

Considering Prior Knowledge When Using Elaborative Interrogation

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SUMMARY

Previous studies have promoted the use of elaborative interrogation (a 'why'-questioning strategy) for the acquisition of factual information. One assumption in these studies is that prior knowledge influences when students will be able to use the strategy, with greater prior knowledge leading to higher recall performance. In the studies reviewed here, the effect of prior knowledge on strategy effectiveness was investigated. Specifically, students' performances were compared for materials about which they possessed substantial prior knowledge, little prior knowledge, inconsistent prior knowledge, or shared prior knowledge. In general, the data support the use of elaborative interrogation when studying alone or in dyads especially when learners possess some relevant prior knowledge about the new information.

Elaborative interrogation is a strategy that is particularly effective in mediating the acquisition of factual information (Pressley, McDaniel, Turnure, Wood, and Ahmad, 1987; Pressley, Symons, McDaniel, Snyder, and Turnure, 1988). This strategy encourages learners to use their prior knowledge to make inferences and elaborations about new materials by answering 'why' questions (e.g. Why would that fact be true?). Establishing an association between new information and prior knowledge makes the to-be-learned information more meaningful and, thus, more memorable (Pressley, Wood, Woloshyn, Martin, King, and Menke, 1992; Weinstein and Mayer, 1986; Wittrock, 1989).

*Participation of the first author and second authors was supported through grants from the Social Sciences and Humanities Research Council. The third author was supported through a fellowship from the Natural Sciences and Engineering Research Council of Canada.

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In the earliest elaborative interrogation studies (Pressley et al., 1987), subjects were presented materials that were linked through random or arbitrary pairings—specifically, single sentences about different kinds of men (e.g. the tall man bought the crackers; the sad man looked at his new boat; the evil man wound the clock). The subjects were asked to explain the relation between the type of behaviour and the kind of man (e.g. Why would that fact be true of that particular man?). Instructions to answer the why questions facilitated retention of the sentences relative to reading the facts with the goal of understanding them. The quality of answer provided to the why question had little affect on retention, however. Rather, the mere attempt to search for an answer seemed sufficient to promote recall.

These initial successes with laboratory materials encouraged the expansion of elaborative interrogation research to determine if the method might promote learning of a variety of materials with an associative component. Thus there were studies of elaborative interrogation effects on learning of facts about gender differences (Pressley et al., 1988), Canadian provinces (Martin and Pressley, 1991; Pressley et al., 1988), and Canadian universities (Woloshyn, Willoughby, Wood, and Pressley, 1990). For both adults and grade-school children, elaborative interrogation produced greater retention than did control instructions (e.g. repetition, a typical default strategy; Garner, 1990). In general, the retention gains associated with elaborative interrogation were large (effect sizes were usually greater than one standard deviation relative to repetition control variance; Cohen, 1977). Learning gains were obtained with varying presentation formats (paragraph versus isolated facts; Woloshyn et al., 1990; paragraphs; Seifert, 1992; sequential facts, Willoughby, Waller, Wood, and MacKinnon, *in press*) and in diverse study contexts (e.g. individual versus group instruction; Wood, Fler, and Willoughby, 1992).

When students studied facts that were more representative of academic content (i.e. non-arbitrary facts for which there were correct answers), elaborative interrogation did not invariably produce improvements in recall over performances in control conditions. For instance, in order to respond to the facts, 'Ontario is the province with the highest percentage of people declaring bankruptcy' and 'The grey seal lives on exposed rocky coasts', learners needed to possess some general knowledge about the topic under study in order to use the strategy successfully (e.g. history, geography, and culture of the province of Ontario; territorial or mating behaviours of mammals).

Many studies have demonstrated that new information can be made more memorable if learners create meaningful associative links (e.g. Stein, Morris, and Bransford, 1987). Presumably, when creating meaningful associations, learners search their available knowledge and use that information to connect new materials. According to schema theory, all knowledge about concepts is stored within an interrelated network of more general information. The extent of activation and retrieval of knowledge depends on the extensiveness of the interconnections within the network and the level of elaboration between the items (Rumelhart, 1980). When students were asked to generate answers to why-questions, in most studies of elaborative interrogation, the questions prompted activation of schemata related to the to-be-learned facts, which facilitated encoding and retrieval. Why-questions cannot have that effect when students possess little knowledge related to to-be-learned content.

Until the beginning of the 1990s, all elaborative interrogation studies involved learning of materials that are relatable to learners' prior knowledge, with why-questioning encouraging use of that prior knowledge to learn the material. For example,

asking students to answer why a specific fact would be true for one gender focuses attention on existing knowledge about that gender, which can mediate construction of a meaningful linkage between the elements of the to-be-learned factual information.

In order to explore whether high prior knowledge and question-answering processes forcing use of prior knowledge are essential for elaborative interrogation gains, five different research directions were explored. One involved analyses of learner responses to questions varying in the degree to which they prompted use of supportive prior knowledge. A second direction was a more analytical study of learning via elaborative interrogation when prior knowledge was high. The third approach was to evaluate elaborative interrogation effects when prior knowledge was low. Fourth, the effectiveness of elaborative interrogation was investigated when learners processed information that was inconsistent with their existing beliefs. Fifth, elaborative interrogation learning gains were documented as students shared their prior knowledge about to-be-learned materials with a partner.

ELABORATIVE INTERROGATION EFFECTS DEPEND ON THE TYPE OF QUESTION ANSWERED

Martin and Pressley (1991) demonstrated that the type of prior knowledge activated by a why-question affects retention, with different types of why-questions promoting activation of different information. Canadian undergraduates were instructed to study factual information about Canadian provinces and territories (e.g. 'Apples were first cultivated in Nova Scotia', 'Manitoba has the highest cancer rate in Canada', and 'Judo was first introduced in the province of British Columbia'). Students presumably possessed some general knowledge about each of these provinces and territories. During study, subjects answered one of four why-questions. The first type of why-question was used in earlier elaborative interrogation work and activated information specific to the province in question ('Why is this fact true given what you already know about the particular province?') Two other types of why-questions partially directed attention away from the province-fact associations ('Why is this fact unexpected given what you already know about the particular province?' 'Why is this fact true given what you already know about other provinces?') A fourth type of why-question completely diverted attention from the to-be-acquired associations ('Why is this fact unexpected given what you already know about other provinces?') A fifth group of students was instructed to repeat the facts for understanding (repetition control).

Only the traditional why-question format focused learners' attention on prior knowledge that supported the new information. Therefore, it was expected that this format would facilitate learning more so than the other formats. For instance, given the traditional why-question and the statement, 'Baseball in Canada was first played in Ontario', Canadian students can generate rationales about the proximity of Ontario to New York, where baseball first started in the United States. Alternatively, they might rationalize that Ontario imports innovations from the United States more often than do other provinces. It was unlikely that students would activate this type of supportive prior knowledge when answering the alternative why questions. Instead students were more likely to discuss more peripheral attributes about Ontario that did not directly support this fact (e.g. 'Because there is a lot of industry in

Ontario', 'The amount of parkland is limited') or attributes about other provinces that again did not directly support the fact (e.g. 'Because Saskatchewan's terrain is flat, it would be ideal to play baseball in that province').

As expected, only questions that fully directed students to activate supportive prior knowledge enhanced retention relative to repetition. Questions that diverted attention away from the province-fact associations did not facilitate learning relative to the repetition control, with trends toward facilitation when why-questions partially diverted attention from to-be-learned associations and no facilitation whatsoever when why-questions fully diverted attention. Retention gains were high when learners activate and search through prior knowledge that was directly related to the critical to-be-learned information.

High Prior Knowledge

When students are asked to process new information from a familiar domain, it is assumed that they have access to a large and richly interconnected network of prior knowledge that can facilitate both encoding and retrieval (Brown, Smiley, Day, Townsend, and Lawton, 1977; Pearson, Hanson and Gordon, 1979). Because elaborative interrogation encourages students to access these networks, this strategy's potency should vary as a function of knowledge base, with high knowledge related to high performance.

Seifert (1992) ensured that students possessed relevant prior knowledge by providing them with critical information prior to studying related concepts. Seifert had sixth and seventh graders read a passage describing five general rules of adaptation (e.g. 'animals have special ways of detecting their enemies') prior to studying facts about animals. Students were instructed to write a summary statement for each of these rules and to complete a short quiz testing this knowledge. Students were then instructed to read prose passages about three animals (the snowshoe hare, the American woodcock, and Richardson's ground squirrel). The main idea of each paragraph was presented in the first sentence. This sentence described a characteristic or behaviour of the animal that exemplified one of the five rules of adaptation. For example, the statement, 'During winter, the coat of the snowshoe hare is white in colour' corresponded with the rule, 'Animals have special ways of protecting themselves from enemies'. The remaining statements provided supplementary information (e.g. 'This change in colour is triggered by changes in temperature and daylight'.)

Processing instructions varied as a function of study condition, with students assigned to one of four conditions: underline main idea, underline main idea with elaboration, elaborative interrogation, and elaborative interrogation with study sheets. Students in the underline condition were instructed to read each paragraph carefully and to underline the most important idea:

Living on a diet of bark, plants, leaves, and twigs, the snowshoe hare prefers to live in areas of dense brush and vegetation. Thus, the snowshoe hare is found in most forest regions of Canada. In fact, large numbers of hares can be found in areas which have been recently burned by forest fires and are growing over again. The brushy growth of young deciduous trees and dense stands of young conifers enable the population to flourish.

In addition to underlining the main idea of each paragraph, students in the underline with elaboration group were provided with a statement that connected the target fact with its associated principle of adaptation:

Living on a diet of bark, plants, leaves, and twigs, the snowshoe hare prefers to live in areas of dense brush and vegetation. Like most animals it lives where it can easily find food. Thus, the snowshoe hare is found in most forest regions of Canada. In fact, large numbers of hares can be found in areas which have been recently burned by forest fires and are growing over again. The brushy growth of young deciduous trees and dense stands of young conifers enable the population to flourish.

Elaborative interrogation subjects were instructed to read the base paragraphs and to answer a why-question about the main idea of each paragraph (e.g. 'Why does the snowshoe hare live in dense brush and vegetation?'). Students using a study sheet with elaborative interrogation were instructed to answer the why-questions but were allowed to use their orientation notes to complete the task. Retention was assessed via an associative matching task (e.g. drawing a line between the snowshoe hare and the attribute 'common forest animal', or between the American woodcock and the attribute 'highly prized by hunters').

Instructing students to use elaborative interrogation facilitated memory of associations relative to instructing them to underline main ideas. The type of answer provided to the why-question was a strong predictor of retention. When students used relevant prior knowledge to provide scientifically correct answers, the probability of retention was high. However, when students provided explanatory answers that contained inaccurate information, the probability of retention was low.

Wood, Willoughby, Bolger, Younger, and Kasper (1992) related general world knowledge and academic achievement to performance when students were instructed to use elaboration interrogation. They found that academically successful students (both average and high achievers) were better able to use elaborative interrogation than low achievers. This difference was thought to be a reflection of average and high achievers' more extensive knowledge base. To investigate this hypothesis, the measure of world knowledge was related to recall performance. Students were asked to complete the information subtest of the Weschler intelligence test for children (Weschler, 1974), a test of world knowledge. Overall, greater world knowledge was associated with higher memory performance, more so in the elaborative interrogation condition than in the control conditions. Again, these findings lend support to the assumption that students who possess a well-developed knowledge base have an advantage when using the elaborative interrogation strategy.

Low Prior Knowledge

In the classroom, students are often required to learn content for which they have limited prior knowledge. This is especially true in the elementary and secondary school programmes where students experience many domains for the first time (e.g. second-language learning, English literature, chemistry). Therefore, it was critical to determine whether elaborative interrogation could also enhance learning when learners possess little prior knowledge about critical content.

Woloshyn, Pressley, and Schneider (1992a) had Canadian and German undergrad-

uates study information about their native country and information about a foreign country (e.g. 'Saskatchewan has Canada's lowest unemployment rate', 'The highest percentage of hotel beds is in the state of Bavaria', 'The province of Alberta had the worst tornado in Canada', 'The largest amount of crude oil is produced in the state of Lower Saxony'). It was assumed that subjects possessed substantial prior knowledge for native-country facts but very little knowledge for foreign-country facts. Students were assigned to one of three conditions: (1) elaborative interrogation; (2) repetition control; or (3) a no-exposure-to-facts control condition. Students in the elaborative interrogation condition answered why each fact was true using information that they already possessed about the province/state in question. Reading-control students were instructed to read the facts in a repetitive manner for understanding. Students in the no-exposure condition did not view the target facts prior to completing the post-test memory measure (e.g. matching the name of the province/state with the associated fact, 'Which province has the lowest unemployment rate?' 'Which state has the highest percentage of hotel beds?')

Elaborative interrogation greatly boosted learning of native-country facts. Elaborative interrogation even had a positive, but much less pronounced affect on learning facts about the foreign country. Even when learners did not possess a well-developed knowledge base, instructions to use elaborative interrogation produced some retention gains, although these gains were small in comparison to when students used the strategy and possessed relevant prior knowledge. These findings suggest that both knowledge base and processing instructions are important components for elaborative interrogation. Specifically, when learners possess high prior knowledge related to target facts, why-questions facilitate performance to the degree that they orient the learner to prior knowledge that is related to the critical content. When prior knowledge is low, attempting to answer why-questions probably facilitates performance because it increases general arousal, attention to the facts, and effort to learn them.

Willoughby et al. (in press) also evaluated learning via elaborative interrogation when prior knowledge was either high or low. Undergraduates were presented facts about both common and exotic animals (e.g. the Western spotted skunk eats corn, the coati rolls its prey under its front feet). Larger learning gains due to elaborative interrogation were expected for facts about the common animals (e.g. the Western spotted skunk), presumably because students would have more extensive and elaborate knowledge bases to draw upon. This hypothesis was supported: elaborative interrogation instructions improved learning relative to a repetition control only for facts pertaining to the common animals.

Willoughby et al.'s findings were replicated in a second study in which students were presented facts about islands from a fantasy book (Willoughby and Waller, 1992). Students had either read the book (high prior knowledge) or had not read the book (low prior knowledge). The facts about the islands were drawn from a text that expanded on information presented in the fantasy book (e.g. 'Pendor is known for its jewels and gold'; 'The people of Atuan speak a different language than in the Earthsea archipelago'). Students were then assigned to either an elaborative interrogation or repetition control condition. It was expected that high knowledge students would use information that they remembered from the book to answer the why-questions. Consistent with previous research, only students who possessed relevant prior knowledge benefited from using elaborative interrogation at study.

The more students tied facts to their knowledge about the book when they answered the why-questions, the better their chance of correct recall (e.g. for the fact 'Pendor is known for its jewels and gold', students could make an association between Pendor, dragons, and the idea that dragons hoard jewels).

Inconsistent Prior Knowledge

Sometimes students are not simply low in prior knowledge but actually possess prior knowledge that is inconsistent with to-be-learned information. This is a difficulty, for when learners read new information that is incongruent with their prior knowledge, they often tend to favour their inaccurate beliefs over new content (e.g. Guzzetti, Snyder, and Glass, 1992). For instance, many students allow their inaccurate beliefs to interfere with learning of scientific concepts (e.g. Roth, 1990, 1991). The consequence is that the new information does not displace the old knowledge, resulting in long-term memory and use of the errant information.

Woloshyn, Paivio, and Pressley (1992b) examined whether instructing sixth and seventh grade students to use elaborative interrogation would facilitate their retention of factual information about which they possessed inaccurate beliefs. These authors hypothesized that most students possess both knowledge that is consistent and knowledge that is inconsistent with new information. Thus, for the fact 'The light of the sun is made up of every different colour', a student might have some prior knowledge supporting that position (e.g. he or she has seen a prism) and some seemingly inconsistent prior knowledge (e.g. the sun appears orange and yellow). When inconsistent knowledge is more familiar and salient than consistent knowledge it is also more likely to affect retention (e.g. Lipson, 1982). Alternatively, if learners are required to activate and reflect on prior knowledge that supports the target facts, the validity of inaccurate beliefs may be discredited and the retention of new information enhanced. Elaborative interrogation is one strategy that requires learners to activate supportive prior knowledge.

The students in Woloshyn et al. (1992b) studied information about four topics (solar system, circulatory system, plants, and animals), with learning assessed via recall (free and cued) and recognition tasks (immediate and delayed). Half of the study statements contained new information that was consistent with most students' prior knowledge (e.g. 'The distance between the earth and the moon changes every day', 'New plants can grow from roots, stems, and leaves', 'New red blood cells are needed about every four months'), whereas the remaining statements were inconsistent with this knowledge (e.g. 'Stars are gases', 'In plants, food travels from the leaves to the roots', 'Some living things have only one cell'). Extensive piloting with students of similar ages and with educators confirmed that the selected facts were either consistent or inconsistent with most students' beliefs. Students were assigned either to an elaborative interrogation or repetition control condition.

Students who used elaborative interrogation retained more belief-consistent facts and more belief-inconsistent facts than students who repeated the facts during study, with positive retention advantage in the elaborative interrogation condition maintained up to six months following study. For the recognition tests, there was also a main effect due to fact type: All students recognized more belief-consistent statements than belief-inconsistent statements.

Under traditional classroom instruction, students' inaccurate beliefs are pervasive

and resistant to change (e.g. Alvermann and Hague, 1989; Hynd and Alvermann, 1987; Roth, Anderson, and Smith, 1987). While learners may comprehend new information presented in class, and may even acknowledge that this information is inconsistent with their existing beliefs, they do little to reconcile inconsistencies between the two knowledge sources (e.g. Roth, 1990, 1991), with the result that long-held errant beliefs persist. Elaborative interrogation seems to help replace errant knowledge with new knowledge, probably by forcing greater reflection about how new information relates to prior knowledge.

Shared Prior Knowledge

Explaining concepts to others also prompts learners to conceptualize materials in new ways (Bargh and Shul, 1980; King, 1990). When students study together, there is an opportunity to share and discover information that is beyond the learner's existing knowledge. In general, learners benefit from peer discussion (Dansereau, 1988; Webb, 1989), partly because it provides them with an opportunity to generate examples and translate new information into familiar terms (Bargh and Shul, 1980; King, 1990). It was assumed that students could use elaborative interrogation when they study together because it encourages learners to generate elaborations in order to create links between what they already know and what they have to learn.

Woloshyn and Gage (1993) instructed sixth and seventh grade students to use elaborative interrogation as they studied factual information that was consistent or inconsistent with their prior knowledge. Students who studied alone were instructed to read each statement silently and to answer aloud the why-questions. Students who studied with a partner also answered the why-questions but were told to listen carefully to the other person's responses and to integrate that information into their own answers whenever possible. Retention of the facts was assessed via two tests of recall (free and cued) and three tests of recognition (immediate, 30-day delay, and 60-day delay).

There was only one significant difference between studying alone and studying with a partner. For the cued recall task, students who studied with a partner retained more factual information than did students who studied alone. In addition, all students recognized more belief-consistent than belief-inconsistent facts.

Wood and Reilley (1993) compared performance when students used elaborative interrogation versus performance when students used self-selected study strategies, both when students studied individually and when they did so with a partner. Undergraduate students were assigned to one of two study conditions (elaborative interrogation or self-study) to learn facts about animals. When working interactively, students in the elaborative interrogation condition studied together to generate an answer to the why-question. For independent study items, students generated an answer to the why-question on their own. In the self-study condition, dyads developed an appropriate study strategy and used that strategy together while studying. They also developed a self-selected strategy for each fact when working alone. Retention was assessed through an associative matching task. Regardless of whether students studied alone or in dyads, recall scores did not differ. In both conditions, retention was greater for facts about familiar animals than facts about unfamiliar animals.

It was somewhat surprising that elaborative interrogation students did not outperform those in the self-study group. However, closer analysis revealed that the students

in the self-study condition tended to use sophisticated strategies, most notably, imagery. Previous studies have demonstrated that students using interactive imagery retain as much information as students answering why-questions (Woloshyn et al., 1990).

In summary, these two studies demonstrate that the same high performance that is evident when students use elaborative interrogation on their own also can be achieved when they study with a peer. Given that many educational contexts involve cooperative learning, these findings hold promise that elaborative interrogation can be used effectively in group settings. Kahl and Woloshyn (1993) are currently investigating whether groups of sixth grade students (with four students in a group), who have been provided with the necessary communicative and social skills training for collaboration (Johnson and Johnson, 1990, 1991), benefit from instructions to share their prior knowledge when answering why-questions.

CONCLUDING COMMENTS

The studies reviewed here demonstrated that elaborative interrogation can promote learning, especially when students' possess relevant prior knowledge for to-be-learned content (Table 1 lists elaborative interrogation effect sizes as a function of knowledge base). There were consistent and large effect sizes for elaborative interrogation in situations where students have high domain knowledge versus situations where they have low domain knowledge ($m = 2.60$ SDs). The same pattern was found when students studied familiar and unfamiliar materials together (effect size greater than 1 SD). Instructing students to use elaborative interrogation alone or with a partner also enhanced retention of belief-inconsistent facts—information that students would usually allow inaccurate prior knowledge to override.

When students possess little or no information about critical content, it might be more appropriate to encourage them to use other elaboration strategies than elaborative interrogation, however. For example, interactive imagery is an effective learning adjunct that does not appear to place large demands on the student's knowledge base (e.g. Willoughby and Wood, 1992; Woloshyn et al., 1990; Wood et al., 1990).

More positively, instructing students to use elaborative interrogation may also promote the spontaneous use of other sophisticated strategies. Wood, Pressley, and Winne (1992) compared recall performance as a function of study strategy for students instructed to use either elaborative interrogation or repetition. The experimenters suspected that students may not always engage in their instructed strategy. To assess this, students recorded their study strategies (e.g. imagery, verbal, repetition) for each fact that was presented. In general, students adhered to the instructed strategy. Students in the elaborative interrogation condition, however, reported using multiple strategies for 83% of the study items, whereas repetition subjects reporting using multiple strategies for only 32% of the items. A possibility worth exploring is that elaborative interrogation can be used in interaction with a repertoire of strategies—which, of course, is what self-regulated strategy use is all about (Schneider and Pressley, 1989). We believe that elaborative interrogation may be a powerful addition to the strategic repertoire of many learners, a strategy than can be applied to relate new material to prior knowledge whenever related prior knowledge is high.

Table 1. Summary of effect sizes in the elaborative interrogation conditions as a function of knowledge base

	Experimental manipulation	Effect size
<i>Low prior knowledge</i>		
Woloshyn, Pressley, and Schneider (1992)	Native- versus foreign-country facts	
	Canadian Students	4.78 SD
	German Students	2.47 SD
Willoughby, Waller, Wood, and MacKinnon (in press)	Familiar versus unfamiliar animals	2.00 SD
Willoughby & Waller (1992)	Established background versus no background knowledge for fantasy facts	2.91 SD
<i>Inconsistent prior knowledge</i>		
Woloshyn, Paivio, and Pressley (1992)	Belief-consistent versus belief-inconsistent facts recognition tasks:	
	immediate	0.65 SD
	14-day	0.41 SD
	75-day	1.08 SD
	170-day	1.06 SD
	Cued recall task	-0.11 SD
	Free recall task	-0.13 SD
<i>Shared Prior Knowledge</i>		
Woloshyn and Gage (1993)	Belief-consistent versus Belief-inconsistent facts	
	Recognition tasks:	
	immediate individuals	0.87 SD
	dyads	0.88 SD
	30-day individuals	0.81 SD
	dyads	0.54 SD
	Cued recall task:	
	individuals	-0.54 SD
	dyads	-0.06 SD
	Free recall task:	
	individuals	0.01 SD
dyads	-0.17 SD	
Wood and Reilly (1993)	Familiar versus unfamiliar animals	
	individuals	0.82 SD
	dyads	1.25 SD

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