The relative effectiveness of embedded versus learner constructed question-answer strategies.

Ashley Murphy

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ABSTRACT

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The Rothkopf question-answer technique was evaluated for its potential to maintain active cognitive processing. As a strategy, it was experimented with in two forms (1) Embedded in prose and (2) applied by the learner. Verbal ability was used as a moderator variable in this transfer of training study to examine possible interaction of the strategy with individual differences. The effectiveness of the manipulation of the Embedded strategy was assessed in a preliminary task against a control group. Transfer of a skill was assessed in an implementation task through comparison of (1) the embedded treatment, (2) a learner-generated question treatment, and (3) a control. Specific facilitation was assessed using test items that were repeated adjunct questions and new items from the same text. Feedback was provided for the criterion test. The results indicate that verbal comprehension accounted for much of the variance, $F(1,92) = 16.90$, $p \leq .0001$; postquestions within text increased learning significantly on the first of two reading tasks, $F(1,92) = 6.19$, $p \leq .015$, there was a statistically significant interaction $F(1,93) = 7.52$, $p \leq .007$ from the direct effect of the strategy, but there was no transfer of training.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

Introduction

"Study aids are assumed to be effective when they assist the learner with the internal processes of learning, resulting in recall of information, and in skilled performance" according to Young (1980).

Context of the Problem

How do adjunct aids help students learn from prose? Encoding processes occur during reading that are controlled by the reader's goal-directed activities and result from interaction with the text (Frase, 1975, p. 3). Further to this, "memory for items is a function of whether they enter subjects goal-directed activites" (p. 14). Therefore, orienting directions and other cues, like questions, influence the reader's purpose and retention.

With this is mind, researchers have investigated experimenter-provided adjunct-aids such as advance organizers (Ausubel, 1960), behavioral objectives (Huck & Long, 1973), the use of inserted questions (Frase, 1968; Rothkopf & Bisbicos, 1967), and mnemonic techniques (Dansereau, 1978).

Answering questions activates prior knowledge in much the same way as advance and concrete organizers or mneumonics. Unlike methods of providing information to ease subsequent learning, instructional objectives and questions

during instruction are "techniques for maintaining active cognitive processing" (Royer & Feldman, 1984, p. 144).

There has been some success with combined strategies. Bernard (1975) for example, got significant results from advance organizer and within-text questioning. The distinctive meaning of concepts and their relevant attributes are presumably provided by the organizers, and within-text questions serve a rehearsal role or elicit a mathemagenic behavior.

Can learner-generated strategies enhance prose processing as well as experimenter-provided aids? Research has also been concerned with the systematic control of learning by learner skills, or metacognitive processes (Wittrock, 1979; Bovy, 1981; Dansereau, 1978).

According to Weinstein (1978) "more successful learners, and those with more years of schooling, use meaningful elaboration strategies in preference to the more rote, or superficial, strategies" (p.53). Yet, with existing text, many teachers will chose "more manageable learner aids and activities" such as underlining or notetaking (Young, 1981, p.67). However, more relevant elaborations tend to effect better retrieval of information, and more elaboration is used by good readers (Reder, 1980).

Understandably, students who have more practice with intellectual skills will develop them more. Although, "it takes longer for students to think their way through a unit

than it does for them to memorize the thinking of others" (Sanders, 1966, p.170). The emphasis has been on higher-level questioning to stimulate thought; (Hunkins, 1969; Sanders, 1966) whereas better designed questions and strategies may be more important, according to Gall et al. (1978).

What is the nature or function of learner strategies for reading? "Many students tend to receive information passively, and consequently do not actively integrate it into their existing cognitive structures" (Dansereau, 1978, p. 8). "Students do not apparently produce multiple memory representations (encodings) of the same material to enhance retrieval" (p. 9).

More active integration of information by readers has been investigated within the context of mathemagenic behavior. Rothkopf's (1966) mathemagenic concept literally means "behaviors that give birth to learning" (p. 288). Learner-generated comprehension-retention techniques have developed out of this research with the use of paraphrase, question-answer, and imagery strategies. Dansereau (1978) found that the techniques have significant effects on recall, but techniques "may be differentially applicable to different types of material" and their effectiveness also depends on individual differences (p. 14).

What is the meaning of Aptitude X Treatment interaction (ATI)? ATI effects result from individual differences in

cognitive style and ability in response to the instructional treatment or curriculum. These must compensate for differences enough to facilitate learning (Wittrock, 1979).

Instruction depends on the learner's constructive activities to link previous knowledge with the meaning of the learning material; "comprehension occurs when the learners use their semantic processes to construct meaning for stimuli by relating them to abstract and distinct memories" (Wittrock, 1979, p. 9).

Assuming that there is a relation between the instructional method and the task-relevant aptitude of the learner, the appropriate processing strategy may be embedded or applied by the learner (Bovy, 1981). For example, learner-generated underlining of sentences has proved more facilitative than experimenter-underlining (Richards & August, 1975), as has learner-generated summary sentence production (Doctorow, Wittrock & Marks, 1978). "Self-generated questions may be among the most potent orienting tasks", because learners search for answers they want to know (Rigney, 1978, p. 199).

However, Cronback & Snow (1977) say that when organization and interpretation depends on learners lacking the ability to process information efficiently, they "tend to be handicapped" (Bovy, 1981, p. 206). Therefore, the choice of learning strategies differs to the extent that the instructional method assumes the necessary processing or the

learner is able to process the material.

As continual reliance on embedded treatments may become debilitating, Bovy supports a formative attitude to the development of learner skills.

Why has cognitive theory moved away from reinforcement theory to a learner responsibility for learning? Bruner, Goodnow & Austin (1956) discovered that learners differed in strategies of information processing which in turn modifies the effectiveness of reinforcement.

Witkin et al. (1977) specifically identified styles by a field-independent construct; field-dependence is a global cognitive style as opposed to an analytical or reflective field-independent style. Field-independents operate with self-definition of goals, intrinsic motivation, and self-reinforcement. Whereas field-dependents respond more to external reinforcement, externally set forth goals and do not appreciate criticism (Wittrock, 1979).

This knowledge is important to instructional design. An inductively organized course can be more useful for holistic (global) processing, while a deductive curriculum can be better for a deductive (analytical) style (Wittrock, 1979). Yet, there is a failure to analyze the impact of instructional treatments on individual learner's cognitive style, "a given method may exert different effects with different learners and thus be lacking in construct validity" (Bovy, 1981, p. 204).

Is there an interaction between individual abilities and an adjunct question strategy? The bright are more likely to have a set for transfer, simply because they demonstrate more transfer, (Ellis, 1971) since a failure to remember can impede transfer of learning (Deighton, 1971), to the extent that comprehension-retention techniques compensate for individual differences in memory, they are facilitative.

Pierce (1973) found highly significant differences between ability groups using adjunct questions based on the Lorge-Thorndike Intelligence Test; high and average children performed better. High ability students perform yet better. Based on the Watson-Glaser Critical Thinking appraisal, there are no significant differences between problem-solving ability groups and the task demands of a self-generated question strategy (Jay, 1981). From Farley and Gordon's (1980, p. 47) description of field-independence, (i.e., "ability to analyze experiences and structure them in new ways"), a self-generated question strategy seems appropriate. Whereas the externally imposed strategy of embedded questions tends to match the field-dependent learner's style. But no study has been done.

Neither dimension of the field-dependent/independent construct is higher in verbal ability (Wittrock, 1979). Where verbal ability is concerned, memory varies with "the semantic context that the reader brings to bear on the

reading material" (Frase, 1975, p. 4). As, an individual's ability to process prose is limited by reading deficiencies, learning from adjunct questions is also limited. There have been significant differences on both immediate and delayed recall due to verbal ability (Anderson & Biddle, 1975). Although, answering verbatim questions was not influenced by verbal ability, "on paraphrase questions, performance fell off sharply as ability declined" (p. 122).

Innovations in the use of questions strategies can be carried out by measurement of process-oriented individual differences, transfer, and understanding.

Statement of the problem

The main purpose of this study was to evaluate the adjunct question strategy for a possible interaction with cognitive style and verbal ability. This aspect was not made clear by the literature.

Another aspect needing clarification was the mathemagenic hypothesis underlying the embedded question strategy. Experimental studies of the effects of this strategy can result in positive and negative learning outcomes (Frase, 1975). Rothkopf's (1966) procedure to test for incidental and relevant learning can be used to pinpoint outcomes (Royer & Feldman, 1984).

Form of question, was yet another aspect of the problem requiring experimentation, as different facilitating effects exist between recall and recognition questions. While

experimental questions have mainly been Cloze items, questions requiring comprehension promote deeper processing, therefore more learning and remembering. Similarly, a constructed response mode is more conducive to acquiring higher order application skills because "this mode will contribute to the necessary deeper level (semantic) processing (Young, 1981, p.65).

To encourage higher-level processing, experimenters have used paraphrased questions. But this has not emphasized learner skills of interpreting (paraphrasing) information while responding or producing questions.

Because the tendency is to give the learner responsibity for learning, the main aspect requiring study is in relation to transfer of training. An information processing skill may be acquired from practice with the adjunct question-answer strategy. Although one exposure task may not be enough to change learners' study habits, as in formative evaluation, tests for transfer can be carried out in an implementation context or second task.

CHAPTER 2

Literature Review

Related research

What is mathemagenic behavior? Firstly, the learner's actions play an important role in determining what is learned (Rothkopf, 1970). Secondly, the research in mathemagenics focuses on instructionally relevant processes of "inspection behavior" (Rothkopf, 1971, p. 288) that influence the achievement of instructional objectives. In Rothkopf's (1971) behavioristic account, mathemagenic behavior is considered a habit system that is altered by environment events like adjunct questions in reading.

What is the role of questions for mathemagenic behavior? Frase (1975) says that Rothkopf uses questions as an effective stimulus control for prose processing. The effects of questions have been investigated as to spacing (Frase, 1967), the shaping of learning activities over time (Morasky & Wilcox, 1970; Rothkopf & Bisbicos, 1967), and the different effects from positioning (Rothkopf, 1965).

Studies by Bruning (1968), Frase (1967), Rothkopf (1966), and Rothkopf and Bisbicos (1967) have consistently found that inserting questions shortly after relevant text segments affect text inspection by prompting a search pattern for information (Rothkopf, 1970).

Does textual information processing increase because

of adjunct questions ? Rothkopf's research has demonstrated that inserted questions in text increase active processing of information. If questions are inserted after a passage, more information is remembered, because the entire passage is attended to more carefully (Royer & Feldman, 1984).

How does question position affect learning? The position of questions has two effects on learning: (1) a direct instructional effect based on rehearsal or the law of exercise,[1] and (2) a mathemagenic (indirect) effect that is presumably the role of the law of effect.[2] Of course, a direct instructive effect is produced regardless of the position of questions (before or after relevant text) because it depends on the information value of questions (Rothkopf, (1972). While learning from mathemagenic activity is only produced by post-questions that follow relevant text material (Rothkopf, 1966; Rothkopf & Bloom, 1970).

Although inspection behavior declines when it does not result in learning required to answer questions, learning of several kinds of text content is facilitated by post questions (Rothkopf & Bisbicos, 1967). Conversely, questions asked before relevant text passages interfere with retention of information incidental to answers (Frase, 1975).

To summarize: When adjunct questions are inserted after relevant text passages (interspersed), they are called intentional questions and are repeated on the criterion test. New test items are incidental or irrelevant items.

Effects are either direct as measured by repeated test items or indirect, as measured by new test items. Rothkopf (1966) illustrates both (Anderson and Biddle, 1975).

What is the nature of the specific effects of adjunct questions? The nature of adjunct questions influences the nature of the knowledge acquired. If adjunct questions deal with quantitative items, test recall is of quantitative items (Rothkopf & Bisbicos, 1967). This concept of specific facilitation is based on earlier work by Postman & Senders (1946) who discovered that directions to learn specific classes of information enhanced learning (Rothkopf, 1970).

One account of the specific effects is that adjunct questions provoke mental review and further cognitive processing of text information (Anderson & Biddle, 1975). Quellmalz (1967) provides a rigorous test of selective facilitation from adjunct questions; subjects performed better on new name items for the section about which they had been asked name questions and better on new application items for the section about which they had been asked application questions.

To summarize: "both direct effects, in which the group that receives adjunct questions outperforms the reading-only control group on repeated criterion test items, and indirect effects, in which the questioned group does better than the control on new test items, have been found "(Anderson & Biddle, 1975, p. 91).

How do questions affect more generalized learning? Semantic encoding of information contributes to the direct and indirect effects of questioning; "searching one's memory to answer a question strengthens or makes more available a system of semantically-related memory features broader than the memory requirements for the original questions (Rothkopf & Billington, 1974, p.669).

Because the direct effects of questions after relevant passages are four times their indirect effects, Anderson & Biddle (1975) recommend asking questions during instruction about each point to be mastered rather than relying on the indirect consequences of questions.

Overall, students do better on repeated than new criterion test items and post-questions are more facilitative than pre-questions. In addition, post-questions have a positive effect on new items; "being questioned about a narrow topic while reading enhances the recall of other material closely related to that topic" (Rothkopf & Billington, 1974, p.678).

What accounts for the incidental learning associated with mathemagenic behavior ? Rothkopf & Billington (1974) maintain not enough evidence for a priming effect (i.e.,performance improves because a question topically related to the test item is recently asked). But there is evidence supporting an indirect review hypothesis (i.e., answering a question facilitates the retention of other

topically related information).

The conclusion is that "indirect review produced elevation in incidental knowledge" (p. 678). Although the effect may be due to students looking back at relevant text passages.

Does prose processing increase because of adjunct questions? An inserted question strategy does not increase the rate, but the effectiveness of verbal information processing skill (Frase, 1975). Rothkopf & Bloom's (1970) study is a case in point. The results indicate that inspection rates for pages preceding experimental questions are consistently greater than average inspection rates for pages following questions.

Does the structural character of the text affect the use of adjunct questions ? Texts may be equivalent in content, but differ in structure and style and, therefore, readability. When time is controlled, word familiarity affects short and long term memory, and easier versions are inspected faster than more difficult ones,(Klare et al, 1959) . Conversely, if inspection time is not controlled, readers tend to adapt to text difficulty in a way that neutralizes structural variables like sentence complexity (Rothkopf, 1972).

While adjunct questions tend to produce longer average inspection times, there are "small positive correlations" between average reader rates and criterion test performance.

"The changes in processing which this moderation reflects apparently results in more effective harvesting of information" (Rothkopf, 1972, p. 330).

To be precise, Haimowitz's (1972) replication of Rothkopf's (1965, 1966) experiments showed that retention scores were depressed for reading speeds faster than 275 words-per-minute and post-questions had a generalized facilitative effect at lower speeds (175 words-per-minute).

Readability measures of prose are derived from a Reading Ease Index; Flesch (1948) calculated this from the number of syllables per 100-words (wl), and the average number of words per sentence (sl) in a word sample of text, RE = 207.835 - .946 wl - 1.015 sl. There are also computerized reading ease indices (Coke & Rothkopf, 1970).

How often should adjunct questions be used in a text passage? The timing of questions varies: Anderson & Biddle (1975) recommend frequent questioning; while, Frase (1967) found that adjunct questions used after two paragraphs resulted in better performances than after one or four paragraphs; Watts & Anderson (1971) used a question after each of five 450-word passages successfully; Rothkopf & Bloom (1970) and Rothkopf (1970) used questions every six pages of a 100-page passage; Rothkopf (1966) used two questions after every two or three pages of a 20-page (5,200-word) text, and Boyd (1973) inserted questions every five paragraphs. It has been concluded that performance

declines in relation to the number of intervening pages (Eischens, Gaite, & Kumar, 1972).

Timing of adjunct questions may also vary with the level; Gulkus (1976) used one application and one knowledge level question at an average of every twelve sentences for example.

In general, the trend in question timing favors frequent questioning (Anderson & Biddle, 1975). Even when they are batched after long passages, questions are facilitative (Anderson & Myrow, 1971). The amount of information intervening between questions is one important factor, contiguity is the other.

The closer the questions to relevant information, the better the performance on repeated test items will be. The physical proximity of relevant text and post questions affects retention because learners search text for relevant information and select information that maintains connectedness (Frase, 1970).

"Presumably, when adjunct questions are inserted a few at a time after short segments of text, the direct effect of questions is a confluence of the mathemagenic process ... and the hypothesized review process" (Anderson & Biddle, 1975, p. 110).

Does the mode of question affect the use of adjunct questions? In addition to other intervening variables, the average proportion by which questioned groups exceed

reading-only control groups on criterion tests is affected by the Mode of adjunct questions.

Based on a box score review, short-answer (recall) questions are more facilitative than multiple-choice (recognition) questions for repeated and new items (Anderson & Biddle, 1975). Taking an initial short-answer test has more effect on a delayed short-answer text than multiple-choice questions (Roderick & Anderson, 1968) and have a greater influence on new test items (Anderson & Biddle, 1975).

Recall and recognition response forms may "make different processing demands when inserted in text, thereby differentially affecting study activities" (Anderson & Biddle, 1975, p. 98). Yet, several studies have not found significant differences in adjunct-question response form (Williams, 1963; Frase, 1968a; Sanders, 1970).

Anderson & Biddle (1975) suggest that because adjunct questions act on information retrievability, it is the criterion response form that is important. For this reason, Felker's (1974) sought synergistic effects by using problem-solving criterion test items. Otherwise, most studies use an adjunct question mode that parallels the test item mode.

What is meant by Rothkopf's existential proof of mathemagenic behavior? Mathemagenic behavior is demonstrated by using two sets of questions; (1) adjunct questions that concern themselves with the same general

topic as criterion test questions and are chosen equally from all sections of the same passage and (2) criterion questions that are unrelated to the specific matter from which the adjunct questions are composed. Hypothetically, there should be no transfer of training from the adjunct questions (set 1) and criterion test questions (set 2). If criterion test performance changes because of the use of adjunct questions, then the modification may be due to mathemagenic activity (Rothkopf, 1972).

"We do not need another demonstration that questions work. Surely, serious application of questioning techniques in the real world of instruction will require knowing why they work and under what conditions" (Anderson & Biddle, 1975, p.108).

First, students' activities tend to adapt to questions, thus questions become effective aids if they are representative of the criterion test. Second, adjunct questions provide an indirect review; that is, questions placed after a passage cause a person to review the material (Frase, 1967). Some form of mental review is implied by better performance on criterion test items exactly like adjunct questions (McGaw & Grúteleuschen, 1972). This question/information relationship may be "spatio-temporal contiguity or topical-semantical similarity" (Anderson & Biddle, 1975, p. 109), whereas the direct effects may be a due to a processing phenomenon or repetition (Young, 1981).

Various strategies have been developed to maximize learning for recall; the emphasis has been on orienting directions or verbal cues that cause the learner to respond to the stimuli prose text (Glynn, 1978). According to Rothkopf (1971) "the practical trick is to formulate a search objective (i.e., appropriate directions to initiate the search activities) that will maximize the translation of sentences relevant to the instructional objectives" (p. 301).

The congruency between instructional objectives and questions in terms of cognitive level and value is an important element (Lewis, 1976). This is exemplified in a study by Young (1981) who found no observable difference when students were provided objectives alone or objectives phrased as adjunct questions. Similarly, studies (Frase, 1970; Rothkopf & Kaplan, 1972) using questions or learning objectives with a text improve recall of information related to those adjunct aids (Frase & Schwartz, 1975).

What processes, other than review, account for learning from adjunct questions? Inspection behavior can be controlled by typographical cueing, such as underlining and color, because these stimulus prompts attract attention to the printed text (Rothkopf, 1971). Denzel (1972) too, saw the function of inserted questions as that of providing attention-directing cues. Young (1981) attempted to use an integrated strategy with color coding for selecting

portions of text related to the enabling and terminal objectives of a chapter-learning hierarchy phrased as adjunct questions. The system did not result in observable differences on test performance. Students rated adjunct questions as the most helpful and color-coded underlining as the least effective.

What is the basis for Rothkopf's research? The research began with an analysis of frame formats in programmed instruction (Rothkopf, 1963b) and focused on the attention-like phenomena of learning from prose (Rothkopf, 1962, 1963a; Rothkopf & Coke, 1963, 1966). He presumed that what the student does with the instructional material is as important as the material itself (Rothkopf, 1970). As such, discrepancies in learning result from two sources: (1) characteristics of the stimuli, and (2) learning activites by students to transform or elaborate the stimuli.

Rothkopf (1970) also based his question theory on a prolonged reading study (Carmichael & Dearborn,1947) in which regressive eye movement was delayed by adjunct questions during 4-6 hours of reading.

What other influences besides an attention-directing cue, can adjunct questions have? Learning behavior for reading includes encoding processes[4] that are controlled by goal-directedness[5] (Frase, 1975, p. 43). Goals can be shaped by orienting directions[6] that constrain the reader's search such that material is relevant or incidental to the

goal. Therefore, learning outcomes can be controlled by stimuli constraints on reading processes.

Aids for prose learning are directed at increasing recall (Frase, 1975). The assumption is that "memory for items is a function of whether they enter into subjects meaningful goal-directed activities" (Frase, 1975, p. 14). That is, items entering working memory with a purpose are better retained.

Frase and Kammann (1974) confirm that a specific search leads to more recall because "thinking about certain characteristics of an object may entail the detection of other salient characteristics, and that this elaborative process can affect the status of that object in memory" (p. 184).

Similarly, criterion for a search (e.g., questions) involve differences in processing that affect the depth of semantic encoding (Frase, 1975). "Recall differences are due to some input rather than a retrieval phenomenon" (Frase & Kammann, 1974, p. 184).

Frase's (1975) model of reading describes the encoding of items according to goal-relevance that is controlled by orienting directions and other cues. If directions are represented in memory, they influence the reader's "goal orientation" (Frase, 1975, p. 6). Unless there are directions, goals are determined by memory (Frase, 1975).

Frase's model has three components: (1) The stimulus

environment (text), (2) What readers do (performance), and (3) The categories of memory events entailed.

Do adjunct questions affect the range of learning from prose? Specific descriptions of learning goals have produced higher recall of goal-relevant items (Kaplan & Rothkopf, 1974; Rothkopf & Kaplan, 1972). The effects have been attributed to intention (Postman, 1964) and selective attention or stimulus processing (Frase, 1975). For example, Cariello (1980) found mastery students learned more of the specific objectives covered on the mastery tests. In addition, controlling attentional processes by questions can produce general learning effects (i.e., acquisition of information other than that specifically required to answer adjunct questions (Rothkopf, 1972).

Activities can be imposed during reading that influence that range and form of the reader's internal representation of the text (Frase, 1975).

Are there other factors that account for the facilitating effects of adjunct questions? "Neither the total length of the text, the topic, the age of subject, nor the medium of presentation text, taped lecture, film) seem to matter much", according to Anderson & Biddle (1975, p. 103).

How has the nature and function of adjunct question activity been conceptualized? A model of text recall to describe the effect of specific descriptions of

instructional goals and verbal learning is, p = f(E,m). Performance on a test is a function (f) of prior experience (E) and mathemagenics (m) (Rothkopf & Billington, 1974).

Another model by Anderson and Biddle (1975), P(D) = k + (1 - k)rt, suggests that the probability of correct responses on delayed tests, P(D), equals the proportion of prior-knowledge, and new information from the passage, k, plus a question increment from items not known (1-k), but that questions cause a learner to retrieve, r, from short-term memory and transfer, t, to long-term, memory (p. 115).

What processes facilitate verbal learning? In general, processes that enhance semantic encoding facilitate learning prose (Anderson & Biddle, 1975). The forms of processes were analyzed by Rothkopf (1970) into three classes of mathemagenics[7]: (1) Translation, - semantic decoding for internal representation; (2) Segmentation, - bridging of terms and interpretation, and (3) Processing, - inter-sentence interpretation and review (Rothkopf, 1970, p. 329). Recall is not limited to information required to answer the question (Rothkopf, 1972).

If adjunct questions merely identify important material or cause review, can review statements be as effective as a question? Bruning (1968) found that questions produced significantly better criterion test results than statements, therefore, the interrogative form is partly responsible for the positive effects (Anderson & Biddle, 1975).

Also important is the focusing provided by questions. For example, Morasky (1972) observed more fixations and regressions per paragraph on the part of subjects who received questions after paragraphs (Anderson & Biddle, 1975). "When subjects anticipate detailed or inferential questions after reading, reading rate is slowed" (McConkie, Rayner, & Wilson, 1973).

Of course learning activites can be supported by text characteristics other than questions; propositions may be repeated in text and related information grouped. Use of these strategies might compensate for prose processing deficiencies (Frase, 1975). For example, Johnson (1967) found that the occurrence of subject matter words as responses on an association test was related to the frequency with which the words appeared in the text. Nonetheless, the real processing needs of students go beyond the paired-association tasks (Rothkopf, 1972) of research situations. Students need to read lengthy passages in journal articles, books, and so forth.

Is the type of response mode an important factor when using adjunct question? For Holland and Skinner's (1961) material, the time spent writing answers to questions is 40 percent of total learning time (Campbell, 1971). But there are few guidelines.

Both "the direct and indirect effects of adjunct questions are more consistent when the subject must make an

overt response" (Anderson & Biddle, 1975). For example, Michael and Maccoby (1961) interrupted a 14-minute film for three adjunct question sessions: mean proportions of correct responses on repeated test items were, .53 for controls; .66 for subjects who mentally composed answers, and .70 for those who wrote answers.

Even having a person answer questions orally increases incentive to study carefully and is more effective than simply reading adjunct questions (Rothkopf, 1972; Rothkopf & Bloom, 1970).

Is feedback a significant variable in the use of adjunct questions? Even though feedback is not provided in over two-thirds of adjunct question studies, it does enhance performance on repeated test items (Anderson & Biddle, 1975). Subjects provided feedback did better on repeated items, but worse on new items (Frase, 1967; Michael & Maccoby, 1961; Rothkopf, 1966). Even when feedback is not available, the direct effects on repeated test items can be substantial (Spitzer, 1939; McGaw & Grutelueschen, 1972).

Rothkopf (1966) acknowledges that feedback is important because it modifies mathemagenics. However, when students receive knowledge of results through exposure to text passages, it cancels out the difference between feedback and no feedback results according to Gulkus (1976). He found that feedback facilitated knowledge level questions only.

Is Operant theory useful in analyzing the conditions

that increase or decrease response to questions? Although there is no identifiable reinforcer shaping inspection behavior due to adjunct questions, when feedback is provided, knowledge of answering correctly may be self-reinforcing, even though it would have little effect on new test items. Using a monetary token-reward system for criterion test response created differences between groups as a function of the amount of incentive (Frase et al, 1970).

What is the relationship between the level of adjunct question and learning? There is little attempt made to deal with the hierarchy of abstractions of mental operations in the use of adjunct questions. The typical adjunct question is a Cloze type question using a verbatim text sentence (Anderson & Biddle, 1975). Rather than relying on these memory level questions, questions requiring comprehension should promote deeper processing, more learning and remembering (Anderson & Biddle, 1975).

When performance with verbatim questions[8] is better than with paraphrased questions[9], the results are not due to rote learning, but because "information in temporary memory is phonologically coded, making it accessible to a verbatim question but relatively inaccessible to a paraphrased one" (p. 120). A verbatim-paraphrased combination of questions yielded better results. Presumably, a verbatim question allows retrieval from

temporary memory, once retrieved, a paraphrase question causes transfer to long-term (semantic) memory (Anderson & Biddle, 1975).

Comprehension questions alone are facilitative: Felker (1974) found comprehension multiple-choice questions better than verbatim questions. Most of the research has been limited to information-type questions, as opposed to higher level functioning questions. However, it is more important that adjunct questions are consistent with test items and performance objectives (Young, 1981).

Higher-level questions help students evaluate and understand low-level facts (Hunkins, 1969). This does not imply disuse of the memory-level question. Low-level operations are a part of every kind of thinking (Bloom, 1956). But there should be more concern with students understanding concepts, not just memorizing facts (Sanders, 1966). High-level questions can measure the amount of transfer to novel contexts (Royer & Feldman, 1984).

Importance of the problem

One instructional problem for students in a changing world is to provide transfer of training by practice of knowledge and skills with wide application. Another problem is the efficiency of learning, especially prose processing.

The determinants of processing efficiency are not restricted to text features, but include various environmental factors that act on the reader. These factors

are the dispositions of attention, learning-to-learn, and set (Rothkopf, 1972).

An attentional model of question effects may alone account for their facilitation of text learning (Goldberg, 1980). If only attentional processes are desired, these can be manipulated by techniques other than questions to maintain active cognitive processing. But Rothkopf (1970) suggests that psycholinguistics and verbal learning research is overly concerned with structural variables of the text; important questions about learning from prose should focus on the control of processing activities. Likewise, there is little emphasis on the interaction of cognitive style and ability with different processing aids.

What is the transfer[11] value of adjunct questions? Cognitive theorists emphasize higher-level questions because of their transfer value to new situations. Only specific factual information is acquired from low-level questions (Royer & Feldman, 1984). Memorization questions produce more intentional than incidental learning, whereas application level questions facilitate both (Cariello,1980).

Studying new example questions may be a meaningful way to acquire concepts because they provide remedial loops that enlarge and stabilize knowledge and skills (Rothkopf, 1971).

What are the characteristics of transfer from adjunct questions? First, a failure to remember is "the failure of transfer of training between the learning situation and the circumstances under which remembering is to take place"

(Deighton, 1971, p.256). In this sense, neither Rothkopf (1966) nor Rothkopf and Bisbicos (1967) found any transfer effects from inserted questions to new test items, but the effects may still be due to transfer. No other studies have used control groups to check for it (Anderson & Biddle, 1975).

Second, where transfer of training of a skill is concerned, "work-study skills similar to strategies can be taught for information-securing and information processing" (Ebel, 1969, p. 1489). For example, studies by Ross (1971) and Borkowski and Kamfonik (1973) not only successfully used embedded questions strategies with educable mentally retarded (EMR) children, but taught them to create and use their own aids.

Conversely, Sanders (1970) did not find adjunct questions produced a skill that was acquired during the task. The possibility exists that both transfer of knowledge and transfer of a skill for information processing are facilitated by adjunct questions.

While training teachers to use questions is important, students can learn to ask questions that will improve their comprehension. In fact, Ross and Kilby (1977) found children remembered responses to their own questions better than similar ones by their peers (Orlich et al., 1980).

What instructional innovation can adjunct questions provide? Richardson (1978) says that "new, and often

effective strategies consist of teaching persons actively to self-direct and self-manage their own processes" (p. 59). Singer (1975) suggests that self-learning techniques can be a major objective of any instructional program. Reading methods such as Thomas & Robinson's (1972) PQ4R encorporate self-generated information seeking question strategies to create a problem-solving situation and thus enhance comprehension and retention (Frase, 1975). Even so, subjects' self-generated questions rarely go beyond the text information (Frase, 1975).

Is producing, or answering questions more facilitative? Rigney (1978) maintains learning strategies that compensate for, or optimize, a particular characteristic, must be embedded in and presented through the material. Experimental results have indicated that embedded questions are more facilitative than subject-generated ones (Morse, 1975). But Frase (1975) reported that groups producing or answering questions scored higher than groups only studying the text, $F(2,84) = 7.19$, $p<.01$, and did not differ significantly from each other (p. 39). Frase and Schwartz's (1975) exploration of the question-answer strategy found students spent twice as long on a passsage when they engaged in questioning or answering than when they studied on their own, a 14-percent increase in learning. But students were unable to produce questions that targeted difficult posttest items. Instructions to construct difficult questions

yielded better results (Frase, 1975).

The first part of this study will attempt to direct the learners' cognitive processing with a question-answer strategy. The second part of the study will provide the learner with the opportunity to develop the processing techniques for themselves by generating their own questions. Will producing or answering a question "differentially facilitate the learning of information that is incidental to the questions that the subjects generate", or will subjects questions have a mainly direct effect? (Frase, 1975,p.37).

How is transfer demonstrated empirically? In Deighton (1971) the amount of transfer is the difference between an experimental group who learns Task A then Task B and a control group that only learns Task B:

$$\text{Percentage of transfer} = \frac{TBe - TBc}{TBc} \times 100$$

The determinants of transfer are task similarity (Ellis, 1967); variety (Harlow, 1949); and meaningfulness (Ausubel, 1963).

Hypotheses

The first part of this experiment was designed to evaluate the effect of an Embedded question strategy on learning from a prose passage and the direction of the postulated facilitative effect. Also of interest, was the ability of task aptitude (i.e., verbal comprehension and learner style) to predict success at the task.

The second part of the experiment was aimed at

comparing both a learner-generated versus Embedded question strategy against a Control. The following alternative hypotheses were formulated for alpha $\leq$ .05.

Task A

H1: The Embedded question strategy will have an enhancing effect on the range of material learned.

H2: There will be a significant difference between groups due to the Embedded question strategy on the relevant-irrelevant question dimension.

H3: Task aptitude (Verbal comprehension) will predict more of the variance than Learner style (Field-independence/dependence).

Task B

H4: Embedded and learner constructed question-answer strategies will increase learning significantly as compared to a control group.

H5: There will be a significant difference in performance on the relevant-irrelevant question dimension due to question-answer strategies.

H6: The group with previous exposure to the embedded strategy will demonstrate transfer of training.

Rationale for Hypotheses

In order to maximize learning from prose, a question-answer strategy should emphasize answering or producing a question because of the memory events entailed (Frase, 1975); recall differences do not depend on retrieval, but on

some input (Frase & Kammann, 1979). For this reason, learner-generated strategies like paraphrasing, imagery, and question answer have been successful (Dansereau, 1978).

Activites that transform or elaborate stimuli are important to learning and recall. For example, "making up questions involves rehearsal of information in the sense that it must be maintained in memory for longer periods of time" (Frase, 1975, p. 5). Using this paradigm, a constructed response should be the optimal response mode.

Questions are better than statements because they are more elaborative and instigate a specific search; in short, questions require answers. Even having a person answer questions orally is more effective than only reading them (Rothkopf, 1972).

The facilitation of questions for prose processing is effective: First, questions inserted after relevant text passages serve an attentional role, like underlining. Second, because subjects do better on repeated items, questions serve a hypothetical review role. Third, Rothkopf (1971) suggests that by instigating a search objective, questions influence goal-directed activities, like objectives, and makes processing efficient. Fourth, questions enhance the persistence of study activities which is important during lengthy readings (Rothkopf, 1968).

But do questions instigate active integration of information with prior knowledge? Learners must use their

semantic processes to construct meaning (Wittrock, 1979). Yet, much of the research relies on the experimenter to provide the required processing. For example, the learners are provided paraphrased questions (Anderson & Biddle, 1975), but no mention is made as to whether the learner can provide a paraphrased answer to a question.

Students may become reliant on embedded strategies (Bovy, 1981), so there should be more concern with learner activity.

Learner performance varies between and within the use of prose processing strategies; strategies may be embedded or applied by the learner, dependent upon individual differences in processing skills.

When embedded, post-adjunct questions are relatively free from variations due to motivation level and beneficial when motivation is low (Frase, 1970).

The effect of adjunct questions also depends on reinforcement (Rothkopf, 1972). The field-dependent/independent measure, not only describes, the global versus analytical style but differences in motivation and reinforcement (Wittrock, 1979). It seems appropriate to use this construct given the two intervening variables, motivation and reinforcement, to test for interaction with question strategies. Because the subjects are all education students (Arts), they may constitute a homogeneous group in this dimension, so verbal ability will be assessed

as well.

Neither end of the field-dependent/independent dimension is higher in verbal ability (Wittrock,1979). In addition, Anderson and Biddle (1975) found significant differences on both immediate and delayed recall due to verbal ability.

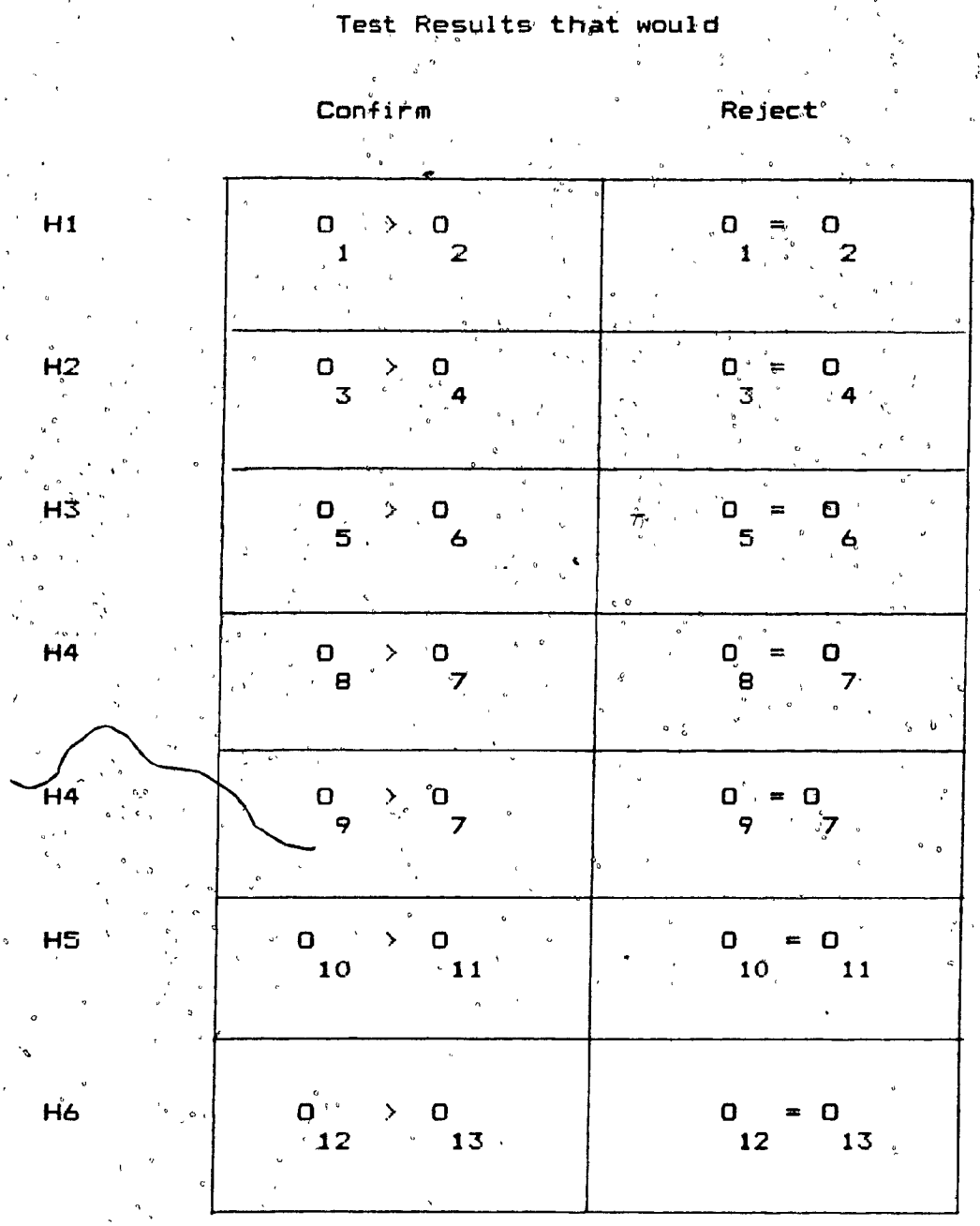

Figure 1. Decision matrix for hypotheses for Tasks A and B where O_n refers to the mean score on the particular test (cf. figure 2).

CHAPTER 3

Method

Sample

One hundred and two undergraduate Concordia University students enrolled in Education courses were used as subjects.

Materials

The stimuli for Task A consisted of a 1,801-word (7-page) text passage about Biofeedback technology (Mulholland, 1973). Half the text packages had Embedded questions; that is, 6 short-answer (recall) questions inserted after relevant material.

All packages for Task A also included a Comprehension test, Part II of the Nelson-Denny Reading test (1973).

All packages for Task A included a 12 item constructed response (short-answer) criterion test; 6 items were repeated adjunct questions and 6 concerned information incidental to adjunct questions. All items were taken from the passage.

The stimuli for Task B consisted of a 2,250-word (9-page) text passage on Intrinsic and Extrinsic learning (Maslow, 1968), with covering instructions appropriate to each of the three different strategies, and a 14-item short-answer question test.

Covering instructions

Task A: The highlight/notetaking group (Control) group were asked to study the material and told they will be tested on it later.

The Embedded question group were asked to respond in writing (in their own words) to the questions as they came upon them in the text. They were told not to wait until the end to answer.

Task B: The Implicit, Control group (Y1) were given instructions to study the material using the strategies they usually do in this situation (i.e., Highlighting and notetaking tactics were suggested).

The first Explicit condition (self-generated question) group (Y2) were given instructions to construct questions that they would normally be expected to know on a posttest (Frase, 1975).

The second Explicit group (Y3) were provided Embedded questions. As in the preliminary task, this group were asked to provide written answers.

Design

For Task A, a one-way design was used that was composed of two conditions, (1) Exposure, and (2) No exposure. The dependent variable (14-item criterion test) was for four observations O_1, O_2, O_3, and O_4.

The observations for Verbal Comprehension O_5 and for Field-independence O_6 were derived separately.

For Task B, a 2 X 3 factorial design was used with three separate treatments along the first independent variable Y consisting of (Y1) an Implicit, No prompt or Contol treatment , and (Y2) an Implicit, with prompt treatment, in which students generate questions. The Explicit, embedded question strategy, (Y3) was the same as for Task A.

The second independent variable X was composed of two conditions; (X1) subjects who were previously exposed to the Explicit embedded strategy, and (X2) those who were not. Observations concerning transfer of training were obtained from this aspect of the design; that is, O_{12} and O_{13}.

The dependent variable was a posttest using repeated (adjunct questions) and including as many new questions. This measure was used for the following observations on effect of the question strategies, and the relevant-irrelevant dimension: O_7, O_8, O_9, O_{10}, and O_{11}.

Procedure

The main purpose of this study was to investigate the effect of the Embedded question strategy in relation to task aptitude, the direction of facilitation of post-questions, and the possibility of training of transfer.

Task A

In the first part of this transfer study, previously randomized material was used to assign subjects to one of two conditions; there were 49 subjects in the Embedded question group (X1) and 45 Control subjects.

Subjects were first assessed on Verbal Comprehension (Nelson-Denny, 1973).

After which, the experimental group received exposure (training) on the passage with Embedded questions and the Control group received highlight and notetaking instructions. A posttest followed the reading.

One week later, subjects were all given correct answer feedback on this test, just before the second task.

Task B

For the second part of this study subjects were assigned to one of three treatment groups by previously randomized material. On the package cover the subjects responded to questions concerning previous exposure to the text, previous exposure to strategy, and supplied the code name they had used on the previous task (cf. Figure 1 for Ss per cell).

All subjects read the second passage. But (Y1) the first Implicit strategy group took notes and highlighted, (Y2) the second Implicit group, generated 2 questions per page on information that they thought important, and Y3, the Embedded question strategy group, constructed written responses to the interspersed questions in the text passage.

The dependent variable for the final observation was a post test made up of repeated items (adjunct questions) and an equal number of new (irrelevant) items.

Finally, because an inserted question strategy does not increase the rate but the effectiveness of verbal information processing, twice the amount of time was allowed for the reading tasks, as is normally allotted (250-words per minute is the norm).

Task A

	Embedded Questions	Control
N = 95	n = 49	n = 46

Task B

	Previous Exposure: Yes (X1)	Previous Exposure: No (X2)
Implicit Y1: No Prompt	n = 11	n = 11
Explicit Y2: Prompt Learner-generated	n = 11	n = 7
Y3: Embedded Questions	n = 16	n = 11

Figure 2. Experimental design with number of Ss per cell.

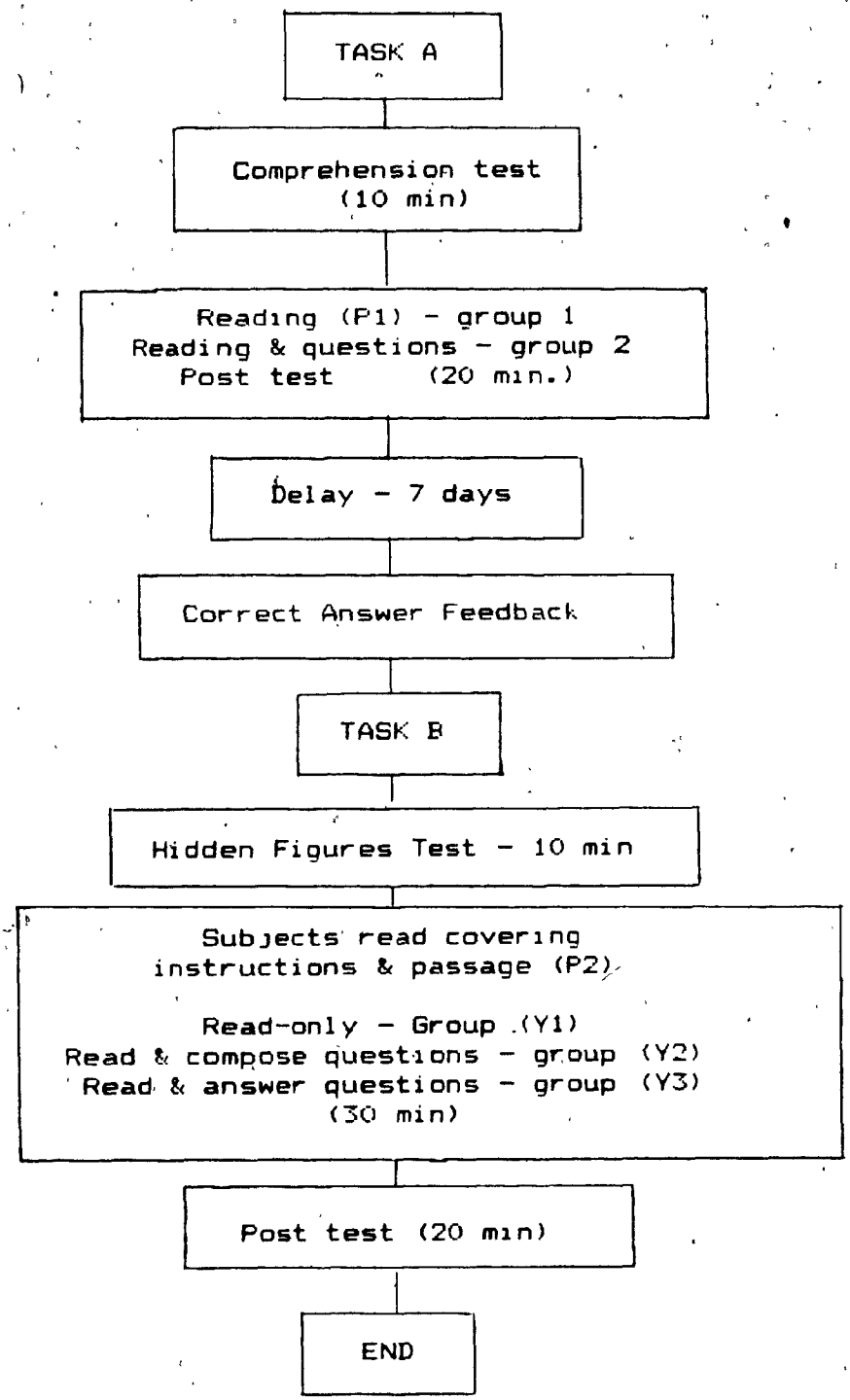

Figure 3. Flowchart of timing for experimental procedure.

CHAPTER 4

Results

Introduction

In the first part of this experiment, the purpose of was twofold: First, to determine the relative effectiveness of Rothkopf's Question-answer strategy by comparing (1) an Embedded question group against (2) a control group. Second, the relation between task aptitude and use of a Question-answer strategy was of interest.

The second part of this experiment was designed to evaluate transfer of training from the preliminary exposure task to an implementation task; this part of the experiment used three groups (1) Control, (2) Learner-generated questions, and (3) Embedded questions. The level of significance for testing hypotheses related to the designs was set at alpha $\leq .05$.

Assumptions for the Analysis of Covariance

The BMDP analysis of covariance with repeated measures (Dickson & Brown, 1981) was chosen to analyse the data. In this way the comprehension variable could be controlled. With equivalence between groups on this dimension, the amount of variance contributed by the question strategies could be measured. By using repeated measures, the repeated and new question categories could be evaluated.

The necessary assumptions for the ANCOVA were tested.

Homogeneity of variance

A oneway analysis of variance was run on SPSS using posttest scores as the dependent variable and Condition as the independent variable. Non significant results confirmed the assumption for Task A data: Cochran's C = .57, $p \leq .326$, and Bartlett-Box $F = .95$, $p \leq .33$ (Nie et al., 1975, pp.430-431). The assumption was also confirmed for Task B data. For Task B, though, the Cochran's C test was calculated by hand to include the whole Task X Aptitude matrix; C = .32, $p > .05$ (Roscoe, 1975, pp. 290-291)[12].

Linearity

Since there were only two groups for the preliminary task (A), a test of linearity of the relationship was not appropriate. However, use of the subprogram Breakdown within the analysis of variance (Nie, et al., 1975, pp. 258-259) was run on Task B with the three original groups (Y1, Y2, & Y3). The results were not significant, $F(1,64) = 1.99$, $p \leq .16$. The possibility of having violated the assumption of linearity was rejected; that is, the Regression tests will not have underestimated the correlation between the covariate and criterion test scores. (Nie et al., 1975, pp.258-259).

Homogeneity of regression

Two separate methods were used to test this assumption. First, a Stepwise Regression (Hull & Nie, 1981, pp.117-118) was used to generate the confidence intervals

for each group to test for a common slope. As the slopes of the population regression line (B) were within the confidence intervals of each other, the assumption of a common slope was verified.

Second, a test of significance was run using the SPSS multivariate analysis of variance (MANOVA) to generate the results (Hull & Nie,1981, p.15) using Comprehension scores by Condition. The results were not significant (NS), therefore, assumption was again confirmed. Task A data yielded F (1,91) = .207, $p \leq .907$, and Task B data yielded $F(2,61) = .27$, $p \leq .8$. Thus, the question Strategies were effective for the whole range of verbal comprehension levels.

Covariate Predictor

The Nelson-Denny Comprehension Test scores predicted a significant amount of the variance, $F(1,92) = 16.90$, $p \leq .0001$ as calculated by the BMDP ANCOVA on Task A data. Therefore, comprehension was used as a covariate in analysis of the data for Tasks A and B (cf. Table 1).

However, the Field-independent/dependent variable, as assessed by the BMDP ANCOVA with repeated measures did not explain a statistically significant amount of the variance, $F(1,60) = .06$, $p \leq .80$. Therefore, it was not included in further analysis of the data (cf. Table 2).

Thus, verbal comprehension was a better predictor of successful performance for the reading tasks.

Table 1

Means and Standard Deviations for Comprehension Covariate.

Task A (N = 95)

Strategy	Embedded Questions		Control	
	SD	M	SD	M
	7.00	16.0	8.09	16.61

Task B (N = 67)

	Previous Exposure			
	Yes		No	
Strategy	SD	M	SD	M
Control	7.28	14.18	6.43	16.82
Learner-generated Questions	8.17	14.18	9.63	13.14
Embedded Questions	7.41	16.94	5.18	18.73

Table 2

Means and Standard Deviations for Learner Style (Hidden Figures Test).

Task B (N = 67)

	Previous Exposure			
	Yes		No	
Strategy	M	SD	M	SD
Control	3.73	2.61	3.36	1.12
Learner Constucted	3.36	2.91	3.29	2.81
Embedded Questions	6.00	3.56	4.64	4.56

Hypotheses

Hypotheses were confirmed or rejected for alpha $\leq$ .05 as this was considered an appropriate level for testing the significance of learning strategies.

Task A

H1 concerning strategy was confirmed. There was a statistically significant main effect for Strategy: $F(1,92) = 6.19$, $p \leq .015$, in favour of the Embedded Question strategy when the ANCOVA with repeated measures was run on Task A data.

H2 concerning question type was confirmed. On the repeated measures, there was a statistically significant main effect for Type of Question, $F(1,93) = 53.31$, $p \leq .001$: Comparison of group means revealed the relevant question reponses were higher (cf. Tables 2 & 3). There was also a statistically significant interaction between Question Type X Strategy: $F(1,93) = 7.52$. $p \leq .007$ (cf. Figure 4). This interaction is characterized as ordinal (Huck, Cormier, & Bounds, 1974, p.87)

H3 concerning task aptitude was confirmed. The Nelson-Denny Test scores predicted a significant amount of the variance, $F(1,92) = 16.90$, $p \leq .0001$ as calculated by the ANCOVA on Task A data.

Thus, the directional hypotheses related to the design for Task A were confirmed by the positive effect of the Embedded question strategy.

Table 3

Summary of the ANCOVA with Repeated Measures for Task A

Source	SS	DF	MS	F	P
Strategy	45.09	1	45.09	6.19	.015
Covariate	123.05	1	123.05	16.90	.0001
Error	669.90	92	7.28		
Type of Question	138.12	1	138.12	53.31	.0000
Q X S	19.48	1	19.48	7.52	.007
Error	240.95	93	2.59		

Table 4

Standard Deviations, Means, and Adjusted Means for Groups on Task A

	Group					
	Experimental			Control		
Type of Question	SD	M	M adj.	SD	M	M adg.
Relevent	2.04	7.96	7.98	2.21	6.46	6.43
Irrelevent	2.87	5.61	5.63	2.20	5.39	5.36

N = 95

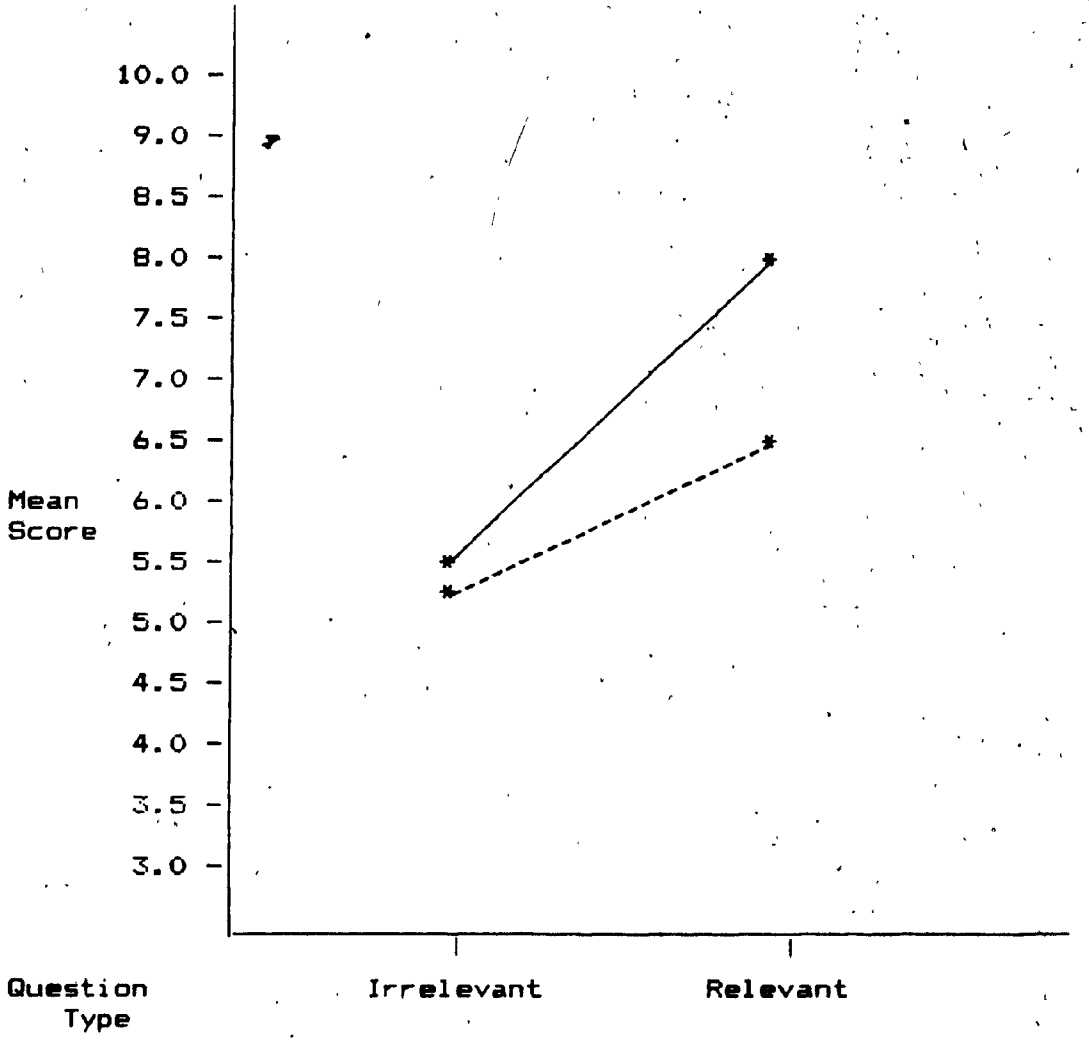

Figure 4. Graph of interaction between type of question and strategy on Task A.

Task B

H4 was rejected. A BMDP ANCOVA with repeated measures of Task B data did not yield a statistically significant main effect for Strategy, $F(2,63) = 2.89$, $p \leq .06$ (cf. Tables 4 & 5). A main effect for Question Type revealed that responses to relevant questions were better, $F(1,61) = 13.11$, $p \leq .0006$.

H5 was rejected as there was no significant interaction (cf. Figures 5 & 6) based on the repeated measures run on this data.

H6 was rejected. The ANCOVA results did not yield statistical significance for the previous exposure variable, $F(1,61) = .132$, $p \leq .70$. Overall, subjects did not demonstrate transfer of training.

Thus, the directional hypotheses related to the Task B design were rejected because statistical significance fell short of previously established alpha level $\leq .05$. Since the actual alpha corresponded to a 0.06 probability level, it seems worthwhile to mention the results for their practical instructional design value.

Summary of Results

The analysis of covariance (ANCOVA) with repeated measures (Dickson & Brown, 1981, pp. 540-580) was chosen as the appropriate test of hypotheses formulated in relation to the experimental designs related to Task A and Task B. The level of significance was set at alpha $\leq .05$.

Table 5

Summary of ANCOVA with Repeated Measures for Task B

Source	SS	DF	MS	F	P
Strategy	45.18	2	22.59	2.89	.0635
Exposure	5.69	1	5.69	.73	.3973
S X E	23.29	2	11.64	1.49	.2341
Covariate	113.81	1	120.46	14.84	.0003
Error	469.57	60	7.82		
Question	33.15	1	33.15	13.11	.0006
Q X S	10.68	2	5.34	2.11	.1298
Q X E	1.51	1	1.51	.60	.4421
Q X S X E	3.75	2	1.87	.74	.4806
Error	154.26	61	2.52		

Table 6

Means and Standard Deviations for Task B

	Previous Exposure					
	Yes			No		
	SD	M	M adj.	SD	M	M adj.
STRATEGY			Control			
Rel[1]	2.84	7.45	7.68	2.61	7.36	7.24
Irr[2]	2.06	7.45	7.68	1.57	6.90	6.78
			Learner-Generated			
Rel	2.08	5.81	6.04	3.28	7.85	8.22
Irr	2.02	5.09	5.31	2.91	5.85	6.22
			Embedded Questions			
Rel	2.56	8.75	8.61	3.06	9.18	8.80
Irrel	1.76	7.06	6.92	2.84	7.90	7.53

[1] Rel = Intentional (Repeated)

[2] Irr = Incidental (New)

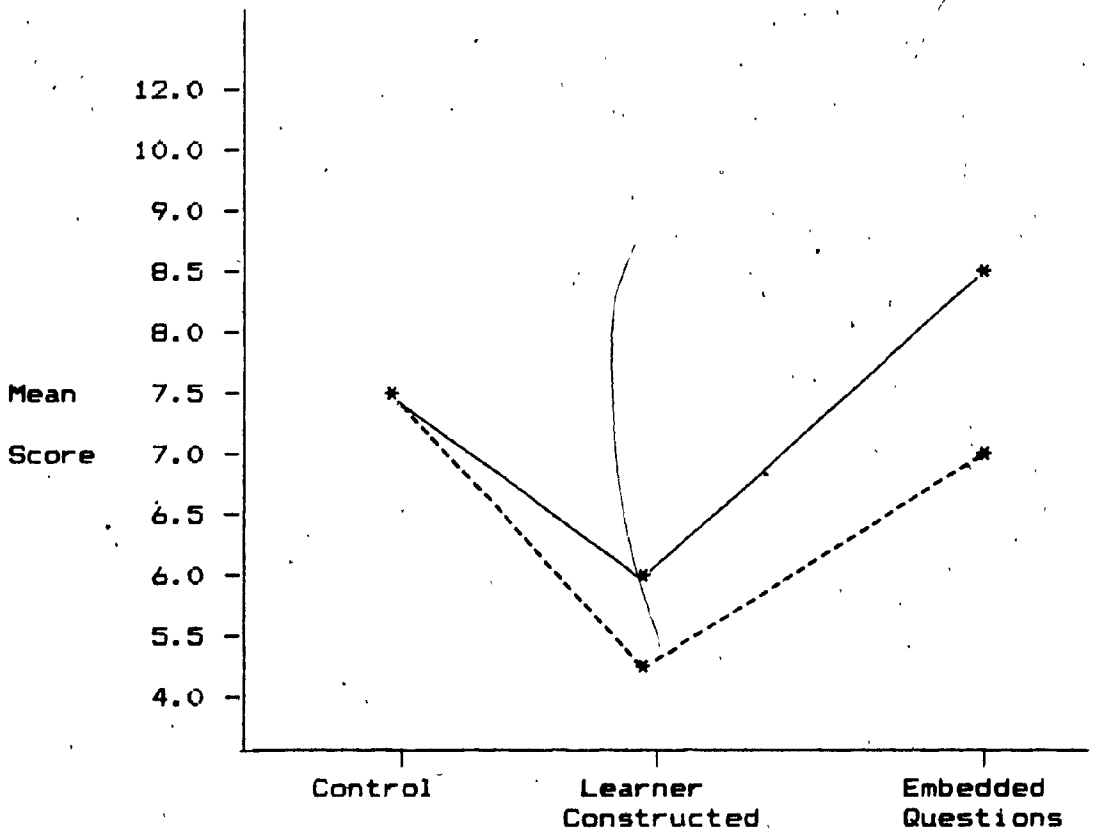

Figure 6. Graph of adjusted means for groups with prior exposure by question type.

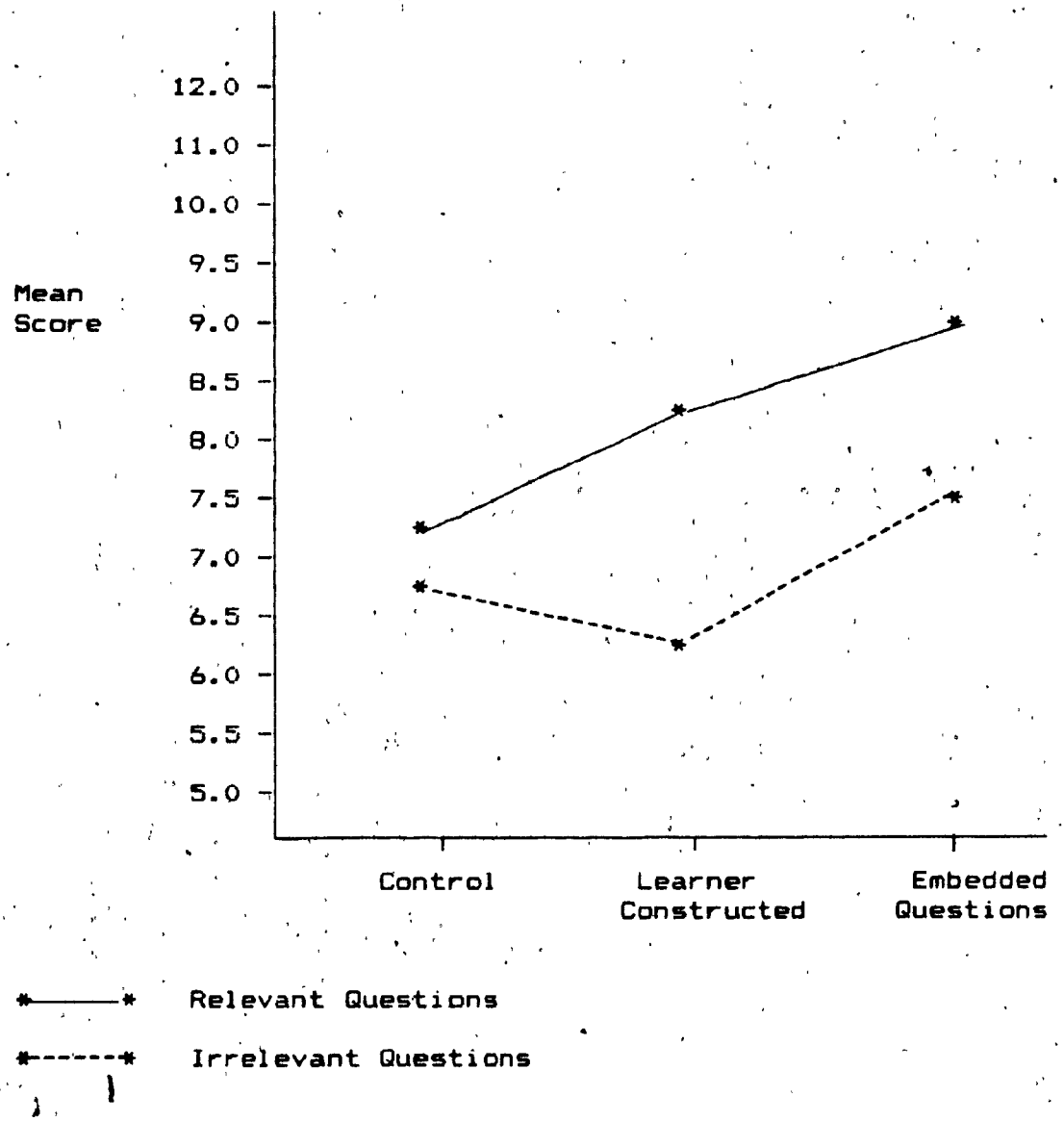

Figure 7. Graph of adjusted means for groups with no prior exposure.

In order to use the ANCOVA, the necessary assumptions were first confirmed. The assumption of homogeneity of variance was confirmed by a Cochran's C test within the SPSS oneway analysis of variance for Task A and calculated by hand for the factorial design related to Task B (Roscoe, 1975). Homogeneity of regression was confirmed by Stepwise Regression on SPSS and a test of significance within the SPSS MANOVA. No significant differential effects were found for level of comprehension in relation to the strategy. The assumption of linearity was confirmed for the Task B design as it was comprised of more than two groups by using the SPSS ANOVA subprogram called Breakdown.

Briefly, for Task A the analysed data yielded statistically significant differences in favour of the Embedded Question strategy, and a significant interaction between Question Type X Strategy on the first task.

On Task B, analysis of the data fell short of significance for Embedded and Learner constructed question strategies. There was no significant interaction between strategy and question type. Neither was there a significant effect due to previous exposure (i.e. no transfer of training).

CHAPTER 5

Discussion

Facilitative Effects

The results support the literature (Rothkopf, 1966; Frase, 1967; Rothkopf & Bisbicos, 1967) in the following ways for Task A: First, Embedded Questions facilitated learning significantly more than the notetaking / highlighting strategy used by the control group. Thus, the hypothesis that inserting questions shortly after relevant text segments affects text inspection positively is confirmed, but only for Task A.

The variance in results between tasks may be due to passage difficulty. The Task A passage was evaluated as easy to read (Reading Ease = 44), characterized as typical of pulp-fiction and interesting as compared to the Task B passage which was very difficult to read (Reading Ease = 18), and characterized as scientific and highly interesting by the Flesch (1948) Readability Measure [13].

Klare et al (1959) suggested that when time is controlled, word familiarity affects recall and easier versions are inspected faster than more difficult ones. When time is not controlled, readers can adapt to text difficulty (Rothkopf, 1972). Since the time available for the experiment was limited by class time, this may have been a factor. However, based on pilot test data, more time

was provided for Task B.

Then again, the different results may have been due to knowledge that criterion test was composed of new and repeated items. The subjects were given a posttest with both kinds of items after the first reading task. Mathemagenic behaviours are adaptive and tend towards forms that will increase the possibility of successful performance (Rothkopf, 1971).

Second, the Embedded Question strategy had a direct effect on learning as demonstrated by the significant interaction on Task A. The results support the Rothkopf's (1966) notion of a direct effect based on the law of rehearsal or exercise, but not the mathemagenic (indirect) effect based on the law of effect that depends upon reinforcement from correct answer feedback.

Therefore, the direct effect of Embedded questions for Task A is not typical of what is suggested by the literature for postquestions (Rothkopf, 1965; 1966; Rothkopf & Billington,1974). Questions positioned before have a question specific facilitation on learning, whereas postquestions should have both direct and indirect effects; that is, a more general effect on learning.

Because the direct effects of postquestions are four times their indirect effects, Anderson and Biddle (1975) recommend asking questions about each point to be mastered as opposed to relying on the indirect effects of questions.

Task B data did not show either facilitative effect.

Finally, the processing effects of within text questions are not unique to high verbal ability groups. In this study, the whole range of verbal ability benefitted from the embedded strategy. Thus, the technique cannot be said to be lacking in construct validity as is often the case according to Bovy (1981). In as much as individuals were limited by reading deficencies, learning from adjunct questions was also limited ; that is, higher verbal ability subjects performed better (Anderson & Biddle, 1975).

Transfer of Training

Close inspection of group means reveals that subjects with previous exposure did not do better than their counterparts in the learner-generated and embedded question strategies. Therefore, no transfer of training can have occurred.

There was no evidence of subjects having acquired a skill by exposure to the strategy and Sanders (1970) results are confirmed. In fact, one student chose to highlight relevant information rather answer embedded questions during the second task, but this was the exception. Overall, subjects responses were very good. Generating questions may have been too demanding for subjects that were field-dependent and low in verbal ability; this strategy seemed to interfere with learning.

But, there might be other explanations than the

interference factor. There may have been a mismatch between the dependent variable and the strategy. That is, had another measure, such as free recall, been used that was not preferenced by the experimenter's choice of content, subjects could have more effectively demonstrated what they had learned.

Educational Implications

The embedded strategy may be of limited interest to teachers who rely on commercial material that is not easily adapted. On the other hand, teachers who develop their own material, instructional designers, and textbook authors may find it useful to intersperse questions with text. However, the effect can only be said to be facilitative for prose that is typical of the Reading Ease of the Task A passage.

Depending on the nature of an educator's objectives, Embedded questions response demands to questions while reading a passage tends to modify processing activities in a very direct way. If it is desirable that specific information be identified, or review initiated of distinct features of the text, Embedded questions seem suitable.

Conclusions

The role of within text questioning was successful in mediating attentional and rehearsal processes for the purposes of selective attention. There was a statistically significant increase in recall of goal-relevant material for Task A, even though the benefits for learning fell short of

being significant on Task B.

Therefore, the notion that a question-answer strategy within text maintains active cognitive processing (Royer & Feldman, 1984) was confirmed.

This study attempted to define valid and useful principles for applying question-answer strategies in instructional design. In order to overcome the descriptive nature of some of the literature, several aspects of experiments by Rothkopf (1966), Frase (1975) and Anderson and Biddle (1975) were adapted to a transfer of training study.

The results suggest that while embedded questions are beneficial for learning with field-dependent learners, whether high or low in verbal ability, generating questions was not detected to be beneficial. A free recall test would have been a more appropriate measure for the self-generated strategy, since it might have detected such benefits.

Because of the specific facilitation of within text questions, such an orienting technique can be considered a helpful tool when specific learning outcomes are desirable.

Finally, no transfer of training was found based on one prior exposure to the strategy in this study.

FOOTNOTES

[1] Understanding refers to the immediate sense of comprehension.

[2] The law of exercise is practice of the correct responses.

[3] The law of effect depends upon knowledge of results and reinforcement of the right answer Rothkopf, 1972).

[4] Encoding (decoding) is the process of responding to incoming information. There are four components: (a) Perception/noticing the message, (b) Interpretation/determining how information relates to prior-knowledge. (c) Evaluation / determining what effect the interpretation has, and (d) Feedback / transmitting intepretive or evaluative information back (Royer & Feldman, 1984).

[5] Goal-directedness entails some representation in memory of intended learning outcomes and the activities that achieve that end (Frase, 1975).

[6] Orienting directions are aids that cause the reader to respond to certain aspects of the stimuli (e.g., specific directions about what to learn or text-relevant interspersed questions) (Frase, 1975).

[7] Evidence for Rothkopf's mathemagenics exists because adjunct questions selectively facilitate learning of specific categories of information (Anderson & Biddle, 1975).

8 Verbatim questions require recognition or memory for the same words of the text. Comprehension questions are paraphrases of the text and require answers that demonstrate an understanding of the literal meaning of the text, abstraction and application of the information in new contexts (Anderson & Biddle, 1975).

9 A paraphrased question can only be answered if the information is semantically encoded, whereas response to a verbatim question is possible if the information is encoded sematically or phonologically (Anderson & Biddle, 1975).

10 High-level questions are made up of analysis, synthesis, and evaluation functions and low-level questions depend on knowledge, comprehension, and application functions in Bloom's (1956) hierarchy.

11 In cognitive theory, information is only understood if there is transfer and knowledge is used for learning in new situations (Royer & Feldman, 1984).

12 The Cochran C test is approprite for unequal sample sizes if n is taken as the average sample size (Roscoe, 1975).

13 The Flesch Readability measure was used as the basis for passage choice for the Nelson-Denny Test (Brown et al., 1976).

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APPENDIX A

Task A

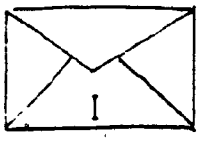
NOTE TO THE STUDENT

This experimental activity is not compulsory. Because it is anonymous there will be no traceable record of your results. But you are likely to learn a valuable technique for improving your learning if you participate. Your participation will be much appreciated.

PLEASE MAKE UP A CODE (number, name, or initials, etc) FOR THE PURPOSES OF THE EXPERIMENT _____.

TASK A (A VOLUNTARY ACTIVITY)

REMOVE



REPLACE

= THE NELSON-DENNY READING TEST

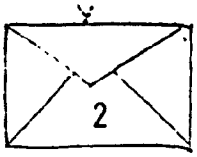
- COMPREHENSION (DIRECTIONS A&B)
- ANSWER SHEET

1—2 3 4 5

1 2 3—4 5

= 20 MINUTES

REMOVE



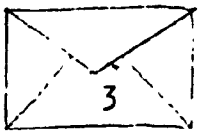
REPLACE

= STUDY MATERIAL

- FOLLOW COVERING INSTRUCTIONS

= 20 MINUTES

REMOVE



REPLACE

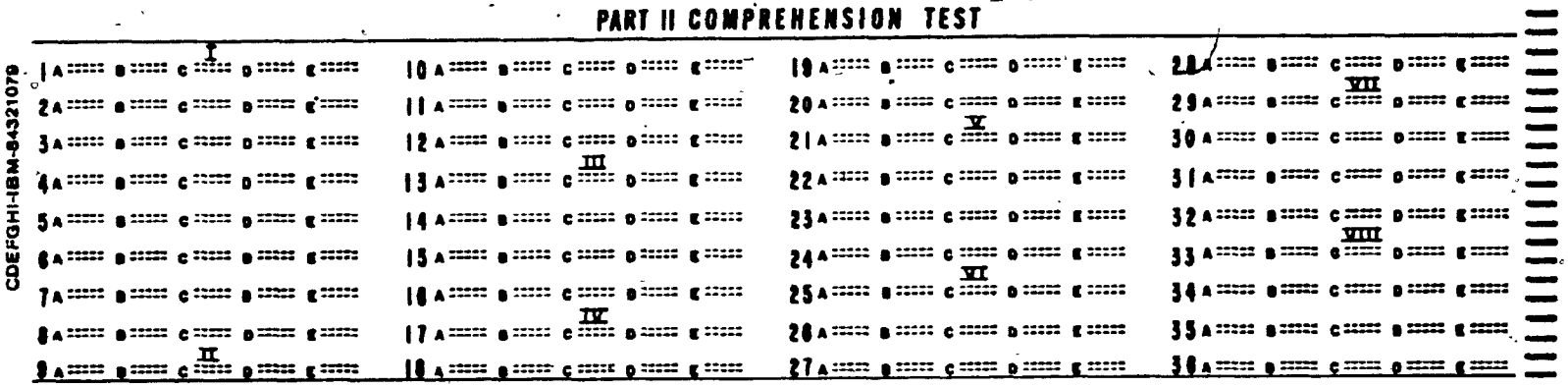
= POSTTEST

- DO NOT REFER BACK TO MATERIAL

= 15 MINUTES

TOTAL TIME = 55 MINUTES

PART II COMPREHENSION TEST



PART II. COMPREHENSION TEST AND READING RATE

Directions to Students

A. Do not turn this page of the test booklet until directed to do so.

B. There are eight selections in this part of the test. Read a selection through completely; then answer the questions to the right of it. When you have completed one selection, go immediately to the next. Keep working until you have completed all eight selections or until you are told to stop. To answer a question, you may, if you wish, look back at the material you have read. But do not puzzle too long over any one question. After a reasonable effort, go on to the next question.

C. Now listen carefully to the examiner for an explanation of how you are to mark your answers.

D. You will have 20 minutes to work on this part of the test. The first minute will be used to determine your reading rate. When the examiner tells you to begin, turn this page and start immediately to read the selection on page 5. At the end of one minute the examiner will call "Mark." Now your examiner will explain how to mark your reading rate.

E. Wait for the signal to turn this page.

MAKE NO MARKS ON THIS TEST BOOKLET

TIME: 20 MINUTES

COMPREHENSION TEST

Like Horace, Virgil was possibly drawn from his studies into battle. The struggle, then at its height, was between Caesar and Pompey. Certainly, his pitiful pictures of the dead on the battlefields of Pharsalia could well have been made by one who had fought under the triumphant standards of Caesar. It is possible also that he saw rather stormy service on the Adriatic Sea with Mark Antony. There are signs that some detested bully of an officer made camp life, none too pleasant at best, quite unendurable for the poet who was never blessed with vigorous health. And the winter of 49 B.C., severe enough to leave even Caesar shaken, may well have shattered Virgil. At any rate, if he served for a time, he returned soon to his books. From the outset, his heart could but little rejoice in the struggle which was making brother fight brother and draining Italy of her best blood.

After his withdrawal from the war, some contend, Virgil made a single and unsuccessful appearance as lawyer before the Roman court of law. This is of considerable interest when we reflect that the orators in his great poem, the *Aeneid*, are all fluent but dreary fellows. We hear of him in Rome, a tall, dark, gaunt man, suffering much in his stomach, throat, and head, sometimes spitting blood, in food and drink most cautious — even at the abundant board of his patron Maecenas, to whom, with such happy results, he had presented his friend Horace. Like Horace, he, too, seems to have lost his lands in the wars, but the poems he had now begun to write made him known and honoured, and other lands were given to him, so that he had enough money to live comfortably. Some scholars detect in one of Horace's satires a reference to Virgil as he might have been just then — a person with a rural haircut, an ungraceful toga, and untied shoelaces. However, it is equally possible that Horace had himself in mind. It was just the sort of thing he liked to do — caricaturing his whimsies and his hayseed locks and his flapping coat.

We can picture the two poets on a now famous journey they took with Maecenas, going to Brundisium. There are Horace with his black eyewash (a lotion for his weak eyes), and Virgil with his black headache, both of them snoring while Maecenas and his company hopped about after the tennis balls. And there was a voyage to Athens which Horace celebrated in another poem. But the two followed their separate ways. Both had a passion for philosophy and a passion for the country in common, but each took his solitude and often his social life in his own fashion.

The first poems Virgil wrote were about the earth and the farmers and the shepherds and the simple things of their life. These poems he called Eclogues. They took the outward form of the pastorals of Theocritus and the other Greek poets of the Alexandrian school. In them Virgil sang the radiance of the seasons, the tenderness of Italian landscapes, the charm of Italian friendships. All of April and the delicate tintings of the wild flowers and the glossy-leafed orchards and his own deep love of home and his tranquil memories and his longing for peace in a troubled world and the melancholy beauty of love — all these things went into the Eclogues. They were different from the Greek pastorals (aside from language) — using the beauty of the earth only as an introduction to a romantic understanding of the larger life beyond the glades and meadows. And with what exquisitely chosen phrases, with what fullness and rhythm and force the new poet sang! Rhyme Virgil never used, and his metre was different from ours.

1. *Reference was made to what game?*
   - A. Chess
   - B. Quoits
   - C. Tennis
   - D. Skittles
   - E. Baccarat

2. *Specific reference was made to*
   - A. Marcus Aurelius.
   - B. Pliny.
   - C. Mark Antony.
   - D. Hercules.
   - E. Plotinus.

3. *Virgil and Horace apparently visited*
   - A. Achaea.
   - B. Athens.
   - C. Pharos.
   - D. Messina.
   - E. Adrian.

4. *It was said that Virgil did <u>not</u> use*
   - A. blank verse,
   - B. rhyme.
   - C. personification.
   - D. metre.
   - E. the heroic couplet.

5. *This passage is mainly about*
   - A. poetry.
   - B Virgil.
   - C. nature.
   - D. history.
   - E. Eclogues.

6. *In discussing the two poets, most emphasis was placed on their*
   - A. similarities.
   - B. differences.
   - C. friendship.
   - D. patriotism.
   - E. attitude toward war.

7. *This passage is primarily*
   - A. historic.
   - B. analytic.
   - C. biographic.
   - D. satiric.
   - E. eulogistic.

8. *You would infer from the reference to the orators in Virgil's <u>Aeneid</u> that Virgil himself would be best described as what kind of speaker?*
   - A. Dull
   - B. Lively
   - C. Inspiring
   - D. Commonplace
   - E. Original

Do not stop here. Turn to page 6.

COMPREHENSION TEST *(Cont.)*

II

At first, in the planets-to-be, particles were collected merely at random, but as each mass grew larger, other particles began to be attracted by the gravity of the central mass. The whirling dust and forming spheres continued to revolve around the sun until finally each planet had swept its own path clean, picking up loose matter like a giant snowball. The orbit nearest the sun was swept clean by Mercury, the next by Venus, the third by Earth, the fourth by Mars, and so on out to Pluto.

This theory of how the planets were formed differs from the one generally accepted a little more than a decade ago. At that time, it was thought by most astronomers that the planets formed as the result of a wandering star passing too close to the sun and sucking chunks of matter out of its fiery mass. The decline of this theory, on the basis of new evidence and new calculation by physicists, geologists, and astronomers, has important implications for the question of whether life exists on other planets. In the vastness of the universe, it is highly unlikely that one star will enter the gravitational field of another, forming a planet like Earth.

III

Sounds are measured in units called decibels. One decibel is the slightest sound that can be heard by someone with good hearing. A reading of about 80 decibels is the loudest comfortable level for the average person. Noise begins to irritate at 80 to 85 decibels.

Each day the average city dweller in the U.S. is assaulted by many sounds louder than 80 decibels. A powerful motorcycle roars by at 115 decibels. A jet plane at close range registers 150.

Doctors are learning more about the effects of noise all the time. Experiments by Dr. Lester W. Sontag, director of the Fels Research Institute in Yellow Springs, Ohio, showed that violent noise, such as sonic booms, may cause permanent damage to unborn babies.

Dr. Samuel Rosen, a New York hearing specialist, describes what happens when a sudden noise strikes the ear. "The heart beats rapidly, the blood vessels constrict, the pupils dilate, and the stomach, esophagus, and intestines are seized by spasms . . . You may forgive noise, your body never will."

"People tolerate noise because they don't realize something can be done about it," says Robert Baron, who organized Citizens for a Quiet City in New York. Listen, think and act.

II

9. *Which planet orbits nearest to the sun?*
   A. Jupiter
   B. Mars
   C. Mercury
   D. Pluto
   E. Neptune

10. *Which planet was not mentioned specifically?*
   A. Jupiter
   B. Mars
   C. Venus
   D. Mercury
   E. Pluto

11. *How many major theories were discussed?*
   A. One
   B. Two
   C. Three
   D. Four
   E. None

12. *This selection deals largely with*
   A. how planets are formed.
   B. how the solar system came into being.
   C. the orbital behavior of planets.
   D. the way stars became planets.
   E. the presence of life on the planets.

III

13. *Mention was made of experimental work done by Dr.*
   A. Fels.
   B. Sontag.
   C. Rosenbloom.
   D. Bacon.
   E. Roberts.

14. *A powerful motorcycle roars by at what decibel level?*
   A. 95
   B. 115
   C. 125
   D. 140
   E. 150

15. *The quoted statement about the effects of a sudden noise, made by a New York hearing specialist, was intended to show how*
   A. slowly the body recovers.
   B. severely the body is affected.
   C. permanent the effects are.
   D. important the decibel level is.
   E. subtly the body is altered.

16. *The chief purpose of this passage is to*
   A. explain how noise intensity is measured.
   B. describe typical noises in terms of decibels.
   C. show how the body is affected.
   D. indicate the average level of noise tolerance.
   E. describe the city noise environment.

Do not stop here. Turn to page 7.

IV

Nothing brings a prince more prestige than great campaigns and striking demonstrations of his personal abilities. In our own time we have Ferdinand of Aragon, the present king of Spain. He can be regarded as a new prince, because from being a weak king he has risen to being, for fame and glory, the first king of Christendom. If you study his achievements, you will find that they were all magnificent and some of them unparalleled. At the start of his reign he attacked Granada; and this campaign laid the foundation of his power. First, he embarked on it undistracted, and without fear of interference, he used it to engage the energies of the barons of Castile who, as they were giving their minds to the war, had no mind for causing trouble at home. In this way, without their realizing what was happening, he increased his standing and his control over them. He was able to sustain his armies with money from the Church and the people, and, by means of that long war, to lay a good foundation for his standing army, which has subsequently won him renown. Thus he has always planned and completed great projects.

IV

17. *Money for the king's military operation came from*
   - A. the nobility.
   - B. the Church.
   - C. piracy.
   - D. seizure of foreign investments.
   - E. conquests.

18. *The king increased his control of the barons by*
   - A. starting a military operation.
   - B. giving them a role in government.
   - C. establishing a tax-sharing program.
   - D. entertaining them at court.
   - E. making large land grants to them.

19. *The king was said to have a*
   - A. professional army.
   - B. nondescript army.
   - C. standing army.
   - D. volunteer army.
   - E. conscripted army.

20. *In this passage, war is considered to be*
   - A. an economic stimulus.
   - B. a waste of resources.
   - C. an evil.
   - D. an end in itself.
   - E. a means toward an end.

V

The concept of almost unlimited time in earth history is a necessary outgrowth of the application of the principle that "the present is the key to the past." For example, geologists know that mountains as high as the modern Rockies once towered over what are now the low uplands of northern Wisconsin, Michigan, and Minnesota. But only the roots are left. The great peaks have long since disappeared. Geologists explain that the ancient mountains were destroyed by rain and running water, wind and creeping glaciers, landslides and slowly moving rubble, and that these processes acted essentially as they do now.

Think of what this explanation means. We know from firsthand observation that streams, glaciers, and winds have some effect on the surface of the earth. But can such feeble forces level whole mountain ranges? Instinct and common sense tell us that they cannot. But this is where the factor of time comes into the picture. True, the small, almost immeasurable amount of erosion during one lifetime has little effect. But multiplied by thousands and millions of lifetimes, it becomes clear that mountains can be destroyed. Time makes possible what seems impossible.

V

21. *Specific mention was made of*
   - A. Michigan.
   - B. Iowa.
   - C. North Dakota.
   - D. Manitoba.
   - E. Montana.

22. *Major attention was given to*
   - A. natural laws.
   - B. glaciers.
   - C. wind and water erosion.
   - D. observation.
   - E. time.

23. *Mention of the vanished mountains was primarily*
   - A. to show how different America once was.
   - B. to indicate how strong the forces of nature are.
   - C. to emphasize the importance of time.
   - D. to stress the relevance of geology.
   - E. to show glacial action.

24. *Most emphasis is on*
   - A. time.
   - B. change.
   - C. natural processes.
   - D. observation.
   - E. erosion.

Do not stop here. Turn to page 8.

TASK A (X1)

TIME: 20 minutes (6 pages).

DIRECTIONS: Study the following passage. Answer questions as they appear in the text. Be prepared for a postest!

Some differences between intrinsic and extrinsic learning. By A. Maslow, Harvard Educational Review, 38, 1968.

We are now being confronted with a choice between two extremely different, almost mutually exclusive conceptions of learning. What we have in practically all the elementary and advanced textbooks in elementary psychology, and in most of the brands of "learning theory" which all graduate students are required to learn, is what I want to call for the sake of contrast and confrontation, extrinsic learning, i.e., learning of the outside, learning of the impersonal, of arbitrary associations, of arbitrary conditioning, that is, of arbitrary (or at best, culturally determined) meanings and responses. In this kind of learning, most often it is not the person himself who decides, but rather a teacher or experimenter who says, "I will use a buzzer," "I will use a bell," "I will use a red light," and most important, "I will reinforce this but not that."

* If learning is extrinsic, then it is externally determined and impersonal. TRUE / FALSE

In this sense the learning is extrinsic to the learner, extrinsic to the personality, and is extrinsic also in the sense of collecting associations, conditionings, habits or modes of action. It is as if these were possessions which the learner accumulates in the same way that he accumulates keys or coins and puts them in his pocket. They have little or nothing to do with the actualization or growth of the peculiar, idiosyncratic kind of person he is.

I believe this is the model of education which we all have tucked away in the back of our heads and which we don't often make explicit. In this model the teacher is the active one who teaches a passive person who gets shaped and taught and who is given something which he then accumulates and which he may then lose or retain, depending upon the efficiency of the initial indoctrination process and of his own accumulation-of-fact process. I would maintain that a good 90 percent of "learning theory" deals with learnings that have nothing to do with the intrinsic self that I've been talking about, nothing to do with

its specieshood and biological idiosycrasy. This kind of learning too easily reflects the goals of the teacher and ignores the values and ends of the learner himself.

Now I'd like to contrast this with an intrinsic kind of learning, which is actually going on, but is usually unconscious and unfortunately happens more outside the classroom than inside. It often comes in the great personal learning experiences of our lives.

* Briefly how do we learn in an intrinsic way?

For instance, if I were to list the most important learning experiences of my life, there comes to mind getting married, discovering my life work, having children, getting psychoanalyzed, the death of my best friend, confronting death myself, and the like. I think I would say that these were more important learning experiences for me than my Ph.D. or any 15 or 150 credits of any courses that I've ever had. I certainly learned more about myself from such experiences. I learned, if I may put it so, to throw aside many of my "learnings," that is, to push aside the habits and traditions and reinforced associations which had been imposed upon me. Sometimes this was at a very trivial, and yet meaningful, level. I particularly remember when I learned that I really hated lettuce. My father was a "nature boy," and I had lettuce for two meals a day for the whole of my early life. But one day in analysis after I had learned that I carried my father inside me, it dawned on me that it was my father, through my larynx, who was ordering salad with every meal. I can remember sitting there, realizing that I hated lettuce and then saying, "My God, take the damn stuff away!" I was emancipated, becoming in this small way me rather than my father. I didn't eat any more lettuce for months, until it finally settled back to what my body calls for. I have lettuce two or three times each week, which I now enjoy. But not twice a day.

Now observe, this experience which I mentioned occurred just once and I could give many other similar

examples. It seems to me that we must call into question the generality of repetition, of learning by drilling. The experiences in which we uncover our intrinsic selves are apt to be unique moments, not slow accumulations of reinforced bits. (How do you repeat the death of your father?) These are the experiences in which we learn who we are, what we love, what we hate, what we value, what we are committed to, what makes us feel anxious, what makes us feel depressed, what makes us feel happy, what makes us feel great joy.

* State in your own words what can be learned from unique personal experiences.

It must be obvious by now that you can generate consequences of this second picture of learning by the hundred. (And again I would stress that these hypotheses can be stated in testable, disconfirmable, confirmable form.) One such implication of the point of view is a change in the whole picture of the teacher. If you are willing to accept this conception of two kinds of learning, with the learning-to-be-a-person being more central and more basic than the impersonal learning of skills or the acquisition of habits; and if you are willing to concede that even the more extrinsic learnings are far more useful, and far more effective if based upon a sound identity, that is, if done by a person who knows what he wants, knows what he is, and where he's going and what his ends are; then you must have a different picture of the good teacher and of his functions.

In the first place, unlike the current model of teacher as lecturer, conditioner, reinforcer, and boss, the Taoist helper or teacher is receptive rather than intrusive. I was told once that in the world of boxers, a youngster that feels himself to be good and who wants to be a boxer will go to a gym, look up one of the managers and say,"I'd like to be a pro, and I'd like to be in your stable. I'd like you to manage me." In this world, what is then done characteristically is to try him out. The good manager will select one of his professionals and say, "Take him on in the ring. Stretch him. Strain him. Let's see what he can do.

Just let him show his very best. Draw him out." If it turns out that the boxer has promise, if he's a "natural," then what the good manager does is to take that boy and train him to be, if this is Joe Dokes, a better Joe Dokes. That is, he takes his style as given and builds upon that. He does not start all over again and say, "Forget what kind of body you have," or "Forget what you are good for." He takes him and builds upon his own talents and builds him up into the very best Joe Dokes-type boxer that he possibly can.

It is my strong impression that this is the way in which most of the world of education could function. If we want to be helpers, counselors, teachers, guiders, or psychotherapists, what we must do is to accept the person and help learn what kind of person he is already. What is his style, what are his aptitudes, what is he good for, not good for, what can we build upon, what are his good raw materials, his good potentialities?

* What must you know about the learner to be a good teacher?

We would be non threatening and would supply an atmosphere of acceptance of the child's nature which reduces fear, anxiety and defence to the minimum possible. Above all, we would care for the child, that is enjoy him and his growth and self-actualization. So far this sounds much like the Rogerian therapist, his "unconditional positive regard," his congruence, his openess and his caring. And indeed there is evidence by now that this "brings the child out," permits him to express and to act, to experiment, and even to make mistakes; to let himself be seen. Suitable feedback at this point, as in T-groups or basic encounter groups, or non-directive counseling, then helps the child to discover what and who he is.

In closing, I would like to discuss briefly the role that peak-experiences can play in the education of the child. We have no systematic data on peak-experiences in children but we certainly have enough anecdotes and introspections and memories to be quite confident that young children have them perhaps more frequently that adults do. However, they seem at least

in the beginning to come from sensory experiences, color, rhythm, or sounds, and perhaps are better characterized by the words wonder, awe, fasination, absorption, and the like.

In any case, I have discussed the role of these experiences in education in (2), and would refer the reader to that paper for more detail. Using peak-experiences or fasination or wonder experiences as an intrinsic reward or goal at many points in education is a very real possibility, and is congruent with the whole philosophy of the humanistic educator. At the very least, this new knowledge can help wean teachers away from their frequent uneasiness with and even disapproval and persecution of these experiences. If they learn to value them as great moments in the learning process, moments in which both cognitive and personal growth take place simultaneously, then this valuing, rather than to suppress his greatest moments of illumination, can validate and make worthwhile the more usual trudging and slogging and "working through" of education.

There is a very useful parallel here with the newer humanistic paradigm for science (1,4) in which the more everyday cautious and patient work of checking, validating and replicating is seen, not as all there is to science but rather as follow-up work, subsequent to the great intuitions, intimations, and illuminations of the creative and daring, innovative, breakthrough scientist. Caution is then seen to follow upon boldness and proving comes after intuition.

* The main process of the scientific method is intuition followed by proof. TRUE / FALSE

The creative scientist then looks more like a gambler than a banker, one who is willing to work hard for seven years because of a dazzling hunch, one who feels certain in the absence of evidence, before the evidence, and only then proceeds to the hard work of proving or disproving his precious revelation. First comes the emotion, the fasination, the falling in love with a possibility, and then comes the hard work, the chores, the stubborn persistence in the face of disappointment and failure.

As a supplement to this conception in which a poetic illumination plays such an important role, we

can add the harsh patience of the psychotherapist who has learned form many bitter disappointments that the breakthrough insight doesn't do the therapeutic job all by itself as Freud originally thought. It needs consolidation, repetition, rediscovery, application to one situation after an another. It needs patience, time and hard work - what the psychoanalysts call "working through." Not only for science but for psychotherapy may we say that the process begins with an emotional cognitive flash but does not end there! It is this model of science and therapy that I believe we may now fairly consider for the process of education, if not as an exclusive model, at least as an additional one.

* List 3 requirements (virtues) for researchers and teachers.

We must learn to treasure the "jags" of the child in school, his fasination, absorptions, his persistent wide-eyed wonderings, his Dionysian enthusiasms. At the very least, we can value his more diluted raptures, his "interests" and hobbies, etc. They can lead to much. Especially can they lead to hard work, persistent, absorbed, fruitful, educative.

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TASK A (X2)

TIME: 20 minutes (6 pages)

DIRECTIONS: Study the following article. Use any means you like (such as highlighting, note-taking, etc.). Be prepared for a posttest!

Some differences between intrinsic and extrinsic learning. By A. Maslow, Harvard Educational Review, 38, 1968.

We are now being confronted with a choice between two extremely different, almost mutually exclusive conceptions of learning. What we have in practically all elementary psychology, and in most of the brands of "learning theory" which all graduate students are required to learn, is what I want to call for the sake of contrast and confrontation, extrinsic learning, i.e.,learning of the outside, learning of the impersonal, of arbitrary associations, of arbitrary conditioning, that is, of arbitrary (or at best, culturally determined) meanings and responses. In this kind of learning, most often it is not the person himself who decides, but rather a teacher or experimenter who says, "I will use a buzzer," "I will use a bell," "I will use a red light," and most important, "I will reinforce this but not that." In this sense the learning is extrinsic to the learner, extrinsic to the personality, and is extrinsic also in the sense of collecting associations, conditionings, habits or modes of action. It is as if these were possessions which the learner accumulates in the same way that he accumulates keys or coins and puts them in his pocket.They have little or nothing to do with the actualization or growth of the peculiar, idiosyncratic kind of person he is.

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in the beginning to come from sensory experiences, color, rhythm, or sounds, and perhaps are better characterized by the words wonder, awe, fasination, absorption, and the like.

In any case, I have discussed the role of these experiences in education in (2), and would refer the reader to that paper for more detail. Using peak-experiences or fasination or wonder experiences as an intrinsic reward or goal at many points in education is a very real possibility, and is congruent with the whole philosophy of the humanistic educator. At the very least, this new knowledge can help wean teachers away from their frequent uneasiness with and even disapproval and persecution of these experiences. If they learn to value them as great moments in the learning process, moments in which both cognitive and personal growth take place simultaneously, then this valuing, rather than to suppress his greatest moments of illumination, can validate and make worthwhile the more usual trudging and slogging and "working through" of education.

There is a very useful parallel here with the newer humanistic paradigm for science (1,4) in which the more everyday cautious and patient work of checking, validating and replicating is seen, not as all there is to science but rather as follow-up work, subsequent to the great intuitions, intimations, and illuminations of the creative and daring, innovative, breakthrough scientist. Caution is then seen to follow upon boldness and proving comes after intuition.

The creative scientist then looks more like a gambler than a banker, one who is willing to work hard for seven years because of a dazzling hunch, one who feels certain in the absence of evidence, before the evidence, and only then proceeds to the hard work of proving or disproving his precious revelation. First comes the emotion, the fasination, the falling in love with a possibility, and then comes the hard work, the chores, the stubborn persistence in the face of disappointment and failure.

As a supplement to this conception in which a poetic illumination plays such an important role, we

can add the harsh patience of the psychotherapist who has learned form many bitter disappointments that the breakthrough insight doesn't do the therapeutic job all by itself as Freud originally thought. It needs consolidation, repetition, rediscovery, application to one situation after an another. It needs patience, time and hard work - what the psychoanalysts call "working through." Not only for science but for psychotherapy may we say that the process begins with an emotional cognitive flash but does not end there! It is this model of science and therapy that I believe we may now fairly consider for the process of education, if not as an exclusive model, at least as an additional one.

We must learn to treasure the "jags" of the child in school, his fasination, absorptions, his persistent wide-eyed wonderings, his Dionysian enthusiasms. At the very least, we can value his more diluted raptures, his "interests" and hobbies, etc. They can lead to much. Especially can they lead to hard work, persistent, absorbed, fruitful, educative.

References

1. Maslow, A. The psychology of science: a reconnaissance. New York: Harper & Row, 1966.
2. Maslow, A. Music education and peak-experiences. Music educators journal, 54, 1968.
3. Maslow, A. Toward a psychology of being (2 ed.). Princeton, N.J.: D. Van Nostrand, 1968.
4. Polanyi, M. Personal knowledge. Chicago: University of Chicago Press, 1958.

POSTTEST A: (X2)

1. If learning is extrinsic, then it is externally determined. TRUE / FALSE

2. What type of learning occurrs with a passive learner?

3. Briefly, how do we learn in an intrinsic way?

4. E::plain how Maslow's anecdote about lettuce is an e::ample of extrinsic and intrinsic learning.

5. State in your own words what can be learned from unique personal experiences.

6. Intrinsic learning is the more basic kind of learning. TRUE / FALSE

7. What must you know about the learner to be a good teacher, according to Maslow?

8. How can a learner's anxiety or defences be reduced?

9. What is the main function of feedback for the learner?

10. Peak-experiences can be used as intrinsic rewards or goals in education. TRUE / FALSE

11. The main process of the scientific method is intuition followed by proof. TRUE / FALSE

12. List 3 requirements (virtues) for teachers and researchers.

APPENDIX B

Task B

STUDENT CODE_____
(initials, number or name you used last week)

NOTE TO STUDENT

PLEASE ANSWER THE FOLLOWING QUESTIONS CONCERNING YOUR PREVIOUS EXPERIENCE WITH THIS EXPERIMENTAL MATERIAL:

1. HAD YOU READ MASLOW'S ARTICLE BEFORE LAST WEEK?

YES / NO

(IF YOUR ANSWER IS YES, PLEASE SAY WHEN _____)

2. DID THE PASSAGE THAT YOU READ BY MASLOW LAST WEEK HAVE QUESTIONS INTERSPERSED (*ONE QUESTION PER PAGE) THROUGHOUT IT?

YES / NO

3. HAD YOU DONE THE NELSON-DENNY COMPREHENSION TEST BEFORE LAST WEEK?

YES / NO

(IF YOUR ANSWER IS YES, PLEASE SAY WHEN_____)

4. CONCERNING THIS WEEKS MATERIAL, PLEASE SAY IF YOU HAVE SEEN -THE HIDDEN FIGURES TEST BEFORE,

YES / NO

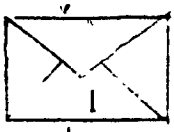
OR HAVE SEEN -MULHOLLAND'S ARTICLE ON BIOFEEDBACK.

YES / NO

(IF YES, PLEASE SAY WHEN _____)

TASK B

REMOVE



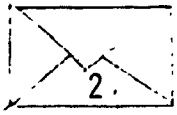
REPLACE

= HIDDEN FIGURES TEST

• USE FIGURE NUMBER ON ANSWER SHEET

10 MINUTES

REMOVE



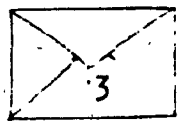
REPLACE

= STUDY MATERIAL

• FOLLOW COVERING INSTRUCTIONS

30 ~~25~~ MINUTES

REMOVE



REPLACE

= POSTTEST

• DO NOT REFER BACK TO MATERIAL

20 MINUTES

TOTAL TIME = 55 MINUTES

HIDDEN FIGURES TEST

Student I.D. _____

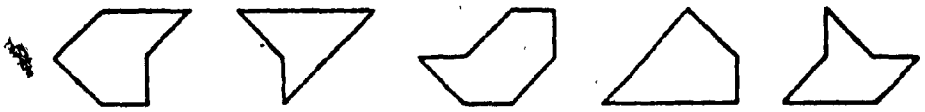
Part 1	Part 2
1. _____	17. _____
2. _____	18. _____
3. _____	19. _____
4. _____	20. _____
5. _____	21. _____
6. _____	22. _____
7. _____	23. _____
8. _____	24. _____
9. _____	25. _____
10. _____	26. _____
11. _____	27. _____
12. _____	28. _____
13. _____	29. _____
14. _____	30. _____
15. _____	31. _____
16. _____	32. _____

HIDDEN FIGURES TEST

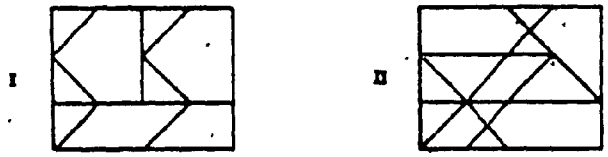
This is a test of your ability to tell which one of five simple figures can be found in a more complex pattern. At the top of each page in the test are five simple figures numbered 1 to 5. Beneath the row of figures is a page of patterns. For each pattern decide which of the five simple figures it contains and mark that alternative by the appropriate number on your answer sheet.

Note: There is only one of these figures in each pattern, and this figure will always be right side up and exactly the same size as one of the five numbered examples.

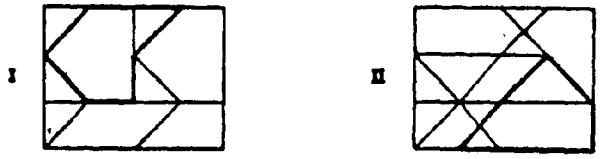
Now try these two examples:



1 2 3 4 5



The figures below show how the figures are included in the problems. Figure 1 is in the first problem and Figure 4 in the second.

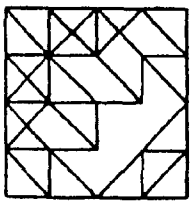


You will have 10 minutes for each of the two parts of this test. Each part has 2 pages. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

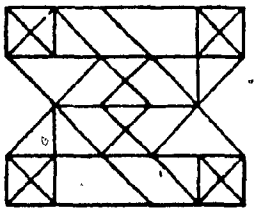
DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Part 1 (continued)

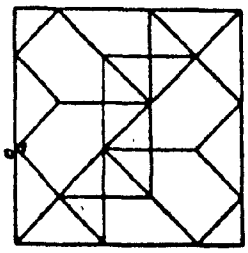
10.



11.



12.



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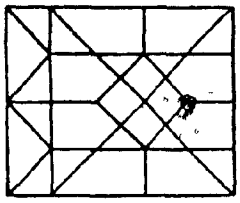
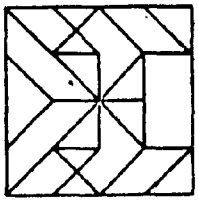


14.



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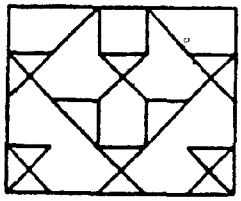
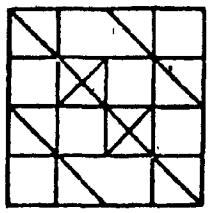


16.



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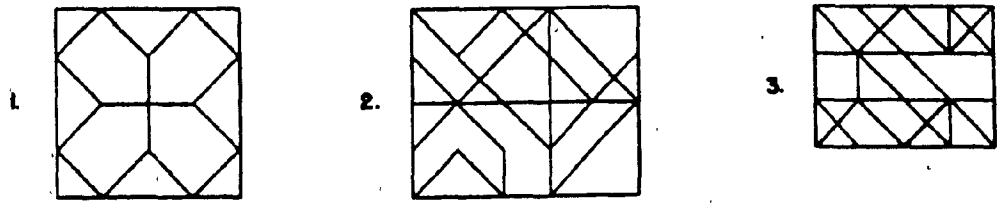
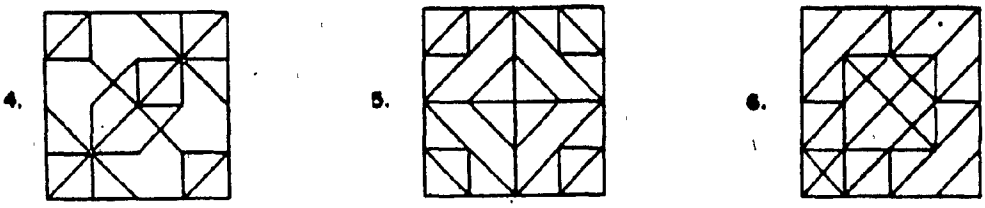
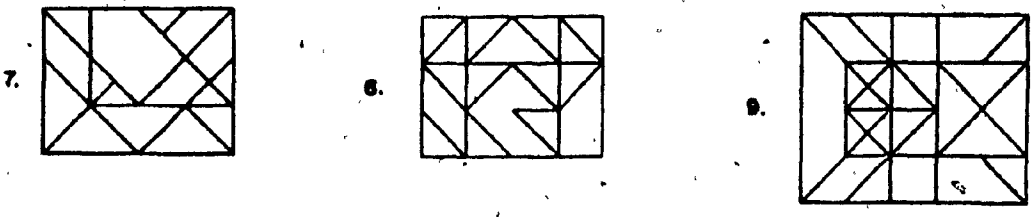
STOP.

Part 1 (10 minutes)







GO ON TO THE NEXT PAGE

TASK B (Y2)

TIME: ~~25~~ 30 Minutes (7 pages).

DIRECTIONS: (1) Study the following article.

(2) Imagine yourself as the teacher: Compose short-answer questions on the important aspects of this article (No more than 2 questions per page).

(3) Write the questions ONLY at the bottom of each page.

(4) Be prepared for a posttest!

TASK B (Y1)

TIME: ~~25~~ 30 minutes (7 pages).

DIRECTIONS: Study the following article. Use any means you like (such as highlighting, note-taking, etc.). Be prepared for a posttest!

Biofeedback technology:
Implications for teaching and learning.
by T.B. Mulholland, Psychology Today, 1973.

Biofeedback technology has arrived. Physiological processes can now be connected, with proper electronics, to light or sound displays that give a person new information about physiological happenings in his own body or brain. Though there have been some excessive enthusiasms for biofeedback, it is unquestionably an important and impressive new way to expand self-awareness, extend self-exploration, and improve self-control. Biofeedback training can serve as an adjunct to meditation, as a compliment to drug experience, as a method of treatment for some stress- or anxiety-related disorders, and as a technique for producing relaxation of mind and body.

Among professionals in the field of education who should be involved in promoting self-awareness, self-exploration and self-control, the techniques of biofeedback remain relatively unknown. Perhaps biofeedback researchers have not given enough consideration to this problem, or perhaps educators are suspicious of strangers, and resistant to new ideas. What ever the cause, a communication gap clearly exists between biofeedback and education. Educators can use biofeedback in three ways: as a vehicle to allow them to participate in the new interest in self-awareness, self-exploration, and self-control; as a general method for accentuating processes that are conducive to learning, and diminishing those that impede learning; and as a way to strengthen specific skills, such as relaxing certain muscles, or increasing certain brain rhythms.
A trip into inner space "turns on" modern youth. They recognize the uniqueness and untapped potential of their own mental processes. Introspection and contemplation are still relevant, but powerful new techniques such as drugs and meditative practices have become popular methods for expanding awareness and

exploring the mind. Any educator who fails to recognize this cultural change will necessarily lose touch with youth. Educators need such contact, yet most will not use drugs, and meditation has become "something to know about" rather than a part of educational practice. Neither mind-expanding chemicals nor Eastern meditative practice fits the contemporary American educational model - pragmatic, information oriented, and technologically biased.

Biofeedback may be an acceptable solution. Many young people share its goals of self-awareness, self-exploration, and self-control. At the same time, biofeedback uses sophisticated electronic and display devices that give a tangible and objective connection to the real world with which most of the older generation can feel comfortable.

Right now, at this early stage of its development, biofeedback provides a way of reaching goals shared by students and educators. Not too far ahead, one can see other direct applications of biofeedback technology in the learning process. Educators could use the procedure to encourage body and brain states that impede them. Most of these applications exist today in the heads of various researchers. But then, that's where all good ideas start. The speculative applications of biofeedback I propose here obviously require further research. I do not offer them as miracle methods, for by its very nature biofeedback training demands long hours of practice to yield enduring control. It requires a well-
motivated learner, patient instruction, and skillful use of sophisticated electronic instruments. As in all learning, some people learn readily; others are much less adept.

One of the obvious potential uses of biofeedback technology is attention, the basic requirement for learning. All educators want and try to get attention from their students, for without it they waste their efforts to communicate. One of the first commands the

student gets in schools is "Pay attention!" whether to visual stimuli, as in reading, or to aural stimuli, as in listening to a lecture. If attention declines to the point of insufficient arousal, unselective scrutiny, or undifferentiated reception of stimuli, the student's perception becomes less accurate and his comprehension declines.

We know surprising little about the optimum combination of attentional processes that enable a student to learn more efficiently. We don't know the proper degree of arousal for learning a list of words. We don't know whether relaxed muscles permit better learning than a high level of muscular tension. Whatever the best conditions for learning, there is clearly some critical level of attention, arousal or alertness below which learning becomes impaired.

Biofeedback researchers are currently very interested in changes in certain brain-wave rhythms that accompany increases and decreases of visual attention. When we are keenly attentive to visual stimuli, alpha rhythms, which originate in the posterior cortex of the brain, and which are measured by electroencephalograph (EEG), become irregular, and less frequent, with reduced amplitude. With biofeedback techniques, we can train students to reduce the amount of alpha produced by their brains. By getting feedback tones or lights which report when alpha waves occur, a person can learn to "turn his alpha off". By learning to regulate feedback the student also acquires skill at regulating his own attention level, at least in the presence of the feedback display.

When the feedback display itself is included in the educational process, the possibilities for feedback training multiply. For, example, instead of a tone or light signaling the absence or presence of alpha waves, an information display can provide material for the students to learn at the same time it gives feedback about his alpha production. Prototype systems already exist in our laboratory with which children can view television, filmstrips, or light

shows, regulated by their control of their own alpha rhythms, or visual attention.

These complex , multipurpose displays introduce new opportunities for reinforcements into the feedback system. For instance, a display could remain on, giving the student the information he wants, only as long as his EEG shows a low level of alpha. If too much alpha occurred, then the display could become scrambled, or an unpleasant noise might sound. This sound would prompt the students return to a state of diminished alpha or increased attentiveness.

Repeated exposure to any visual display usually causes a drop in one's EEG reaction to it, an effect called "habituation". Complex displays stand up better than simple displays, in terms of slowing the process of habituation, but even with complex displays one's attention declines after repeated exposures. A technician can chart this decline with a mathematical curve. A computer can use these "impact" and "fadeout" functions to control further the feedback displays. When attention lags, the display would change. For example, if the attentional reaction dropped off after repetitive sampling of one class of verbal stimuli, say, names of state capitals, the display could then shift to an arithmetic lesson, or an art appreciation lesson.

Such use of biofeedback technology could lead to a new category of teaching machines, controlled by physiological processes associated with attention. The technology now exists for the new man-machine interactions, and the time has arrived for examining the potential of this technology for teaching.

The emotional state of the student has perhaps as much effect as attention on the learning process. Unpleasant emotions such as anxiety, fear, or anger can impede learning, as can too much or too little emotional arousal. By using biofeedback techniques we could train a person to maintain the physiological

states associated with moderately pleasant feelings while he learned. This accomplishment would facilitate learning, remembering and retrieval.

Overactive or "hyperactive" children could also benefit from the use of biofeedback technology in education. Many teachers must now contend with children that fidget, or who waste energy by unproductive movement or by maintaining too much tension in their muscles. We already know that biofeedback training can help bring muscle relaxation under voluntary control. Educators should explore the ways that muscle-relaxation and muscle-tension training can help the overactive, jittery or restless child whose motor activity impedes his learning. Today, educators must rely on tranquilizers to do the same job. Biofeedback training offers a non-chemical alternative to this misuse of tranquilizers.

Drowsiness is another common student problem that biofeedback training might help eliminate. While drowsiness actually may be a sign of fatigue, it is often a result of classroom monotony, or high temperature or humidity. One way to avoid drowsiness is to learn physiological responses incompatible with it. By using biofeedback techniques, students can learn to increase their alertness to a level compatible with the requirements for learning. This would enable them to take notes at a monotonous lecture without drifting off into a state of drowsiness.

In addition to its potential for solving such general problems as attention, biofeedback training can also counteract specific processes that hinder learning. For example, students sometimes subvocalize when they read, an activity which, though not resulting in audible speech, does slow down their reading rate, and may act as a fatiguing interference. Two biofeedback experiments on this problem have been reported by Curtis Hardyck and Lewis Petrinovich in

1969. They first worked with a sample of 50 college students at UC, Berkeley. The experimental subjects learned to eliminate subvocal activity within the first hour of treatment. The control group, which received no feedback, showed no change over three recording sessions. After the experiment, the control group received the feedback treatment, and learned to inhibit their subvocal activity also. Only two out of the 50 subjects failed to respond to the biofeedback conditioning.

Hardyck and Petrinovich achieved similar results with a group of 30 high-school students, although they did take longer to learn. they needed as many as three sessions before they eliminated subvocal activity. When the researchers correlated IQ with the number of sessions required for learning, they found that average and above-average high-school students learned as quickly as college students. Subjects with below average IQ scores required many more sessions to eliminate subvocal activity, and follow-up studies conducted the following year showed that they had reverted to subvocalization. The students with average and above-average IQ scores continued to read without subvocalization.

Hardyck and Petrinovich concluded that the treatment of subvocal speech might help high-school and college populations improve their reading skills. If educators used the technique together with established reading improvement methods, these students might learn to read faster and still retain their comprehension. On the other hand, perhaps we should encourage students who have difficulty comprehending even relatively low-level material, to subvocalize. Teachers could reverse the treatment sequence to insure that they learn how to subvocalize, and to insure maximum possible comprehension. Of course, further research is necessary before we understand all aspects of the relationship between subvocal speech and reading speed.

Biofeedback could be creatively used to teach human psychology, and the physiology of the higher

nervous functions. The student could be his own laboratory material, and do experiments on himself. One would surely want to avoid gimmickry, but a balanced approach could make fruitful use of biofeedback technology as an adjunct to classroom discussion and reading.

It should be recognized by now that, despite gigantic expenditures for mass education in recent years, there is still a great deal we don't know about the learning process. Many biofeedback researchers have already demonstrated the potential value and uses of their technology for education. It's now time for educators to take advantage of these opportunities. By intelligent and creative application of the new biofeedback technology, the educational community may achieve major advances in the processes of communicating, teaching and training.

TASK B (Y3)

TIME: 25 minutes (7 pages)

DIRECTIONS: Study the following article. Answer questions as they appear in the text. Be prepared for a posttest!

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Implications for teaching and learning.
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Biofeedback technology has arrived. Physiological processes can now be connected, with proper electronics, to light or sound displays that give a person new information about physiological happenings in his own body or brain. Though there have been some excessive enthusiasms for biofeedback, it is unquestionably an important and impressive new way to expand self-awareness, extend self-exploration, and improve self-control. Biofeedback training can serve as an adjunct to meditation, as a compliment to drug experience, as a method of treatment for some stress- or anxiety-related disorders, and as a technique for producing relaxation of mind and body.

Among professionals in the field of education who should be involved in promoting self-awareness, self-exploration and self-control, the techniques of biofeedback remain relatively unknown. Perhaps biofeedback researchers have not given enough consideration to this problem, or perhaps educators are suspicious of strangers, and resistant to new ideas. What ever the cause, a communication gap clearly exists between biofeedback and education. Educators can use biofeedback in three ways: as a vehicle to allow them to participate in the new interest in self-awareness, self-exploration, and self-control; as a general method for accentuating processes that are conducive to learning, and diminishing those that impede learning; and as a way to strengthen specific skills, such as relaxing certain muscles, or increasing certain brain rhythms.

* List 3 ways that educators can use biofeedback for learning _____

_____

_____

_____

A trip into inner space "turns on" modern youth. They recognize the uniqueness and untapped potential of

their own mental processes. Introspection and contemplation are still relevant, but powerful new techniques such as drugs and meditative practices have become popular methods for expanding awareness and exploring the mind. Any educator who fails to recognize this cultural change will necessarily lose touch with youth. Educators need such contact, yet most will not use drugs, and meditation has become "something to know about" rather than a part of educational practice. Neither mind-expanding chemicals nor Eastern meditative practice fits the contemporary American educational model - pragmatic, information oriented, and technologically biased.

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Right now, at this early stage of its development, biofeedback provides a way of reaching goals shared by students and educators. Not too far ahead, one can see other direct applications of biofeedback technology in the learning process. Educators could use the procedure to encourage body and brain states that impede them. Most of these applications exist today in the heads of various researchers. But then, that's where all good ideas start. The speculative applications of biofeedback I propose here obviously require further research. I do not offer them as miracle methods, for by its very nature biofeedback training demands long hours of practice to yield enduring control. It requires a well-
motivated learner, patient instruction, and skillful use of sophisticated electronic instruments. As in all learning, some people learn readily; others are much less adept.

* List 4 requirements for successful biofeedback training _____

_____

_____

_____

One of the obvious potential uses of biofeedback technology is attention, the basic requirement for learning. All educators want and try to get attention from their students, for without it they waste their efforts to communicate. One of the first commands the student gets in schools is "Pay attention!" whether to visual stimuli, as in reading, or to aural stimuli, as in listening to a lecture. If attention declines to the point of insufficient arousal, unselective scrutiny, or undifferentiated reception of stimuli, the student's perception becomes less accurate and his comprehension declines.

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* When alpha rhythms decrease, then attention increases. TRUE /FALSE

With biofeedback techniques, we can train students to reduce the amount of alpha produced by their brains. By getting feedback tones or lights which report when alpha waves occur, a person can learn to "turn his alpha off". By learning to regulate feedback the student also acquires skill at regulating his own attention level, at least in the presence of the feedback display.

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shows, regulated by their control of their own alpha rhythms, or visual attention.

These complex , multipurpose displays introduce new opportunities for reinforcements into the feedback system. For instance, a display could remain on, giving the student the information he wants, only as long as his EEG shows a low level of alpha. If too much alpha occurred, then the display could become scrambled, or an unpleasant noise might sound. This sound would prompt the students return to a state of diminished alpha or increased attentiveness.

* Briefly explain the use of biofeedback to tangibly reinforce learning.

Repeated exposure to any visual display usually causes a drop in one's EEG reaction to it, an effect called "habituation". Complex displays stand up better than simple displays, in terms of slowing the process of habituation, but even with complex displays one's attention declines after repeated exposures. A technician can chart this decline with a mathematical curve. A computer can use these "impact" and "fadeout" functions to control further the feedback displays. When attention lags, the display would change. For example, if the attentional reaction dropped off after repetitive sampling of one class of verbal stimuli, say, names of state capitals, the display could then shift to an arithmetic lesson, or an art appreciation lesson.

Such use of biofeedback technology could lead to a new category of teaching machines, controlled by physiological processes associated with attention. The technology now exists for the new man-machine interactions, and the time has arrived for examining the potential of this technology for teaching.

The emotional state of the student has perhaps as much effect as attention on the learning process. Unpleasant emotions such as anxiety, fear, or anger can impede learning, as can too much or too little emotional arousal. By using biofeedback techniques we could train a person to maintain the physiological

states associated with moderately pleasant feelings while he learned. This accomplishment would facilitate learning, remembering and retrieval.

* How might biofeedback about our emotions be used to facilitate learning?

Overactive or "hyperactive" children could also benefit from the use of biofeedback technology in education. Many teachers must now contend with children that fidget, or who waste energy by unproductive movement or by maintaining too much tension in their muscles. We already know that biofeedback training can help bring muscle relaxation under voluntary control. Educators should explore the ways that muscle-relaxation and muscle-tension training can help the overactive, jittery or restless child whose motor activity impedes his learning. Today, educators must rely on tranquilizers to do the same job. Biofeedback training offers a non-chemical alternative to this misuse of tranquilizers.

Drowsiness is another common student problem that biofeedback training might help eliminate. While drowsiness actually may be a sign of fatigue, it is often a result of classroom monotony, or high temperature or humidity. One way to avoid drowsiness is to learn physiological responses incompatible with it. By using biofeedback techniques, students can learn to increase their alertness to a level compatible with the requirements for learning. This would enable them to take notes at a monotonous lecture without drifting off into a state of drowsiness.

In addition to its potential for solving such general problems as attention, biofeedback training can also counteract specific processes that hinder learning. For example, students sometimes subvocalize when they read, an activity which, though not resulting in audible speech, does slow down their reading rate, and may act as a fatiguing interference. Two biofeedback experiments on this problem have been reported by Curtis Hardyck and Lewis Petrinovich in

1969. They first worked with a sample of 50 college students at UC, Berkeley. The experimental subjects learned to eliminate subvocal activity within the first hour of treatment. The control group, which received no feedback, showed no change over three recording sessions. After the experiment, the control group received the feedback treatment, and learned to inhibit their subvocal activity also. Only two out of the 50 subjects failed to respond to the biofeedback conditioning.

* Biofeedback is an effective technique for treatment of subvocalization. TRUE / FALSE

Hardyck and Petrinovich achieved similar results with a group of 30 high-school students, although they did take longer to learn. they needed as many as three sessions before they eliminated subvocal activity. When the researchers correlated IQ with the number of sessions required for learning, they found that average and above-average high-school students learned as quickly as college students. Subjects with below average IQ scores required many more sessions to eliminate subvocal activity, and follow-up studies conducted the following year showed that they had reverted to subvocalization. The students with average and above-average IQ scores continued to read without subvocalization.

Hardyck and Petrinovich concluded that the treatment of subvocal speech might help high-school and college populations improve their reading skills. If educators used the technique together with established reading improvement methods, these students might learn to read faster and still retain their comprehension. On the other hand, perhaps we should encourage students who have difficulty comprehending even relatively low-level material, to subvocalize. Teachers could reverse the treatment sequence to insure that they learn how to subvocalize, and to insure maximum possible comprehension. Of course, further research is necessary before we understand all aspects of the relationship between subvocal speech and reading speed.

Biofeedback could be creatively used to teach human psychology, and the physiology of the higher nervous functions. The student could be his own laboratory material, and do experiments on himself. One would surely want to avoid gimmickry, but a balanced approach could make fruitful use of

biofeedback technology as an adjunct to classroom discussion and reading.

It should be recognized by now that, despite gigantic expenditures for mass education in recent years, there is still a great deal we don't know about the learning process. Many biofeedback researchers have already demonstrated the potential value and uses of their technology for education. It's now time for educators to take advantage of these opportunities. By intelligent and creative application of the new biofeedback technology, the educational community may achieve major advances in the processes of communicating, teaching and training.

* Very briefly, what might the educational community achieve with biofeedback?

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POSTTEST B: (Y2)

1. Very briefly, why is biofeedback relatively unknown among educators?

2. List 3 ways that educators can use biofeedback technology.

3. Biofeedback fits a contemporary educational model?
TRUE / FALSE

4. List 4 requirements for successful biofeedback training.

5. When alpha rhythms decrease, then attention increases. TRUE / FALSE

6. How can you learn to regulate your attention with biofeedback?

7. Briefly explain the use of biofeedback to tangibly reinforce learning.

8. Define the concept of "habituation".

9. How might biofeedback about our emotions be used to facilitate learning?

10. Name one common learning problem that could be eliminated by biofeedback techniques.

11. If readers subvocalize, then reading rate decreases. TRUE / FALSE

12. Biofeedback is an effective technique for treatment of subvocalization. TRUE / FALSE

13. What subjects matters could be taught with biofeedback?

14. Very briefly, what might the educational community achieve with biofeedback?