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Comparison of Self-Questioning, Summarizing, and Notetaking-Review as Strategies for Learning From Lectures

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Underprepared college students in three conditions viewed a lecture, took notes, and then engaged in their respective study strategies. Those trained in questioning generated (and answered) their own questions based on the lecture, those trained in summarizing wrote original summaries of the lecture, and those in an untrained control group simply reviewed their lecture notes. At immediate testing, summarizers recalled more of the lecture content than did self-questioners, who in turn outperformed notetaking-reviewers. On a retention test of lecture content one week later, the self-questioners performed somewhat better than the summarizers and significantly better than the notetaking-reviewers. Self-questioners' and summarizers' lecture notes contained more ideas from the lecture than did those of the notetaking-review students. Use of these generative study strategies appears to enhance learning from lectures by improving encoding both during the lecture and following the lecture; and for long-term retention of lecture material, self-questioning may be a more effective study strategy than summarizing.

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To succeed in high school and college, students need to be able to understand and remember material presented to them in classroom lectures. For most students the sole strategy that they use for learning from lectures is taking verbatim notes during the lecture (Bretzing & Kulhavy, 1981; Kiewra & Fletcher, 1984; Peper & Mayer, 1986) and then rereading those notes at a later time (Kiewra, 1989). However, the work of Wittrock (e.g., 1974, 1990) suggests that *generative* learning and study strategies (i.e., ones in which students interact with the material to generate unique learning or study aids) would be more conducive to learning. According to Wittrock's model of generative learning, students comprehend and remember new material best when they use their own prior knowledge and experience to reconstruct presented information in new, personally meaningful ways and, in particular, when they build relationships among the new ideas and between that new information and their own knowledge and experience base (Wittrock, 1990). This approach to learning is consistent with current constructivist views of learning (for reviews, see Meyers, Cohen, & Schleser, 1989; Paris & Byrnes, 1989), which argue that reformulating given information or generating new information based on what is provided helps a student to build extensive cognitive structures connecting the new ideas together and linking them to what that student already knows (see also Brown & Campione, 1986; Brown, Bransford, Ferrara, & Campione, 1983; Doctorow, Wittrock, & Marks, 1978; Mayer, 1981; Mayer, 1984; Thomas & Rhower, 1986). According to this view, creating such elaborated structures in long-term memory facilitates understanding of the new material and makes it easier to remember.

Two generative learning strategies commonly used in processing *written* material are self-questioning (where the product generated is a set of questions and answers) and summarizing (where a summary is produced).[1] Previous research in the area of *reading* comprehension has shown that both self-questioning and summarizing can be effective strategies for encoding and remembering material presented in text format. Presumably these strategies may also have some promise for fostering comprehension of material presented in lecture format.

Self-Questioning

In two recent reviews of studies on the use of self-questioning in reading comprehension, Wong (1985) and Rosenshine and Chapman (1990) concluded that, when students receive adequate training in how to generate their own questions, their use of self-questioning during or after reading usually results in improved comprehension.

Asking and answering high-level questions during learning presumably facilitates students' comprehension by inducing such cognitive activities as focusing attention, organizing the new material, and integrating the new information with existing knowledge (Brown et al., 1983; Palincsar &

Brown, 1984). Furthermore, self-questioning is also considered to be a metacognitive strategy because it provides learners with a way to test themselves; that is, it helps them to check how well they are comprehending what they are studying (Baker, 1989; Davey & McBride, 1986; Haller, Child, & Walberg, 1988; Palincsar & Brown, 1984). Thus, the effectiveness of self-questioning is attributed to both its cognitive and metacognitive functions.

Recently King (1989, 1990, 1991) has extended the research on self-questioning by examining the effectiveness of this strategy for comprehending orally presented material in teacher-led expository instruction such as lectures. In two of those studies (King, 1989, 1991), high school and college students used a guided self-questioning procedure to process expository material presented in lecture format. During study sessions following a lecture, the students used a set of generic question stems, such as "What is the main idea of. . .?" and "How does. . . relate to. . .?" and "What conclusions can I draw about. . .?" to guide them in processing the lecture content. They used these general content-free question stems to generate and answer their own specific questions on the lecture content. Students who used this guided self-questioning procedure achieved higher scores on subsequent lecture comprehension tests than did students who used discussion or independent review strategies.

In those studies, the self-questioning procedure presumably served both of the cognitive and metacognitive purposes proposed above. In addition to facilitating students' comprehension of the material during and immediately after the lecture, self-questioning also provided them with an opportunity to test themselves on how well they actually understood the lecture; that is, self-questioning was used for both fostering and monitoring comprehension. Specifically, King (1990, 1992) attributed the success of the self-questioning procedure to the metacognitive (comprehension-monitoring) nature of self-questioning and also to the role that the generic question stems played in guiding students' knowledge construction. King concluded that the particular generic question stems that were used controlled the type and level of the specific questions asked by the students; and those questions in turn influenced the level of the responders' thinking (as evidenced by the type of elaboration in their responses), resulting in improved comprehension and subsequent recall of the lecture content.

Summarizing

Summarization of passages read has also been found to enhance comprehension and recall of passage content (e.g., Brown & Day, 1983; Reinhart, Stahl, & Erickson, 1986; Ross & DiVesta, 1976; Wittrock & Alesandrini, 1990). By definition, a summary must capture the gist of a piece as well as reduce the material substantially. The ability to create summaries develops slowly, and even many high school and adult students have difficulty with this skill (Brown & Day, 1983; Hidi & Anderson, 1986).

According to Wittrock (1990; Wittrock & Alesandrini, 1990), effective summarization is generative in nature; that is, learners use their own words and experiences to construct novel sentences (ones that do not appear in the presented material) and those sentences make connections among the presented concepts and relate the new information to the learners' prior knowledge and experience. When learners use their own words to summarize, connections between the to-be-learned material and each learner's existing knowledge are automatically constructed because those words are associated with information stored in that particular learner's memory. This sort of summary is in striking contrast to the conventional form of summarization used in most summary training studies (e.g., Brown & Day, 1983), in which learners simply select, delete, and modify existing sentences to produce a summary.

Although summarizing has been studied as a strategy for enhancing memory for test passages and oral summarizing of lectures has been examined to a limited extent (e.g., O'Donnell & Dansereau, 1990), generative summarization has not yet been investigated as a strategy for understanding and remembering orally presented material such as a lecture. Obviously, summarizing an oral presentation such as a lecture differs from summarizing a text passage (as does the use of self-questioning in both contexts) in that learners cannot use look-back or rereading tactics for a lecture as they can when working with written materials. Nevertheless, in view of the parallel nature of processing information presented orally and information in text (Danks & End, 1987) and the success of both self-questioning and summarizing with written materials, it appears that these two strategies may have promise as methods for fostering comprehension of material presented in lecture format, and a comparison of the effectiveness of these two strategies is needed.

Notetaking-Review

The time-honored practice of taking notes during lectures has been found to enhance learning, as has the subsequent review of those notes (for a discussion of the encoding and storage functions of notetaking, see DiVesta & Gray, 1972, and Kiewra, 1989). Research has shown that both methods of taking notes and methods of reviewing notes can be improved, resulting in increased learning (Kiewra, 1989). However, the present study did not attempt to manipulate notetaking per se. Rather, it focused on an examination of different approaches to reviewing notes taken by students; that is, all students took notes from the lectures in their usual manner but reviewed those notes in different ways.

Because of the generative nature of self-questioning and summarizing strategies, reviewing lectures using these strategies should result in improved understanding and memory of the lecture material. Specifically, in the present study, students trained to use self-questioning and summarizing strategies

for reviewing lectures were expected to remember the lecture content better than students in a comparison condition who reviewed their lecture notes in their usual way, as evidenced by scores on tests of lecture comprehension taken immediately and a week later. Furthermore, because there was some indication in an earlier study (King, 1989) that students trained in self-questioning began to use their strategy during the lecture (perhaps in anticipation of their reviewing the lecture in this manner later on), it was expected that use of these generative study strategies might also enhance initial encoding of the lecture and that this might be evidenced by more complete lecture notes in the self-questioning and/or summarizing conditions vs. the notetaking-review condition.

Many college freshmen are not prepared for the kind of learning environment that they encounter at the university level. For example, Simpson (1984) found that these students tend to use a limited number of strategies for learning and remembering course material and they lack awareness of how and when to use a strategy or why a particular strategy is important; that is, they appear to be deficient in metacognitive knowledge and skills. For these reasons, underprepared college students were selected as participants in the present study. Such students apparently do not already use effective learning and study strategies that might interfere with training in a new strategy and, in fact, would probably benefit from training in using strategies for facilitating their own comprehension and comprehension-monitoring activities.

Method

Sample and Design

College students in three sections of a remedial reading and study skills course participated in the study. These students had been placed in this basic skills course on the basis of scores below 500 on the verbal section of the Scholastic Aptitude Test (SAT) and scores on the Nelson Denny Reading Test (Form E) of either below 45 on the comprehension subtest or below 44 on the vocabulary subtest. Analyses of these test data revealed no significant differences among the three classes (all $Fs < 1$), suggesting that the three classes did not differ in preexperimental verbal abilities. Mean age of participants was 19.09 years.

Classes were randomly assigned to one of three conditions: self-questioning, summarizing, and notetaking-review (an untrained control group). Seven students were dropped from the three groups due to absence during practice or testing sessions, resulting in the following group sizes: self-questioning—19, summarizing—19, and notetaking-review—18.

Procedure

The training, practice, and testing components of the study (eight sessions total) were designed and delivered as part of the regular study skills course

content. Each of the classes met three times per week for 50 minutes at different times during the morning in the same classroom, and all three classes were taught by the same instructor.

Students in the three conditions listened to lectures and took notes and then either generated and answered their own questions on the lecture content, or wrote summaries of the lectures, or simply reviewed their lecture notes. To determine entry skill, during the first session, participants in the three classes were pretested on their ability to comprehend presented lectures by viewing a videotaped lecture and then answering a 15-item multiple-choice test on its content. The self-questioning and summarizing groups then received training (Session 2), followed by practice in the use of their respective strategies in conjunction with other videotaped lectures (Sessions 3–6). After viewing a final lecture, all three groups engaged in their respective strategies and then took a comprehension test on the content (Session 7). A separate retention test was administered one week later (Session 8).

Materials

For all training and testing phases of the study, students viewed videotaped lectures from an introductory university-level social science course. Each lecture was between 20 and 30 minutes in length and dealt with one topic, the content of each lecture being independent of the previous ones. The lectures selected for this study covered such topics as "Contemporary Socio-Political Thinking" and "Civil Liberties" for the training and practice sessions, "Political Socialization" for the pretest session, and "The Role of Media in Political Campaigning" for the final testing. The last two topics were selected for the testing sessions because it was expected that few students would have sufficient prior knowledge of these particular topics to affect their comprehension of the lectures. The videotaped presentations simulated typical college classroom lectures in that they were all presented by the same lecturer and the camera focused on the lecturer at all times with the exception of an occasional brief shot of a statistical chart, historical photograph, or a caption denoting a lecture subtopic. These taped lectures were selected in order to control for lecture content and presentation variables across the three conditions.

Training and Practice

In both treatment conditions, the strategy to be learned was described and its benefits for self-regulated learning were explained. This explanation, which was briefly reiterated during each of the practice sessions, emphasized the value of applying one's metacognitive knowledge and of continuously monitoring comprehension during learning. Students were also shown how their particular strategy would benefit encoding and recall. Providing this sort of specific information to students has been shown to promote their

use of a trained strategy (e.g., Pressley, Borkowski, & O'Sullivan, 1984).

During training and practice, the self-questioning and summarizing students were provided with direct explanation, explicit cognitive modeling, and scaffolded practice in the use of their respective strategies while reviewing their notes after viewing lectures. Neither of these groups received training in notetaking.

The self-questioning group was presented with a set of 13 generic question stems, such as "How does. . . affect. . . ?" and "Do you agree or disagree with this statement: . . . ? Support your answer." Similar questions had been used in previous studies (e.g., King, 1990) and were designed to guide students in processing the lecture content by such means as analyzing the ideas and concepts in the lecture, determining how these ideas relate to each other, and relating the new information to their own prior knowledge or experience. Figure 1 displays the generic question stems along with the cognitive processes these questions were expected to induce in the students.

The self-questioners were trained to use these content-free general questions to guide them in creating their own "think type" questions specific to the content of the lecture viewed. Using the generic questions, the instructor first modeled how to generate specific questions on the lecture content. In doing so, she continuously verbalized her thought processes about the important ideas from the lecture and how she combined those

questions	cognitive processes the questions are intended to induce in learners
Explain why . . . . (Explain how . . . .)	analysis of processes and concepts --explicit or implicit in the lecture translating terms into different vocabulary
What is the main idea of . . . ?	identification of central idea explicit or implicit in the lecture
How would you use . . . to . . . ?	application of information in another context --perhaps relating to prior knowledge or experience
What is a new example of . . . ?	generation of novel examples of a concept or procedure --perhaps involving relating to prior knowledge or experience
What do you think would happen if . . . ?	retrieval of background knowledge and integration with lecture material to make predictions
What is the difference between . . . and . . . ?	analysis of two concepts --comparison and contrast of concepts
How are . . . and . . . similar?	analysis of two concepts --comparison and contrast of concepts
What conclusions can you draw about . . .?	drawing conclusions based on the content presented
How does . . . affect . . . ?	analysis of relationships among ideas
What are the strengths and weaknesses of . . . ?	analysis and integration of concepts
What is the best . . . and why?	evaluation of ideas based upon criteria and evidence
How is . . . related to . . . that we studied earlier?	activation of prior knowledge and integration with new information

Figure 1. **Generic questions with corresponding intended cognitive processes**

ideas to develop specific questions. The notion of linking ideas from the lecture to create questions was heavily stressed. After creating each question, the instructor continued to "think aloud" in order to model how to answer that question fully. Next, students worked individually to generate their own questions, which they then shared orally with the class. Feedback and support were provided by the instructor until all students became proficient in generating these types of questions. For example, during the oral sharing of questions, the instructor explained to the students why a particular question they had written was appropriate or not; if the question was not a thought-provoking one or did not link lecture ideas together, she made specific suggestions for a more effective question and explained why that was an improvement. In a similar manner, feedback and support were provided for their answers to questions. Following training, the self-questioners practiced their questioning strategy in conjunction with videotaped lectures. They viewed the lecture and took notes; then they read their notes, generated questions, and answered those questions.

The summarizers were trained to generate summaries of the lectures by linking ideas from the lecture together and using only their own words to do so. Using their own words and generating their own sentences in this way was expected to help students to construct their own idiosyncratic representations of the lecture in long-term memory. First, based on their notes and memory of the lecture, summarizers identified the main topic of the lecture and then created a sentence to reflect that topic. Next, they identified and noted subtopics and main ideas from the lecture and then wrote sentences that linked those ideas and topics to each other. These several sentences constituted the lecture summary. It should be noted that these summaries were truly generative in nature because students wrote original sentences that paraphrased the lecture ideas and related those ideas to each other, and they used their own words in place of sociopolitical terms and expressions heard in the lecture. This approach can be distinguished from approaches in which summarizers simply modify sentences they remember from the material presented (a standard practice in many summarizing studies, e.g., Brown & Day, 1983). This approach was used because the summaries were to be used as a way of checking comprehension, and inventing sentences for the summaries was considered to be more likely to help the students construct their own cognitive representations of the lecture. As with the questioning strategy, the instructor used cognitive modeling to demonstrate the summarization procedure to the summarizers during training, and scaffolding with continuous feedback was provided during practice.

In the first two practice sessions, all students used their strategy in a small group context. In those sessions, the self-questioners first generated questions independently and then worked in groups of two or three to ask and answer each other's questions. The summarizers wrote summaries in-

dependently and then read their summaries aloud to their small group and jointly constructed a group summary. The notetaking-review students discussed their notes in their groups. This cooperative approach to practice provided experimental students opportunities for modeling their questions and answers (or their summaries) on those of their peers, thereby presumably improving their questioning and answering (or their summarizing). Further, observing others and practicing in cooperative groups was expected to help individual students to internalize the questioning and answering (or summarizing) skills (Brown & Palincsar, 1989; Vygotsky, 1978). During the final two practice sessions, all students worked independently to apply their strategies to learn from the final practice lectures.

During training and practice, the set of generic questions (see Figure 1) was displayed for the questioners on an overhead screen. Similarly, a scheme depicting the summarization rules was displayed for the summarizers (see Figure 2). However, during the final (testing) lecture, these strategy prompts were removed. The notetaking-review students received no training in either notetaking or review, and during the practice sessions these students viewed the same lectures as the other students, took notes in their usual manner, and then reviewed their notes in whatever manner they were accustomed to. During the posttest session, all three groups were given the same amount of time (15 minutes) to learn the material prior to testing and all three groups completed the same comprehension tests.

IDENTIFY	WRITE (Use your own words)
TOPIC of LECTURE	Turn topic into a sentence reflecting main idea of lecture
ONE SUBTOPIC (or MAIN IDEA) and RELATED IDEAS	Link together----->one sentence
ANOTHER SUBTOPIC (or MAIN IDEA)and RELATED IDEAS	Link together----->another sentence
ANOTHER SUBTOPIC (or MAIN IDEA)and RELATED IDEAS	Link together----->another sentence
ANOTHER SUBTOPIC (or MAIN IDEA)and RELATED IDEAS	Link together----->another sentence
Etc.	

Figure 2. **Scheme depicting summarization rules**

Tests

Measures of both cognitive and metacognitive performance were taken. Cognitive measures consisted of lecture comprehension tests and content analyses of students' lecture notes. Metacognitive activity was assessed through students' self-report rating scales as well as experimenter observation during practice and testing. Individual differences in students' use of learning strategies were also examined. Prior to treatment, students were assessed on their previous use of lecture comprehension strategies; and after the final comprehension test, students were assessed on their use of their trained strategies during the present study.

Lecture comprehension. Pretreatment, posttreatment, and retention tests on lecture content were constructed from test materials accompanying the video lecture series. Each test contained 10 multiple-choice items and measured comprehension by evaluating students' ability to recall ideas presented in the lectures. The posttreatment and retention tests were essentially two forms of the same test and were comprised of different items. In pilot testing with freshmen political science students who viewed the lecture on "The Role of Media in Political Campaigning," the correlation between these two tests was .79. The level of difficulty of all three tests was set high to avoid a ceiling effect.

Lecture notes. Notes taken by students during the pretest and posttest lectures were collected and analyzed (Kintsch & van Dijk, 1978) to determine the number of idea units from the lecture that were captured in student notes. Independent raters scored all protocols and resolved discrepancies by discussion. Interrater reliabilities were .91 and .90 for the pretest and posttest lectures, respectively. The number of idea units (from a possible 140 in the pretest lecture and 126 in the posttest lecture) were converted to percentages of available idea units.

Prior use of strategies. Immediately after the pretreatment lecture and corresponding comprehension test, all students were surveyed to determine what strategies they typically used to learn from lectures. It was particularly important to assess students' previous use of questioning or summarizing strategies during studying because individual differences or group differences in prior use of these strategies could influence effects of strategy training. The questionnaire to assess strategy use consisted of two items. The first of these asked students to identify from a list of five strategies all those that they actually used during the pretest lecture to help them understand and remember what was being presented. The strategies listed were "took notes," "repeated key ideas silently to memorize them," "asked myself questions about the lecture," "visualized or pictured the ideas while listening," "made it personal (explain)," and "other (explain)." The second item asked students to identify from a list of nine strategies all of those that they typically use after a class lecture or outside of class to study material their professors present in class lectures. Those strategies were "reread my

lecture notes," "rewrite my lecture notes," "write a summary of the lecture," "have a friend or family member listen while I tell what the lecture was about," "get a friend or family member to quiz me on the lecture," "make up questions on my own and answer them," "ask a friend or family member for additional information or help," "think up a personal example for each main idea," "associate each main idea with a letter or an object and memorize the list of letters/objects," and "other (explain)."

Metacognitive process. After each practice session, students rated the extent to which they used specific aspects of their strategies during that practice session. On a 5-point scale, each student answered the following items adapted from Davey and McBride (1986): "How well did I identify important information?" "How well did I link information together?" "How well did I answer my questions?" (or "How well did I summarize?" for the summarizers) "How well was I able to use my own words rather than exact words from the lecture?" The consistent use of these ratings was expected to serve the metacognitive function of helping students to monitor their use of the strategies. Davey and McBride (1986) have suggested that attention to such metacognitive components of training may enhance trained students' strategy use.

Strategy use. Following the final session, students completed a two-item questionnaire to assess the helpfulness of their strategy. Using a 7-point scale, they rated (a) the extent to which they used their strategies during that final study session to help them learn the lecture material, and (b) the helpfulness of the stategy overall for helping them learn and remember the information in the lectures during this study. Pressley, Levin, and Ghatala (1988) found that learners' perceptions about the helpfulness of a particular strategy are critical to their continued use of that strategy.

Results

Use of Strategies

The pretreatment questionnaire on students' typical use of study strategies prior to this experiment revealed that there were no significant differences among conditions on typical strategy use with the exception of the strategy "rewrite my lecture notes." On that study strategy, a significant difference was found among the groups, $F(2,50) = 4.51$, $p < .05$, and Tukey's post hoc comparisons of the three group means revealed one significant comparison: students in the questioning condition used the study strategy of rewriting their lecture notes more frequently than did the summarizing students ($p < .05$).

Experimenter observation revealed that, during practice and posttesting, all students in the strategy training conditions engaged in their respective study behaviors as directed. Observation of the notetaking-review students during the posttest study session revealed that all students reread their lecture notes; and additional tactics of underlining information in the notes

and/or adding material to the notes were used by fewer than 10% of that group, indicating poor study habits/skills.

Participants' self-reports about use of their trained strategies revealed that all students in the self-questioning and summarizing groups used the strategy they had been trained in during the posttest session. On a 7-point scale, the self-questioners rated their use of self-questioning as 5.78, and the summarizers rated their use of summarizing as 5.42. Analysis of variance showed no significant difference between these ratings, F (1,36) = 1.8, $p > .05$. Although students may have also used other, previously learned strategies, it seems unlikely that such behavior interfered with their use of the learned strategy. In the pretest measure of strategy use, 76% of students in all groups said that they typically relied on rereading their lecture notes as their sole review activity; and, in the present study, they were able to continue use of that procedure because it was actually incorporated into both the self-questioning and summarizing strategies.

The extent to which these students found their strategy helpful was rated 5.58 on a 7-point scale by the self-questioners and 5.05 by the summarizers. The difference between these ratings was not significant, F (1,36) = 1.65, $p > .05$.

Lecture Comprehension

Analysis of the baseline pretest of lecture comprehension revealed no significant differences among conditions. Means and standard deviations are presented in Table 1. Analysis of covariance was used to determine effects of treatment on lecture comprehension at posttest, adjusted for pretreatment performance. Posttest means, standard deviations, and adjusted means for this analysis are also shown in Table 1. A significant difference among groups was found, F (2,52) = 10.84, $p < .001$. The Tukey post hoc comparison procedure was used to examine multiple comparisons among the three group means. These comparisons revealed that both the self-questioning and summarizing groups outperformed the notetaking-review group, ps < .05; there was no significant difference between the self-questioners and summarizers on posttest lecture comprehension.

Lecture Notes

Means and standard deviations from the content analyses of students' lecture notes appear in Table 1. An ANOVA on the percentage of lecture ideas found in the pretest lecture notes showed no differences among the three groups. Although the mean percent of idea units found in the notes is small, it must be recalled that the participants in the present study were underprepared college students and their performance appears to be consistent with earlier studies showing that generally students capture less than 40% of available lecture information in their notes (e.g., Hartley & Cameron, 1967; Howe, 1970) and college freshmen in particular record only about

Table 1

Means, Standard Deviations, and Effect Sizes for Cognitive Outcome Measures in Three Strategy Conditions

Cognitive measure	Self-Questioning[a]				Summarizing[b]				Notetaking-Review[c]			Significant post hoc comparisons*
	Mean	(*SD*)	Adj. Mean	Effect size	Mean	(*SD*)	Adj. Mean	Effect size	Mean	(*SD*)	Adj. Mean	
Lecture comprehension												
Pretest	63.79	(10.00)			60.00	(8.74)			63.20	(12.36)		
Posttest**	67.74	(11.16)	67.15	.63	74.68	(9.41)	75.62	1.33	59.90	(12.06)	59.52	S-Q; SUM > N-R
Retention*	51.05	(12.87)	50.90	.87	44.74	(25.25)	44.98	.57	33.88	(19.75)	33.70	S-Q > N-R
Lecture notes % Important idea units												
Pretest Lecture	14.20	(3.50)			12.40	(2.50)			12.20	(1.90)		
Posttest Lecture*	17.70	(4.80)	17.00	.69	17.20	(5.20)	17.50	.79	13.30	(4.80)	13.70	S-Q; SUM > N-R

[a]$N = 19$; [b]$N = 19$; [c]$N = 18$
*$p < .05$; **$p < .001$.

11% (Hartley & Marshall, 1974).

Analysis of covariance on the percent of ideas found in the posttest lecture notes, adjusted for pretreatment performance, revealed a significant difference among the conditions, $F(2,52) = 3.49$, $p < .05$. Tukey's post hoc comparisons revealed that both the self-questioners and summarizers captured a significantly higher percentage of the available lecture ideas in their notes than did the notetaking-review students ($ps < .05$). This difference cannot be accounted for by differences in length of students' notes. No differences were found in the number of words that self-questioners, summarizers, and the notetaking-review students recorded in either their pretest lecture notes (means were 127.84, 129.21, and 114.67, respectively) or their posttest lecture notes (means were 116.74, 112.53, and 116.28, respectively).

Retention

Analysis of covariance on the 1-week retention test scores (adjusted for pretreatment performance) revealed significant differences among groups, $F(2,52) = 3.43$, $p < .05$. Means, standard deviations, and adjusted means for this analysis are presented in Table 1. Tukey's post hoc comparisons revealed that self-questioners performed significantly better on this test than did notetaking-review students ($p < .05$), but not significantly better than summarizers. There was no significant difference between the performance of summarizers and notetakers.

The differential effects of these two strategies at week delay cannot be accounted for by differences in the number of ideas in students' study products. Content analyses of these study products (i.e., questions/answers and summaries) generated during the posttesting study session showed that the summarizers included a significantly higher percentage of the lecture ideas in their summaries (mean = 9.74) than the self-questioners did in their questions/answers (mean = 5.79), $F(1,36) = 40.73$, $p < .001$.

Discussion

Both guided self-questioning and summarizing are effective strategies for learning from lectures. Students who were trained to generate (and answer) their own thought-provoking questions following a lecture and those who were trained to write summaries of the lecture performed better on lecture comprehension at immediate posttesting than students who simply took notes and reviewed their notes; and, on a retention test one week later, the questioners significantly outperformed the notetaking-review students. Furthermore, self-questioning and summarizing students reported that they found these strategies helpful for learning from lectures.

Comprehension

Wittrock (1990) and most constructivists would argue that the learning strategies of self-questioning and summarizing were effective because they facilitated students' construction of meaning for the lecture through the process of making internal connections among the ideas within the lecture and making external connections between the lecture and their existing knowledge. In this study, those two learning strategies were deliberately structured to guide students to build those kinds of connections (see earlier discussion). Furthermore, the rating scales that the trained students used after each practice session reinforced the importance of making such connections by asking students to rate how well they actually did link information.

By engaging in these generative self-questioning and summarizing activities, students were constructing their own representations for the meanings of the lecture. Apparently these learner-constructed representations enhanced comprehension of the lecture, as evidenced by the superior performance of self-questioning and summarizing students over the notetaking-review students on the posttest.

Retention

Both the self-questioning and summarizing strategies were effective at immediate testing, but only the questioning strategy was superior to notetaking-review at week delay. Although the self-questioners did not perform significantly better on the retention test than did the summarizers, their performance was somewhat better; and, since differences in effect sizes were substantial (.87 for self-questioning vs. .57 for summarizing), for practical considerations the self-questioning strategy might have some advantage over the summarization strategy for retention of information. But why might this be so? Researchers have found that different strategies have different effects on students' cognitive processing and on the way in which information is represented in memory (e.g., Brown et al., 1983; Mayer, 1984; Wittrock, 1986), and both research and theory (e.g., Craik & Lockhart, 1972; Craik & Tulvig, 1975; Wittrock, 1990) concur that the more completely information is processed, the better it is remembered over time. The primary focus of the summarizing strategy was on making internal connections among the lecture ideas, whereas the questioning strategy promoted both internal and external connections. This difference in the strategies would presumably result in differences in cognitive processing and differences in memory representations of the lecture and may account for the differential effects on retention for self-questioning and summarizing. In particular, questioning may have promoted long-term retention of the lecture ideas to a somewhat greater extent than did summarizing because it increased cognitive processing in ways that the summarizing did not. For example, the questioning and answering guided students to connect the ideas from the lecture in very specific ways, and the question stems prompted students to

elaborate on the material by going beyond what was stated in the lecture.

First, although both strategies were designed to facilitate integration of the lecture through building internal connections among the lecture ideas and both groups were instructed to link information, only the questioning strategy provided students with explicit structure and guidance for such generative processing. That structure was in the form of question stems, and those particular question stems guided students in constructing specific kinds of connections. For example, certain question stems prompted students to generate specific kinds of idea realtionships such as comparison and contrast, cause and effect, strengths and weaknesses (refer to Figure 1). The questioning students who processed the lecture by making these specified connections between or among ideas would undoubtedly construct different kinds of meanings than the summarizers who received no such structure and whose connections were more spontaneously generated (having been prompted only by the ideas contained in their lecture notes). Also, the variety of available question stems may have prompted the questioners to think about the lecture in several different ways (such as looking for both similarities and differences and evaluating ideas), causing the questioners to forge a variety of different links between and among the lecture ideas in their memory structures (cf. comparison networks vs. argument response networks, Mayer, 1981). Thus, it seems likely that the questioners, who were provided with so much explicit guidance, would construct representations of the lecture in long-term memory that were more richly integrated—more complete—than those of the summarizers. Such extensive cognitive representations would contain more cues for recall, making the material more accessible over time.

Second, many of the question stems required students to go beyond the lecture, that is, to elaborate on the lecture material by generating inferences, drawing conclusions, making evaluations, and so forth. Such elaboration has consistently been shown to enhance recall because the information is encoded more precisely and more meaningfully (e.g., Bransford, Stein, Vye, Franks, Auble, Merzynski, & Perfetto, 1982; Pressley, Symons, McDaniel, Snyder, & Turnure, 1988). In contrast, the summarizers were not prompted to go beyond the lecture in their processing activity. Although using their own words would presumably connect the lecture content to their own previous knowledge to some extent (Wittrock & Alesandrini, 1990), it is unlikely that it would have been as effective as using specific questions that required such connections. Use of students' own words may not automatically achieve this external connecting, especially for these less academically able students, and they may have needed some form of guidance, such as the question stems, in order to make precise and explicit connections deliberately. Thus, as a result of the guidance provided by the question stems, the questioners' cognitive representations of the lecture would be more elaborated than those of the summarizers; that is, the ques-

tioners' memory structures would be both more precise and more personally meaningful. Such memory structures would tend to resist decay, making the material more memorable over time.

Furthermore, the metacognitive nature of the self-questioning strategy may have promoted the building of more accurate representations of the lecture by students who used that strategy. Self-questioning is a metacognitive strategy that helps students check the accuracy of their understanding (Davey & McBride, 1986; Haller et al., 1988; King, 1992; Palincsar & Brown, 1984), and such comprehension monitoring may have improved the accuracy of the questioners' constructed representations of the lecture, thus promoting accurate recall and retention.

In summary, the guidance provided by the questioning strategy may have enhanced the accuracy, the meaningfulness, and the completeness of the students' constructed meanings for the lecture. This may explain why use of the questioning strategy resulted in better retention of the material over time than did use of the summarizing strategy. These differential effects of the questioning and summarizing strategies on retention suggest that, while the two generative strategies may both be effective approaches for learning from lectures when the goal is to remember the information right away, self-questioning may be a more effective strategy if the material is to be retained for any length of time.

Initial Encoding

Although none of the students captured a large percentage of the available lecture ideas in their posttest session notes, self-questioners and summarizers produced more complete notes than did the notetaking-review students. According to research on the encoding function of notetaking (Kiewra, 1989), this may indicate that these strategies enhanced initial encoding of the lecture. This effect for question generation and summary generation on notetaking suggests that students may have anticipated that they would be generating questions or summaries after the lecture and may have begun to apply these strategies in some manner during the lecture. Such activities may have facilitated their initial encoding of the lecture. Such a phenomenon has been observed in previous research (e.g., Ross & DiVesta, 1976) where students, who expected they would be summarizing material after reading it, later recalled more of that material than those who had not been told they would be required to summarize. In the case of the questioning strategy, for example, perhaps students generated some questions while listening to the lecture, and the process of simply raising such thought-provoking questions on the lecture content (without even answering them) may have required them to think about the material and engage in such generative activities as identifying important ideas, speculating on relationships among those ideas, predicting outcomes, and evaluating the significance of concepts. Such activity may have enhanced encoding dur-

ing the lecture, resulting in more of the lecture ideas appearing in the questioners' lecture notes.

In learning from lectures, the lack of availability of the presented material at a later date places a great deal of emphasis on initial encoding and, although the learner's ability to encode the material during the lecture is generally facilitated by notetaking (Kiewra, 1989), findings from this study suggest that other strategies such as self-questioning and summarizing may also enhance encoding during a lecture.

The findings from the analysis of the lecture notes indicate that the self-questioning and summarizing students increased the completeness of their notes, suggesting that initial encoding of the lecture was improved for these students. The fact that they were also the ones who performed best on the comprehension posttest suggests that the improvement in initial encoding during the lecture may have contributed to their superior comprehension. Thus, the generative strategies of self-questioning and summarizing appear to be effective both during the lecture (by improving initial encoding of the lecture material) and after the lecture (in reviewing the lecture).

Educational Implications

On a practical level, this study shows that underprepared college students can be successfully trained to augment notetaking by using the strategies of self-questioning and summarizing to facilitate their learning from lecture. However, when the material is to be retained for any length of time, such as for a subsequent exam, use of the self-questioning strategy may be preferable to summarization. In fact, the superior effects for the self-questioning strategy suggest that, not only do these less academically able students benefit from using this strategy, they may actually need the explicit guidance that such a strategy provides for processing lecture information. Students who are poor comprehenders (such as those in this study) are less likely to engage in spontaneous elaboration and higher level thinking on their own during learning (Bransford et al., 1982; Brown et al. 1983) and may need to be prompted to engage in such generative activities. Perhaps college instructors should be advised to provide this sort of support and guidance to their students by teaching them to use generative strategies such as self-questioning and by designing their lecture courses to allow opportunities for students to process the material immediately after it is presented.

Although these generative questioning and summarizing strategies appear to enhance learning for these less academically able college students, who apparently do not already have efficient lecture-processing skills that they typically use, this may not be the case for more successful learners, especially adult learners who have, over the years, developed and refined their own most efficient strategies for learning and study. Previous research

(King, 1990; 1991) has shown the self-questioning strategy to be effective for learning from lectures by academically successful high school and university students; however, results for the summarizing strategy should not be generalized to populations other than underprepared college students.

Finally, this study shows that the self-questioning and summarizing study strategies can be readily incorporated into the instructional component of a "real-world" study skills course in a college classroom. Furthermore, students actually consider the strategies to be beneficial. These findings together may encourage instructors of other college courses to utilize these strategies to help their students learn from lectures.

Note

[1]Notetaking can also function as a generative strategy when, for example, students have learned to take notes by making a concept map, an outline of the presentation, a matrix (Kiewra, DuBois, Christian, McShane, Meyehoffer, & Roskelley, 1988), or a series of summary statements. However, students untrained in such specialized forms of notetaking are far more likely to produce notes that simply list main ideas or repeat verbatim what the lecturer said rather than organize the material into some sort of personally significant framework or indicate in some other manner that the new information has been integrated with their prior knowledge (Bretzing & Kulhavy, 1981; Kiewra & Fletcher, 1984).

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