results suggest that the mapping strategy may help students process text in a way that facilitates recall. (Author/RL)

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Technical Report No. 160

THE EFFECT OF MAPPING ON THE FREE RECALL OF EXPOSITORY TEXT

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Abstract

This is an exploratory study of the effectiveness for middle school students of an innovative reading comprehension strategy called Mapping. In Mapping, students identify the important relationships that define the text structure and re-represent the interconnected ideas symbolically, thus yielding a diagrammatic representation of text meaning.

In this investigation, 11 eighth graders were taught to map short expository prose passages during approximately 12 hours of instruction. In a static group comparison, subjects who mapped two passages recalled a greater proportion of idea units than did control subjects who used their own preferred reading strategy. The difference was statistically significant for the 24-hour delayed recall following one passage and approached significance for the immediate recall following the second passage. For both passages, the probability of recall of mapped idea units was significantly greater than the probability of recall of unmapped idea units. These results suggest that Mapping may help students process text in a way that facilitates recall. Other evidence regarding eighth graders' comprehension of various relationships in text is presented.

The Effect of Mapping on the Free Recall of Expository Text

The purpose of this investigation was to answer general questions about the effectiveness of Mapping the relationships among ideas in expository text for middle school students. The most interesting question was whether middle school students could use the technique to help them comprehend and recall expository text. Another question was what problems middle school students would encounter while learning to map prose. Before reporting the study, the technique of Mapping will be briefly described.

Mapping

Mapping is a technique that conveys the meaning of important relationships in text by re-representing them in an interconnected diagram. The particular content selected for Mapping can vary according to the reader's purpose, prior knowledge, perspective, and interest.

In order to use the Mapping technique, the student must learn to identify seven basic relationships in text: (a) EXAMPLE; (b) PROPERTY (characteristic), (with DEFINITION as a special case); (c) COMPARE/CONTRAST (similar to, greater than, less than); (d) TEMPORAL; (e) CAUSAL; (f) ENABLING; (g) CONDITIONAL (if A, then B). Negation and the logical connectives and, or, and but are also used. Students are taught to identify these relationships by attending to a few "key words" or other standard linguistic devices. Students are also taught the Mapping symbols corresponding to these relationships. Table 1 presents the relationships used in Mapping, the

Insert Table 1 about here.

corresponding symbols for representing these relationships, and the words and phrases that commonly express these relationships in text. Figure 1 presents a sample passage and a possible map representing that passage.

Insert Figure 1 about here.

Rationale for Mapping

Theories and empirical findings from many areas of psychology and educational psychology help explain why the process of Mapping may facilitate prose comprehension and recall. Three of the most important contributions are research indicating the importance of semantic involvement with the text on the part of the learner, research on the effect of text structure on learning and retention, and research on the instructional effectiveness of diagrams.

The first strand of research relevant to the process of Mapping is research suggesting that tasks requiring meaningful semantic involvement on the part of the reader promote greater recall than do tasks requiring less semantic involvement. For example, Watts and Anderson (1971) and Felker and Dapra (1975) varied the type of inserted questions in text and found that questions requiring paraphrasing and application of information to new situations enhanced performance more than did questions requiring responses verbatim from the text. In addition, meaningful semantic involvement on the part of the student may also explain the occasional success story

in the literature on studying strategies. Studying techniques which encourage students to interact with the meaning of text in an active way appear to produce the greatest comprehension gains (e.g., André & Anderson, 1978-1979; Barton, 1930; Frase & Schwartz, 1975; Duell, Note 1). (See Anderson & Armbruster, in press, for a complete review.)

A second strand of research findings concerns the psychological correlates of text structure. The research suggests that one determinant of the comprehension and retention of written materials is the structure of the prose itself. The experimental literature on the psychological correlates of text structure reveals that (a) connected discourse is much more readily learned and remembered than randomly ordered sentences or words (e.g., Myers, Pezdek, & Coulson, 1973; Perlmutter & Royer, 1973; Yekovich & Kulhavy, 1976); and (b) the more highly organized the text or the more congruent the text is with the reader's knowledge and expectations, the better the recall (e.g., Anderson, Spiro, & Anderson, 1978; Kintsch & van Dijk, 1975; Rumelhart, Note 2; Stein, Note 3). (See Goetz & Armbruster, in press, for a review of this literature.) Of particular relevance is research done by Meyer, Brandt, and Bluth (Note 4). In this study, ninth graders who identified and used the author's textual schema recalled much more information from expository passages than those who did not use the author's schema.

A final area of research concerns the effect of visual displays or diagrams on comprehension and retention of information. Although studies

in this area are sparse, they tend to show an instructional advantage for diagrams. Holliday and his colleagues (Holliday, 1975, 1976; Holliday, Brunner, & Donais, 1977; Holliday & Harvey, 1976) found that subjects who read text plus diagrams or diagrams alone attained significantly higher scores on multiple-choice posttests than did subjects who read the text alone. In basic electronics instruction, Gropper (1970) found that programmed instruction using primarily diagrams and accompanying questions was more effective and efficient than conventional instruction.

In sum, research from several areas supports the contention that the process of Mapping is likely to facilitate comprehension and recall since Mapping requires semantic involvement with the text, attention to text structure, and the transformation of prose into a diagrammatic representation.

Some research has been completed on a technique called Networking that is conceptually very similar to Mapping. Studies by Dansereau (1979) and by Long, Hein, and Coggiola (Note 5) suggest that Networking can facilitate learning in adult subjects. However, to the authors' knowledge, no previous research has addressed the question of whether learning in children can be enhanced by representing text relationships in diagrammatic form.

Method

Design

This study used a "pre-experimental" static group comparison (Campbell & Stanley, 1963). A true experimental design was impossible because of practical problems involved in running a long-term study in the public

schools (e.g., inability to assign subjects randomly to experimental and control conditions). Five test passages were used. The experimental subjects were randomly assigned to two groups and tested over the five passages as follows:

	Pretest	Posttest
Group 1:	"Sod Houses" "Seeds"	"Glass" "Ants"
Group 2:	"Sod Houses" "Ants"	"Glass" "Seeds"
Groups 1 and 2:		"Telescopes"

Thus, for the pretest, all experimental subjects read "Sod Houses"; in addition, they read either "Seeds" or "Ants." For the posttest, all experimental subjects read "Glass," and whichever of the "Ants" and "Seeds" passages they had not read for the pretest. At a second posttest session, all experimental subjects read "Telescopes." The assignment of passages was different for the control group, for they were tested only at the time of the posttest. During the first session, each control group subject read a randomly assigned pair of passages selected from "Sod Houses," "Seeds," "Ants," and "Glass." During the second session, all control group subjects also read the "Telescopes" passage.

This design was selected because it allowed the following comparisons: pretreatment comparisons between the experimental and control groups, post-treatment comparisons between the experimental and control groups, and pretreatment-posttreatment comparisons within the experimental group.

The dependent variable was proportion of idea units recalled in a free recall task. This dependent variable was chosen because free recall protocols presumably reflect the way information is stored in memory, thus providing a rich data source.

Subjects

Eleven eighth graders (7 males and 4 females) from a middle school eighth grade in a medium-sized mid-western city participated in the training. Their teachers selected the participants from a roster of students enrolled in a language arts curriculum who had elected not to take a foreign language class.

In order to obtain information about the students' knowledge of text relationships prior to instruction, subjects were given a pretest requiring them to identify and discriminate among EXAMPLE, PROPERTY, TEMPORAL, and CAUSAL relationships. The high scores on the relationships pretest indicated that these eighth graders probably did not have to be taught the meaning of the various relationships or even, for the most part, how to identify them in text. However, the pretest did reveal more difficulty with the CAUSAL relationship and discriminations among several relationships than with the EXAMPLE, PROPERTY, and TEMPORAL relationships.

The control group consisted of 43 eighth graders (24 males, 19 females) from another school--a junior high school in a small town in central Illinois.

The Mapping Training Program

The instruction took place over 14 consecutive school days during March and April, 1979. One of the authors and a teacher's aide, also familiar with Mapping, met with the students for 54 minutes each day in a classroom in the student's school. The general instructional procedures will be briefly described. It should be noted that the procedure varied somewhat for absentees in that they were briefly "caught up" on missed instruction by the teacher's aide upon their return.

Students were taught six of the Mapping relationships; they were not taught to map the CONDITIONAL relationship. The instructional strategy was to introduce the relationships one at a time in the following order: EXAMPLES, PROPERTY, DEFINITIONS, COMPARE-CONTRAST, TEMPORAL, and CAUSAL. For each relationship, students were first shown a chart with the name of the relationship, the "key words" that often signal the relationship in text, and the Mapping symbol used to map the relationship. Then students practiced mapping single sentences containing the relationship. Next, short passage-length text (up to approximately 180 words) was introduced. Students first examined and discussed completed maps corresponding to the passages. Then they supplied the missing content or relationships in "cloze maps" (partially filled in maps) for other passages. Finally, they mapped passages without the aid of cues. After several relationships had been introduced, students were also given discrimination exercises in which they had to decide which of the relationships was salient before

attempting to map the passage. Students worked individually, in pairs, and in small groups. Assistance and feedback were constantly available from the teacher and teacher's aide.

A unique segment of the instruction was a "think aloud" exercise where students were individually tape recorded as they talked about their thoughts while mapping a common passage. This exercise was undertaken to gain insight into how the students grappled with problems about structure at the text level, information that was obscured in the group teaching context.

To help collect these observations, three adults were hired to interview the students. During the 10th, 11th, and 12th days of instruction, three students at a time met with their assigned interviewers in other school rooms. The students were given a passage entitled "Subways" (from the workbook that accompanies a sixth-grade basal reader), paper, and pencil. The interviewers told the students that they were to try to map the passage and to talk about their thoughts as they mapped. The interviewers were instructed to probe the students about their reasons for mapping the text the way they did. The sessions were recorded with portable cassette tape recorders and later transcribed.

Materials

In order to help ensure that all subjects could read them, the passages used for the pre and posttests were selected from fifth- and sixth-grade basal readers. Computations of the readability levels using the Fry formula indicated that one passage was at the third-grade level ("Ants"), three

were at the sixth-grade level ("Sod Houses," "Seeds," "Glass"), and one was at the ninth-grade level ("Telescopes").

Procedure

The pretest for the experimental group was administered before any instruction in Mapping. Testing took place in a classroom in the students' school in the presence of the investigator and the teacher's aide.

On the first day, subjects who had previously been randomly assigned to Groups 1 or 2 received envelopes containing the appropriate pretest passages, additional paper, and pencils. The passages were arranged in counterbalanced order and stapled with a colored sheet between them to prevent reading through the page and to aid monitoring during the reading session. Subjects were instructed to read the materials using their own preferred method in preparation for a free recall test the following day. Subjects were given ten minutes to read each passage. Then the subjects replaced all materials in the envelopes and returned them to the investigator.

At the beginning of the period on the second day, two blank sheets were distributed to each subject. Subjects were told to use the sheets to write down everything they remembered from what they had read the previous day. They were told that they could recall the information in any order they wished, that they did not need to use complete sentences in their recall, and that spelling did not count. While they were writing,

subjects were reminded to "just write down anything you can remember about what you read!" The free recall was not timed, but all subjects had finished writing within 15 minutes. The recall protocols were collected at this time.

The first part of the posttest for the experimental group was administered after approximately 12 hours of instruction in the Mapping technique. The procedure for administering the first two posttest passages was the same as for the pretest, except that now subjects were required to map the two passages rather than using a preferred reading strategy. Subjects were aware that their maps would be collected.

The second part of the posttest was administered three days after the completion of the first posttest. Due to problems with cooperation and motivation (to be discussed in greater detail later in the paper), the experimental subjects were divided into three groups and tested under adult supervision in three separate rooms. Students were given the same instructions used on the previous posttest, except that they knew the recall was to take place during the same class period. They were warned that the passage was difficult and that they should simply do their best to map the text in a way that made most sense to them. Students were allowed 20 minutes to read and map the passage. At the end of this time, the passages and maps were collected and a filler cloze test of irrelevant content was distributed. Pupils were told to try to guess the one word that had been deleted. After 7 minutes, the cloze tests were collected and blank sheets of paper distributed for the free recall. Students were allowed 15 minutes to write their recalls.

Testing of the control group took place at the time of the posttesting of the experimental group. The testing was done by the investigator in the subjects' regular classroom. The teacher was not present during testing.

The procedure on the first two days was exactly as it had been for the experimental group pretest, with subjects receiving randomly assigned pairs of the passages "Sod Houses," "Seeds," "Ants," and "Glass." The procedure for the final posttest was the same as for the final posttest for the experimental group except that students used their preferred reading techniques and remained in intact groups of approximately 20 students.

Scoring

The stimulus passages and protocols from the free recall study were parsed into idea units. Protocol idea units communicating the gist of the passage idea units were counted correct. Each subject's score was proportion of total idea units recalled according to the gist criterion.

For each of the five passages, two protocols each from the experimental and control groups were randomly selected and given blind to a second scorer. Interrater reliability was .92.

For each passage, the idea units were classified into four levels of importance following the method of Johnson (1970). For each recall protocol, the idea units counted correct were classified into one of the four levels of importance.

Results

The first results to be presented will be the findings pertaining to the question of whether eighth graders can use Mapping to help them recall

expository text. The proportion of idea units recalled for all passages was subjected to one-way analyses of variance.

Before testing the hypotheses of interest, free recall performance of the control and experimental groups prior to training was compared. The one-way analysis of variance revealed no significant differences between the free recall scores of the experimental and control groups on the "Sod Houses" passage (Table 2).

After training, however, the results are quite different. On the "Glass" passage, the experimental group mean of .34 is more than twice the control group mean of .15, a difference that is statistically significant, $F(1,28) = 18.43$; $p < .001$, according to an analysis of variance (see Table 2). For the "Telescopes" passage, the experimental group mean was also higher than the control group mean (.23 compared to .16). This difference is not statistically significant, $F(1,32) = 2.50$; $p = .12$, but the probability level is nonetheless impressive considering the small n of the experimental group.

Comparisons between Mapping trained subjects and untrained control subjects for the "Seeds" and "Ants" passage at the time of the posttest show a different pattern of results (Table 2). For the "Seeds" passage, the mean is clearly higher for the control group. For the "Ants" passage, the differences are negligible. These differences are statistically non-significant, but the meaningfulness of the analysis is questionable, since the n of the trained group is only 5.

Insert Table 2 about here.

Another way of looking at the effect of Mapping on recall is to compare the probability of recall of idea units given that they have been mapped, $P(R|M)$, with the probability of recall of idea units given that they have not been mapped, $P(R|\overline{M})$. The conditional probabilities were computed for each experimental subject at each level of importance of the four passages administered as posttests. The resulting probabilities were then subjected to a 2 (Conditional Probabilities) x 4 (Importance Levels) analysis of variance, with both factors as repeated measures. The factor of Importance Level was included because prior analyses had shown that both number of idea units mapped and number of idea units recalled were functions of level of importance.

Results of the analysis revealed a powerful main effect for the Conditional Probabilities factor for "Glass" ($p < .0001$) and "Telescopes" ($p < .001$) and a marginally significant main effect for "Seeds" ($p = .07$) and "Ants" ($p = .08$). For all passages, the probability of recall of idea units which have been mapped is greater than the probability of recall of idea units which have not been mapped. The Conditional Probability x Importance Level interaction is significant for the "Glass" passage ($p < .01$) and marginally significant for the "Telescopes" passage ($p = .08$). In both cases, the ordinal interaction is attributable to the fact that the difference between the probability of recall of mapped units and unmapped units is greater at the higher levels of importance than at the lower levels.

of importance. For "Seeds" and "Ants," the nonsignificant interaction reflects the fact that the recall of mapped information is uniformly greater than the recall of unmapped information at all levels of importance.

The hypothesis that students would recall more idea units after Mapping instruction than before was tested by comparing the performances of the two groups of experimental subjects on the pre and posttest administrations of the "Seeds" and "Ants" passages. The results are presented in Table 3. For both passages, the differences in means is in favor of subjects before training. The differences do not reach statistical significance, but once again the meaningfulness of the analysis is questionable because of the very low n.

Insert Table 3 about here.

In order to answer the question about what problems middle school students would encounter while learning to map, observations were made of the relative ease of mapping the relationships during the instruction. Students experienced very little difficulty with mapping text exemplifying the EXAMPLE, PROPERTY, DEFINITION, COMPARE-CONTRAST, and TEMPORAL relationships when they knew from the context of instruction which relationship was appropriate. However, even when they knew the CAUSAL relationship was in the text, they experienced difficulty mapping it. Confusion between causes and effects was apparent even within single sentences.

With longer units of text, the following problems were noted: failure to identify CAUSAL relationships altogether, tendency to confuse the CAUSAL

relationship with other relationships, and tendency to confuse the causes and effects once the relationship had been identified. Another problem was difficulty in dealing with multiple effects of single cause and multiple causes of a single effect.

With the exception of the COMPARE-CONTRAST structure, students often had difficulty discriminating the predominant relationship in relatively "pure" higher order text structures (e.g., paragraphs describing a process). When this difficulty occurred, they perceived PROPERTY to be the default option, with most text ideas being treated as if they were simply characteristics of a "main idea." Also, students generally did not try to integrate the various relationships into one map; instead, they mapped each identifiable substructure as a separate entity. Thus, the end product consisted of several distinct map segments rather than an integrated structure representing the higher order structure of the entire passage.

Finally, it should be noted that student interest in Mapping and motivation to map text was very low for the group as a whole. Students were often inattentive and restless. It was difficult to get them to attempt to map text longer than short paragraphs.

From observations made during the "think aloud" exercise, it was evident that the students readily used Mapping terms when referring to the structure of parts of the passage, and most were able to describe appropriate ways to represent those relationships. Another observation was that the students were experiencing a so-called "blinder effect." That is, they

seemed to focus on one relationship at a time and fail to see other co-occurring relationships. For example, students selected either a TEMPORAL or a COMPARE-CONTRAST structure, but failed to recognize that TEMPORAL relationships existed within the COMPARISON. Perhaps they were operating under the assumption that relationships are mutually exclusive, disjunctive concepts. Finally, as observed in other tasks, the CAUSAL relationship was confusing to most students.

Discussion

On the basis of observations made during this preliminary investigation, it appears that eighth graders can be taught to map at least some types of expository prose. Although the maps produced were often not of very high quality (i.e., containing some inaccuracies or consisting of fragment maps), it seems reasonable to suppose that Mapping skill could be strengthened with practice.

Despite less-than-perfect mapped representations of text, results from this study suggest that Mapping may be an effective aid to recall of at least some kinds of expository passages for at least some eighth graders. One result in support of Mapping was the finding that the group trained in Mapping recalled an impressively greater proportion of idea units from two passages than did control subjects using their own preferred reading strategy. This result is noteworthy considering the very small number of experimental subjects (resulting in relatively low power for the statistical tests), as well as the apparent lower motivation of the experimental group compared with the control group at the time of posttesting. Also in support of

Mapping as an effective strategy is the finding that the probability of recall of mapped idea units is significantly or marginally significantly greater than the probability of recall of unmapped idea units for all four passages administered as posttests.

In contrast to results favoring Mapping is the apparently contradictory finding that the experimental subjects recalled a greater proportion of idea units before training in Mapping than after training (albeit the difference was nonsignificant). One possible explanation for the apparent contradiction in these findings lies in the different structural characteristics of the passages recalled for each comparison. First, let us consider the two passages used to test the pre and posttraining differences in recall ("Seeds" and "Ants"). These passages have similar COMPARE-CONTRAST structures. Both describe attributes of three examples of a concept. We learned from observations during instruction that the students trained in Mapping found the COMPARE-CONTRAST structure particularly easy to handle, both when producing maps from prose and when producing prose from maps. It may be that this structure is especially conducive to encoding and retrieval, perhaps because people of this age have a schema for the compare-contrast structure in the same way that even young children seem to have a schema for stories. If this is so, mapping "Seeds" and "Ants" for the posttest may have been far too sophisticated a weapon for the job to be done. Attending to the mechanics of Mapping may actually have disrupted a more "natural" processing of this structure. Indeed, a strategy as simple as

read-reread might have been the most efficient studying technique for "Seeds" and "Ants." The foregoing speculation is one reasonable way to explain the lower performance on "Seeds" and "Ants" after Mapping training. Of course, the perceived lower motivation at the posttest than at the pretest could also have contributed to this effect.

The two passages used to test the experimental and control group differences are quite different from "Seeds" and "Ants." "Glass" and "Telescopes" have more complex structures entailing several kinds of relationships. The passage about glass consists of EXAMPLES and two distinct processes. The passage about telescopes is more difficult yet, both in terms of readability level and complexity of relationships. With its hodgepodge of DESCRIPTION, DEFINITION, COMPARE-CONTRAST, TEMPORAL, and CAUSAL relationships, this passage was described as "poorly written" by several of the graduate students who ranked its idea units for level of importance. Another observation about map production and prose production from maps was that students had difficulty dealing with text containing more than one major relationship. Eighth graders, as relative newcomers to expository prose, may find such text as intractable and unmemorable as is unconnected, randomly organized prose for adults. It might be that it is on just such text, as represented by "Glass" and "Telescopes," that Mapping has the effect hypothesized by its developers. That is, Mapping forces the students to analyze a text into its simpler component ideas and relationships that may otherwise have been masked by the apparent complexity. These ideas and relationships then have a greater likelihood of being meaningfully processed and retrieved.

In sum, the apparent contradiction between the findings of better recall for experimental and control subjects yet poorer recall after training for the experimental group may be explained on the basis of the structures of the stimulus passages. Mapping may be superflous and perhaps even distracting for text the students could already meaningfully process; the value of Mapping may lie in dealing with more complex structures that require real "effort after meaning."

Obviously, the results of this study need to be replicated in true experiments involving more subjects before Mapping can be advocated as an effective reading comprehension strategy. Future studies should use additional dependent variables. Since criterion tests administered in schools rarely involve uncued recall, proportion of idea units recalled may not be the best index of the potential of Mapping as a reading strategy. Other measures more closely resembling the criterion measures of school settings (e.g., systematically generated questions) should be used in addition to free recall in order to increase the ecological validity of the results.

Another observation that merits discussion is the low motivation of students to map text. The low motivation is probably due to two factors: (a) the absence of a criterion measure that affected their grades, and (b) the intense effort involved in mapping. Mapping is definitely hard work, and people are generally only willing to work hard when the pay-off seems worth the effort.

These impediments to motivation may not exist in more naturalistic studying situations. Students usually have incentives in the form of grades. In addition, students often have some knowledge of the criterion task for which they are studying. Good students also have metacognitive skills that enable them to know whether they understand the requisite information well enough to succeed on the criterion task. Students may be motivated to use Mapping as a comprehension/studying strategy in situations where they know they do not understand the material well enough to succeed on a criterion task. Under such circumstances, students may be quite willing to invest attention and cognitive effort in a systematic technique that promises results.

If the effectiveness of Mapping is upheld in future studies, Mapping might be used in instructional settings in several ways. Mapping could be used in the elementary grades in the inital teaching of reading comprehension. In content area reading, students could be taught the relationships and structures intrinsic to particular disciplines. They might, for example, learn CAUSAL and COMPARE-CONTRAST in science class, TEMPORAL and PROBLEM-SOLUTION in social studies, and the binary-choice flowchart convention in courses such as industrial arts and home economics. Finally, Mapping might be used for the purpose for which it was initially designed--as a studying strategy. Students could use Mapping as a way of encoding and externally storing information from text that is relevant to particular criterion task demands or studying purposes.

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Yekovich, F. R., & Kulhavy, R. W. Structural and contextual effects in the organization of prose. Journal of Educational Psychology, 1976, 68, 626-635.

Table 1

Relationships and Symbols Used in Mapping

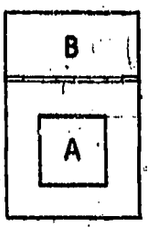
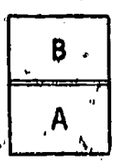
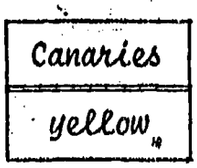
	Key Words
(1) A is an instance of B.  *Example: A common type of setter is the Irish Setter.* 	to be, for example, for instance, type of, kind of, example of, e.g., such as, include, including
(2) A is a property of B.  *Example: Canaries are yellow.* 	(to be), (to have), is a property of, is a feature of, is a characteristic of, is a part of, that is, is called, i.e., is defined as, is called, in other words, means that

Table 1 (Cont'd)

	Key Words
(3) A defines (restates, clarifies) B. B Define A Example: *Anthropology is the scientific study of human culture.* anthropology DEF. = scientific study of human culture	that is, in other words, i.e., (to be), is named, is called, is defined as, is referred to as, is labelled, means that, that is, the definition is
(4) A is similar to B. A ≈ B Example: *In most respects, Illinois and Ohio are very similar.* Illinois ≈ Ohio	like, likewise, is similar, similarly, in the same way or manner

Table 1 (Cont'd)

	Key Words
(4a) A is not similar to B. $A \not\sim B$ *Example: The Soviet economic system is quite different from the American system.* Soviet economic system $\not\sim$ American economic system	is different from
(5) A is greater than B. $A > B$ A is less than B $A < B$ *Example: A liter is slightly more than a quart.* *liter* > *quart*	more, greater, larger, less, smaller

Table 1 (Cont'd)

	Key Words
(6) A occurs before B. A ⟶ B *Example: Nixon resigned shortly before the Bicentennial celebration.* *Nixon resigned* ⟶ *Bicentennial celebration*	then, and then, before, after, next, follows, earlier, later, previously, prior, subsequently, precedes, (dates)
(7) A causes B. A ⟹ B *Example: Excessive exposure to the sun causes sunburn.* *excessive exposure to sun* ⟹ *sunburn*	causes, affects, leads to, in order to, produces, therefore, because, since, as a result of, this is because, consequently

Table 1 (Cont'd)

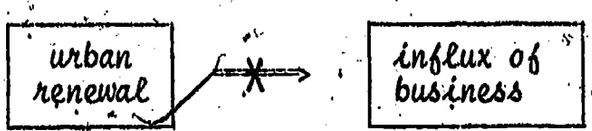
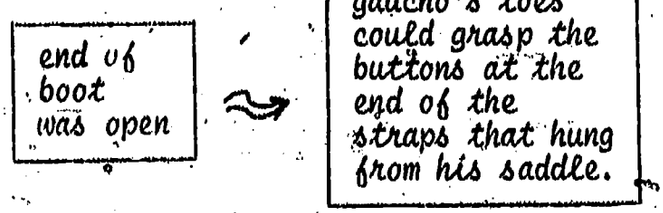
	Key Words
(7a) A does not cause B. $A \not\Rightarrow B$ Example: *The urban renewal project did not bring an influx of business into the city.* 	
(8) A enables B.  Example: *The end of the boot was open so that the gaucho's toes could grasp the buttons at the end of the straps that hung from his saddle.* 	enables, allows, permits, so that

Table 1 (Cont'd)

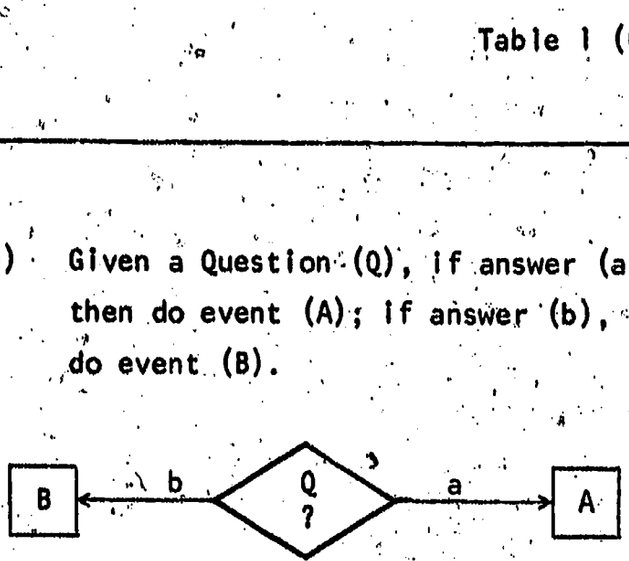
	Key Words
(9) Given a Question (Q), if answer (a), then do event (A); if answer (b), then do event (B).  *Example: Do you want the paneling to feel smooth? If so, use a fine grade sandpaper. If not, use a more coarse grade.* 	

Table 1 (Cont'd)

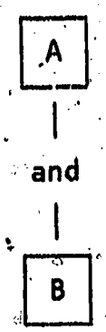
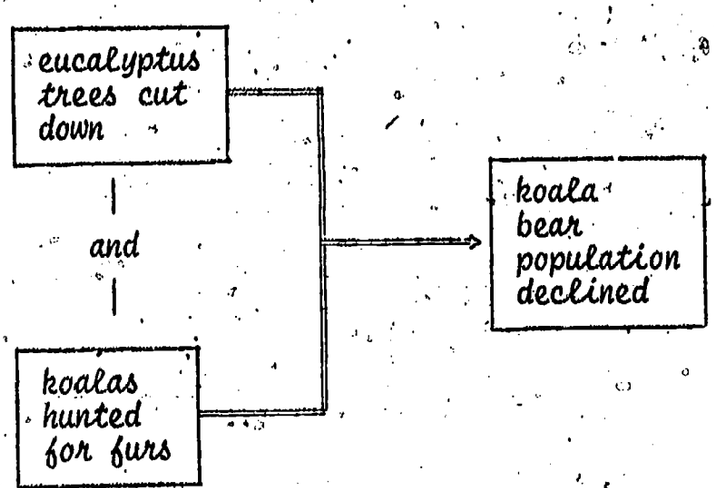
	Key Words
(10) A and B  Example: Because the eucalyptus trees were cut down and the animals were hunted for their furs, the koala bear population declined.  	and, in addition to, also, as well as

Table 1 (Cont'd)

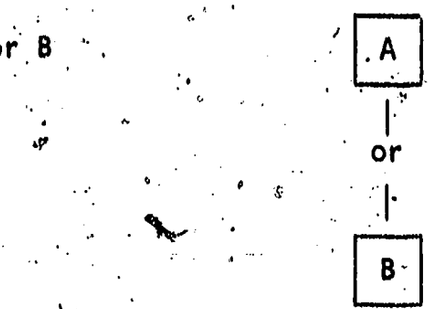
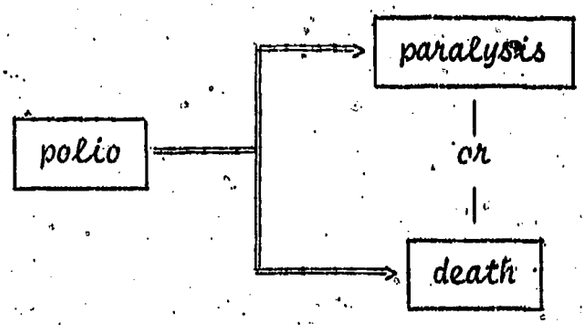
	Key Words
(11) A or B  Example: Polio causes paralysis or death. 	either . . . or

Table 1 (Cont'd)

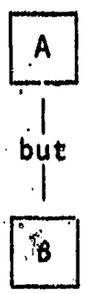
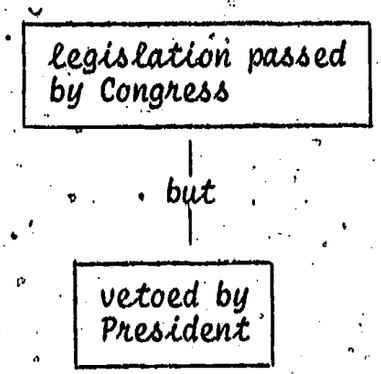
	Key Words
(12) A but B :  Example: The legislation was passed by Congress, but it was vetoed by the President. 	but

Table 2

A Comparison of Recall Scores

for Experimental and Control Subjects on All Passages

Passage	Groups	N	Mean Proportion Recalled	Standard Deviation	F	p
"Sod Houses"	Experimental	9	.32	.07	0.09	N.S.
	Control	21	.34	.21		
"Glass"	Experimental	10	.34	.10	18.43	<.001
	Control	20	.15	.12		
"Telescopes"	Experimental	9	.23	.10	2.59	.12
	Control	25	.16	.11		
"Seeds"	Experimental	5	.18	.14	0.93	N.S.
	Control	24	.27	.22		
"Ants"	Experimental	5	.36	.21	0.22	N.S.
	Control	21	.35	.24		

Table 3

A Comparison of Recall Scores Before and After Mapping Training for "Seeds" and "Ants"

Passage	Group	N	Mean Proportion Recalled	Standard Deviation	F	p
"Seeds"	Pretraining	3	.35	.06	3.93	N.S.
	Posttraining	5	.18	.14		
"Ants"	Pretraining	6	.50	.09	2.15	N.S.
	Posttraining	5	.36	.21		

Figure Caption

Figure 1. Sample Passage from The Old World (Lefferts & Soifer, 1978) and Corresponding Map.

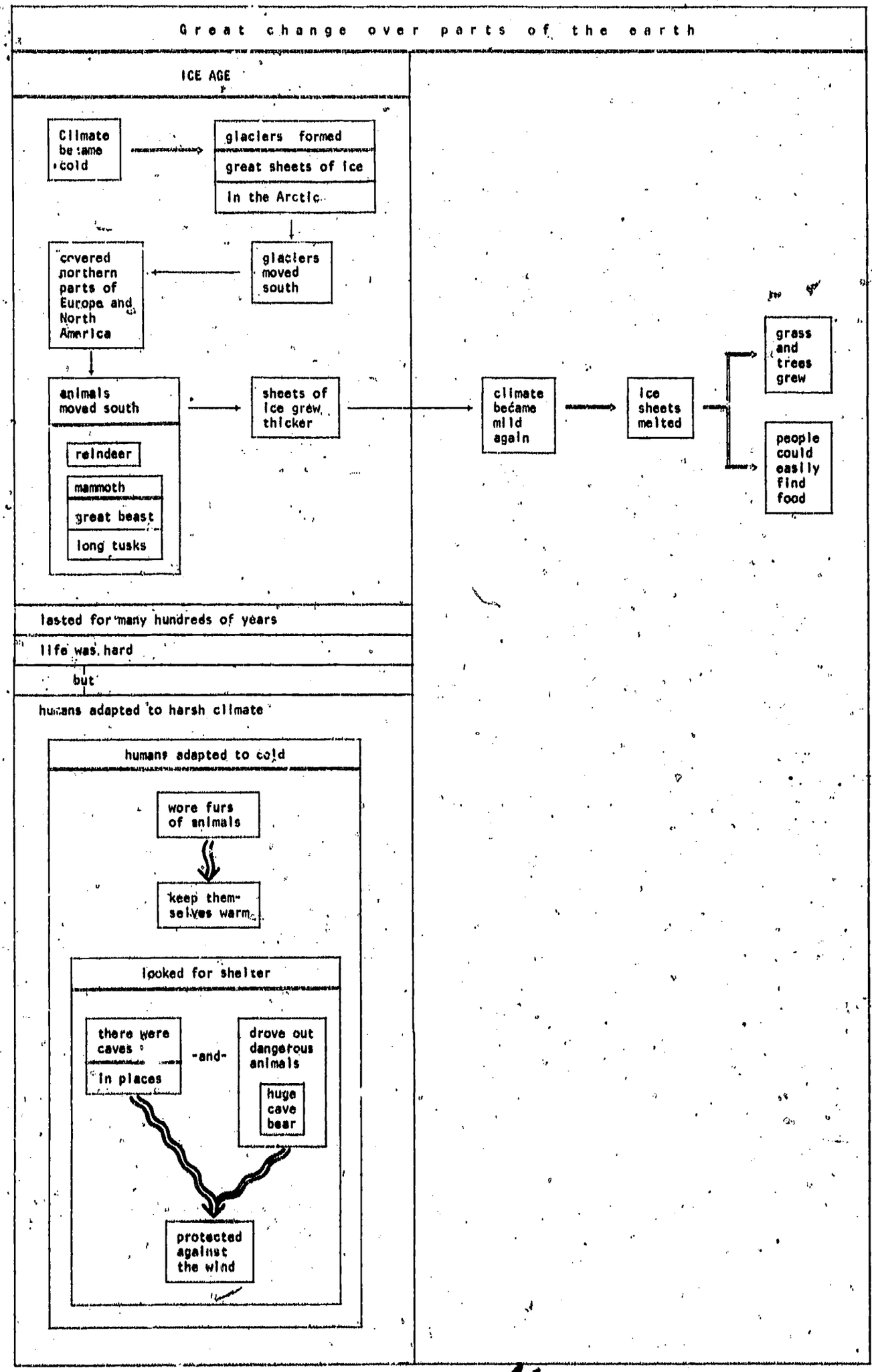
ICE AGE

As time passed, a great change came over parts of the earth. The climate became very cold. Cold temperatures caused glaciers, or great sheets of ice, to form. The glaciers moved from the Arctic regions southward until they covered northern parts of Europe and North America.

This period of time when the glaciers were moving southward is now known as the Ice Age. Such animals as the reindeer and the mammoth moved far south. The mammoth was a great beast with long, curved tusks.

The Ice Age lasted for many hundreds of years. Life was hard, but humans were able to change their ways or adapt themselves to the harsh climate.

As the sheets of ice grew thicker and covered more and more land, humans had to adapt themselves to the cold. They wore the furs of animals to keep themselves warm. And they looked for shelter to protect themselves against biting winds. In many places there were caves. Sometimes, before humans could live in a cave, they had to drive out dangerous animals like the huge cave bear. In time the climate became mild again, and the ice sheets melted. Grass and trees grew again. People increased in numbers because they could easily find food.


Great change over parts of the earth
ICE AGE
Climate became cold
glaciers formed
great sheets of ice
in the Arctic
glaciers moved south
covered northern parts of Europe and North America
animals moved south
reindeer
mammoth
great beast
long tusks
sheets of ice grew thicker
lasted for many hundreds of years
life was hard
but
humans adapted to harsh climate
climate became mild again
ice sheets melted
grass and trees grew
people could easily find food
humans adapted to cold
wore furs of animals
keep themselves warm
looked for shelter
there were caves
in places
-and-
drove out dangerous animals
huge cave bear
protected against the wind

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