The Effects of Active Versus Passive Review on Recall and Instructional Time in an Interactive Videodisc Lesson

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ABSTRACT

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The present study examined the effect of different review strategies on recall and instructional time in interactive videodisc instruction. Thirty undergraduate biochemistry students were randomly assigned to one of three treatment groups, in which a lesson on the tools and steps of the swipe check method was presented with either: (a) *no review*, which did not include a review of any type and thus acted as a control for the study; (b) *passive review*, which presented review information in the form of direct statements; and (c) *active review*, which grouped questions following the lesson and provided the correct responses as feedback. Results of the study indicated that the use of a passive review yielded significantly higher recall of procedures than did no review. No significant differences between treatment groups were observed for the recall of facts. Instructional time was recorded and was found to significantly increase with interactivity. As expected, the amount of time spent in active review was significantly greater than that associated with passive or no review. Relevant studies have suggested that significant increases in instructional time imply decreased instructional efficiency. Although the passive

review group showed significantly higher instructional time than did the control group, the learning gains resulting from the inclusion of a passive review may substantiate its use as a teaching method in interactive video instruction.

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CHAPTER 1

Introduction

Amid the excitement surrounding the advent of new technology is the inference that technological innovations can yield improvements in learning. These effectiveness claims are often attributed to enhancements in media design and tend to minimize the contribution of instructional design principles. It is generally believed that the capabilities of the medium determine the success of instruction. Lesson design is thus seen to be technocentric, in that it is thought to be influenced by the capabilities of the technology itself (Hannafin & Phillips, 1987). But is it the media or the methods that, in fact, determine whether instruction is effective?

Research has shown that a given instructional method can demonstrate learning improvements across a wide variety of training media (Allen, 1957; Chu & Schramm, 1967; Clark, 1983). This suggests that it is not the media per se which facilitate learning but, rather, that it is the teaching methods which are employed to stimulate cognitive activity that determine instructional success.

It is often difficult to separate instructional strategies from the media characteristics that support them. If a training device imposes constraints on a chosen instructional method, that device is of reduced value in effective instruction. If the instructional method does not make appropriate use of the capabilities of the medium, then a more suitable medium could perhaps be effectively employed. The extent to which teaching techniques are supported or constrained by the inherent features of the media is of some concern to instructional designers, who are interested in the manipulation of design strategies to maximize learning potential.

The selection of instructional design alternatives, therefore, is largely dependent upon the available support provided by the medium. Fixed-pace, fixed-sequence media, such as film or videotape, are limited in their ability to promote interactive or self-paced instruction. As a result, such linear instruction is often perceived as passive and thus yields insufficient mental effort on the part of students to process relevant information (Salomon, 1983). Computer-based instruction, on the other hand, while capable of varying degrees of interactivity and learner control, is limited in its ability to provide visual and auditory realism. This may affect the transfer of learning from the classroom environment to real-life situations.

Interactive videodisc (IVD) is the latest technology to emerge as an effective instructional device. With the introduction of IVD as a medium of instruction, the apparent limitations of video and computer technologies can be somewhat reduced. IVD utilizes the visual and aural capabilities of videodisc technology, the learner control and interactive features of computer-based instruction, and the unique capabilities inherent in the combination of these technologies to create a powerful instructional medium (DeBloois, 1982; Hannafin & Phillips, 1987). Through the video-computer interface, IVD can provide realistic visual motion and varying levels of interactivity, which range from linear video display to learner-controlled, response-dependent lesson interaction (Hannafin & Phillips, 1987; Schaffer & Hannafin, 1986). As a result, the passivity generally inferred from video-based instruction is diminished. Students are presumed to invest greater mental effort in interactive instruction, which serves to strengthen cognitive associations among items of information and improve learning.

Interactivity is one of the key components of IVD and has been found to enhance instructional effectiveness (Cohen, 1984; Dalton, 1986; Hannafin, Phillips, & Tripp, 1986; Ho, Saveyne, & Haas, 1986; Smith, Jones, & Waugh, 1986). But interactivity in lesson design can take several different forms, depending upon the manner in which questions are incorporated in instruction. The type, frequency, and location of questions, as well as the type and amount of feedback provided, will have differential effects on learning achievement using IVD (Dayton & Schwier, 1979; Rickards & Di Vesta, 1974; Yost, Avila, & Vexler, 1977).

The success of interactive instruction depends largely on the quality of the lesson design (Bork, 1982; Palmer & Tovar, 1987). IVD presumes that learners will process instruction in new ways; ways that are different from the linear approach of video- or film-based instruction (Allen, 1986). As a consequence, the instructional designer must understand the learning strategies employed by students and formulate new approaches to lesson design that effectively stimulate student learning (Cohen, 1984). The design of interactive lessons is therefore important in determining the effectiveness of IVD instruction, and merits further investigation.

The present study was concerned with the effective application of design methods in interactive videodisc instruction and has focused specifically on the effect of active versus passive review strategies on learning achievement and instructional time.

CHAPTER 2

Literature Review

There is a growing trend in the literature to support the use of Interactive Videodisc (IVD) as a teaching tool. As in the case of computer-based instruction, much of the research has focused on the interactive potential of the medium and its contribution to learning. Yet interactivity is defined differently depending upon the manner in which it is incorporated within instruction. Some researchers focus on the learner control aspects of interactive instruction, whereas others concentrate on the use of interactivity to promote active learner involvement. It is the latter focus that was of primary interest to the present study.

Cognitive Activity in Learning

Instruction is often labelled *passive* or *active* depending upon the degree to which student interest, attention, responding, and processing activities are stimulated. If students are unaware or fail to process relevant information, then learning is bound to be affected (Bovy, 1981).

Much of the literature pertaining to interactive instruction has concentrated on the process of learning from a cognitive perspective. Cognitivists assert that instructional methods affect learning or performance via student cognition. They suggest that external stimuli affect knowledge acquisition and the mastery of cognitive skills through the mediation of established schemata (Salomon, 1983; Clark, 1984).

The cognitive approach proposes that individuals consistently construct conceptual models in order to understand the situations that arise in their physical world. They form cognitive categories, or schemata, in which information is organized and they then exhibit a generalized readiness to process new information on the basis of the associations that constitute a particular schema. Information processing, therefore, is seen to be the result of an active interpretation of new information based on the associations which already exist in cognition. As more knowledge is acquired, additional associations develop and the existing schemata grow more inclusive.

Information becomes meaningful, therefore, only after it has been initially perceived and integrated into a cognitive structure (Ausubel, 1965). Perceptual interpretations of information, in the form of visual or aural input, reflect a general awareness of the meanings of words or symbols and their syntactical relationships, but they do not imply that the inherent meaning of the message has been grasped. Cognitive interpretation of these perceptions through activities, such as selective attention, information processing, or rehearsal, enable meaning to be attributed in accordance with the idiosyncratic cluster of established constructs in the learner's cognitive structure. These cognitive activities have been termed *mathemagenic* by Rothkopf (1970) and have significant import in determining the extent to which learning occurs.

Mathemagenic activities are often covert and thus cannot be measured directly. They are speculated to be operant when an instructional stimulus has been placed within *perceptual range* of the student (Rothkopf, 1970). However, if mere presence of information was the sole factor in activating mathemagenic behavior, then learning gains would occur for all students to whom the instructional stimulus was presented. This does not seem likely; rather, one would suggest that learners engage in mathemagenic activities to a greater or lesser extent and that the design of instruction can stimulate or inhibit the performance of these activities.

This view is supported by Rothkopf (1966, 1968), who suggested that mathemagenic behavior can be shaped by instructional consequences and that instruction should, therefore, focus on promoting student actions which will encourage the attainment of objectives. Although instructional designers have minimal direct control over the covert processes that operate within the minds of students, they can guide them toward the key elements of a task through sound instructional techniques (Chu & Schramm, 1967). These techniques can affect the level of mathemagenic activity by providing opportunities for lesson review and instructional interaction.

Reviews

One way in which to stimulate mathemagenic activity is to incorporate reviews into lesson design. Reviews are deemed effective because they introduce additional opportunities for practice. This practice serves to consolidate presented information and yield improvements in the acquisition and retention of relevant content (Ausubel, 1965; Bruning, 1968; Maccoby & Sheffield, 1961; Miller & Levine, 1961; Rothkopf, 1966, 1968).

When reviews were presented following initial instruction, significant recall improvements were reported. In conducting two similar studies, Gay (1973) found that classes which received a review were able to recall up to 45% more of the lesson content than were classes which did not receive the review. Ho, Saveyne, and Haas (1986) reported that the inclusion of a review, whether mandatory or optional, was effective in improving learning in IVD instruction.

The facilitative effect of reviews on recall may be attributed to their incorporation following the initial presentation and processing of relevant material (Kaplan & Simmons, 1974). Reviews may serve to reinforce the learning of material previously presented and provide a second attempt at comprehending information which may have been overlooked during initial presentation (Hannafin, 1985).

It is believed that repeated exposure to a potentially meaningful message facilitates the integration of perceived content into existing schemata upon which meaning is derived. The learner becomes sensitized to the potential meaning during initial encounters so that, on subsequent exposures, effort is not placed on the apprehension of meaning but, rather, on its retention (Ausubel, 1965).

However, the extent to which repeated exposure facilitates or inhibits learning through mathemagenic activities is questionable (Carver, 1972; Faw & Waller, 1976). Rothkopf (1968) examined the effects of review frequency on recall and inspection time using written instructional materials. University and high-school students completed a varied number of self-paced inspections of a textual passage and were then tested on recall using a completion (or "fill-in-the-blanks") measure. The findings of this study indicate that retention of information is a function of repeated exposures to an educational stimulus, but that, after two inspections, a ceiling effect occurs. Since inspection time and test time were found to decrease with additional repetitions, Rothkopt concluded that students modified their mathemagenic behaviors with prolonged exposure to materials and that, as a result, diminished learning effects were observed.

It is important for the instructional designer to understand the mathemagenic strategies employed by students in order to create an instructional environment that will stimulate learners to become active participants in the learning process.

Use of Questions

The inclusion of interactive techniques, such as adjunct questions, in the design of reviews may affect mathemagenic activity by eliciting students' active participation, as defined by a conscious display of overt activity directed toward the fulfillment of an educational goal (Allen, 1957; Pratton & Hales, 1986).

Questions appear to focus learner attention on the salient aspects of a lesson to assist encoding and information processing activities. A study conducted by Michael and Maccoby (1953) investigated the impact of motivation versus practice on learning through active participation. Classes of high-school students were assigned to one of 12 treatment groups and were tested on their knowledge of factual information conveyed by an instructional film. Results showed that the inclusion of questions in the active review yielded significantly higher retention of presented information than did the passive review, which did not incorporate questioning techniques. Additionally, the facilitative effect of participation procedures was attributed primarily to the practice of questioned content and not to the motivational factors assumed to be associated with active review.

Much of the historical research on the use of questions to enhance learner involvement has been conducted using traditionally linear media, such as print, film, videotape, and slide/tape. These studies incorporated interactive questions in the form of supplemental programmed text and provided support for the facilitative effects of questions in improving recall.

Rothkopf (1966) examined the effects of test-like questions on learning from instructional text. University students were divided into treatment groups and were asked to read a textual passage, in which the location of questions and the provision of correct answers were varied. Results indicated that test-like questions presented after the instruction had a facilitative effect on the learning of question-specific content and of content not queried.

This finding is consistent with other research studies which have inserted questions into fixed-pace, fixed-sequence instruction to promote active learning. In their review of the literature, Chu and Schramm (1967) suggested that television or film instruction, coupled with programmed text, improves learning by encouraging students to actively respond to the instruction and by providing feedback to their responses.

A study conducted by Heestand (1979-80) used embedded questions in psychology videotapes to increase active participation on the part of students. Results showed higher scores for the postquestion treatment group than for the control group on measures of intentional learning. Heestand concluded that inserted postquestions can improve learning from videotape programs and other fixed-pace, fixed-sequence media.

If the insertion of questions into fixed-pace, fixed-sequence lessons can facilitate learning, then the introduction of computer-based technologies should provide even greater opportunity for interactive instruction due to their inherent capabilities for processing of responses and for conditional branching (Alessi & Trollip, 1985; Gery, 1987). In fact, embedded postquestions have been found to facilitate learning in computer-based interactive video instruction.

In studying the effects of varied levels of interactivity on recall in computer-based interactive video, Schaffer & Hannafin (1986) embedded content-specific questions in an interactive video lesson and systematically increased the opportunities for feedback and review. Their results showed an increment in the quantity of information learned, but a reduction in the efficiency of learning as compared to instruction using linear video. They concluded that interactivity can be effective in directing learner attention to criterion information and improving recall through the provision of relevant feedback and remediation.

Feedback

Feedback appears to be a significant factor in facilitating recall in studies examining the inclusion of embedded postquestions. Appropriate feedback permits students to verify their understanding of lesson content and clarify erroneous perceptions (Ausubel, 1978). The provision of correct responses is seen to have a positive effect on retention due to the opportunity it presents for covert rehearsal of desired performance (Michael & Maccoby, 1953). It also provides valuable insight to students regarding their progress and competency levels, and allows deeper processing of information by strengthening the associations resident in their cognitive structures (Gery, 1987). Teather and Marchant (1974) found that the insertion of questions with feedback of the correct response was significantly more effective in improving learning than querying students without feedback.

Questions Versus Statements

The incorporation of questions and feedback in lesson reviews has been shown to increase learner involvement and mathemagenic activities by forcing the learner to respond overtly. However, the relative importance of overt activity as compared to covert activity has been examined with mixed results.

In the study by Michael & Maccoby (1953), the differential effects of overt versus covert practice in active review were examined. In the overt condition, students were asked to write down their responses to questions posed verbally by the instructor; in the covert treatment, they were merely instructed to "think" about their responses without verbalization. No significant differences were noted between overt and covert practice on posttest scores, thereby suggesting that it is not how one responds to test questions (i.e. overtly or covertly), it is simply that one responds.

Most of the research supporting the facilitative effects of questions in IVD instruction has focused merely on the presence or absence of questions within the lesson. Studies which have investigated the comparative effectiveness of questions versus statements in lesson reviews have reported inconsistent findings.

Bruning (1968) investigated the effects of criterion-relevant and test-type review on prose learning. The results of the study showed that test-type items, coupled with knowledge of correct responses, have a greater facilitative effect on recall than do declarative statements. This appeared to be true even when test-type items were unrelated to the criterion measure, thereby leading to the conclusion that questioning yielded more active inspection of materials, which in turn resulted in significantly fewer errors on the completion posttest.

Teather and Marchant (1974), on the other hand, did not find superior recall effects for questions over statements. Postgraduate students viewed sections of an educational psychology film and, at appropriate intervals, either read statements or responded to questions which reiterated relevant lesson content. For one group of subjects, feedback was provided in the form of the correct response. The results of their study showed that there were no significant differences between presenting questions and feedback and presenting information as direct statements. These findings are consistent with reported research in computer-based instruction.

Schwier and Misanchuk (1988) examined the effectiveness of covert versus overt strategies and motivation on achievement and learning time using computer-based instruction (CBI). Managers and management students completed a needs assessment questionnaire and were assigned to one of three treatment conditions: CBI with embedded questions and feedback, CBI with content review, or CBI without embedded questions or review frames. The reported findings were contrary to the proposed hypothesis that the incorporation of questioning techniques would result in greater learning than would the use of review summaries. There were no significant differences reported between the treatment and control groups for achievement scores nor for time spent on instruction. It was speculated that learners in the control group may engage in covert activities, in the absence of imposed strategies, and therefore utilize as much time as the treatment groups to cognitively process the lesson content.

The issues of overt versus covert mathemagenic activity and their relationship to learning remain unsolved. The facilitative effects of active learning reported in the literature, which have been attributed to the display of overt behavior, should result in superior learning as compared to covert non-questioning techniques, such as declarative statements. The purpose of this study was to examine the effectiveness of questions and statements in the design of reviews in interactive videodisc instruction.

Facts Versus Procedures

Interactivity has been shown to be effective depending upon the type of information that is taught. Hannafin, Phillips, and Tripp (1986) tested the recall of practiced versus non-practiced lesson information, using multiple-choice questions on facts and applications. Significant effects were reported for the use of questions in improving the learning of factual information.

This finding is consistent with the results of other studies in IVD instruction (Dalton & Hannafin, 1987; Schaffer & Hannafin, 1986). Hannafin and Colamaio (1987) examined the effects of varied lesson control options and embedded questioning on the acquisition of factual and procedural knowledge and the learning of problem-solving skills in graduate and advanced-level undergraduate students. Results indicated that practice facilitated the learning of facts and problem-solving skills, but did not assist the learning of procedures. Chu and Schramm (1967) suggest that questioning techniques may not be necessary for the learning of procedures. Visual images can improve the learning of procedural tasks simply by demonstrating the sequence of steps required to perform the task. Students may covertly rehearse the procedural steps in their minds so that overt practice is not required. The present study examined the differential effects of review strategies on the learning of facts and procedures.

Instructional Time

The issue of instructional time is of additional concern to the instructional designer. Interactive lessons have been found to increase the duration of an instructional session, thereby decreasing their instructional efficiency (Schaffer & Hannafin, 1986). This leads the designer to question the value of interactivity as a teaching variable and results in trade-off decisions between effectiveness and efficiency in selecting the best method of instruction.

Due to the inconsistency of reports on the effectiveness of review statements versus review postquestions, the present study investigated the use of these different review strategies on the recall of facts and procedures and on the amount of time devoted to IVD instruction.

In conducting the study, the following hypotheses were proposed:

1. the active review condition would demonstrate significant facilitative effects for the retention of facts;

2. no significant differences between review strategies would be observed for the learning of procedures; and

3. the use of review would result in a greater amount of time spent in instruction, with the active review group recording significantly higher learning times than that of the passive review group.

CHAPTER 3

Method

Subjects

Thirty undergraduate biochemistry students volunteered to take part in this study. As a prerequisite to their participation, students were asked whether or not they had prior knowledge of the concepts or procedures taught in the lesson. Only those students who were unfamiliar with the lesson content participated in the present study.

Material

Lesson. An interactive videodisc program developed at Concordia University was used in the preparation of treatments for this study. The videodisc was designed to teach the detection and decontamination of radioactive isotopes and comprised the following lesson segments: introduction, direct check method, swipe check method, decontamination procedures, and body decontamination procedures. Due to the large scope of the interactive videodisc program, only the module pertaining to the swipe check method was used in this study. The lesson was designed to teach the swipe check method for assessing low-level radioactive contamination in a laboratory through demonstration and explanation of the tools and steps needed to properly carry out the procedure. The lesson was created within an experimental context, rather than for a classroom application. As a result, the lesson design options that were not manipulated in the conduct of the study were held constant, and norm-referenced tests were used in order to examine differences among treatment groups. In a classroom setting, a mastery learning approach would have been implemented and criterion-referenced posttests would have been administered, given the critical nature of the subject matter.

Treatments

Three versions of the program were developed; two of which included a mandatory review of the lesson content. The reviews differed in their orientation toward passive versus active learning. The treatment versions of the program are described below:

(a) *No Review.* This version of the videodisc program presented the lesson segment on the swipe check method only. Information concerning when to apply the swipe check and the tools and materials required to perform the proocedure were presented using a combination of still images on the video monitor and accompanying textual descriptions on the computer screen. Video demonstration of the procedure in a laboratory setting was then presented with accompanying voice over. As this version did not include a review segment, it served as a control for the study.

(b) *Passive Review.* In addition to the lesson segment provided in the no review condition, this version presented a review of the method application, the required tools and materials, and a step-by-step demonstration of the procedure. The step number was displayed on the computer screen, while the video monitor displayed the freeze-frame image of the start of each step. When the student pressed <Return>, the step was demonstrated without accompanying audio and was then frozen at the start of the next step. A textual description of the demonstrated step was presented on the computer screen.

(c) *Active Review.* This version of the program presented the same lesson segment as the other two versions. It also incorporated a review segment, which was identical to that described in the passive review, but asked students to overtly identify the necessary tools and demonstrated steps, rather than providing a textual description. After the student had input a response, feedback was given in the form of the correct answer displayed above the student's answer for comparison. Feedback responses in the active review condition were worded identically to the textual descriptions provided in the passive review version. All visual prompts and video demonstration segments were identical as well.

Dependent Measures

Recall Posttest. The posttest consisted of three constructed response questions, which were designed to measure students' recall of the main points of the lesson: (a) when to apply swipe check procedures; (b) the required tools and materials; and (c) the sequence of steps necessary to perform the procedure. A sample of the posttest is provided in Appendix A. The first two questions were designed to test the recall of factual information, whereas the last question was intended to measure procedural knowledge. Recall score was assessed by the sum of points awarded through a key word check. The assignment of points was as follows: 2 points for a correct response; 1 point for a partial response; and 0 points for an incorrect response. The maximum possible score for factual recall was 12 points and for procedural recall was 28 points. Detailed scoring instructions and criteria are presented in Appendix B.

Instructional Time. The duration of the instructional session was included as a dependent measure to examine its relationship to the different lesson versions. Instructional time was recorded in minutes.

Procedure

Based on a compiled list of names, in no particular order, students were systematically assigned to one of three treatment groups: (a) no review, (b) passive review, or (c) active review. Two research assistants, who were knowledgeable about the study, telephoned students to arrange individual appointments for lesson viewing. Upon arrival at their designated appointments, students were seated at a desk in front of a computer and a video monitor, and they received a brief introduction to the study and the lesson. They were not told of the true nature of the study; they were informed that the purpose of the study was to evaluate the design of the lesson. Students then viewed the lesson module which corresponded to their assigned treatment group. Treatments were administered individually. The research assistant remained present in the room while students completed the lesson, in order to respond to technical problems or questions, and was instructed not to respond to any questions pertaining to the lesson or to the study itself. At the same time, the research assistant timed the duration of the lesson as viewed by each student and recorded it for further analysis.

Upon completion of the lesson module, the recall posttest was administered to students. At the top of each posttest, the research assistant indicated the number corresponding to the version viewed; i.e., 1 = no review, 2 = passive review, 3 = active review. To minimize potential contamination, students were asked not to discuss the study or lesson with others. Additionally, feedback on their posttest performance was not provided in an effort to discourage possible disclosure of the test responses.

Tests were scored by verifying the presence of key words within the students' responses. Partial or whole points were assigned in accordance with the scoring criteria provided in Appendix B. The correct sequence of steps was mandatory in order to earn points for the procedural subtest; key words which were out of sequence were considered to be incorrect. Tests were scored separately by two independent scorers, who were unaware of treatment group membership, and the mean of the resultant two scores was used in the statistical analysis. Interrater reliability, as assessed using the Pearson Product-Moment Correlation, was found to be .95.

Design and Data Analysis

The study employed a Posttest-Only Control Group design (Campbell & Stanley, 1966), with three levels of lesson review (i.e., no review, passive, and active) as the between-subject variable. Dependent measures included recall scores for facts and for procedures and instructional time. Statistical analyses of the data were performed using Multivariate Analysis of Variance (MANOVA) procedures to examine the main effects and interactions among treatments and the dependent variables. Univariate Analyses of Variance (ANOVA) were used to examine the effects of the treatments on each dependent measure, and cell mean differences were analyzed using the Scheffé multiple comparison test.

CHAPTER 4

Results

A Multivariate Analyses of Variance (MANOVA) was performed on the dependent measures of factual recall, procedural recall, and instructional time.

Recall of Facts and Procedures

The recall posttest was subdivided into items pertaining to factual knowledge and those relating to the recall of steps in the swipe check procedure. These scores, along with recorded instructional times, were analyzed using the Hotellings trace criterion and a significant effect was found (F (4, 50) = 31.99, $p < .01$). Univariate ANOVAs were then performed which yielded significant main effects for procedure scores (F (2, 27) = 3.54, $p < .05$) and for learning times (F (2, 27) = 103.37, $p < .01$). The results of the ANOVA for procedural recall are listed in Table 1. No significant effects were found for the recall of facts (see Table 2).

Table 1

Univariate ANOVA with Procedural Recall as Dependent Measure

Source	*df*	*SS*	*MS*	*F*	*p*
Treatment	2	192.15	96.08	3.54	.04
Error	27	732.73	27.14		

Table 2

Univariate ANOVA with Factual Recall as Dependent Measure

Source	*df*	*SS*	*MS*	*F*	*p*
Treatment	2	14.52	7.26	2.38	.11
Error	27	82.35	3.05		

Comparisons of mean scores for procedural knowledge, using the Scheffé test, revealed significantly higher recall for the passive review treatment as compared to the control group ($p < .05$). No significant differences were noted between the passive and active review treatments, nor between the active review and control conditions. Mean scores for the recall of facts and procedures are provided in Tables 3 and 4, respectively.

Table 3

Means and Standard Deviations (SD) on Recall of Facts

Treatment	*Mean*	*SD*
No Review	7.95	2.24
Passive Review	9.65	1.55
Active Review	8.70	1.32
Total	8.77	1.83

Table 4

Means and Standard Deviations (SD) on Recall of Procedures

Treatment	*Mean*	*SD*
No Review	15.45	6.78
Passive Review	21.60	4.05
Active Review	19.20	4.35
Total	18.75	5.65

Instructional Time

Time, as a dependent measure, revealed significant differences between all groups using the Scheffé procedures ($p < .01$). Students in the active review treatment were found to devote significantly more time to instruction than did students in either the passive or control conditions.

Similarly, the passive review treatment produced significantly higher mean instructional times than did the control group. Mean instructional times are presented in Table 5.

Table 5

Means and Standard Deviations (SD) on Instructional Time (in Minutes)

Treatment	*Mean*	*SD*
No Review	8.80	1.14
Passive Review	19.80	2.86
Active Review	31.60	5.32
Total	20.07	10.07

CHAPTER 5

Discussion

The results of the present study indicate that the passive review was significantly more effective in increasing the recall of procedures than the control group which received no review. There were no significant differences found between passive and active reviews, nor between active review and the control group on measures of recall.

The facilitative effect of the passive review on recall performance is consistent with the literature advocating the inclusion of reviews in instruction (Ausubel, 1965; Bruning, 1968; Gay, 1973; Ho et al., 1986; Kaplan & Simmons, 1974; Rothkopf, 1966, 1968). The use of a passive review may serve to reinforce the associations between items of information presented during the lesson by providing additional practice or repeated exposure to relevant material, thereby resulting in improved recall.

Contrary to the proposed hypotheses, there were no significant differences observed among treatment groups for the recall of factual information. There is considerable empirical evidence to support the effectiveness of interactivity in improving the recall of facts in IVD instruction (Hannafin & Colamaio, 1987; Hannafin & Phillips, 1987; Hannafin, Phillips, & Tripp, 1986; Schaffer & Hannafin, 1986). However, the use of questions in this study did not prove to be superior to either of the other two treatments on the measure of factual recall. The relatively high means and low variability for factual recall scores, as seen in Table 3, suggest a test ceiling effect which would make these results difficult to interpret.

The inconsistent findings of the present study with previous research may pertain to the level of interactivity incorporated into lesson design, the type and location of questions asked, or the construction of the tests themselves. In most studies, interactivity is manipulated by embedding questions throughout a lesson in order to review concepts immediately following their presentation; in the present study, questions were grouped at the end of the lesson in order to provide a summary review. Studies which have compared the use of embedded reviews with summary reviews have reported mixed results. Coldevin (1975) found no significant differences between review statements that were interspersed within a presentation and those that appeared as a summary segment. Other studies, however, have shown superior effects for distributed (or spaced) reviews as compared to summary (or massed) review segments (Maccoby & Sheffield, 1961; Miller & Levine, 1961; Rothkopf, 1968). The difference in relative positioning of questions to the lesson may have had an effect on the results reported in the present study; however, further research would be required.

The finding that active review and control groups did not significantly differ with regard to procedural recall was consistent with the results reported by Hannafin & Colamaio (1987). They suggest that the visual imagery inherent in the use of interactive video has a facilitative effect on the learning of procedures, which has been demonstrated in similar studies using film and videotape (Chu & Schramm, 1967). Visual demonstration of procedures is believed to stimulate mathemagenic activity, in the form of a vicarious rehearsal of the sequence of steps and their consequences. As a result, the use of questioning techniques may not be necessary for the learning of procedural steps.

The design of the study itself may have had an impact on the reported findings. For instance, the number of students assigned to each condition was relatively small. Perhaps with a larger sample, significant treatment effects would have been more apparent.

The failure to detect significant differences between the different review strategies on recall performance is consistent with most of the literature which examined the effects of questions versus statements (Schwier & Misanchuk, 1988; Teather & Marchant, 1974). The active learning implied by overt responding to questions had no apparent effect in improving the recall of facts or procedures.

Although the present study did not examine the effects of learner characteristics, the literature suggests that learner motivation may affect the extent to which students engage in overt and covert mathemagenic activities. Schwier and Misanchuk (1988) noted a significant interaction between perceived need for training and the different review treatments. The use of inserted questions significantly improved achievement scores for students with a high perceived need for training, but these questions had a disadvantageous effect for low-need learners. It is believed that motivated learners may develop individually relevant covert strategies to process instruction, which in turn result in increased learning. Although overt instructional techniques may encourage passive learners to actively attend to stimuli and alter their covert learning strategies, these techniques could potentially inhibit the performance of motivated learners, who develop their own covert approaches to instruction. This is an important issue that should be investigated in subsequent studies.

Salomon (1983) found that the manner in which individuals perceive instruction has a direct impact on the amount of mental effort that is invested in information processing and thus affects the degree to which learning occurs. Students who perceive an instructional medium as "easy" apply insufficient effort in the encoding and processing of lesson content and thereby hamper their recall of the information presented.

Although learners' perceptions of the need for or the ease of instruction were not examined in the present study, they have important instructional design implications and thus merit further investigation with regard to their effect on overt and covert learning strategies.

The lack of observable differences between the active review and control groups on recall measures is believed to reflect a cor rable use of mathemagenic strategies by learners ir ı groups. Schwier and Misanchuk (1988) surmise' tha learners in the control group used covert activities to process information in the absence of instructional prompts, and that these activities were reflected in learning times that were not significantly different from those recorded for students in the review conditions. This explanation for a lack of treatment differences is not applicable to the present study, since significant differences were found between groups regarding the amount of time spent on instruction.

In fact, the only findings which were consistent with the proposed hypotheses related to instructional times. As expected, the control group spent significantly less time learning than did the passive or active review groups. The active review condition yielded the highest learning times of the three groups, which suggests that the time involved in the formulation and input of student responses has a large impact on the amount of time devoted to instruction (Hannafin, 1985). The extent to which increments in instructional time are due to the repetition of lesson information or to the use of covert activities by students is unknown.

Increased learning, at the expense of instructional time, is an important issue if the achievement gains are deemed to be worthwhile. It is not a question of whether repetition is worth the expenditure of additional time, but whether more effective alternative methods can make better use of the time spent on instruction. Overt active participation in instruction does not appear to be the best means toward successful learning, and the time savings associated with a less interactive approach can be applied to other learning situations.

The results of this study suggest that the use of review statements can improve the recall of procedural knowledge in IVD instruction. The differential effects of active and passive review strategies in stimulating or inhibiting mathemagenic activity, however, require further investigation.

CHAPTER 6

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Appendix A

Recall Posttest

The following questions are designed to provide us with information about the program that you have just seen. We would like to find out how much you can recall from the presentation in order to assess whether the material was clear and comprehensible. **Be as precise as possible when answering the questions**. Please don't be concerned about what you cannot remember; it is the presentation and not you which is being evaluated. Thank you for your cooperation.

(1) When is the Swipe Check used?

(2) What tools and materials are needed to perform the Swipe Check?

(3) Describe **step by step** the procedure to carry out the Swipe Test.

Step #   Description

Appendix B

Scoring Instructions

Attached is a list of key words and their associated values. When scoring the tests, look for the presence of these key words in the students' answers and then assign points as indicated. For example, if the student writes, "the swipe check is used to detect radioactivity" in response to question #1, then assign 1 point, since "radioactivity" is a close match to the key word "radioactive". If the student also adds an example of a radioactive isotope (e.g. tritium), then add an additional point.

For question #2, each tool or material listed in the student's answer will earn 1 point. However, the response must match the key words; e.g. if the student mentions "ethanol" without specifying "50% ethanol", then the response is incorrect. There will be no partial points given for this section of the test.

In questions #1 and #3, partial points will be given when the student includes some key words, but omits others. The acceptable key words for partial points are listed directly below those key words that will earn full points.

e.g. wet filter + ethanol ____ 2 points (correct response)

wet + ethanol ____________ 1 point (partial response)

wet + filter _____________ 1 point (partial response)

In this example, the student may write, "wet the filter paper over a beaker", which would earn 1 point. The answer "wet filter paper with ethanol" would earn 2 points.

It is not essential that students break down the procedure in distinct steps, but do ensure that the sequence is correct; e.g. "place the filter paper in forceps" must precede "wet the filter with 50% ethanol". Key words which are out of sequence will be considered incorrect.

Don't be concerned with spelling or grammatical errors (i.e. they are allowed to make these kinds of mistakes). However, do not interpret too much; if you are in doubt, do not consider the words to be correct. There will be instances in which you will have to rely on your own judgement; try to be as accurate as you can.

Total up the points for each question and mark them beside the question number. Then sum these points to arrive at the total test score. The maximum total score for this test is 40 points.

Scoring Checklist

1. When is the swipe check used?

   (maximum is 3 points)

   low level radioactive isotopes ______ 2 points

   radioactive or isotopes ______ 1 point

   mention at least 1 example ______ +1 point

   (e.g., tritium)

2. What tools & materials are needed to perform the swipe check?

   (in any order; maximum score is 9 points)

   filter papers or filters ______ 1 point

   tongs or forceps ______ 1 point

   50% ethanol ______ 1 point

   beaker ______ 1 point

   scintillation vials ______ 1 point

   scintillation fluid ______ 1 point

   waterproof marker or pen ______ 1 point

   scintillation vial racks or vial racks or racks ______ 1 point

   scintillation counter or counter/machine ______ 1 point

3. Describe step by step the procedure to carry out the swipe test.

   (maximum score is 28 points)

   1. filter paper or filter + tongs or forceps ______ 2 points

	filter paper or filter	1 point
2.	wet filter paper + ethanol	2 points
	wet + ethanol	1 point
	wet + filter paper	1 point
3.	background + swipe 100 sq cm	2 points
	area + no contamination + swipe 100 sq cm	2 points
	background + swipe (x) area	1 point
	area + no contamination + swipe (x) area	1 point
4.	filter paper in scintillation vial	2 points
5.	fill at least half + scintillation fluid	2 points
	fill + scintillation fluid	1 point
6.	cap and shake	2 points
7.	mark cap + background code	2 points
	mark cap	1 point
8.	vial + rack	2 points
9.	repeat + contaminated area	2 points
10.	mark cap + area code + scintillation rack	2 points
	mark + rack	1 point
11.	racks + scintillation counter	2 points
	racks + counter/machine	2 points
	counter	1 point
12.	operate counter	2 points
13.	record + log/book + compare	2 points
	record	1 point
	compare	1 point
14.	decontaminate	2 points