EVALUATING THE EFFECTS OF TRAINING HIGH SCHOOL STUDENTS TO USE SUMMARIZATION WHEN TRAINING INCLUDES ANALOGICALLY SIMILAR INFORMATION

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ABSTRACT

The present study investigated the impact of instructing high school students to summarize by comparing students taught to summarize versus those who received no formal instruction. To test whether the amount of detail in the study material affected the content of summaries, some students were provided with elaborated text and others were given condensed text. Additionally, performance was compared for students who were trained using information that was analogous and transferable to study passages versus students who were not exposed to analogous materials. The effects of these manipulations were assessed through written summaries produced by students, free recall and performance measures. The most important finding was that the students experienced some benefit from explicit instruction in summarization skills, including greater strategic knowledge about the structure of summaries and modest achievement gains.

Recently, researchers have focused on promoting cognitive skills that facilitate students' transition from elementary school to the more complex and more structured high school environment (e.g., Ganz & Ganz, 1990; Garner, 1987). Summarization is one skill that high school students can use to help them acquire information from texts and lectures. Summaries are condensed versions of elaborated discourse or text. They reduce the quantity of information to be learned to a more manageable size and organize it for efficient learning. Although teachers
occasionally provide students with previously prepared summaries, it is more typical for students to prepare their own summaries. The procedures involved in summarizing include determining which information is most important, which can be excluded, and organizing the important material into a coherent form (Hidi & Anderson, 1986). The cognitive activities executed to create a summary are hypothesized to enhance students’ acquisition of new information (Rewey, Dansereau, & Peel, 1991; Rinehart, Stahl, & Erickson, 1986).

The cognitive plan that underlies the creation of summaries is somewhat complex and not always reflected by developmental advances in cognitive processing. One of the three macrorules (Brown & Day, 1983; Kintsch, 1990) involved in constructing a summary—deleting trivial or redundant information—can be acquired and demonstrated by children as young as grade five (Brown, Day, & Jones, 1983). Two other macrorules for creating summaries—substituting superordinate categories for details, and integrating the information by framing a topic that describes it—are skills that develop more slowly and may not be used proficiently even by college students (Garner, 1987; Hidi & Anderson, 1986; Kintsch, 1990). These outcomes suggest that explicit strategy instruction may be necessary to facilitate efficient summarization. Our study extends the existing literature to a high school population. Although it was anticipated that the senior high school students would know some rules for summarizing, we expected that their repertoire could be enhanced and articulated through training.

**Instructing Students to Use Summarization**

Constructing summaries can improve learning. Summarizing can direct students’ attention to key information and thereby boost their learning of main ideas (Brown & Day, 1983; Garner, 1982). Also, studying summaries, instead of reading a text that is embellished with examples and details, can improve students’ recall of a text’s main ideas (Reder & Anderson, 1980, 1982). In Reder and Anderson’s studies, students who read summaries recalled more total information and more main points than students who read the entire text. Moreover, the gains from studying only a summary compared to reading the entire text were even greater when students in both groups were allowed only the same time to prepare for a test. Finally, preparing a summary has been shown to improve both general writing and reading skills (Taylor & Beach, 1984).

There also can be hazards in having students prepare a summary. These become apparent in cases where students’ recall of details is necessary or appropriate. Garner (1982) found that undergraduates who generated good summaries were sometimes unable to identify whether newly presented information was inconsistent with information in the text that students had read previously. She suggested that efficient summarizers, relative to inefficient summarizers, selectively integrated only some of the information that was available in the full text. The resulting
streamlined cognitive representation may not have provided a sufficient basis for students to determine whether new information was consistent with what was read. Thus, it seems that students who create or study summaries may be at a disadvantage when a retrieval task requires them to recognize or reproduce detailed information. However, since students in Garner’s study were not trained to create summaries, it is possible that details were not processed in the first place. This might account for their poor ability to discriminate information.

In contrast, Reder and Anderson (1980, 1982) demonstrated that studying condensed (or summarized) texts can be as effective as studying full or embellished texts. However, the high school students in their studies did not create the condensed versions of the text that they studied. Having to process details in a text might increase the likelihood that details are acquired and subsequently can be retrieved. When students applied the three macrorules—deletion, generalization, and integration—to create summaries they needed to process all of the information in order to make decisions about what was appropriate and necessary in a summary. In other words, the process of generating summaries involves evaluation of all information that is presented.

To determine whether the process of summarizing and studying from summaries is “strategically” unsuitable for acquiring and recalling detailed information, our study compared students trained to summarize with students not trained on two kinds of tasks, free recall and a battery of performance measures. The free recall task, administered after training but before summaries of a passage were written, tested whether training students about how to summarize influenced their encoding of information during reading compared to students who were not trained. The existing literature about the effects of training students to use the macrorules for summarizing has not addressed the question of when students apply these rules. Do students generalize the macrorules for summarizing, applying them while reading a text that they know they will summarize later, or do they reserve these cognitive operations for a period after the text has been read? Training to summarize does improve students’ ability to answer free recall essays that are scored for main points (e.g., Rinehart, Stahl, & Erickson, 1986). However, in these studies, the tests were administered after students both read and summarized a text. To test whether students also apply macrorules for summarization during reading, a free recall measure was administered after reading but before students summarized the text in the present study.

The effect of training on the recall of detailed information was assessed through the free and cued performance measures. Since students exposed to prepared summaries performed better on performance tests that measure their acquisition and retrieval of main ideas (e.g., Reder & Anderson, 1980), it was anticipated that students required to prepare their own summaries would also perform better on the performance measure requiring recognition of factual details.
The Impact of Passage Length and Content on Summaries

The study also examined the impact of the structure and length of study materials both for memory performance and for the content and construction of summaries. Reder and Anderson (1980, 1982) provided students with either condensed or elaborated passages and found that passage length did not affect learning. In their study, however, summaries were provided to students. Our study extends this research to a situation where students actively summarize elaborated or condensed text. This manipulation provides a test of whether the amount of detail in the study material affects the content of summaries.

An additional question was whether students who were trained using information that was analogous and transferable to the passage to be learned would produce better summaries and learn more. The passages in the training packages were constructed to be structurally equivalent but to differ in their transferability to the content provided in the study passage on computer memory. Given that summarizing encourages learners to process new information in light of existing prior knowledge as well as constructing interrelations among newly presented information (Wittrock & Alesandrini, 1990), we expected that students provided with the transferable training materials would be at an advantage both for the construction of summaries and for subsequent learning. Learners exposed to the analogous training materials could use this information to better integrate the new study information within existing semantic networks.

In summary, the present study investigated the impact of instructing high school students to summarize. We compared students taught to summarize versus those who received no formal instruction. The quality of the summaries and the extent of learning was also examined as a function of the materials that students were provided during training and at study. Finally, the study addressed concerns with the existing literature by ensuring that students completed a free recall task prior to the generation of their summaries (rather than after the generation of summaries) to get a better understanding of the effect from “on-line” summarization. The effects of these manipulations were assessed through written summaries produced by students, free recall, and cued recall posttest performance measures.

METHOD

Participants

 Ninety-two 11th and 12th graders participated in the first segment of this study. Fifteen students were deleted because of absences from one or more of the remaining sessions. The final sample was comprised of the 77 students who attended all three phases of the study. The students (33 females and 44 males) were drawn from five classrooms in one Canadian senior secondary school. Students ranged in age from 16 to 19 years (M=17 years 2 months, SD=7 months).
All the students participated in the experiment during their regularly scheduled English classes. Students within each classroom were randomly assigned to one of three summary training conditions: no training, training with materials analogous in structure to the study materials, and training with materials analogous in structure and content to the study materials (27, 26, and 24 students, respectively). Half of the students in each training condition were provided with condensed text during the study phase and half studied elaborated text.

**Materials**

Two sets of stimulus materials were prepared for each of the training and study sessions.

*Training materials.* Two passages of six paragraphs each were developed, one about photography, and the other about sound recording. Corresponding paragraphs in each passage were constructed to be approximately equivalent regarding structure and the presentation of information in order to minimize extraneous sources of variance that might influence students' comprehension of information and therefore might affect the cognitive processes students applied to produce summaries. Structural similarity was achieved by matching the number of sentences, words, and syllables across the corresponding passages. The objective of matching paragraphs on these variables was to equate readability (see Fry's formula; Fry, 1968).

Similarity in the presentation of information was achieved by maintaining the theme and the amount of information across paragraphs in both packages. Paragraphs 1 and 2 in each passage described the history of techniques used to produce sound recordings or photographs, respectively. Paragraph 3 described the materials used for storing information (i.e., disks or films). Paragraph 4 presented information about the qualities of the technique for storing information on these respective materials. Paragraph 5 sketched advances in techniques for storing information, and paragraph 6 presented information about how the quality of stored information can vary (see Appendix A for the complete training materials).

Information presented in the six paragraphs about sound recording included declarative propositions that could be transferred directly to information about secondary memory in computers that all students would read during the study phase. For example, one fact about sound recordings was that "magnetized spots are used to code the sounds onto tape." This corresponded directly to information in the passage about secondary computer memory: "The coding of data is usually done by using a read/write head to create tiny magnetized spots." Information presented in the photography passage did not include any transferrable information (see Appendix B for the passage on secondary memory).

*Study materials.* A 1,200-word, 12-paragraph passage on secondary memory in computers was constructed from information contained in several introductory texts on computers. From this passage, a second condensed passage was developed.
containing 600 words in 10 paragraphs. Seven rules were used to create the condensed version from the elaborated passage. These rules are reported in Table 1.

Using Armbruster and Anderson's (1984) procedures, text maps were created to compare the idea units in each version of the passage (Winne & Carney, 1986). The maps of information in the elaborated and the condensed versions of the passage were congruent and contained the information that would be tested on the posttest performance measure.

*Free recall test.* This measure focused on a single topic addressed in the last three paragraphs of the elaborated and condensed passages. The question was limited to information in the last three paragraphs to ensure that the content was the same for all students and to reduce the task demands. Students were given 5 minutes to write as much as they could recall about "secondary memory devices."

*Posttest performance measure.* Each of the thirty items on this test related directly to one detail presented in the study passages about secondary memory in computers. There were 5 short-answer items, 14 multiple-choice items, and 11 true-false items. Questions reflected content presented throughout the entire passage on secondary memory.

Four of the five short-answer items were worth 2 points, 1 point per fact. All other test questions addressed a single fact and were worth one point each. Four of the multiple-choice items were analogy questions matched to propositions presented in the passage about secondary memory in computers. Items in each format were considered as a separate measure in analyses. Thus, maximum scores for each test were 9 points for the short-answer items, 10 points for the regular multiple-choice items, 4 points for the analogical multiple-choice items, and 11 points for true-false items.

Table 1

*Rules for Condensing the Secondary Memory Passage*

1. Retain vocabulary, sentence length, and sentence structure as much as possible in order to maintain readability level and other unspecified text features.
2. Remove headings and spacings separating sections—modify sentence that introduced section, if necessary.
3. Delete information not needed to answer achievement measure questions.
4. Delete details not needed to answer achievement measure questions, e.g., descriptive, relational, transitional, or explanatory words or phrases.
5. Delete any analogies not needed to answer achievement measure questions.
6. Delete cues, e.g., signals for itemization or categorization.
7. Insert necessary transitional words or phrases to make the sentences grammatical.
Procedure

The three phases, training, study, and test, were conducted over 3 consecutive days.

Training Phase. Students were randomly assigned to one of the three training conditions: (a) training using the sound recording paragraphs (analogous in content and structure), (b) training using the photography passages (analogous in structure only), or (c) no training. Each group received independent instruction.

The two trained conditions received instruction about how to construct summaries. Instruction followed matched scripted lessons lasting approximately 40 minutes. A copy of the six training paragraphs was given to each student and the experimenter presented them on an overhead projector. Instruction covering the first three paragraphs was primarily a lecture and demonstration. The instructor read each paragraph aloud as students read it silently. The instructor explained what summaries were, and demonstrated how to construct a summary using the following four rules (derived from Brown & Day, 1983):

1. Think up a label for the main idea in the paragraph.
2. Write down the most important points that relate to that label.
3. Cross out some of the points that seem less important.
4. Write a summary of two to three sentences based on the information that is left.

One overhead was provided to demonstrate each of the four steps. A final overhead contained a previously prepared summary of the paragraph.

Instruction covering the fourth and fifth paragraphs of the materials allowed for student participation and practice in applying the four summary rules. For these paragraphs, students were prompted to apply each rule one at a time in the appropriate sequence. Students wrote their responses after each prompt. They were then asked to check the use of the rules in two ways. First, they examined the instructor's work, presented on the overhead. Simultaneously, the instructor reviewed how each rule had been applied and why the summary produced by using the rules was a good summary. Second, students checked their own work and received feedback.

On the sixth paragraph, students worked independently to construct their own summaries. This was followed by the same two procedures for checking the use of rules as described previously. Specifically, the instructor presented a model summary on the overhead and reviewed it with respect to how it reflected the rules to be used in producing good summaries.

Students assigned to the no training condition wrote essays about one of four topics (the solar system, education, animal safety, or languages) that were assumed to be unrelated to computers, sound recording, and photography. They were not exposed to the information in either of the training packages nor were they given any instruction in summarization.

Study Phase. On the second day, students within each training condition were
randomly assigned to study either the elaborated version or the condensed version of the passage about secondary memory devices. Each group was tested separately.

Students assigned to read the elaborated version of the passage were given 10 minutes to read. Students reading the condensed passage were given a crossword puzzle for the first 5 minutes followed by 5 minutes for reading. After this 10-minute study period, all students completed three consecutive tasks.

First, students spent 2 minutes completing a five-item questionnaire that served as an interpolated task. The questionnaire asked students about their previous experience with computers. For example, students were asked whether they had formal instruction in computers, where such instruction had been given, and what the topics of instruction were (e.g., programming, hardware, software).

Second, students were given 5 minutes to complete the free recall task. During this period, students were not allowed to refer to the text.

Third, the text was returned and students were instructed to construct a summary for the passage on secondary memory in computers. They were told explicitly to refer to the previously read passage while preparing their summaries. Thirty minutes were allowed to complete the task. Students who had previously received training in producing summaries were given a sheet that provided the rules for constructing summaries to insure that their use of the procedure did not depend on memory of the rules. Students in the no-training condition were only told to prepare a summary.

Posttest. All students remained in their regular classrooms. The summary about secondary memory in computers that each student had generated the previous day was returned and students were given 5 minutes to study it. Students were instructed to study the content for a subsequent test. After collecting the summaries, students were administered the posttest performance measure. Students were instructed to complete each section of the test consecutively in the order of short answer items, multiple-choice items, and true-false items. The students were told they could have as much time as they needed to complete the test.

RESULTS

The data from each phase of the experiment were analyzed separately by the task requirements of each day and were later compared across days. The three sets of data analyzed included; the summaries constructed during training and at study, free recall of the study passage, and the posttest performance scores.

Summaries

The summaries generated during the training and study phases each received two scores. The quantitative score reflected students use of summarizing rules. The
quality score was based on the information students recorded in their summaries.

The quantitative score was based on a 5-point scoring scheme. A score of zero indicated a total absence of rule use, undecipherable prose, or failure to produce a summary. Demonstrating the use of any of the first three rules (see Procedures section) was awarded 1 point per rule. For scoring, rule 4 was broken into two parts. One point was given for using two to three sentences in the summary. A second point was given if students used the information from the text that remained after applying rule 3.

The quality score was a 4-point scoring scheme with the following values: 0 signalled an absence of all main ideas; 1 indicated a summary containing less than half the main ideas; 2 reflected a summary containing more than half the main ideas plus one or more subsidiary ideas; 3 indicated a complete, well articulated summary containing all the main ideas and at least two subsidiary ideas.

Scoring keys for main ideas and subsidiary ideas for both the training materials and the study passages were identified by having judges, students in graduate level computing courses, evaluate the materials. Six judges evaluated the training paragraphs and five evaluated the study paragraphs. The judges independently examined each paragraph three times. Presentation order of the paragraphs for each phase was randomized across judges. During the readings judges were instructed to; delete information they considered extra detail; highlight the information they felt was important from the remaining phrases in each paragraph, and then identify the information that was crucial and maintained the themes of the paragraphs. Following this process main ideas were defined as information selected as crucial by all but one of the judges. Subsidiary ideas were those identified as crucial by all but one of the judges.

Training phase summaries. The summaries of the two groups who received training were compared to determine whether both groups were equivalent in their summarizing skills following training. Summaries for the sixth paragraph of the training materials each received a quantitative score (maximum 5 points) and a quality score (maximum 3 points). Judges ratings produced three main ideas and three subsidiary ideas for the photography paragraph, and three main ideas and four subsidiary ideas for the sound recording paragraph.

Forty percent of the students summaries were scored by two raters. Interrater reliability was 93%. The remaining training summaries were scored by either one or the other rater.

Both groups demonstrated acquisition of the rules for summarization. The mean quantitative score for the group exposed to the sound recording passage was 3.88 (SD=1.33) compared to a mean of 4.00 (SD=1.18) for students exposed to the information about photography. The quality of the content represented within the summaries ranged from 1.96 (SD=1.11) for the sound recording paragraph to a mean of 2.08 (SD=1.02) for the photography information.
Two analyses of variance (ANOVA), were conducted to test for differences between the two training conditions for the quality and quantitative scores assigned to these training summaries. The summaries produced by the groups studying transferable materials did not differ from those studying the nontransferable information, largest $F(1, 48)=.16, p>.69$ for the quality score. The training materials did not appear to differentially affect summarization skills between the two training groups.

Study phase summaries. After reading the passage about computer memory, students were required to create summaries for the entire passage. The maximum score for the quantitative scale was 60 for students reading the elaborate version of the passage (12 paragraphs $\times$ 5 points per paragraph) and 50 for students reading the condensed version of the passage (10 paragraphs $\times$ 5 points per paragraph; see the section about posttraining summaries). The maximum quality scores for students reading the elaborate and condensed versions of the passage were 36 and 30, respectively. Comparisons of the condensed and elaborated versions of the text were based upon proportions to equate the total possible scores.

Twenty percent of the study summaries were scored by the same raters that scored the training summaries. Interrater reliability was 93%. The remaining summaries were scored by one or the other of the two raters.

There was a significant correlation between the number of rules used and the quality of content in the summaries $r=.54, p<.001$. Means are presented in Table 2.

A 3 $\times$ 2 (Training Conditions $\times$ Passage Version) multivariate analysis of variance (MANOVA) was used to test for differences in the students' summaries about secondary memory in computers as a function of training condition and passage length (see Table 2 for means). There was a significant main effect for training (Pillais's criterion=.322, $F=6.82, p<.001$). The main effect for passage length (Pillais's criterion=.03, $F=1.06, p>.35$) and the interaction of training condition and version of the passage were not significant (Pillais's criterion=.015, $F=.26, p>.90$).

A subsequent analysis of variance (ANOVA) was conducted on the main effect of training. The three training conditions differed on the use of rules to produce summaries $[F(2, 71)=4.49, p<.014]$ but did not differ in the quality of summaries $[F(2, 71)=1.69, p>.192]$. Duncan range post hoc comparisons ($p<.10$) revealed that means for the content transferable and content nontransferable groups were not statistically different and that both were greater than the mean for the untrained group (see Table 2 for means).

Free Recall of the Last Three Paragraphs about Computer Memory

Scoring keys for the free recall protocols were based on the evaluations provided by the five judges who reviewed the passages for the construction of summaries. Crucial ideas were defined as those selected as crucial by four of the five
Table 2

Means and Standard Deviations on the Study Phase Summaries

<table>
<thead>
<tr>
<th>Group</th>
<th>Use of Rules</th>
<th>Quality of Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Elaborate Text</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content Transferable Training</td>
<td>2.08</td>
<td>1.39</td>
</tr>
<tr>
<td>SD</td>
<td>.72</td>
<td>.54</td>
</tr>
<tr>
<td>Content Nontransferable Training</td>
<td>1.96</td>
<td>1.75</td>
</tr>
<tr>
<td>SD</td>
<td>.48</td>
<td>.32</td>
</tr>
<tr>
<td>No Training</td>
<td>1.61</td>
<td>1.70</td>
</tr>
<tr>
<td>SD</td>
<td>.42</td>
<td>.76</td>
</tr>
<tr>
<td>Condensed Text</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content Transferable Training</td>
<td>2.69</td>
<td>1.64</td>
</tr>
<tr>
<td>SD</td>
<td>.92</td>
<td>.66</td>
</tr>
<tr>
<td>Content Nontransferable Training</td>
<td>2.27</td>
<td>1.81</td>
</tr>
<tr>
<td>SD</td>
<td>1.16</td>
<td>.75</td>
</tr>
<tr>
<td>No Training</td>
<td>1.86</td>
<td>1.90</td>
</tr>
<tr>
<td>SD</td>
<td>.43</td>
<td>.59</td>
</tr>
</tbody>
</table>

judges, and subsidiary ideas were those identified by at least three of the five judges. The set of crucial and subsidiary ideas were defined as main ideas for the purposes of scoring. Students’ answers to the free recall item received three separate scores. The main idea score reflected the number of main ideas drawn from the last three paragraphs that were relevant to the free recall question. Students were awarded one point for each idea to a maximum of 37 points. The second score reflected correct information that was not part of the main idea. Students were awarded 1 point for each of these details that were relevant to the free recall question. Intrusive main ideas were also awarded 1 point. These included correct main ideas that were drawn from a paragraph other than the three paragraphs that were related to the free recall question.

Correlations were calculated to determine the relationship between the total recall score from the three target paragraphs and the extraneous information. Greater free recall of main ideas in the last three paragraphs was positively correlated with both greater recall of intrusive main ideas ($r = .18, p < .05$) and details ($r = .25, p < .02$) from the rest of the text.
Comparisons among the three training groups for recall of main ideas, details, and intrusive information was assessed through a $3 \times 2$ (Training Conditions $\times$ Passage Version) MANOVA (see Table 3 for means). The main effect for training condition (Pillai’s criterion=.095, $F=1.17$, $p>.326$) and the interaction of training condition $\times$ passage version (Pillai’s criterion=.029, $F=.35$, $p>.911$) were not significant. There was a trend, however, toward a significant main effect for version of the passage (Pillai’s criterion=.100, $F=2.56$, $p<.06$). Subsequent ANOVAs for each of the three recall measures revealed that this effect was due solely to the greater number of relevant details recalled by students reading the condensed version of the passage about computer memory [$F(1, 71)=5.47$, $p<.02$: Means=3.1 and 2.28 for the condensed versus elaborated version of the passage, respectively]. Neither of the other two variables showed a statistically reliable difference ($ps>.15$).

**Table 3**

**Means and Standard Deviations for Free Recall**

<table>
<thead>
<tr>
<th>Group</th>
<th>Relevant Main Ideas</th>
<th>Intrusive Main Ideas</th>
<th>Relevant Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elaborate Text</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretraining with Transferable Content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>2.58</td>
<td>1.58</td>
<td>2.08</td>
</tr>
<tr>
<td>$SD$</td>
<td>2.50</td>
<td>1.62</td>
<td>1.44</td>
</tr>
<tr>
<td>Pretraining with Nontransferable Content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>2.22</td>
<td>1.22</td>
<td>1.56</td>
</tr>
<tr>
<td>$SD$</td>
<td>2.95</td>
<td>1.09</td>
<td>1.01</td>
</tr>
<tr>
<td>No Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>2.07</td>
<td>2.50</td>
<td>2.86</td>
</tr>
<tr>
<td>$SD$</td>
<td>2.09</td>
<td>2.21</td>
<td>1.88</td>
</tr>
<tr>
<td><strong>Condensed Text</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretraining with Transferable Content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>3.29</td>
<td>1.50</td>
<td>3.29</td>
</tr>
<tr>
<td>$SD$</td>
<td>3.07</td>
<td>1.35</td>
<td>2.23</td>
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<tr>
<td>Pretraining with Nontransferable Content</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>2.80</td>
<td>1.80</td>
<td>2.53</td>
</tr>
<tr>
<td>$SD$</td>
<td>3.21</td>
<td>1.61</td>
<td>1.96</td>
</tr>
<tr>
<td>No Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>3.31</td>
<td>2.00</td>
<td>3.84</td>
</tr>
<tr>
<td>$SD$</td>
<td>2.49</td>
<td>1.68</td>
<td>2.51</td>
</tr>
</tbody>
</table>
Posttest Measures

To examine differences among groups on the posttest test, scores on the short-answer questions, regular multiple-choice questions, multiple-choice analogy questions, and true-false questions were analyzed using a 3 x 2 (Training Condition x Passage Version) MANOVA (see Table 4 for means). This analysis revealed that there were no statistically significant main effects for training condition (Pillai's criterion=.145, F=1.31, p>.24) or for version of the passage (Pillai's criterion=.012, F=.202, p>.93). However, there was a statistically reliable interaction of training condition by version (Pillai's criterion=.268, F=2.59, p<.01).

Subsequent ANOVAs showed that this interaction was limited to the regular multiple-choice items [F(1, 71)= 5.02, p<.009; other variables' Fs<1.8, p>.05].

Table 4

Means and Standard Deviations for the Objective Measures of Achievement

<table>
<thead>
<tr>
<th>Group</th>
<th>Short Answer</th>
<th>Regular Multiple-Choice</th>
<th>Analogy Multiple-Choice</th>
<th>True-False</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaborate Text</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretraining with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transferrable Content</td>
<td>M</td>
<td>3.17</td>
<td>6.33</td>
<td>2.17</td>
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<tr>
<td></td>
<td>SD</td>
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<td>1.37</td>
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Post hoc Duncan range comparisons on the regular multiple-choice items indicated that there was a significant difference whereby untrained students reading the elaborate version of the passage scored lower than students in three other groups: untrained students reading the condensed version, students trained with the transferable materials reading the elaborate version, and students trained with the non-transferable materials reading the elaborate version. These latter three groups did not differ among themselves. No other contrasts were statistically significant.

**DISCUSSION**

The findings of this study can be clustered into four sets: (a) the effects of training on students' generation of summaries, (b) the effects of different topics used during training and of different versions of the passage at study, (c) the effects of training to summarize and version of the passage on students' achievement, and (d) the effects of using transferable or nontransferable information during training on summarizing and on learning the content of the study phase.

**Effects of Training on Students' Summaries**

The training provided to students had mixed effects on their production of summaries. On the training summaries, students applied four out of the five rules they had been taught in the preceding half hour to a single paragraph. A day later, these students used 3.6 or 4.3 rules per paragraph (for long versus condensed passages, respectively) compared to untrained students who used only 3.1 or 2.9 rules per paragraph. This difference between trained and untrained students suggests that high school students can become more systematic in their construction of summaries when they are given explicit instruction about the structure and procedures for generating summaries.

Although trained students applied the rules (and cognitive operations) more systematically than untrained students, the quality of the content in the summaries did not differ between these groups. The absence of a poorer showing by the untrained group was unexpected. According to their teachers, none of these students had received formal instruction in producing summaries. This suggests that the untrained students, at this grade level, had already acquired adequate strategies for identifying main ideas. However, anecdotal data gathered during the scoring of summaries suggests that some untrained students quality scores may have been inflated because students received high-quality scores for copying sections of each paragraph verbatim. Trained students, on the other hand, were more likely to translate information into their own words. This observation is consistent with the developmental progression of strategies outlined by Garner (1987). Similar to the less efficient strategy users described by Garner, the untrained students in our study may have relied upon the less effective procedures of rote rehearsal of the informa-
tion whereas the trained students engaged in more strategically efficient procedures that involved cognitive manipulation of the information.

Effects of Passage Length on Summaries

When summarizing elaborate or condensed passages to learn them for a test, students’ use of rules for summarizing did not depend on the version of the passage that they summarized. Neither was there an interaction between training and version of the passage as relates to students’ use of rules. Thus, training was neither more nor less applicable to summarizing the two versions of the passages. This is an important finding—applying the rules for summarizing to the condensed version of the passage should be easier because information in the condensed version is already partially summarized relative to information in the elaborate version. This structural difference in the passage was not a factor governing students’ use of the rules for summarizing even though training did elevate students’ use of rules overall.

Effects of Training and Version of Passage on Performance

Free recall. Students were administered the free recall measure after reading a passage but before summarizing it to test whether training in summarizing affected students’ encoding. It did not. Thus, assuming that the cognitive processes engaged while summarizing text boost acquisition, as previous research suggests (e.g., Garner, 1982), it appears that students do not engage these processes as they read but rather when they summarize. Alternatively, it may be that the cognitive processes students use to summarize text do not contribute to better or more encoding.

Varying the elaborateness of the passage did not affect students’ recall of main ideas either from the text directly referred to by the free recall item or from the rest of the text. However, there was a trend suggesting that the version of the passage did affect students’ free recall of relevant details. Students reading the condensed text recalled more details. This is an interesting finding. It does not replicate previous research (e.g., Reder & Anderson, 1980) findings that condensed text enhances acquisition of main ideas relative to elaborate text. This may be a product of the high structural control exerted in the design of our materials. The controlled order of presentation of information may have made the main ideas particularly salient in both versions of the passage. Alternatively, it may be that the operational definition characterizing the two versions of text in previous research is not comparable to ours.

Posttest performance measures. The four measures of achievement were administered a day after students read and summarized the passage, and minutes after they studied their summaries. We selected this sequence because it corre-
sponds more directly to what students do in school. There were no statistically reliable main effects on the set of performance measures due to either training or to version of the passage. The statistically reliable interaction of training and version of the passage found for the performance measures was pinpointed only to the regular multiple-choice items.

Untrained students who read the condensed version of the passage answered multiple-choice items about details as well as both groups of students who were trained to summarize and who read the elaborate version of the passage. These three groups outscored untrained students who read the elaborate version of the text. The comparison of the two untrained groups relates directly to and extends Reder and Anderson's (1980) findings about the superiority of reading a condensed text. Whereas they found condensed texts to promote acquisition and retrieval of main ideas by untrained students, we found that such text is also associated with better recognition of details. Perhaps this reflects untrained students' rehearsal of information as they copied verbatim sections from the condensed passage where facts were easy to find.

Our findings extend Reder and Anderson's in a second way. Whereas untrained students in their study and in ours fared well with condensed texts, trained students in our study outscored untrained ones when they both read and summarized an elaborate text. Training students to transform elaborate text into a very condensed form, a summary, and then allowing them to study the summary has the same general effect as having untrained students read a condensed form in the first place. Thus, improving students' recognition of details can be achieved either by condensing text for them and then having them summarize it, or by having them summarize elaborate text into a "super" condensed form. Since textbooks used in schools correspond to the elaborate version of our text (Winne & Carney, 1986), it would be more efficient for teachers to train students to summarize once rather than condensing text for them every time students are assigned material to read.

**Transfer Effects of Training**

The passages in the training packages were constructed to be structurally equivalent but to differ in their transferability to the content provided in the passage on computer memory. This manipulation did not affect any of the performance measures. Working with material that is logically transferable to a subsequent passage while learning to summarize gave trained students no edge over untrained ones.

This lack of effect may be a function of students failing to spontaneously transfer across materials. Although we established a basis for students' to draw connections in semantic memory, students may need an explicit cue to engage and execute the operations necessary to transfer information. Consistent with related research on metacognition and good strategy use (e.g., Deshler, Alley, Warner, & Shumaker, 1981; Schneider & Pressley, 1989), we predict that, to facilitate transfer between
training and study materials, these high school students require an explicit cue to draw connections and promote positive transfer effects when learning a second topic.

In summary, our study demonstrated that even students at the high school level can experience some benefit from explicit instruction in summarization skills. These benefits include greater strategic knowledge about the structure of summaries and modest achievement gains. We did not find condensed passage length, or the inclusion of transferable content to provide much benefit. However, we believe that these issues are worthy of further investigation particularly for less structured and more naturalistic written passages.

REFERENCES


Photography

Cameras were invented before photography. The first projected images from "camera obscuras" were popular in the 11th century with Arabian scientist-philosophers. Camera obscuras projected an image of an outdoor scene through a small hole in one wall of a darkened room. This formed an image on the opposite wall. At the end of the 16th century, Della Porta experimented with a lens that could sharpen the projected image. With this lens, he was able to project a series of movements made by actors outside. His audience panicked at the sight of tiny human forms cavorting upside down on the wall. As a result, he was brought before the Pope on a charge of sorcery and had to flee the country. By the end of the 17th century, camera obscuras took the form of portable boxes. Artists often used them to trace outlines of buildings and scenery on their paper.

With the new discovery of light-sensitive compounds, photography became possible. In 1826, a plate of pewter was coated with light-sensitive chemicals and inserted in a camera obscura. After exposing the plate for 8 hours the world's first photograph was produced. Exposure time was reduced to half an hour when much greater light-sensitive chemicals were discovered. The design of a new lens that admitted 16 times more light further reduced exposure time to less than a minute. With the use of these faster plates, the camera needed a mechanical shutter to produce exposures in a fraction of a second. Amateur photography did not become commercially successful until cameras could be hand held. The first hand held camera became available in 1888.

Images can be recorded on either glass plates, roll film, or cut film that has been coated with light-sensitive chemical emulsions. These emulsions are composed of mainly microscopic crystals of silver bromide suspended in gelatin. Different types of film produce pictures of different quality. Film can vary in its ability to produce images with the correct color tone. No film can render colors in the exact tones that the eye sees them. This is because film tends to be more sensitive to blue and violet, while the eye tends to be more sensitive to yellow. Films also vary in the speed with which light affects their chemical emulsions. This difference also affects the degree of graininess that occurs in the final picture. The slower the speed of the film, the sharper or less grainy the image will be.

One common type of camera used today is the viewfinder or box camera. It uses the simplest and usually the least expensive of all the viewing systems. It is found in the cheapest cameras. They are reliable because there are no moving parts that can break. It is also very simple to insert film in these cameras. For these reasons, they are the best choice for simple snapshots. A simple viewfinder uses a small peep-hole for viewing the scene, and a separate opening for projecting the image onto the film. This means that what you see
will not be exactly the same as the image that the lens sees. Although it is easy to focus in low light conditions, the final picture may not be as good as one taken with better cameras.

A single-lens reflex camera allows you to see exactly what the lens sees. When the image is projected through the lens, the mirror reflects it through a prism to the eye, thus allowing you to view the image right-side up. In this way, you can use the camera lens to compose and focus the image. During exposure, the mirror is flipped up and out of the way. This makes the camera somewhat noisy and may startle the subject. It also means that there is a greater risk of something going wrong with the moving parts. This camera allows quick and easy focusing, although it may be difficult to focus in low light. Film for this camera is cheap and it is popular with amateur and professional photographers alike.

The lens is the most important part of the camera. The quality of the lens is measured by the sharpness and accuracy of the image it projects. A sharp image is obtained by the use of several layers of carefully ground optical glass. Good lenses are expensive. A normal lens produces images that appear normal in terms of size and perspective. A short, or wide-angle lens, produces a wider view and smaller images than the eye sees. The long, or telephoto lens, magnifies distant objects so that you can get a large image without moving up close. Lenses also differ in the amount of light that they will let in. The wider the aperture, the more light the lens will let in, and the more capable the camera is of taking pictures in low light conditions.

Sound-Recording

Disks were developed before tapes. The first mass produced sound-recordings on disk were made in 1887 by Emile Berliner. Record speeds varied a great deal at first because they found that recordings made at higher speeds could reduce noise distortion. In 1938 the long playing record was introduced. It was played at 33 1/3 rpm, which was a much slower speed than the 78 rpm records used before. The slower speed allowed a longer playing-time which was made to coincide with one reel of motion picture film. Pfleumer originated the concept of a magnetic coating on plastic or paper tape. The first tape recording was of a symphony orchestra in 1936, produced by a German company. The recording industry was especially interested in the production of tapes because they could be edited easily. The general public gained easy access to quality recordings because of the introduction of the Dutch Philips company's tape cassette.

A disk is used like a mold to physically represent the original sound. A disk is stamped or pressed so that more copies of the original sound can be made. At first recordings were made on a metal disk covered with grease or wax. Sounds were then etched into the grease or wax during the recording. When the disk was then dipped in acid, the grooves formed by the etching allowed some metal to be eaten by the acid. This template or mold was the master that more records could be made from. the early copies were each made the same way, using the master. This made the process very slow. Now, one master can be used to mass produce many copies at once.

The materials that disks or records have been made from have changed. The way in which the sound has been recorded has also changed. Early disks made from vulcanized
rubber flattened out over time. Harder records were produced from a shellac compound. They had good molding qualities and were hard enough to allow a lot of playings with the early steel needles. Laminated disks and vinyl disks were then produced and more advanced diamond styluses were needed to translate the sound. These more advanced materials created a smoother quieter surface and less sound distortion. They were also cheaper to produce, which made them more available to the public. Now digital sound recordings are made without any physical object contacting the surface of the disk. The sound is translated through the use of a laser, and this almost totally removes any distortion.

Tapes have the ability to produce long uninterrupted recordings with lower levels of noise distortion. They became popular for recording because it is easy to edit and make improvements on them. The principle of magnetic recording is based on the notion that sound waves can be changed to electro-magnetic fields and coded on the surface of the tape. This is done by using microphones and amplifiers to convey sound to an inductive coil. This will magnetize iron-oxide particles on a moving tape in such a way that the original sound waves will be translated and saved on the tape. The magnetized particles, when moved past a read/write head, will create electric signals that can be converted back to sound waves.

The magnetic coding of early tapes was done using tapes with a paper base. The paper had a rough surface which produced a lot of noise distortion or “hiss.” A cellulose acetate tape base was introduced later, and is still used today. Although it is cheap, it becomes brittle and decomposes over time. This results in the permanent loss of the sound-recording. Mylar tape was introduced int he 1950's and has become the standard tape used today because it lasts much longer. Even though tapes can be read by lasers, there is still more noise or hiss than with a disk. This is because the head comes in direct contact with the surface of the tape.

There are a number of problems that can occur with both disks and tapes that will lead to a loss of sound-recording. Dust particles can become embedded in the grooves of a disk. This can cause the familiar ticks and scratching sounds. Dust can also damage the backing and coating of tapes. This can lead to “drop-out” or the complete loss of sound from the damaged part of the tape. Disks and tapes should not come into contact with fingers because body oil attracts dust. Excessive heat can also cause damage to both disks and tape recordings. Other reasons that recorded sounds may be lost include physical damage of disks and accidental erasure of tapes. Tapes must be kept at least 3 inches away from all electrical sources and magnetic fields so that the electro-magnetic coding on the tapes will not be disturbed.

APPENDIX B

Secondary Memory

Without programs and data the computer cannot do the work it was designed to do. The secondary, auxiliary, or mass storage holds the program instructions and data that will eventually be needed by the computer. Secondary memory is located outside the computer. The devices that actually store the data can be very different in size, depending on the type.
For instance, they can be as large as your school classroom or as small as a cassette tape. The price of these units and the amount of information they can store depends on their size and type.

In order for the computer to store what we give it, the data must be kept in the form of a code that uses 1's and 0's. These are called binary digits or bits. A group of 6 or 8 digits is called a byte. A secondary memory unit can usually store between 250 thousand bytes and several billion bytes of data depending on what kind it is and what size computer it is with.

The coding of data is usually done by using a read/write head to create tiny magnetized spots. These spots can be either "positive" or "negative." When a spot is positive it stands for a 1. When a spot is negative it stands for a 0. If the electric current that runs the computer is turned off, the magnetized spots will be saved. This means that the data being processed or worked on by the computer can be saved when the machine is turned off. For this reason, we usually talk about secondary memory as permanent storage or non-volatile memory.

Secondary memory is like a note book that might be used at school. A note book, like secondary memory, holds the information that will be needed at a later time. Information can be changed, added, or removed. When we are finished working in the book, we close it and the information is saved. When we are finished working with a computer program, we turn the computer off and the information in secondary memory is saved.

When the data stored in secondary memory is needed for processing by a program, it can be moved from secondary memory to the central processing unit or CPU. The CPU has indirect access to the data in secondary memory. This means the transfer of data to and from secondary memory can be much slower than it is with primary memory. Once the data has been processed by the CPU it can be moved back to the secondary storage device. It is important to remember that each piece of stored data will stay the same until it is changed by the CPU. This is like the idea that the information in a note book will stay the same until someone changes it in some way or removes it completely.

Even though we usually think of secondary memory as permanent, there are some kinds of secondary memory devices that store data semi-permanently and temporarily. For instance, charge-coupled devices will store information temporarily using electric circuits. The information disappears from the device when the machine is turned off.

We have already talked about how the information that we store in secondary memory has to be changed into a binary code. This code also has to be organized in certain ways so that the computer can access and process the information easily. When bits of data are used together in a program, they form a record. Records are separated by interrecord gaps or spaces in secondary memory. You might think of a record as being like a chapter in a textbook. Each chapter contains information on one topic. Chapters have titles so people can find the one they want. Just like chapters have titles, records have key identifiers so the computer can find the record it needs.

When we want to process a piece of information that a computer's secondary memory has stored, we usually look for a file. A file is a group of related records or related blocks of data that are stored in the memory of the computer. A database of information refers to a large number of files that are stored in one program. For instance, a single database might store many files on a single topic.
Damage can occur to secondary memory devices that can result in the loss of information. This can be a very big problem if there is no "backup" or copy of the information. A backup of secondary memory is made by saving the data that you are working with to another place in secondary memory. Radioactive materials can cause the loss of data by disturbing the magnetized surface that contains the coded information. Data can also be lost from secondary memory if the coded surface is damaged by dust or fingerprints. A third problem source can be physical abuse. For example, if a magnetic tape was to stretch while handling the reel the information would be lost.

Magnetic tape memory uses plastic mylar film that is wound on reels. Most tape is about 15 millimeters wide and looks like an audio tape that is used to record music. Most reels will hold about 2,400 feet of tape. A current of electricity puts magnetized spots on the tape. A magnetized area can have either a positive or negative charge that can be used to code data. Magnetic tape devices are being phased out, but they are still used with many large computer systems. Microcomputers also use this type of memory unit because it can be quite small. Magnetic tape units also have the advantage of being quite cheap to use. This is because each tape stores a great deal of information and the tapes are quite inexpensive.

Magnetic disk memory uses platters of metal or plastic. Magnetic disks are coated with chemicals that can hold a magnetic charge. There are a number of circular tracks on each disk. Each disk looks something like a grooveless phonograph record. The information that a disk holds is coded magnetically along each track. Magnetic disks are used with both large computer systems and microcomputers. One advantage that magnetic disks have over magnetic tapes is that the data can be accessed in much less time. This is because the data is not stored in a particular order. Another benefit is that they can store a great deal of information in a much smaller space.

Paper card memory consists of paper cards punched with small holes. Data is stored using a binary code, just like the other forms of secondary memory. A hole in the card stands for a 1, and the absence of a hole stands for a 0. One disadvantage of punched cards is that they can store less data than magnetic tapes or magnetic disks in the same amount of space. Other disadvantages are that the storage of the cards is awkward, and the risk of loss is very high. Magnetic memory is now beginning to replace punched cards, so they are no longer used in most systems.

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