Improving Lecture Comprehension: Effects of a Metacognitive Strategy

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SUMMARY

In previous research self-questioning strategies have been found to significantly improve reading comprehension, presumably because of the metacognitive nature of the self-questioning process. The purpose of the present study was to determine whether this metacognitive strategy also enhances lecture comprehension, that is, comprehension of non-text, orally presented material. In a self-questioning combined with reciprocal peer-questioning condition, ninth-graders were trained to pose questions for themselves during classroom lectures; following the lectures, they used their questions to engage in reciprocal peer-questioning and responding. Students in a self-questioning only condition also engaged in self-questioning during the lectures and then answered their own questions; in a review condition, students discussed the lecture material in small cooperative groups; and in a control group students reviewed the lecture material independently. On post-practice and 10-day maintenance tests participants in the self-questioning with reciprocal peer-questioning and the self-questioning only strategy groups showed lecture comprehension superior to that of participants in both the discussion review and control groups. These results suggest that: use of a self-questioning strategy can improve high school students' comprehension of lectures; students can maintain this strategy when external prompts are removed; and this metacognitive strategy can be readily taught to high school students and incorporated into their real-world classroom learning environment.

With the recent interest in the role that metacognition plays in learning (e.g. Brown, 1980; Brown, Armbruster & Baker, 1986; Corno, 1986; Perkins, Simmons & Tishman, 1989), much emphasis has been placed on encouraging students to take a more active role in controlling their own learning process through direct instruction of metacognitive strategies in the classroom. According to Brown, Bransford, Ferrara and Campione (1983) metacognition refers to planning, monitoring, and regulating one's cognitive processes during learning, and includes such activities as setting learning goals, selecting learning strategies, matching strategies to task demands, and comprehension-monitoring. Furthermore, recent research indicates that students can be successfully trained to use these metacognitive skills (e.g. Palincsar & Brown, 1984; Pressley, Borkowski & O'Sullivan, 1984; Paris, Cross & Lipson, 1984; Weinstein, 1988).

Self-questioning

One of the metacognitive strategies which successful learners use to monitor their comprehension during learning is self-questioning (Brown et al., 1983; Palincsar 0888-4080/91/040331-16$08.00 © 1991 by John Wiley & Sons, Ltd. Received 12 March 1989 Revised 15 August 1989
& Brown, 1984; Weinstein & Mayer, 1985). Self-questioning is considered to be a metacognitive strategy because it functions as a form of self-testing that helps learners keep a continuous check on their understanding during learning; that is, the metacognitive process of self-questioning is used to control the cognitive processes of comprehension. Specifically, asking and answering questions for themselves during learning has been found to help students control such specific cognitive processes as integrating content with prior knowledge, comparing main ideas, confirming assumptions, making predictions, discovering gaps in understanding, and remediating comprehension failure (Bransford, Stein, Arbitman-Smith & Vye, 1985; Brown et al., 1983; Palincsar & Brown, 1984; Wong & Jones, 1982). For example, a self-question such as ‘How does this idea relate to what I learned before?’ may assist the learner to integrate the new information with previously learned material; a question such as ‘What are the advantages and disadvantages of this procedure?’ may alert the learner to insufficient comprehension and trigger a follow-up question, ‘How can I find out?’, which may in turn suggest remedial action such as listing attributes, reviewing notes, or rereading text passages. In her review of research on the uses of this sort of self-questioning as a reading comprehension strategy, Wong (1985) found that, at various grade and ability levels, students who had been adequately trained to use self-questioning during reading generally showed comprehension superior to that of those who used other strategies. Furthermore, in a recent meta-analysis of 20 empirical studies on effects of various metacognitive strategies on reading comprehension, Haller et al. (1988) found self-questioning to be the most effective monitoring and regulating strategy.

As yet no studies have examined the effects of self-questioning on comprehension of material presented in lectures. If self-questioning is an effective comprehension strategy with written text, it might also facilitate understanding material which is presented orally in lectures. Although written text and oral communication are quite different forms of presentation, Danks and End (1987) have argued that reading and listening impose similar cognitive demands on the learner; in fact, Townsend, Carrithers and Bever (1987) have reported that learners’ reading and listening comprehension appear to be highly related.

The ability to comprehend material presented in lectures is critical to academic success in high school, where students receive so much information in lecture form. To learn from lectures students must comprehend the information presented, accurately encode it, and be able to recall it at a later time, such as on an exam. Posing their own questions while listening to a lecture could enhance students’ processing of the lecture content; for example, it could help them to make internal connections among ideas presented in the lecture, it could facilitate building external connections to their existing knowledge, and it could promote their comprehension-monitoring.

On the other hand, self-questioning may not be as effective a strategy with oral material as it is with written text. For example, the process of generating questions during a lecture may distract the learner from focusing attention on the ideas presented. Loss of attention is of particular concern in oral contexts, since the learner cannot go back and reread (or relisten) in order to clarify meaning or answer a question, as is possible during reading. In addition, as Perkins et al. (1989) have pointed out, cognitive load can be a problem in the use of any learning strategy because adding a metacognitive strategy to cognitive activities may increase cognitive load to the point of disruption of performance. This is particularly so in the initial
stages of strategy use before proficiency with the strategy has been attained. In a lecture context effective listeners must use working memory capacity for such cognitive tasks as organizing information, relating it to prior knowledge, and rehearsing it for storage in long-term memory. However, the act of generating questions during a lecture may actually strain the capacity of working memory and interfere with these processes, and consequently may decrease the amount of material the learner can accurately encode. Therefore, self-questioning, when used with lecture material, may make greater demands on both attentional processes and on working memory than it does when used in a reading context. It is possible that these additional cognitive burdens may decrease the benefits of the self-questioning strategy when used in a lecture context.

Reciprocal/cooperative learning

There is some evidence to suggest that a cooperative self-questioning learning context may be more effective than independent use of the self-questioning strategy. Extensive research on cooperative learning has revealed that, at all levels of schooling and ability, students working in small learning groups generally outperform independent learners (Johnson, Maruyama, Johnson, Nelson & Skon, 1981; Sharan, 1980). One explanation for these results is the notion of pooled expertise. In most cooperative learning groups each learner participates to the extent possible so that collaboratively the group reaches a level of understanding and accomplishment not possible by any individual group member.

Reciprocal teaching/learning is a form of cooperative learning in which learners assist each other to learn by exchanging roles during such tasks as asking and answering questions, giving and taking tests, giving and following directions. The few studies which have examined effects of reciprocal questioning strategies suggest that a cooperative context may increase the effects of a self-questioning strategy. For example, Frase and Schwartz (1975) found that high school and college students who used reciprocal questioning as a study strategy scored higher on achievement tests than did those who independently reread the text. Fantuzzo, Dimeff and Fox (1987) reported that college students who engaged in reciprocal peer tutoring, during which they tested each other on multiple-choice questions, received higher scores on a course exam than did independent learners who only wrote questions. Palincsar and Brown (1984; Brown & Palincsar, 1982) also reported impressive reading comprehension gains for elementary school students using a reciprocal teaching strategy which included self-questioning as a major component. By way of explanation of these effects, Brown and Palincsar (1988) pointed out that, in these kinds of cooperative questioning contexts, the group provides mutual support, shared expertise, and models for expert questioning and responding. These few studies suggest that a cooperative learning context may enhance comprehension effects of a self-questioning strategy.

The present investigation

This study was undertaken to examine the effectiveness of self-questioning strategies on high school students’ lecture comprehension. Ninth graders were selected as the sample because metacognitive instruction has been found to be particularly effective
at the junior high and early high school levels, presumably because students of this age are approaching full Piagetian formal operational thinking (Haller et al., 1988). Honours classes were selected because these particular classes were determined, through testing and teacher observation, to be homogeneous with regard to student characteristics of high ability, achievement, and motivation to succeed on academic tasks. Motivation to learn is an important component of self-regulated learning, and McCombs (1988) has pointed out that when students have strong intrinsic motivation to learn they are more likely to be successful in strategy use. Thus the high level of student motivation in this sample was expected to facilitate strategy use. Furthermore, it was expected that using a sample which was homogeneous with regard to ability, achievement, and motivation, would help to control for effects due to these variables and thus reduce the likelihood of confounding such variables with strategy use.

Ninth-graders in a self-questioning condition were expected to outperform those in a review condition on lecture comprehension, consistent with findings from studies using self-questioning strategies with written materials. It was further expected that students in a self-questioning combined with reciprocal peer-questioning condition would show better comprehension of lecture content than would those in a self-questioning only condition, because of the added effect of the cooperative learning context. However, as previous research has shown, improved comprehension could result from cooperation alone, without the self- and peer-questioning component. Therefore, to further isolate the self-questioning and cooperative learning variables, it was decided to include a comparison group (a discussion review condition) that was cooperatively structured but did not use the self-questioning strategy. Because of the shared expertise inherent in such cooperative discussion contexts, participants in this condition were expected to outperform students in a control group working independently using their usual preferred review strategies.

A second purpose of the study was to determine the feasibility of using such a self-questioning strategy in a real-world context as a regular aspect of classroom learning and instruction. Students were expected to be able to utilize the self-questioning strategy in the small group and individual learning contexts commonly used in high school lecture classes. On a lecture comprehension test given immediately after practice with their respective strategies in these contexts, students were expected to perform as indicated above; that is, performance would be highest for the self-questioning plus reciprocal peer-questioning group, followed by the self-questioning only group, the discussion group, and finally the control group.

Transfer and maintenance

However, truly self-regulated learners eventually learn and study alone, without the advantage of peer input and without an externally structured study session. Therefore, an additional question was: Will students trained in the self-questioning strategy use it on their own in a lecture context where they are not instructed to use the strategy and are not provided with a post-lecture strategy-use session? On a comprehension test given after a lecture where external strategy prompts were not used, and post-lecture practice was not provided, it was expected that performance of students in the self-questioning strategy conditions would indicate some degree of strategy transfer and maintenance.
METHOD

Sample
 Fifty-six honours program ninth-graders, enrolled in two sections of freshman honours world history in a southern California suburban high school, participated in the study. Eligibility for the honours program was based on high academic performance in eighth grade English and history courses as well as superior scores on eighth-grade standardized achievement tests in reading and mathematics. Students in the two classes were comparable on these criteria and were scheduled into one or the other of the two sections of freshman honours world history by the school computer. Both classes were scheduled during the mornings (periods 2 and 3), were taught by the same teacher, and covered the same curriculum using the same classroom and materials. Ethnic minority representation consisted of 53 per cent in one class and 41 per cent in the other. Most of the minority students were Asian or southeast Asian, and a few were Hispanic. Socioeconomic status of the students ranged from lower middle class to middle class. The ratio of males to females was 11 to 18 for one class and 15 to 12 for the other.

Students in both classes were accustomed to working in mixed-sex cooperative learning groups, and had been doing so for several months prior to the beginning of the present study.

Design
 One class was randomly assigned to the questioning treatments. Students within that class were then randomly assigned to either the self-questioning only or the self-questioning with reciprocal peer-questioning condition. Within the latter condition participants were randomly assigned to groups of three. Students in the other class were randomly assigned to either the discussion or control groups, and within the discussion treatment, groups of three were randomly formed. This procedure resulted in four strategy groups: self-questioning with reciprocal peer-questioning (n = 15); self-questioning only (n = 14); discussion (n = 15); and independent review, an untreated control group (n = 12).

With the exception of one of the learning triads in the discussion condition (which was composed of three females), all groups of three were heterogeneous with regard to both sex and ethnicity.

In an effort to increase external validity, and to assess the real-world utility of the self-questioning strategy, the study was embedded within the structure of the existing history course. The study was designed in such a way that strategy training, practice with learning strategies, and testing were incorporated into the course as a means of learning and evaluating the regular course content. In this way all elements of the study became naturally occurring classroom phenomena. Presumably this structure reflects that commonly found in high school classrooms where the course material is presented by teacher lecture, students study it in some manner (usually independently and frequently in discussion groups), and are then tested for comprehension.

All participants were given a lecture comprehension pretest at the beginning of the study to gather baseline data. Following strategy training, participants practised their strategies in the classroom setting in conjunction with five course lectures.
At the end of the fifth practice session a test was given, to assess participants’ comprehension of that session’s lecture. Essentially this post-practice test evaluated comprehension on ‘practised’ lecture material, since students had used their respective strategies to process this lecture. After 10 days delay all participants listened to another course lecture without having been instructed to use their strategies. This time there was no post-lecture study session and, immediately after the lecture, students were tested on their comprehension. The purpose of this test was to evaluate student performance on *unpractised* material and to assess strategy maintenance.

**Procedures**

*Lecture materials*

Seven course lectures were selected for use in the study. Both classes were taught by the same teacher who rigidly followed written lecture notes for all seven presentations in order to maintain consistency between the two classes with regard to content covered, use of examples, and time allocated to topics. Students were not allowed to ask questions, take notes, or interrupt during the experimental lectures. These procedures helped to ensure that the in-class experience of the four groups was essentially the same, and differed only with regard to the learning strategy used by students. The lectures were presented in logical order, maintaining the usual topic sequence for this course, and covered the following topics: geography and early history of Japan, external influences on Japan’s history, Japan’s feudal system, the Shogun, the Samurai, Zen, the civil war in Japan, flourishing of the arts and growth of towns in medieval Japan, background of the American Revolution, causes of the French Revolution.

*Strategy training and practice*

Students in the two self-questioning conditions were provided with direct instruction in generating higher-order questions. First they learned to differentiate between factual questions (ones which require the learner to simply recall facts and ideas explicitly stated in the lecture), and higher-order questions (which require the learner to recall the facts and ideas but also to engage in application, analysis, interpretation, or evaluation of those ideas). Higher-order questions were emphasized in this study because Hamaker (1986) has argued that such questions elicit meaningful learning, presumably because they stimulate more thorough processing of information.

Students in the questioning conditions were then provided with a set of generic question stems which they could use to guide them in asking higher-order comprehension questions specific to any presented content. This ‘question starters’ approach to questioning training was used because it is a simple strategy and presumably easy to internalize, it provides structure for generating the questions, and it allows students freedom to create questions relevant to their own learning needs. A simple strategy was designed in order to avoid the possibility of students modifying or abandoning the strategy as Bean (1985) has pointed out often occurs when complex learning strategies are used. The students practised using these stems to write and share specific higher-order questions on history content recently covered. They continued generating questions with teacher guidance and feedback until they had
reached proficiency. This sharing plus feedback provided the students with models of well-constructed higher-order questions.

These students were also provided with a brief explanation of metacognition, including a discussion of the beneficial effects of monitoring one’s comprehension during learning. They were informed that self-questioning is a metacognitive strategy because it acts as self-testing, helping learners check on their comprehension. They were also told that they themselves would soon be using this strategy to help them learn from class lectures. The benefits of such ‘informed strategy training’ have been pointed out by a number of researchers (e.g. Brown & Palincsar, 1982; Paris et al., 1984; Pressley, 1988; Pressley et al., 1984), who argue that informing students of the rationale for using a particular strategy will enhance the effects of the strategy and more likely ensure continued voluntary use of that strategy.

The students were then trained to generate specific metacognitive (comprehension-monitoring) questions such as: ‘What do I still not understand about this?’ Again students shared with the class examples of the questions that they wrote.

Inspection of Table 1, which contains examples of question stems with sample student endings, shows that the question stems were designed to facilitate students’ understanding of the lecture content, integration with prior knowledge, and comprehension-monitoring; that is, the question stems address both cognitive and metacognitive processes.

Total training time for the self-questioning groups consisted of two 45-minute sessions. (In pilot work with similar subjects this amount and type of training was sufficient to reach proficiency in self-questioning.)

Students in the discussion and control conditions were also presented with the information on metacognition and the explanation of the benefits of constantly monitoring their comprehension during learning. This precaution was taken in order to control for effects due to metacognitive knowledge. Care was also taken not to provide the self-questioning students with any additional training or instructions regarding variables such as listening skills, mental note-taking, or silent rehearsal which could have influenced their encoding of the lectures.

Following training, the sequence of lectures and strategy practice sessions began. The post-lecture practice sessions were each 12 minutes in length. (Pilot work with similar students indicated that this was adequate time for the task.) During these five practice sessions each of the four groups utilized only its assigned processing strategy, that is, self-questioning with reciprocal peer-questioning, self-questioning working alone, discussion in small cooperative peer groups, or independent review of material.

In the self-questioning combined with reciprocal peer-questioning condition students were instructed to independently generate questions during the lecture and then, following the lecture, to spend the first few minutes of the 12-minute session to write down two or three higher-order questions based on the lecture content. They were further instructed to take turns posing their questions to the other members of their cooperative learning triads and, as a group, discuss possible answers. During their post-lecture session the self-questioning only students first wrote down questions they had generated during the lecture, and then proceeded to answer them working independently all the while. Students in the discussion and control groups were instructed to listen carefully to the ideas presented during the lecture; then, in the post-lecture session, students in the discussion triads engaged in unstructured
### Table 1. Question stems and sample questions generated by students

<table>
<thead>
<tr>
<th>Stems</th>
<th>Student questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>How are ... and ... alike?</td>
<td>How are Shintoism and Buddhism alike?</td>
</tr>
<tr>
<td>What is the main idea of ...?</td>
<td>What are the main ideas about the mercantile system in England and America?</td>
</tr>
<tr>
<td>What do you think would happen if ...?</td>
<td>What do you think would have happened if the king and church didn’t have all the power in France?</td>
</tr>
<tr>
<td>What are the strengths and weaknesses of ...?</td>
<td>What were the strengths and weaknesses of the French government under Louis XIV?</td>
</tr>
<tr>
<td>In what way is ... related to ...?</td>
<td>Which ways is Japan related to the other civilizations that we learned?</td>
</tr>
<tr>
<td>How does ... affect ...?</td>
<td>How did the rise of power of the Shogun affect the development of Japanese government and culture?</td>
</tr>
<tr>
<td>Compare ... and ... with regard to ...</td>
<td>Compare and contrast Japan’s and Russia’s isolation with regard to the way they developed and were influenced by countries.</td>
</tr>
<tr>
<td>What do you think causes ...?</td>
<td>What do you think caused Japan not to be conquered until World War II?</td>
</tr>
<tr>
<td>How does ... tie in with what we have learned before?</td>
<td>How does Japan’s government–military relationship tie in with what we learned before?</td>
</tr>
<tr>
<td>Which one is the best ... and why?</td>
<td>Which king was best for England? Why?</td>
</tr>
<tr>
<td>What are some possible solutions for the problem of ...?</td>
<td>What are some possible solutions for the problem of the Russian serfs’ land conditions?</td>
</tr>
<tr>
<td>Do you agree or disagree with this statement: ...? Support your answer.</td>
<td>Agree or disagree: The monarch had the most fault in starting the French Revolution.</td>
</tr>
<tr>
<td>*What do I (you) still not understand about ...?</td>
<td>What don’t I know about Samurai family life?</td>
</tr>
</tbody>
</table>

*Metacognitive question.

Discussion of the presented content, while those in the control group were told to review the material independently in any manner they wished (presumably their usual preferred review strategies).

According to anecdotal teacher observation records, students in the questioning conditions and the discussion groups engaged in the strategies as they were instructed. Students in the control group were observed using the following spontaneous processing strategies: silent rehearsal, jotting down notes on what they could remember of the lecture, reading and rereading of those notes.

**Comprehension tests**

Pre-test, post-practice, and maintenance tests of lecture comprehension were administered to all participants individually. These tests contained both multiple-choice and open-ended questions, and the difficulty level of test items was set high in order
to avoid the possibility of a ceiling effect. Test questions were designed to elicit higher-order thinking, requiring the learner to integrate several pieces of information, elaborate on ideas, analyse information or apply it in a new context. Two independent raters, blind to experimental condition, scored the open-ended questions on each of the three tests; they used the teacher's lecture notes as an indicator of content covered. Inter-rater reliabilities on the pretest, postpractice, and maintenance tests were .95, .93, and .95 respectively. In all cases of discrepant scores an average was taken. The internal consistency coefficients for the three comprehension tests were .75, .78, and .80, well within the acceptable reliability range for experimental research (Gronlund, 1977).

**Group interaction**

During the final practice session discussions were audiotaped to provide information regarding the verbal interaction and other behaviour occurring in the cooperative learning groups. Two reciprocal questioning triads and two discussion triads were randomly selected for taping. The tapes were transcribed and the interaction was coded into task, social, and maintenance behaviours. Task interactions included such behaviour as asking questions, giving explanations, giving low elaboration responses. Although it was not within the scope of this study to examine the verbal interaction within groups, these data were collected and analysed to determine whether students had any problems interacting with each other in the groups. In cooperative learning the group composition can affect how students interact with each other, particularly when there are boys and girls in the same group as was the case in this study. If such interaction problems were present, or if the reciprocal questioning and discussion triads were found to differ with regard to amount of on-task or social behaviour, such differences could account for any comprehension effects.

**RESULTS**

**Comprehension**

Analysis of variance revealed no significant differences among the four groups on the lecture comprehension pretest, $F(3,51) = 1.15$. Means and standard deviations for the comprehension pre-test, post-practice test, and 10-day maintenance test appear in Table 2.

Figure 1 shows the performance of the four strategy groups on these tests.

| Table 2. Means and standard deviations for strategy groups on lecture comprehension tests at pre-test, post-practice, and maintenance |
|-----------------|----------|----------|----------|
|                 | Pre-test | Post-practice | Maintenance |
|                 | M  | SD  | M  | SD  | M  | SD  |
| Self-questioning/peer questioning | 63.4  | 10.6 | 88.7  | 9.1  | 87.4  | 10.2 |
| Self-questioning only | 56.1  | 14.2 | 81.7  | 20.4 | 80.5  | 14.4 |
| Discussion | 62.7  | 13.2 | 72.8  | 17.7 | 61.7  | 21.5 |
| Independent review | 61.9  | 8.2  | 64.2  | 23.6 | 60.8  | 15.6 |
Inspection of Figure 1 reveals that, although comprehension means for the four groups were similar at pre-test, differences in performance among the groups became apparent following strategy practice, and for the two questioning groups this level of performance was maintained on the delayed maintenance test. In fact, the learning curves of the self-questioning combined with reciprocal peer-questioning and self-questioning only groups appear to closely parallel each other, with means on the post-practice and maintenance tests above that of both the discussion and control groups. Specifically, on the post-practice test there appears to be a clear ordering of the means for the four groups; performance was highest for the self-questioning plus reciprocal peer-questioning group, followed by the self-questioning only group, the discussion group, and finally the control group. Figure 1 shows this pattern of performance holding up on the delayed test with the exception that the discussion group’s performance reverted to baseline.

Analyses of covariance (ANCOVA) were used to analyse participants’ scores on the comprehension post-practice and maintenance tests. The comprehension pre-test was used as a covariate. The analysis on the post-practice test scores showed a significant effect for strategy, $F(3,51) = 4.91$, $p < .01$. In post-hoc analyses the adjusted means of the four groups were compared using the Tukey (HSD) procedure with alpha set at .05. (The critical range for pairs of means was 17.62.) Results indicated that both the self-questioning combined with reciprocal peer-questioning group and the self-questioning only group performed significantly better than the control group. The self-questioning combined with reciprocal peer-questioning vs discussion comparison was marginally significant. Although the self-questioning combined with reciprocal peer-questioning group performed better than the self-questioning only group, the comparison did not reach significance.

The ANCOVA on the 10-day maintenance comprehension test also revealed a significant effect for strategy, $F(3,51) = 10.82$, $p < .001$. Tukey’s HSD post-hoc comparisons (alpha = .05) showed the reciprocal peer-questioning group scoring significantly higher than both the discussion and control groups; in addition, the mean for the self-questioning group only was significantly higher than that of both the discussion and control groups (critical range = 15.49). Again, the difference between
the means of the self-questioning combined with reciprocal peer-questioning and the self-questioning only groups was not significant. This finding suggests that students who had prior practice with the questioning strategies maintained their use of the strategies when external prompts and practice were removed.

These results uphold the study’s general hypothesis in that students using the self-questioning strategies showed lecture comprehension superior to that of students using review strategies on both practised and unpractised lecture material. However, the findings do not support the hypotheses for cooperation. The reciprocal peer-questioning group did not perform significantly better than the self-questioning only group; furthermore, although the mean for the discussion (cooperative review) group was higher than that of the control (independent review) group on practised lecture material, suggesting an effect for cooperation, these effects disappeared on the delayed (unpractised) test when the means for these two groups were essentially the same.

Questions

To determine whether the quality of questions generated changed over time for the self-questioning with reciprocal peer-questioning group and the self-questioning only group, students’ questions from each of the strategy practice sessions were rated by two independent raters for overall quality. A question’s quality was judged in terms of the extent to which it required the learner to apply, interpret, analyse, or evaluate lecture content. Average inter-rater reliability for the five sets of questions was .90. A 2 (strategy) × 5 (time) repeated measures analysis of variance on the ratings of questions generated during practice sessions revealed no significant differences between the self-questioning plus reciprocal peer-questioning and the self-questioning only strategy groups ($F < 1$), and no change over time for either group ($F < 1$). These results show that the quality of the questions generated by the two groups was comparable and neither improved nor deteriorated over the duration of the study. This finding suggests that the question stems were quickly adopted by the students and their use remained stable over the course of the five practice sessions. It further suggests that the question stems strategy may be relatively resistant to the kinds of learner modifications that Bean (1985) warned about.

Group interaction

Analyses of the verbal interaction within the cooperative learning groups indicate that both the questioning and discussion triads remained on task to a similar extent during the study session and students did not encounter problems interacting with each other. There was no significant difference between the questioning and discussion groups in total amount of task talk with the number of task statements per student per minute of interaction being nearly equal (means = 2.17 and 2.13 respectively). No significant differences between questioning and discussion triads were found for amount of social talk (means = .03 and .09 social comments per student per minute), or group maintenance behaviour (means = .16 and .05).

ANOVA on the verbal interaction categories did show important differences between strategy conditions with regard to quality of task talk, and these findings will be discussed fully elsewhere.
DISCUSSION

This strategy training study was designed to determine the effectiveness of self-questioning (a metacognitive strategy) as an approach to learning from lectures. Results indicated that high school students who used either the self-questioning strategy or reciprocal peer-questioning (a cooperative form of self-questioning) demonstrated significantly better comprehension of classroom lectures than did students in discussion or independent review groups. These results are consistent with findings from studies of the use of self-questioning to foster reading comprehension (Wong, 1985), and lend support to the role that metacognition plays in theories of self-regulated learning (Brown et al., 1986; Corno, 1986; McCombs, 1986).

Metacognition

Presumably the success of the self-questioning strategy with lecture comprehension can be attributed to the metacognitive nature of self-questioning, as Brown et al. (1986) and others (e.g. Haller et al., 1988) have argued is the case with reading comprehension. Specifically, posing questions for themselves during the lectures probably helped students control their cognitive processes such as focusing attention on the lecture content, discerning the organization of ideas, and relating lecture material to their prior knowledge. Responding to self and peer questions following the lectures would presumably further extend the connections with prior knowledge, facilitate comprehension monitoring, and fill in any gaps in understanding. Indeed, the question stems students were trained to use were specifically designed to foster self-regulation of these very cognitive and metacognitive processes.

It was outside the scope of the present study to empirically establish that such metacognition was occurring during self-questioning. However, it would have been fruitful to have probed students regarding exactly what metacognitive and cognitive processes they were engaging in while asking (and answering) these questions.

Personal control

Although the question stems strategy emphasized metacognitive monitoring and regulation, the element of personal choice may have played an important role also. These particular self-questioning strategies were designed so as to enhance students’ perception of personal control (sense of agency) by providing them with the opportunity to choose their own question stems and create questions relevant to their personal learning needs. A number of studies have shown that when individuals are able to make such personal choices during learning their feelings of agency and intrinsic motivation are increased (Thomas, 1980). Furthermore, the questioning strategy provided this freedom of choice within the structure of the question stems framework, and, as Thomas (1980) pointed out in his review of the research on agency, student-controlled activities such as this, which balance freedom and structure by providing students with free choice within a structured framework, tend to enhance their sense of agency and improve learning.

Both Corno (1986) and McCombs (1986, 1988) have emphasized that learners’ sense of agency plays a central role in self-regulated learning, and they have suggested that theories of self-regulated learning must take into account the notion that meta-
cognition interacts with such motivational components as self-efficacy and sense of agency. In this study students in the two questioning groups presumably increased their sense of agency through the personal control they exercised in choosing and applying the question stems during their use of the metacognitive strategy. Thus agency may have interacted with metacognition to increase lecture comprehension. Further research is needed to help clarify the role of choice in self-questioning and its relationship to metacognition.

Strategy transfer and maintenance

The effect of the questioning strategies was surprisingly similar on both practised and unpractised lecture material. Prior to the maintenance test, 10 days had elapsed during which students had not been reminded to use their strategies. On the day of the maintenance test they received a lecture on totally new material, they were not prompted to use their questioning strategy, and they were not given the opportunity to use their strategies in groups or independently following the lecture. However, the questioning strategy groups’ performance on this comprehension test was again superior to that of the discussion and control groups and, in fact, was comparable to their own previous performance on practised material. This suggests that the self-questioning strategy had been maintained by these students, and was deliberately called into service when a similar task was presented.

From a practical point of view, this indication of strategy transfer and maintenance is particularly encouraging in that the 10-day maintenance test closely replicated the learning circumstances which exist in most academic settings, that is, unguided, independent learning from lecture without the support of a peer study group and teacher-structured study sessions. Furthermore, the unprompted application of strategies demonstrated in this study is an indication of self-regulation in learning, and suggests the real-world utility of training in this self-questioning strategy.

The durability of the self-questioning strategy can probably be attributed to the extensive strategy training plus in-class practice with the strategy received by the two questioning groups, and to their being informed of the metacognitive rationale and benefits of the strategy. Pressley (1988; Pressley et al., 1984) argued that successful strategy instruction and maintenance depend upon such informed strategy training.

As is the case in most strategy training studies, the groups in this study received different amounts of training. The questioning students received 90 minutes of self-questioning training, and it is possible that their improved comprehension could be attributed to their making more effort as a result of this additional attention. In future studies amount of training should be equivalent for all groups.

Transfer to individual learning

It must be pointed out that although students in the reciprocal peer-questioning triads practised the self-questioning strategy in a cooperative learning setting, they were tested individually; that is, they were able to transfer these metacognitive skills to an individual learning context on both the post-practice and maintenance lectures and tests. Apparently monitoring and extending each other’s comprehension through group questioning and responding actually led to improved self-monitoring of
comprehension. This suggests that, at least for this particular self-questioning strategy, a cooperative learning context may serve as an effective strategy training ground.

Cooperation

It is not clear exactly why the cooperatively structured self-questioning with reciprocal peer-questioning strategy group's performance on lecture comprehension did not exceed that of the self-questioning only group, as expected. One possibility is that these bright, academically competent students were more adept at studying alone than in groups and, for those in the reciprocal peer-questioning group, an attempt to learn a new strategy in cooperative groups may have interfered with their usual learning proficiency.

Another possible explanation is that the triads were so homogeneous in terms of ability and prior knowledge that individuals could not benefit from the 'expertise' of others because it was not appreciably different from their own. Effects of the reciprocal peer-questioning aspect of this strategy are currently being investigated with less academically able students, where it is expected that the benefits of peer input may be more evident.

Educational implications

On a practical level, results of this study have implications for both learning and instruction. First of all, findings indicate that self-questioning and reciprocal peer-questioning can be used by high school students as a learning strategy for processing and studying expository material. It is expected that this lecture comprehension strategy would be effective with average and learning-disabled high school students also in view of the success of self-questioning strategies with such subjects in the area of reading comprehension (Wong, 1985).

Furthermore, this study indicates that the self-questioning approach can also be used as an instructional strategy when teaching the kind of expository material so frequently taught in high school and junior high. Variations of the strategy used in this study might include such alternatives as the teacher calling on students to verbalize or write down their questions during the presentation, or sharing questions among groups.

Finally, this study demonstrates that these student questioning strategies can be successfully implemented in an ordinary, 'real-world', high school classroom. Specifically, in this study use of these strategies during lectures and in the post-lecture study sessions became a normal part of a history course and, according to informal student feedback, were not perceived as obtrusive or unnatural.

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