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ABSTRACT

The purpose of this study was to examine the effects of replacing multiple-choice and short-answer questions in programmed tutorial courseware practice interactions with learner-generated summaries on three types of verbal information learning outcomes. The study was designed to empirically investigate the claim that the level of mental processing is increased when students use prior learning to create new knowledge. Sixty-nine students participated in an interactive videodisc tutorial on biology. Data were analyzed using a pretest-posttest comparative group design. Results indicated that students in the learner-generated summaries group took more time to complete the task, yet scored lower on short-answer and multiple-choice tests than students in the multiple-choice and short-answer groups. It is concluded that replacing short-answer and multiple-choice questions in computer assisted instructional tutorials with generative processes such as learner-generated summaries does not facilitate learning outcomes. (88 references) (DB)

# Learner-Generated Summaries in Tutorial Courseware



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Running Head: LEARNER-GENERATED SUMMARIES

## Learner-Generated Summaries in Tutorial Courseware

Currently, the majority of commercial instructional softv. are for microcomputers, otherwise known as courseware, is in the tutorial and drill-and-practice modes (Cohen, cited in Jonassen, 1988). According to Jonassen (1988), the typical instructional design of such courseware is similar to linear programmed instruction, where information is presented, followed immediately by recall or recogni questions about the information. The learner's input is then immediately followed by feedback, which varies considera ly in complexity and mode.

Tutorial courseware allegedly enacts a dialog between the program designer and the learner. According to Soulier (1988), "dialog frames" present information to the learner, as well as carry out an interactive dialog/feedback between the learner and the computer. Soulier borrows the terminology of "dialog frames" from Alfred Bork (1980), who defined dialog as "a 'conversation' between a student and a teacher, where the student is at the computer display and the teacher is conducting the dialog through the medium of a computer program" (p. 15).

Soulier (1988) explains that dialog frames in computer-based instruction (CBI) usually have three parts: rules, examples and interactions. The information or subject matter is usually presented in the first two parts. The third part is the practice, or as Soulier refers to it, the interaction function.

According to Alessi and Trollip (1985), the most common method of CBI interaction is for the computer to pose questions the learner must answer. Questions serve a number of purposes. They keep the student attentive to the lesson, force the student to practice, and assess the student's recall and comprehension. In addition, student responses to the questions determine the sequencing for the remainder of the lesson.

Questions can be categorized into two basic types: selected-response and constructed-response. Selected-response questions are those for which the student chooses the correct response or responses from a list of two or more options. These include true/false, matching, multiple-choice, and marking. Multiple-choice items are the most common type of selected-response questions used in CBI (Alessi & Trollip, 1985). Constructed-response questions are open-ended questions that require the student to produce rather than select a response. The three major types of constructed-response questions are completion, short-answer, and essay. In CBI, the most frequent are completion and short-answer questions.

In a chapter of a recent book on designs for microcomputer courseware, Jonassen (1988) states that one of the problems with most tutorial courseware is that the level of mental processing required of learners is too shallow. He claims this weakness is due to the multiple-choice and short-answer questions predominantly used in CBI interactions. He states that the nature of the interactivity is usually recognition and recall of information presented on the previous screen, with little, if any, attempt to relate the information to prior knowledge, so that it will be meaningful and therefore retrievable by the learner. Jonassen (1988) states,

> Tutorial courseware is basically a mis-application of the programmed learning model of instructional design, which has been the dominate paradigm in the field of educational technology for nearly 3 decades. Since the programmed learning model is easily confused with the procedure or technique of programmed instruction, it is better conceptually defined by the mathemagenic hypothesis.
>
> Mathemagenic behaviors are "those student activities that are relevant to the achievement of specified instructional objectives in specified situations or places," that is, those which "give birth to learning" (Rothkopf, cited in Jonassen, 1988). These behaviors, according to the hypothesis, can be controlled or manipulated by specific design attributes of instruction. The form or structure of instruction or the activities stimulated by it induce the necessary cognitive operations to produce the desired learning. . . . The purpose of mathemagenic activities, such as inserted questions (the basis of programmed learning), is to control the way in which information is transformed and encoded into memory. It is therefore a reductive approach to

learning, which regards learners as active performers whose mental behavior should be strictly controlled by the activities imposed by the lesson. (p. 152)

Jonassen continues by stating that one of the problems with computer applications of the mathemagenic model is that the level of processing normally produced by mathemagenic behaviors (especially programmed learning) is too low or shallow.

To solve the problem, Jonassen (1988) recommends tutorial courseware be developed based on a more constructive conception of learning, that is, instruction which focuses more on cognition, requiring deeper levels of mental processing.

In order to increase the level of mental processing, Jonassen (1988) recommends that tutorial courseware should enhance meaning of course information by stimulating the learners to call up and apply what they already know. He suggests that this deeper processing can be achieved by incorporating learning strategies into the courseware. These learning strategies sometimes referred to as cognitive strategies, are mental operations or procedures that represent a wide range of cognitive activities including underlining main ideas, generating examples or analogies, summarizing, outlining, etc. which the student may use to acquire, retain, and retrieve different kinds of knowledge (Rigney, 1978). They are designed to increase the number of "links" between presented information and existing knowledge in order to enhance retention and to allow the student to process information generatively (Wittrock, 1974). They are always performed by the learner--at the initiation of the student or the instructional system.

According to Weinstein and Mayer (1986), in recent years increased attention has been placed on the role of the learner as an active participant in the teaching-learning act. Many articles suggest that the effects of instruction depend partly on prior knowledge, and the learner's active cognitive processing during the learning process (Anderson, Spiro & Montague, 1977; Cook & Mayer, 1983; Dansereau, 1985; Jones, Amiran & Katims, 1985; Mayer, 1984; Ryan, 1981; Weinstein, 1978; Weinstein & Underwood, 1985; Wittrock, 1974, 1978). Wittrock's (1974) generative learning hypothesis, assumes that when faced with instructional stimuli, learners construct and assign meaning to the stimuli on the basis of prior learning. The meaning generated by learners for information they receive is individual and cannot be controlled by the author. According to Wittrock (cited in Jonassen, 1988), learning is not "a passive reception of someone else's organizations and abstractions" (p. 153). Instead, learning is an active, constructive process. According to Jonassen (1985),

> The purpose of generative strategies is to provide learners with active, constructive skills for proactively transferring prior knowledge. Meaning (knowledge, if you prefer) is learner-constructed, not media-controlled. These [learning] strategies, such as paraphrasing, generating questions, and imaging, are all individual processes for constructing meaning. (p. 31)

How should an instructional designer integrate learning strategies into CBI? Rigney (1978) describes a framework of several approaches for integrating learning strategies into an instructional system. Some are detached from the content, such as explicit instructions to generate a question or form an image about the material. Learning strategies may also be embedded in the content, so that the learners must perform the mental operations in order to acquire the material, such as a question that requires the learners to relate new material to prior learning or solve a problem applying a concept before the next information will be given. Rigney draws an additional distinction--crucial to computer-based instruction--between instructional system assigned strategies (ISA), which recommend when the student should use one or more of the strategies as a part of the courseware, and student-assigned (SA) strategies, which are initiated by the students without guidance from the system (Allen & Merrill, 1985). The relationship between these two dimensions is shown as a matrix in Figure 1.

Each cell in the matrix represents a different approach for integrating learning strategies. Cell "D" represents instruction which incorporates the cognitive learning strategy that the designer considers the best for each particular phase of learning into the design of the learning sequence.

| Cognitive Learning Strategy | Control of Orienting Task | |
|---|---|---|
| | SA | ISA |
| Detached | A | B |
| Embedded | C | D |

Figure 1. Alternative Approaches for Integrating Cognitive Learning Strategies (Rigney, 1978).

Cell "A" represents instruction in which the designer makes no attempt to induce any particular cognitive learning strategy, leaving the selection and the control with the individual learner. Cell "C" represents the condition which encourages the learner to choose from a number of possible strategies that are embedded within the instructional system. Cell "B" represents the situation in which the instructional system suggests that the learner use a learning strategy that is detached from the instruction (Eucker, 1984).

Jonassen (1985) explains that microcomputers are especially amenable to the inclusion of learning strategies because they can accept, store, and manipulate a variety of input, and they can insist on a response before allowing the learner to proceed, something which traditional print media cannot do. For instance, after presenting the information, the computer system could direct the learner to go through a particular learning strategy, with the computer functioning as an "electronic notebook." The learner can key in a response which the computer evaluates for quantity or existence of key concepts and sometimes manipulates through rearranging or mapping and then stores for use by learners as a review or retrieval strategy. Jonassen (1988) believes that assessing user input will ensure higher levels of processing than the multi-option recognition or recall tasks included in most tutorial courseware.

Jonassen (1988) recommends that "the simplest method for integrating [learning] strategies in courseware is to replace the adjunct, mathemagenic activities that are normally included as practice in courseware with specific information processing or perhaps metalearning strategies" (p. 160). More specifically he suggests:

> For example, rather than inserting multiple-choice questions to test immediate recall or comprehension of information in a program, you might periodically insert any of the following directions: Summarize in your own words the ideas presented; recall and record key ideas and use them to create analogies, outlines, or cognitive maps; draw a picture or generate a mental image of the subject matter; or list the implications of the material that you are studying (p. 160).

Jonassen's approach is an example of cell "D" (Instructional system-assigned/ embedded approach) of Rigney's matrix in Figure 1.

In discussing the rationale for replacing multiple-choice and short-answer questions in CBI interaction frames, Jonassen (1988) explains that "only deeper, semantic processing of information requires the learner to access prior knowledge in order to interpret new material" (p. 153). He makes the point that integrating cognitive strategies into CBI interactions will facilitate higher level learning outcomes, such as comprehension and understanding, and will also increase the amount of information that is recalled. Because learners assign more meaning to the information presented during the tutorial, they will be able to remember more. Jonassen continues,

> It is exactly this level of meaningful learning that is most frequently missing from tutorial types of courseware. The emphasis is on practice of associations in working memory based only on information recently presented in the courseware. In interacting with the tutorial courseware, learners are too seldom required to access prior knowledge in order to interpret the information that is presented. (p. 153)

The primary purpose of this study was to examined the effects of replacing multiple-choice and short-answer questions in tutorial courseware practice interactions with a learning strategy (learner-generated summaries) on three types of verbal information learning outcomes. The study was designed to investigate empirically the approach recommended by Jonassen (1988) to integrate learning strategies by replacing the traditional short-answer and multiple-choice questions in CBI interactions.

A verbal information learning outcome can be defined as the kind of knowledge the learner is able to state from memory. As Gagne, Briggs and Wager (1988) explain, "All of us have a great deal of verbal information or verbal knowledge. We have readily available in our memories many commonly used items of information such as the names of months, days of the week, letters, numerals, towns, cities, states, countries, and so on" (p. 47). Verbal information may be recalled or stated, but not necessarily understood. As Tessmer, Jonassen & Caverly (1989) explain,

> The learner acquires knowledge of a concept, rule, principle, or procedure, but does not necessarily understand the concept, rule or principle. Nor can we be assured that the learner can use the rule or concept even though they can say it. Verbal information refers to the statement of facts, rules, concepts, etc. The statement of information is different from the use or application of the information. . . . If the learner only memorizes the information so that she or he may later state it, the outcome is verbal information (pp. 33-34).

There are many specific types of learning outcomes within the domain of verbal knowledge or verbal information. For example, the ability to describe the procedure for making withdrawals from a bank, recall the quadratic formula, state the definition of hegemony, or recognize Robert's Rule of Order regarding a quorum (Tessmer, Jonassen & Caverly, 1989). Another verbal information learning outcome is the capacity to explain or describe the gist of paragraph-long passages of information (Gagne, Briggs & Wager, 1988).

Even though verbal information learning outcomes are the lowest category in most learning taxonomies (see Bloom, Englehart, Furst, Hill, & Krathwohl, 1956 and Gagne, 1985), the usefulness of a student's "information store" should not be minimized (Nitko, 1983). As Nitko explains, "A base of knowledge in a subject is important (a) when learning complex intellectual skills, (b) in communicating with others in the context of everyday living, and (c) as a 'medium' or 'carrier' of thought for more reflective and creative thinking and problem solving" (p. 215).

The present study assessed the effects of integrating the learning strategy of learner-generated summaries in tutorial courseware on three types of learning outcomes within the domain of verbal information: short-answer recall, recognition, and recall of organized information.

Although several studies within the last few years have investigated the effects of integrating individual learning strategies in instructional systems and developing instructional systems that train learners how to use a particular learning strategy (Weinstein & Mayer, 1985; Dansereau et al., 1979; O'Neil, 1978; O'Neil & Spielberger, 1979), the practice of integrating learning strategies in CBI interactions has not received much attention in the literature. The few studies which have been conducted had a different focus than the present study. For example, these studies either dealt with a different learning outcome than verbal information or they tried to validate a different type of learning strategy (for example, see Eucker, 1984; Allen, 1982; Wilshire, 1990). The results from each of these studies did not support the hypothesis that integrating a learning strategy in CBI would be more effective in facilitating learning than the traditional approach used by the comparison group(s).

In a recent article Mayer (1989) concluded that having learners use the cognitive strategy of building conceptual mental models (used to promote more deeper, meaningful, systematic mental processing) actually reduced verbatim retention of verbal information. His article examined the effects of using conceptual models on three learning outcomes: recall of conceptual information, verbatim retention, and generation of creative solutions on transfer problems. In a review of 20 studies involving 31 tests, results consistently indicated that this strategy improved recall of conceptual information, decreased verbatim retention, and increased creative solutions to transfer problems. Mayer's article and some of the studies cited previously provide some evidence which does not support the premise stated by Jonassen (1988) that integrating a learning strategy in CBI by replacing short-answer and multiple-choice questions will facilitate more recall of verbal information. The present study is innovative in that it investigated the specific effects of integrating learner-generated summaries on verbal information learning outcomes.

Several studies have examined different aspects of student-generated summaries (Annis, 1985; Brown, Campione, & Day, 1981; Day, cited in Brown, Campione, & Day, 1981; Ballesteros, 1986); however, none have examined the specific effects of integrating this strategy in CBI interactions on verbal information learning outcomes.

The following hypotheses were addressed in this study:

*Hypotheses*

1. Learner-generated summaries in tutorial courseware will be more effective in facilitating learners' ability to recall and recognize isolated facts or parts of information than multiple-choice or short-answer questions.
2. Learner-generated summaries in tutorial courseware will be more effective in facilitating learners' ability to recall organized information than multiple-choice or short-answer questions.

## Method

*Subjects*

Subjects were obtained from an undergraduate computer course (Computers in Education) offered in the College of Education at a university in Utah. They were required to complete the intervention for this study as one of their assignments in the course. Sixty-nine students participated in the study: 57 females and 12 males. The subjects were undergraduates (expect for six graduate students) enrolled in teacher education majors.

*Materials*

The intervention for all treatment groups consisted of an interactive videodisc tutorial on developmental biology, developed by WICAT Incorporated in 1979, under a grant from the National Science Foundation (Bunderson, Olsen & Baillio, 1981). The hardware consisted of a Macintosh-based interactive videodisc system.

The instruction, which was developed for university-level students, dealt primarily with verbal information learning outcomes. This explanative material (Mayer, 1989) consisted of an introduction to basic developmental biology concepts such as DNA, RNA, genes, chromosomes, etc. It was selected for several reasons. First, the researcher believed that most students had very little prior knowledge about the content, which was desirable determining whether a learning effect occurred as a result of the treatment. Second, the instruction on the videodisc had been effectively developed using the traditional tutorial courseware approach: an instructional segment followed by short-answer and multiple-choice questions as the form of practice. Finally, since the content area was not related to the course in which students were enrolled, it was expected that they would not make extensive use of self-initiated learning strategies during the intervention as they might if the information held strong interest or high motivation for them. The addition of self-initiated learning strategies could have seriously confounded the results of the study.

The interaction frames and the courseware that controlled the videodisc were developed on the computer by use of the authoring program *The Best of Course of Action*, developed by Authorware, Incorporated (Authorware, 1987).

*Instruments*

A pretest was developed using 20 items selected from a test developed by WICAT Inc. and a professor of Biology at Brigham Young University, based on the information presented in the videodisc. Multiple-choice, matching, true/false, and short-answer test items were selected to assess students' preexisting knowledge of developmental biology in terms of verbal information learning outcomes.

Three posttests were developed measuring the three learning outcomes: (a) a short-answer recall test, (b) a multiple-choice and matching test assessing recognition, and (c) a restricted-response essay test assessing recall of organized information. The material presented on the videodisc was analyzed to identify all the knowledge elements presented during the instruction and test items were written for each. The items for the short-answer and multiple-choice tests assessed exactly the same knowledge elements; however, to prevent cueing, the items on the multiple-choice test were randomly reordered. The short-answer recall and recognition posttests were developed to measure the degree to which learners were able to remember all the information presented during the instruction.

The four questions on the essay test were written with the intent to assess how much organized information the learners could recall. One of the purposes of including an essay test was to determine if students who wrote summaries would perform better on an explanation test than students who selected the correct answer or constructed a short answer.

Internal consistency reliability measures were computed on the test scores to assess the reliability of the results. The reliability (Cronbach Alpha) coefficients for the pretest, short-answer and multiple-choice tests were .72, .89, and .80, respectively.

Three raters judged the students' answers to the restricted-response essay questions. Table 1 shows the results of interrater reliability coefficients computed for each essay question and the total score for the essay test.

As an estimate of content-related evidence of validity, three raters (two graduate students and one undergraduate student) were asked to review the instruction and determine to what degree the tests actually assessed the material presented in the instruction. Two raters were very familiar with the material presented in the instruction. The raters were asked by the researcher to make a quantitative judgment concerning the evidence of content-related validity for the results of the instruments using a 10-point scale, 10 being the highest and 0 being the lowest. As the raters' judgments were eight, eight, and nine, their judgments were highly consistent, and the validity rating for the results of the instruments was very high.

*Procedure*

*Administration of intervention.* To reduce the internal validity threat of experimenter bias, two male proctors who did not know the specific nature of the study or the hypotheses administered the study. They administered the intervention to each student individually, during a prearranged one-hour time slot. When the students arrived, a proctor briefly explained the general nature of the study and then requested the students to sign a participation consent form and complete the pretest.

Table 1

*Estimated Interrater Reliability Coefficients for Each Essay Question and the Total Score for the Essay Test*

| Essay Question | Alpha Coefficient |
|---|---|
| 1 | .969 |
| 2 | .978 |
| 3 | .978 |
| 4 | .982 |
| Total Score | .987 |

After the students completed the pretest, the proctor provided some basic explanations on how to use the instructional system, then selected the appropriate treatment group for which each student had been assigned.

Following a few introductory frames in the computer program, the students entered their names and social security numbers. The program then presented four segments of instruction. After the first segment, which consisted of several still frames and a motion sequence, students assigned to Group 1 answered multiple-choice questions, students in Group 2 wrote short-answer questions while students in Group 3 composed a summary about the information presented. If the students in Group 1 or 2 selected the correct answer, the system provided a short statement affirming the correct selection or answer. However, if the wrong answer was selected or constructed, the students were informed the answer was incorrect and then were given the correct answer. If the students were in Group 3, the system presented a model summary as a form of feedback immediately after the students typed in their summary. Students were allowed unlimited time to answer questions, but were not allowed to search back to the text for answers.

This process was the same for the remaining three segments of instruction. Students in Group 1 answered a total of 35 multiple-choice questions; students in Group 2 answered a total of 38 short-answer questions; students in Group 3 wrote four summaries during the intervention. The computer program recorded the time students started the intervention and the time they completed the instruction. In addition, the program recorded the number of practice items which students in Groups 1 and 2 scored correctly and the self-generated summaries students in Group 3 typed.

After completing the intervention, students completed the recall test, which preceded the recognition test to avoid prompting or cueing. Following the recall test, students completed the recognition test and then the restricted-response essay test, after which they were thanked for participating in the study. It took an average of about 60 minutes for students to complete the entire intervention.

*Training of proctors.* The proctors (a graduate student and an undergraduate student) were trained by the researcher and provided with a sample dialogue to ensure consistency in administering the intervention.

*Procedures for grading essay tests.* The primary researcher and the two proctors rated the essay tests. To increase the interrater reliability of the results of the test, the two proctors received a two-hour training session conducted by the primary researcher.

The raters followed the procedures for rating the essay tests recommended by Mehrens and Lehmann (1984) and Gronlund and Linn (1990): (a) the tests were graded one question at a time for all tests, (b) the tests were randomly shuffled after grading each question, (c) the tests for all students were graded without interruption, (d) the tests were graded anonymously, (e) the rating criteria were applied as consistently as possible, and (f) the mechanics of expression were judged separately from the content.

*Scoring procedures and data entry.* To ensure that the pretest, recall and recognition tests were scored correctly, each proctor graded all the tests using a separate answer sheet for each student's test. Each proctor then entered the data from the answer sheets into the computer. The researcher compared the sets of data, using a comparison program on the VAX mainframe computer, and corrected discrepancies. The verified, corrected data were used in the final data analyses.

*Research Design*

The research design was a Pretest-Posttest Comparison Group Design. The students were randomly assigned to one of three treatment groups. The instruction delivered during the intervention was the same for all three treatment groups--four segments consisting of video sequences and several still frames on developmental biology.

The independent variable was the type of learner response required during the CBI interaction following the instructional frames in the tutorial courseware. Several dependent variables were included: short-answer recall measured by the short-answer test, recognition measured by the multiple-choice test, and recall of organized information measured by the restricted-response essay test.

*Statistical Procedures*

The hypotheses were addressed using the following procedures. Because there was more than one dependent variable, a multivariate analysis of variance was used to determine if there was a statistically significant difference between treatment groups with respect to at least one dependent variable. The multivariate analysis was followed by separate univariate one-way analyses of variance for each dependent variable. If an analysis of variance resulted in a significant difference between treatment groups, the Newman-Keuls multiple comparison method was used to determine which means differed from the other. One-way analysis of variance was used to analyze the pretest scores.

## Results

Of the 69 subjects, 23 were in Group 1 (multiple-choice questions), 22 were in Group 2 (short-answer questions), and 24 were in Group 3 (learner-generated summaries). Means, standard deviations and ranges were computed for the number of correct answers on the pretest (20 possible) and for each of the dependent variables: (a) number of correct answers on the recall test (35 possible), (b) number of correct answers on the recognition test (25 possible), and (c) number of correct answers on the essay test (32 possible). Table 2 summarizes the results of these computations.

One-way analysis of variance showed that the differences between means on the pretest scores were not statistically significant, an indication that the three groups were equivalent in terms of preexisting knowledge about the material presented in the instruction , $F(2, 66) = .04$, $p = .96$.

The multivariate analysis of variance showed a significant difference between the treatment groups with at least one dependent variable using Wilk's Lamba (Exact $F = 3.37$, $df = 6, 128$, $p = .005$).

Table 2

*Group Means, Standard Deviations, and Ranges for Pretest Scores, Recall Test, Recognition Test, and Essay Test*

| Treatment Group | Pretest Scores | Recall Test | Recognition Test | Essay Test |
|---|---|---|---|---|
| Multiple-Choice | | | | |
| Mean | 9.0 | 25.8 | 21.5 | 14.3 |
| SD | 3.3 | 5.7 | 3.3 | 5.3 |
| Range | 4-16 | 12-33 | 10-25 | 5.0-25.3 |
| Short-Answer | | | | |
| Mean | 9.4 | 27.6 | 22.0 | 13.9 |
| SD | 4.0 | 6.4 | 2.1 | 4.8 |
| Range | 2-17 | 11-35 | 18-25 | 4.3-21.7 |
| Learner-Generated | | | | |
| Mean | 9.1 | 20.8 | 18.5 | 13.2 |
| SD | 4.0 | 7.3 | 4.3 | 5.6 |
| Range | 3-18 | 12-35 | 9-25 | 2.3-30.3 |

Note: The range of scores for the essay test is reported in decimals because the scores given by three raters were averaged to create a single rating for each examinee.

The results of the univariate analysis of variance showed a significant difference between the means of the three treatment groups on the results of the short-answer test, $F(2,66) = 6.77$, $p = .0021$. Results of a Newman-Keuls multiple comparison ($p < .05$) indicated that the mean for the learner-generated summaries group was significantly lower than the mean of the multiple-choice group and the mean of the short-answer group. There was no significant difference between the means of the short-answer and multiple-choice groups.

An analysis of variance on the results of the recognition test also showed a significant difference between the three treatment groups, $F(2,66) = 7.31$, $p = .0014$. As with the short-answer test, a Newman-Keuls multiple comparison ($p < .05$) indicated the mean of the learner-generated summaries group was significantly lower than the mean of the multiple-choice group and the mean of the short-answer group. Like the previous analysis, there was no significant difference between the means of the short-answer and multiple-choice groups. These results do not support and are opposite to those predicted in Hypothesis One, which states the use of learner-generated summaries in tutorial courseware will have a greater facilitative effect on learners' ability to recall and recognize isolated facts or parts of information than multiple-choice or short-answer questions.

An analysis of variance showed that the differences between the treatment means on the essay test scores were not statistically significant, $F(2,66) = .25$, $p = .780$. These results do not support Hypothesis Two, which states that the use of learner-generated summaries in tutorial courseware will more effectively facilitate learners' ability to recall organized information than multiple-choice or short-answer questions.

## Discussion

The results of this study did not support the first hypothesis. Students in the learner-generated summaries group took significantly more time to complete the intervention and yet scored significantly lower on the short-answer and multiple-choice tests than students in the multiple-choice and short-answer questions groups.

It was also hypothesized that students in the learner-generated summaries group would score higher on the essay tests than students in the other groups, since part of the task of generating a summary involves recalling organized information. However, the results of this study showed that students in the multiple-choice and short-answer groups performed as well as students in the learner-generated summary group.

What are the theoretical implications of these findings? First, for the particular verbal information learning outcomes assessed in this study, students may need the practice items of short-answer and multiple-choice questions to provide the necessary repetition required for immediate recall and recognition (Gagne, 1985; Gagne, Briggs & Wager, 1988). Second, the short-answer and multiple-choice response items may have highlighted the key knowledge elements presented in the instruction which focused the learners' attention on the information that was really important. Third, the short-answer and multiple-choice practice items provided feedback on each of the major knowledge elements presented in the instruction so learners knew if they missed some particularly important information. The students in the learner-generated summaries group did not receive specific feedback on each of the major knowledge elements presented in the instruction, which may have had an influence. Fourth, another theoretical issue which may have had some influence on the results of this study is the degree of instructional alignment between the learning strategy and the learning outcomes (Cohen, 1987). Perhaps using learner-generated summaries was not the most appropriate strategy to use for the particular learning outcomes measured. Learner-generated summaries may have facilitated other higher-level learning outcomes that were not measured in this study, such as understanding, transfer, synthesis, etc. Finally, another possible explanation which may have influenced the results of this study was the degree to which students wrote effective summaries. Perhaps the subjects in this study were much more familiar with responding to short-answer and multiple-choice items and hadn't received much practice in writing summaries of explanatory material.

What are the major contributions of this study? The results of this study show that replacing short-answer and multiple-choice questions in tutorial courseware with learner-generated summaries does not facilitate the specific learning outcomes of short-answer recall, recognition, and recall of organized information for the material used in this study. In fact, the results of this study show that using learner-generated summaries in place of short-answer and multiple-choice questions is not only less effective, but also less efficient for the particular material presented in this study. Students who generated their own summaries not only scored significantly lower than students who answered short-answer and multiple-choice questions, but they also took significantly longer to complete the instruction.

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