DOCUMENT RESUME

ED 320 766 SE 051 474

AUTHOR Schmidt, Henk G.; Patel, Vimla L.
TITLE Effects of Prior Knowledge Activation through Small-Group Discussion on the Processing of Science Text.
PUB DATE 87
NOTE 9p.; Paper presented at the Annual Meeting of the American Educational Research Association (Washington, DC, April 20-24, 1987).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Biology; Content Area Reading; Decoding (Reading); Foreign Countries; *Misconceptions; *Prior Learning; *Reader Response; Reading Comprehension; Reading Processes; Reading Tests; Secondary Education; *Secondary School Science; Small Group Instruction; *Word Recognition
IDENTIFIERS *Netherlands

ABSTRACT

The purpose of this study was to investigate the extent to which problem analysis facilitated the subsequent processing of expository text, both for novices and a comparison group. A text on osmosis consisted of six-pages and was used as reading material. The ninth-grade students were considered novices because they were unfamiliar with the biological content used in the experiment. The tenth-grade student who had studied the content were considered as a comparison group. The subjects (88 students from a Dutch secondary school: 46 ninth-grade and 42 tenth-grade students) were randomly assigned to either the experimental or the control group. The text was studied less than 20 minutes and discussed less than 10 minutes in the experimental group. A different picture was found from the data by the grade 10 and grade 9 students on free recall. For the grade 9 students producing explanations for a blood cell problem facilitated the processing and retrieval of the problem-relevant text. This indicated the facilitative effect of activation of prior knowledge influenced the integration of new knowledge into existing structures. An analysis of the verbatim protocols showed that the grade 9 students dealt with the blood cell problem by segmentation. No statistically significant differences were found related to the grade 10 data. A table showing naive conceptions of the processes underlying the blood cell was presented. (YP)

Effects of Prior Knowledge Activation through Small-Group Discussion on the Processing of Science Text

Henk G. Schmidt[1] and Vimla L. Patel[2]

[1]University of Limburg, Maastricht, the Netherlands
and [2]McGill University, Montreal, Canada

Paper presented at the Meeting of the American Educational Research Association, Washington, DC., 1987.
The work reported in this study was supported in part by a grant from the Faculty of Medicine of McGill University to H. G. Schmidt while a visiting professor at that institution and a grant from the Josiah Macy Jr. Foundation (# 27798) to V. L. Patel of McGill University.

Research in the domain of text processing has well established the crucial role played by existing cognitive structures in the comprehension of expository texts. Prior knowledge acts as a frame of reference within which new information can be understood and enables scaffolding for the representation of new concepts in memory (Anderson, Spiro & Anderson, 1978). However, prior knowledge needs to be **activated** in order to provide a context for the integration of new information from text (Bransford and Johnson, 1972).

Several instructional methods have attempted to deal with the problem of the integration of new knowledge into old. The literature suggests at least three distinctive approaches. The first is to encourage the production of elaborations based on prior knowledge, while studying a text. Examples are: asking students to answer questions about a text, take notes, or write a summary of a text (Mayer, 1985). The second is to provide students, prior to reading, with a description of a concrete model which can be considered an analogy of the concepts to be understood. For example: descriptions of mechanical models, concrete advance organizers and metaphors (Royer & Cable, 1976). These analogies are supposed to bridge the gap between what is already known and what should be learned.

More recently, a third approach has been suggested, namely to encourage learners to construct an explanatory model themselves, prior to the processing of new information. Typically, students are confronted with the description of a set of natural phenomena, or witness an experiment, and are asked to generate an explanation for the phenomena, or predict the outcome of the experiment, based on their prior knowledge (Champagne, Klopfer and Gunstone,1982). Subsequently, they read an expository text on the subject, are lectured about it, or see the actual result of the experiment.

In this paper, a variation on this paradigm is proposed, that is, using small-group discussion as the main vehicle for the construction of an initial representation of the problem (Schmidt, 1982). In this approach, small groups of learners are given the description of a set of natural phenomena, e.g.: "A red blood cell is put into pure water under a microscope. The blood cell swells rapidly and eventually bursts. Another red blood cell is added to a solution of salt in water and is observed to shrink." The learners are asked to **explain** these phenomena in terms of underlying processes, principles or mechanisms. After discussing this problem for some time and proposing possible explanations, based on prior knowledge of these or similar phenomena, they are presented with a text which provides explanatory information relevant to the problem. De Grave, Schmidt, De Volder and Moust (1986) have shown that the analysis of such a problem is an effective activator of previously acquired knowledge. Compared with a control group, the problem-analysis group recalled more than twice as much information. The purpose of the present experiment was to investigate the extent to which such problem analysis facilitates the subsequent processing of expository text, both for novices (that is: subjects with no specific prior knowledge related to the problem) and experts (who possessed knowledge relevant to the problem). In addition, we were interested in the kind of knowledge used by novices and experts in the explanation of the phenomena presented to them.

METHOD

Subjects were 88 students from a Dutch secondary school: 46 ninth-grade and 42 tenth-grade students. The ninth-grade students were unfamiliar with the biological subject to be studied as part of the experiment, although they had general knowledge of biology. Hence, they were considered novices The tenth-grade students had finished that part of their biology course which included the subject under study; they were the experts in this experiment.

Materials consisted of two problem descriptions, a text and a free recall test. In addition to the description of the blood cell problem, a placebo problem was used. The text on osmosis (the biological process explaining the blood cell problem) consisted of a six-page typewritten booklet of about 2,220 words The free recall test consisted of an instruction to write down everything the subject could remember from the text, followed by three blank pages.

Procedure. The subjects were randomly assigned to either the experimental or the control group. Subsequently, they were subdivided in groups of 6 or 7. The experimental subjects analyzed the blood cell problem, whereas the control subjects analyzed the placebo problem. The discussions were audiotaped and verbatim transcripts were produced. None of the groups needed more than 10 minutes for the discussion. The text was studied for no longer than 20 minutes. Finally, the free recall test was administered without time limit.

Scoring. Free recall protocols were parsed into clauses using a technique proposed by Winograd (1983). In addition, clauses were classified as either explanatory or descriptive. According to Mayer (1985) the number of explanatory clauses in recall is a sensitive measure of the amount of integration of information in existing knowledge structures.(Interrater agreement: 89%)

RESULTS AND DISCUSSION

Free recall. Table 1 summarizes the results on free recall both for the experimental and the placebo condition, and for the novices and the experts.

Table 1: Average number of correct clauses recalled in Experiment 2

		Blood cell problem			Placebo problem		
		Mean	SD	N	Mean	SD	N
Novices	No. of clauses	26.0	12.4	22	18.5	6.6	24
	explanations	19.5	9.9		13.7	6.5	
	descriptions	6.5	4.1		4.8	1.8	
Experts	No. of clauses	53.4	25.7	21	48.2	15.6	21
	explanations	41.8	18.3		32.5	11.5	
	descriptions	11.6	7.3		15.2	7.6	

These results indicate that, for the novices, producing explanations for the blood cell problem facilitates the processing and retrieval of the problem-relevant text, as reflected by the better free recall. A significant difference was found for the number of correct clauses recalled ($F(1, 44)= 6.61$, $p< .01$). The same holds for the number of explanatory clauses produced ($F(1, 44)= 5.60$, $p< .02$). The number of descriptions found in the recall did not differ significantly at the .05-level. These results suggest that the facilitative effect of activation of prior knowledge, using the explanation task, particularly influences the integration of the new knowledge into existing structures. These results are in accordance with other prose comprehension studies using the explanation/description distinction as the dependent variable (Mayer, 1985).

A different picture emerges from the data provided by the experts. No statistically significant differences were found in the data. However, the number of explanatory clauses in the protocols shows a tendency in the predicted direction ($F(1, 40)= 3.73$, $p< .06$). This again, appears to be an illustration of Mayer's (1985) conviction that better integration of new knowledge into existing structures is reflected in the trade-off between explanatory and descriptive clauses. So, although experimental and control experts are not distinguisible using total recall, they appear to be different with respect to the extent to which they have integrated the subject-matter as a consequence of the experimental manipulation.

It is unclear why the instructional strategy tested is less successful among experts than among novices. A hypothesis suggested by cued recall data not reported here is, that the text did not contain much information new to the experts, so that the failure to find a difference might indicate a ceiling effect.

Verbatim protocols. An analysis of the verbatim protocols of the discussions might provide further insights into the nature of the agent causing the superior recall of the novices. To that end, the protocols were screened for (partial) explanations of the blood cell problem provided by the experimental subjects.

In general, the novices dealt with the blood cell problem by segmentation, that is: they showed a tendency to try explanations, unique to each of the phenomena described. Table 6 summarizes twelve distinct explanations found in the protocols. (As a frame of reference, it may be useful to know that osmosis is a process by which water can move freely through a semi-permeable membrane, whereas salt is prevented from doing so. If concentrations on both sides of the membrane are different, a flow of water takes place in order to restore equilibrium. This process explains the phenomena described in the problem.)

Table 2: Naive conceptions of the processes underlying the blood cell problem

Swelling

1. Cell is filled with tiny sponges absorbing the water
2. Cell takes in water by unidentified mechanism because wall is porous. However, wall contains valves that prevent the water from escaping
3. Red blood cells carry oxygen. Cell withdraws oxygen from water and swells
4. Cell contains salts dissolved in liquid. Solution exerts pressure on wall larger than counter-pressure exerted by pure water
5. Intake of water triggers unknown chemical reaction in cell

Bursting

6. Blood cells usually take in small amounts of liquids, because in the body there are many of them. In this particular case, there is only one cell, who has to take in too much water.
7. Animate objects only have a limited life-span

Shrinking

8. Water or other liquids are withdrawn from the cell because of hygroscopic properties of salt
9. Salt-water exerts higher pressure on wall than contents of cell
10. Salt corrodes wall by affecting wall molecules. Cell begins to leak
11. Salt diffuses into cell and digests cell from within

Swelling, bursting and shrinking

12. Cell contains salt which withdraws water from environment because of hygroscopic properties. If water in environment contains higher concentration however, liquids will be withdrawn from cell

The naive conceptions provided by the novices, appear to be largely based on common-sense knowledge and pre-scientific ideas, as reflected by the extensive use of metaphors, like balloons inflated to bursting or bodies floating in the sea, and the virtual absence of scientific concepts in their conversation.

Second, the novices' explanations are invariably incorrect. This suggests that it is not so much the extent to which previously held beliefs are accurate that facilitates learning, but rather the clash between new information and deficient knowledge of which the learner becomes aware. As Anderson (1977) puts it: "My conjecture is that the likelyhood of schema change is maximized when a person recognizes a difficulty in his current position and comes to see that the difficulty can be handled within a different schema."(p. 427)

And third, although the experts' groups came up with an integrative and largely accurate account for the phenomena, some of them still displayed the misconception that the flow of the water is caused by the hygroscopic properties of the salt.

CONCLUSIONS

Attempting to explain natural phenomena in terms of underlying processes activates causal knowledge, which facilitates the comprehension of science text and supports the retrieval of explanatory information, indicating better integration of knowledge into existing structures. The knowledge activated does not necessarily need to be accurate in order to be effective. Rather, the cognitive conflict between naive and imprecise conceptions of the world and scientific knowledge may be a major source of learning.

References

Anderson, R.C. (1977). The notion of schemata and the educational enterprise: general discussion of the conference. In R.C. Anderson, R. J. Spiro & W.E. Montague (Eds.). **Schooling and the Acquisition of Knowledge.** Hillsdale, N.J.: Lawrence Erlbaum.

Anderson, R.C., Spiro, R.J. & Anderson, M.C. (1978). Schemata as scaffolding for the representation of information in connected discourse. **American Educational Research Journal,** 15, 433-430.

Bransford, J.D. & Johnson, M.K. (1972). Contextual prerequisites for understanding: some investigations of comprehension and recall. **Journal of Verbal Learning and Verbal Behavior,** 11, 717-726.

Champagne, A.B., Klopfer, L.E. & Gunstone, R.F. (1982). Cognitive research and the design of science instruction. **Educational Psychologist,** 17, 31-53.

De Grave, W., Schmidt, H.G., De Volder, M.L. & Moust, J.H.C. (1986). **Can previously acquired knowledge be activated through small-group discussion?** Technical Report. Maastricht, the Netherlands: University of Limburg.

Mayer, R.E. (1985). Structural analysis of science prose: can we increase problem-solving performance? In B.K. Britton & J.B. Black (Eds.) **Understanding Expository Text.** Hillsdale, N.J.: Lawrence Erlbaum.

Royer, J.M. & Cable, G.W. (1976). Illustrations, analogies and facilitative transfer in prose learning. **Journal of Educational Psychology,** 68, 205-209.

Schmidt, H.G. (1982). Activation and restructuring of prior knowledge and their effects on text processing. In A. Flammer & W. Kintsch (Eds.). **Discourse Processing.** Amsterdam, the Netherlands: North-Holland.

Winograd, T. (1983). **Language as a Cognitive Process: vol.1: syntax.** Reading, MASS.: Addison-Wesley Publishing.