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ABSTRACT

The purpose of this study was to examine the effects of behavioral and cognitive organizing strategies and varied processing intervals on factual and inferential learning. A total of 49 upper-division undergraduate and graduate students, who were randomly assigned to either a cognitive, behavioral, or individual orienting strategy group, received computer-assisted instruction (CAI) with either 10 or 30 seconds of access time to branch to lesson segments. Presented at identical locations throughout the lesson, orienting strategies addressed criterion information either explicitly or in more general abstract terms. Upon completion of the lesson, students were administered a posttest measuring both factual and inferential learning. Results indicate that the explicitness of the orienting strategy did not affect the learning of either facts or inferences differentially; however, a marginal effect was found for access time, with students performing better with 30 seconds. The results suggest that differences in orienting strategies may not be as important as sufficient time for strategy utilization. A list of references, two data tables, and two figures are included. (Author/JB)

THE EFFECTS OF PRESENTATION LATENCY AND EMBEDDED ORIENTING STRATEGIES ON LEARNING FROM COMPUTER-BASED INSTRUCTION

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Abstract

In this study, the effects of explicit versus general orienting strategies and varied access time on the learning of facts and inferences were studied. A CAI lesson focusing on fictionalized science concepts was presented. Students were randomly assigned to either a cognitive or behavioral embedded orienting strategy group, receiving CAI which used either 10 or 30 seconds of access time to branch to lesson segments. Orienting strategies were presented throughout the lesson, and addressed criterion information either explicitly or in more general, abstract terms. Upon completion of the lesson, students were administered a posttest measuring both factual and inferential learning. Results indicated that orienting strategy explicitness did not affect the learning of either facts or inferences differentially. A marginal effect was found for access time, with students performing best with 30 seconds. The results suggest that differences in orienting strategies may not be as important as sufficient time for strategy utilization.

THE EFFECTS OF PRESENTATION LATENCY AND EMBEDDED ORIENTING STRATEGIES ON LEARNING FROM COMPUTER-BASED INSTRUCTION

Each new instructional technology brings with it the potential to solve current educational problems. In many instances, the expected contributions to education never materialize. The reason for for these unfulfilled expectations is not faulty technology per se but the way new technologies are incorporated. One recent computer-based instructional technology is interactive video. Floyd defined instructional interactive video as "... any video program in which the sequence and selection of messages is determined by user's response to the material" (Floyd, 1982, p.2). During the past few years, interactive video has been the subject of increased interest and utilization for instructional applications (Hannafin, Garhart, Rieber. & Phillips, 1985). However, this growing interest is founded in very little research from which to develop guidelines. To obtain optimum results from this technology, research must be performed from which empirically based guidelines can be developed (Dwyer, 1985; Hannafin, 1985).

A current concern involves the type of video delivery system best suited to interactive video: videodisc or videotape. The videodisc is considered by some to be the most significant breakthrough in instructional technology since the invention of the printing press (Reigeluth & Garfield, 1984). Because of the ability of videodisc to access video segments randomly and at much greater speeds than videotape, it is considered by many to be superior for interactive video (Hoffos, 1983).

If speed of access were the prime consideration, videodisc would indeed be the superior technology. However, other factors must be considered. For example, there are limits to the rate at which learners can process information. Providing learners with more information than they can process effectively may inhibit learning (Travers, 1982). Delays in access time between lesson segments of a lesson may provide an opportunity for the learner to process information (cf. Chu & Schram, 1967). Delays might also be utilized to present meaningful information or instructions, such as advance organizers, to improve learning and retention (Stone, 1983).

In effect, the "access time" issue may be more a learning and processing than a technology issue. Since the principal issue in the tape vs. disc arguement pertains to access time, perhaps the study should center initially on time and processing variables in learning from any computer-based lesson (Hannafin & Hughes, 1986).

Processing of information requires sufficient time to select, encode, and integrate (Tennyson, Christensen, & Park, 1984). When individuals are provided more information than able to process, they became disorganized, to the point of being unable to process information at all (Travers, 1982). Rest times between portions of video instructions increase learning by providing information process time (Chu & Schramm, 1975). From this research, it can be concluded that processing time is often useful in improving learning.

Delayed access time between lesson segments could be utilized to present advance organizing strategies to the learner. In a meta-analysis of 112 studies, Stone (1983) found that advance organizers were associated with increased comprehension and retention of material to be learned. The use of "concrete" advance organizers have had a strong effect upon the learning and retention of specific information (Mayer, 1984). Explicit strategies aid in the learning of cued information, but inhibit the learning of uncued information.

The purpose of this study was to examine the effects on learning of presentation access latency, organizing strategies, and the combination of latency and strategy. Specifically, the effects of behavioral and cognitive organizing strategies and varied processing intervals on factual and inferential learning were studied.

Methods

Subjects

The subjects were 49 college upper-division undergraduate and graduate students enrolled in computer literacy courses. Students participated during a regularly scheduled class session and were provided extra credit for participation.

Materials

The instructional treatments were modified versions of a computer-assisted instruction (CAI) lesson which was initially developed for a previous research study (see Garhart & Hannafin, 1986). The lesson described the discovery of a fictitious element on a fictitious island, and the scientific, cultural and political ramifications of the discovery on a previously primitive society. The lesson was presented as a factual account of the discovery: students were not informed as to the fictitious nature of the lesson until the study was completed. This lesson was chosen for the following reasons: 1) the fictitious content was plausible and thus eliminated the effects of prior learning; and 2) the relative ease with which factual and inferential test items could be identified

Three orienting strategies were developed: 1) instruction with embedded behavioral orienting strategies; 2) instruction with embedded cognitive orienting strategies; and 3) instruction with prompts for the learner to use individual learning strategies.

Behavioral orienting strategy. This strategy oriented the student with prompts which were specifically related to the factual content of the lesson segment which followed. The prompts provided the learner a specific orientation to the factual material subsequently assessed. The strategy consisted of a single computer frame, directing the student to attend to two specific informational items which included subsequent lesson text. One example of this strategy is: "In the next section be sure to learn this information: When the anthropologists began arriving on Jexium Island." These factual items consisted of names of people, places, specific events, and other details presented during the following lesson segment.

Cognitive orienting strategy. This strategy oriented the student with broader, more abstract prompting to the instruction which followed. These prompts were not tied to specific facts, but were designed to provide a broader contextual orientation to the content which followed. The strategy consisted of a computer frame directing the student to consider two general concepts which were to follow in the lesson text. An example of this strategy is: "In the next section, you will be presented information about: The importance of studying cultures."

Individual orienting strategy. This strategy provided no prompts to direct student attention to lesson information. Instead, the strategy simply advised the students to pay close attention to the information which followed. An example of this strategy is: "In the next section, try your best to learn the information." As in the prior two cases, three strategy frames were given before questioning.

All treatment strategies were embedded at identical lesson locations. Each strategy was presented in two access time versions: 10 seconds and 30 seconds. The strategy remained on the screen during the access interval and the computer ignored student input during the alloted processing time.

An introductory section was included to obtain general information concerning student identification, gender, age, and study preferences. The student was also given a general orientation as to the nature and organization of the lesson as well as directions for answering the questions on the computer.

The lesson consisted of four parts. Each part consisted of 10 to 14 text frames of easy to read, double-space paragraphs. Six graphic displays which supported the thematic content of the lesson were also included at various points, but were not related to specific criterion information. The orienting strategies were embedded at three evenly spaced intervals during each of the four parts.

Each part was followed by six questions: three factual type and three inferential. The 24 embedded questions also served as posttest items. Feedback was not provided after any of the questions, either during the lesson or the posttest.

Each part of the lesson began with a banner page which was displayed for 3 seconds. The first orienting strategy frame was then displayed for either 10 or 30 seconds. This was followed by four to six frames of instruction. This sequence was repeated two additional times. The student was then presented a transition frame explaining that the lesson part had concluded and that six questions would follow. After answering these open-ended, short answer type questions, the student was presented with the next banner frame for the next lesson part. This cycle was repeated for all four lesson parts.

At the conclusion of the lesson, the student was given a transition frame explaining the posttest. The posttest presented all 24 embedded questions, but in random order. The student was continually informed of the number of questions remaining in the posttest. Additional prompts were given one-third and two-thirds through the posttest. At the end of the posttest, the students were informed of the fictitious nature of the lesson and were directed to signal the proctor that the lesson was completed.

Dependent Measures

Embedded postadjunct questions. Each of the four parts of the lesson was followed by six postadjunct questions: three factual and three inferential. These were open ended, short answer questions. Factual questions measured recall of information presented during the lesson; the inference questions assessed the accuracy of conclusions based on lesson content. Reliability was .91 for the factual scale, and .81 for the inference scale. Validity was established through test item-lesson congruence and review by four evaluators.

Posttest. The 24 item posttest was a repetition of the four groups of six embedded questions presented in a random order.

Student response time. Time required by students to answer each of the two types of questions, adjunct and posttest, was also collected and collated by scale: factual and inferential. Response time was calculated by the computer and rounded to the nearest second.

Procedures

Students were randomly assigned to one of the six treatments upon arrival to class. All students were given an instruction sheet which was summarized briefly by the proctor. Each student was assigned a microcomputer terminal and given a computer diskette in accordance with their treatment group. Participants completed the lesson and posttest at their own rate, signaling the proctor when finished. During the study, all data were collected and recorded on separate diskettes.

The study was conducted during three sessions spanning a four-day period. Students completed the study in times ranging from approximately 45 to 105 minutes. In order to avoid possible contamination between the sessions, students were briefed following their participation and urged not to discuss any portions of the lesson until completion of the study. Also, the students were randomly assigned to the treatments during each day of the study in order to randomize possible contamination effects over time.

Results and Discussion

Learning Effects

The mean percent accuracy and standard deviations for both the embedded questions and the posttest are contained in Table 1. Marginally significant effects were obtained for access time, $F(1,43)=2.92$, $p<.10$. Students provided 30 seconds of controlled access time to utilize the orienting strategy performed slightly better overall than those given 10 seconds. This effect was consistent across orienting strategy, although the magnitude of the effect was modest.

Insert Table 1 About Here

Marginal differences were also found between en-route performance on embedded questions and the corresponding items on the posttest, $F(1,43)=2.62$, $p<.10$. The direction of this effect, however, was not anticipated. Student performance on posttest items was slightly better than on the embedded questions during instruction. Since the embedded questions did not include either feedback or remediation, this effect cannot be attributed to either correction or confirmation resulting from practice. Instead, the effect was likely attributable to the cuing function served by the question. En-route questions appear to cue students to presumably important lesson information. The inclusion of a question appears to direct students to retain the information contained in the question, while permitting them to ease cognitive overload by either forgetting or attending less to non-questioned information.

Although an orienting strategy main effect was not found, an orienting strategy-by-test scale interaction was detected, $F(2,43)=4.08$, $p<.05$. This interaction, illustrated in Figure 1, was characterized by better performance for the cognitive and behavioral strategies for factual versus inferential learning, while the individual strategy was most effective for inferential versus factual learning.

Insert Figure 1 About Here

Response Time

Means and standard deviations for response times are contained in Table 2. As shown, the time required to respond declined significantly from the embedded to the posttest, $F(1,43)=96.65$, $p<.0001$. This may be due to the familiarity of students with the items contained in both embedded questions and posttest portions of the study. It is also possible that students were simply more confident of their responses during the posttest, and responded more rapidly.

Insert Table 2 About Here

Students also responded more rapidly to factual versus inferential questions, $F(1,43)=80.16$, $p<.0001$. The level of learning and processing required for the retrieval of sufficient information to permit inference could contribute to the observed differences. Vickers and Packers (1982) posited a cognitive complexity paradigm. Conclusions that involve greater evaluation of "below-surface" information integrated within existing cognitive networks require greater time to retrieve. This is likely to be the case for inferential tasks, where several pieces of learned information must be evaluated concurrently in order to form conclusions. Conversely, learning that is more explicitly defined, such as factual recall, would be correspondingly easier to recall, requiring less time to retrieve. (cf Vickers & Packers, 1982).

In addition, a test interval-by-test scale interaction was also significant, $F(1,43)=21.95$, $p<.0001$. This interaction, shown in Figure 2, was characterized by a regression toward the mean during the posttest. Inferential questions still required significantly more time to answer, but the differences in response time from embedded to posttest items was not uniform.

Insert Figure 2 About Here

General Discussion

The results suggest that within the limits of this study greater access time improve learner performance. This appears to be true regardless of the type of orienting strategy present. This is inconsistent with research by Belland, et al (in press), who suggested that reductions in allotted processing time tends to intensify effort and improve learning. Since only two processing times, 10 and 30 seconds, were studied it remains to be seen if this difference would continue beyond 30 seconds, and if so, how far.

Another implication of this study pertains to the role of embedded questions as an organizational strategy. Embedded questions seem to provide an additional cue with which to organize and retrieve both factual and inferred lesson material. This contention is supported by the decrease in response time during the posttest. Since posttest questions were identical in form to the embedded questions, students were already familiar with the style and content of the posttest. It is also possible that students gained insight to questions answered incorrectly on the embedded questions as they continued through the lesson, thus correcting mistakes made during the lesson.

The increased time necessary to answer inferential questions is not surprising. Retrieval time for questions which require higher level cognitive tasks should generally be greater than for tasks which required only a lower level cognitive task, such as factual recall (Vickers & Packers, 1982).

The surprising result found in this study was the general lack of differential effect attributable to orienting strategies. It was hypothesized that students in the cognitive orienting strategy group would generally perform better than the other two groups, especially on inferential questioning. However, this was not found in this study. An explanation for this comes from Carlson, Kincaid, Lance & Hodgson (1976), who noted that students tend to revert to their own individual strategies regardless of how they are prompted during instruction. If this is the case, orienting strategies would all assume the characteristics of a "use your own" strategy. This might account for why access time resulted in more noticeable effects.

Several directions for further research are indicated. The study of access time needs further refinement in order to expand the contention that increases in time aids learning. Also, further research is necessary to determine if a ceiling level for processing time exists, and if so, the relationship between access time limits and different cognitive tasks. Further research is also needed to study whether or not students use imposed orienting strategies, or if they simply revert to individual strategies acquired over time. It would also be of interest to study developmental influences with young subjects, since they may not be as likely to have highly refined existing cognitive strategies to rely upon.

This study has raised several questions concerning how students learn from computer-based instruction. Based on this study, we can tentatively conclude that students may profit from increases in access time to process instruction, and that the computer's potential for rapid access may need to be controlled to ensure adequate processing time. Further research should clarify the roles of orienting strategies and cognitive processing time in supporting learning.

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Table 1.

Mean Percent Accuracy and Standard Deviations for Fact and Inference Scales on Embedded Questions and Posttest.

Processing Time		Behavioral	Cognitive	Own	Totals
		Cognitive Processing Strategy			
		Embedded Questions			
Facts					
10"	Mean	70.1	68.3	64.4	67.7
	(SD)	(8.1)	(17.2)	(27.3)	(18.2)
30"	Mean	72.1	67.3	79.8	73.1
	(SD)	(17.9)	(21.3)	(10.8)	(17.3)
Totals	Mean	71.0	67.8	72.1	70.3
	(SD)	(13.2)	(18.7)	(21.6)	(17.8)
Inferences					
10"	Mean	54.5	69.3	65.9	62.9
	(SD)	(21.8)	(11.8)	(17.3)	(18.2)
30"	Mean	59.1	76.1	77.3	70.8
	(SD)	(12.9)	(11.8)	(16.8)	(15.9)
Totals	Mean	56.7	72.7	71.6	66.8
	(SD)	(17.8)	(11.9)	(17.5)	(17.4)

Table 1 (cont)

Processing Time		Behavioral	Cognitive	Own	Totals
		Cognitive Processing Strategy			
		Posttest Questions			
Facts					
10"	Mean	70.1	65.4	64.4	56.8
	(SD)	(9.8)	(16.4)	(27.3)	(18.4)
30"	Mean	74.0	71.2	83.7	76.3
	(SD)	(16.9)	(19.6)	(13.3)	(17.0)
Totals	Mean	72.0	68.3	74.0	71.4
	(SD)	(13.3)	(17.7)	(23.1)	(18.2)
Inferences					
10"	Mean	61.6	71.6	67.0	66.5
	(SD)	(23.1)	(17.1)	(21.1)	(20.3)
30"	Mean	59.1	78.4	77.3	71.6
	(SD)	(12.9)	(16.1)	(16.8)	(17.2)
Totals	Mean	60.4	75.0	72.2	69.0
	(SD)	(18.4)	(16.4)	(19.2)	(18.8)

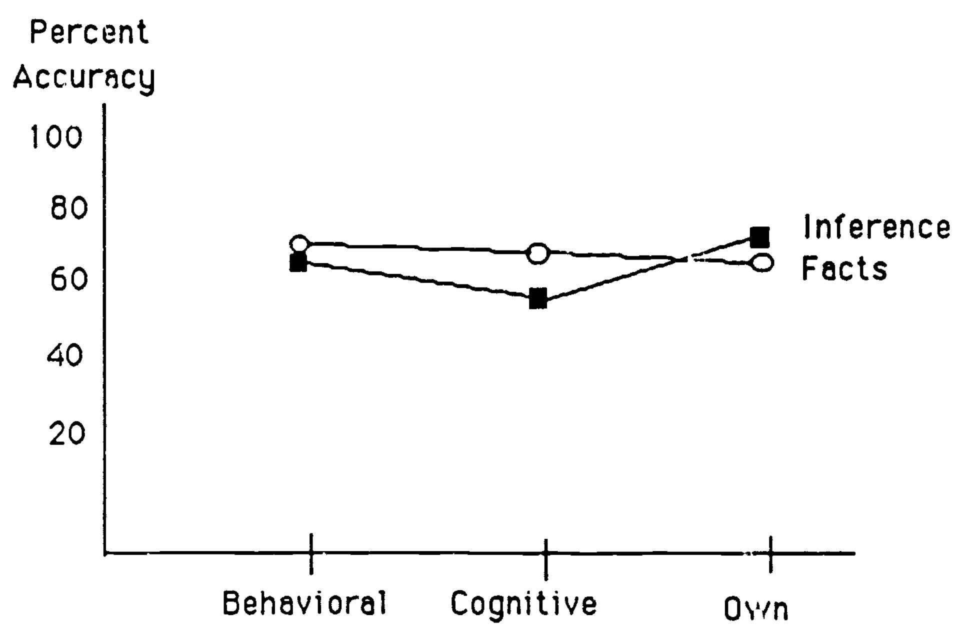
Table 2.

Means and Standard Deviations for Response Time Per Item for Fact and Inference Questions During Embedded Questioning and Posttest.

		Cognitive Processing Strategy			
Processing Time		Behavioral	Cognitive	Own	Totals
		Embedded Questions			
Facts					
10"	Mean	19.7	19.2	22.6	20.4
	(SD)	(8.1)	(10.2)	(5.6)	(8.0)
30"	Mean	20.7	19.9	20.8	20.5
	(SD)	(7.2)	(7.2)	(8.2)	(7.3)
Totals	Mean	20.2	19.5	21.7	20.5
	(SD)	(7.5)	(8.6)	(6.9)	(7.6)
Inferences					
10"	Mean	25.3	28.3	33.8	29.0
	(SD)	(7.7)	(6.0)	(8.6)	(9.8)
30"	Mean	26.9	30.6	29.4	29.0
	(SD)	(14.3)	(12.8)	(15.4)	(13.7)
Totals	Mean	26.1	29.5	31.6	29.0
	(SD)	(11.0)	(9.8)	(12.3)	(11.1)

Table 2 (cont)

Processing Time		Cognitive Processing Strategy: Behavioral	Cognitive	Own	Totals
		Posttest Questions			
Facts					
10"	Mean	15.6	11.7	14.5	14.0
	(SD)	(6.1)	(4.5)	(2.8)	(4.8)
30"	Mean	13.7	13.9	12.9	13.5
	(SD)	(4.1)	(3.1)	(2.9)	(3.3)
Totals	Mean	14.7	12.8	13.7	13.8
	(SD)	(5.2)	(3.9)	(2.9)	(4.1)
Inferences					
10"	Mean	18.4	17.9	18.9	18.4
	(SD)	(5.5)	(2.7)	(5.2)	(4.5)
30"	Mean	18.3	18.5	17.9	18.2
	(SD)	(8.0)	(5.5)	(6.5)	(6.4)
Totals	Mean	18.3	18.2	18.4	18.3
	(SD)	(6.6)	(4.2)	(5.7)	(5.5)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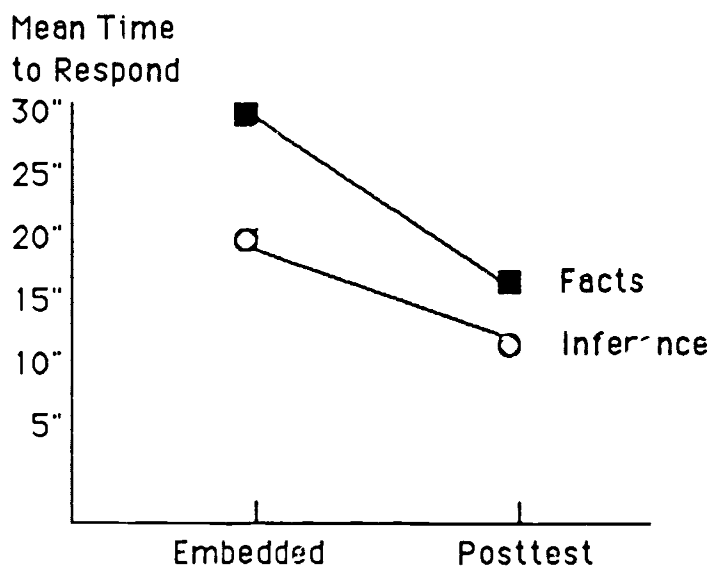
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