

THE USE OF INSTRUCTIONAL
ILLUSTRATIONS TO ACCOMPANY
PROSE AND THE
LEARNING EFFECTS
ON UNIVERSITY STUDENTS

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DEDICATION

To my husband, Bob - with love and gratitude.

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ABSTRACT

THE USE OF INSTRUCTIONAL ILLUSTRATIONS TO ACCOMPANY PROSE AND THE LEARNING EFFECTS ON UNIVERSITY STUDENTS

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This study examined the effects of functionally designed pictures on prose learning. The mathemagenic effects of pictures and the effects of pictures on memory over time were also examined. In order to acknowledge the practical aim of educational research, methodological guidelines for creating more representative experiments were applied. The subjects were 78 undergraduate students who were randomly assigned to one of four experimental conditions: prose + pictures, prose only, prose + pictures (overt) and prose + pictures (covert). Before the experiment began, subjects were asked to complete the Nelson Denny Reading Test (NDRT). An immediate posttest was administered followed by three and six week delayed posttests.

A regression analysis indicated that the NDRT was an excellent predictor of posttest scores. A repeated measures analysis of the multiple choice dependent measure revealed greater overall effects for the prose + pictures group when compared with the prose + pictures (overt) group. Repeated measures analysis of the free recall dependent measure indicated a substantial drop in scores over time for the prose only group.

Results of this study indicated differential advantages for illustrated text according to the nature of the dependent measure. Additionally, mathemagenic strategies appeared to interfere with learning in more naturalistic settings.

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CHAPTER 1

Introduction

While the time may be far off when we "can identify an instructional problem and then faultlessly select the proper instructional mix to solve it" (Allen, 1971, p. 12), the educational technologist, among other things, is challenged to continue working toward laying a foundation for a theory of instructional media. Indeed, a brief look at the history of media research shows that we are on the right track, for instructional media research has matured.

Prior to 1950, research was characterized by evaluative comparisons where, for example, learning from film was compared to learning from an instructional presentation. A more systematic approach to problems in instructional media arose in the 50's with the military research programs on instructional film and programmed instruction. During this time, (mid 50's to mid 60's) with the advent of educational television, the cycle of evaluative research was repeated as researchers aimed at demonstrating the value of television as a substitute for conventional teaching. While the more public and commercial interests of programmed instruction and educational television rose and fell, a base of solid research was being established (Allen, 1971).

This base has been built upon the interest created in instructional media research and the hypotheses generated by the early (although often evaluative and nonscientific) studies. In addition, the intensive military studies used a systematic approach to research as they dealt with a number of psychological, production, and utilization variables in their film and programmed instruction research. This helped to refine educational research questions and illustrated the folly of assigning generalized and all inclusive attributes to specific classes of media under all conditions (Allen, 1971).

Today, instructional media research is slowly building upon the base supplied by its forerunners as it reaches for useful theories of instructional media. This is evidenced in the development of two research areas which have important implications for future progress: three-way interaction studies and research on the structure and sequencing of instruction. Regarding the former, discussions by Salomon & Snow (1968), and Salomon (1970) illustrate an attempt to discover the unique attributes of instructional media and their relationships to the performance of particular psychological functions with different kinds of learners. The latter research area is contributing to our knowledge of the proper use of instructional materials. Some results of this work are evident in the hierarchical characteristics of content (eg. Schallert, 1976, Shimmerlik, 1978, and Meyer, Note 1) and the use of advance organizers (Ausubel, 1960 and

Barnes & Clawson, 1975 followed by Lawton & Wanska's (1977) reply and Mayer & Bromage (1980) to name a few. Other factors relating to learner actions that lead to increased learning are also being investigated. These include the use of headings, behavioral objectives, elaboration techniques and questioning strategies. Applications of this work are becoming evident in many high school and university textbooks.

There is a growing research interest in the effects on learning of the most widely used supplement to printed instruction - pictures (Brody & Legenza, 1980). In the past, pictures were included in instructional textbooks because it was thought that they increased learner interest and added attractiveness to the printed page. This general sentiment promoted the design of pictorial materials based on aesthetic criteria (Levin & Lesgold, 1978). There is mounting empirical evidence however that pictures can also add to the instructional effectiveness of the printed page. The current study focused on this (picture/prose) aspect of media research.

As with other media research, picture research has its roots in two areas of investigation; the psychological effects of illustrations and the proper instructional use of illustrations. Information about the influence of pictures on learning began with the progress in understanding the psychological effects of pictorial stimuli. Knowlton's (1966) description of logical and analogical pictures helped

to develop operative conceptions of pictorial stimuli. In the last 15 years, headway has been made in the area of pictorial information and storage. Shepard (1967) discovered the large capacity of pictorial recognition memory and Bower (1972) illustrated the surprising efficacy of mental imagery for verbal learning. Paivio's (1971) research provides evidence that combined encoding (eg pictures and words) leads to optimal learning.

In studying the retentive effects of pictures, Peeck (1974) showed that memory performance is better with pictures than their verbal counterparts. Split-brain studies (Wittrock, 1978) supply physiological evidence of the separate storage of verbal-sequential information in the left brain and spatial pictorial-simultaneous information in the right brain. These works suggest that illustrations have an important psychological effect on learning and may provide instructional effectiveness far beyond their interest generating and motivational functions.

In addition to investigations of the psychological effects of pictures on learning, other research is studying the instructional effectiveness of particular attributes of illustrations. Duchastel (1978) and Levin (1979) have begun to sort out the functions that illustrations can perform and to identify the ways in which illustrations should be designed and used in each case. Between them, they have proposed eleven functions of pictures in prose. Duchastel's three global functions, (motivational, explicative and

retentional) encompass Levin's eight more specific functions, (decoration, renumeration, motivation, reiteration, representation, organization, interpretation and transformation). According to these authors, pictures based solely on aesthetic criteria do not contribute to improved prose learning. They suggest that "prose pictures" designed to, for example, explain or organize text information, will contribute to prose learning. Duchastel's emphasis on a "systematic application of an illustrative strategy" (1978, p. 30) is a progressive step toward further refinement of picture/prose research and ultimately, a theory of instruction within the limits of the medium.

Included in investigations aimed at improving the instructional effectiveness of the printed page is the developing area of mathemagenic research. The term "mathemagenic" was coined by Rothkopf (1970) to refer to student behavior relevant to the achievement of instructional objectives. Rothkopf contends that, in a sense, the student has complete veto power over learning, since without some activity on his part the instructional objectives can never be achieved - "You can lead a horse to water but the only water that gets into his stomach is what he drinks" (1970, p 400).

Research on mathemagenic behavior has almost exclusively, considered instructional strategies using the print medium. This has resulted in some valuable instructional design information, particularly with research on advance

organizers and questioning strategies. Results of recent studies illustrate the possibility that pictures in texts can also serve mathemagenic functions by encouraging the learner to overtly or covertly review just read material (Snowman & Cunningham, 1973 and Brody & Lagenza, 1980).

This more detailed, analytical approach to research on text illustrations is helping to add to our knowledge about the instructional effectiveness of pictures and how they function psychologically. The nature of this research however, often necessitates a detachment from the real world of education. Salomon & Clark (1977) point out that as media research emphasizes internal validity, representativeness, or external validity is often lost. Thus, in spite of the improved quality of educational research (including of course research on text illustration) outcomes often fall short of accomplishing the important objective of improving educational practise.

Statement of the Problem

This thesis attempted to apply the knowledge gained from educational research on: pictorial information processing, picture functions and mathemagenic behavior to the design of an instructional segment for a specific group of adult learners. In order to acknowledge the practical aim of educational research, some recent methodological guidelines for creating more representative educational research were also considered.

As educational research moves away from attempts at global generalizations (Snowman, 1978), it was hoped that this experiment would contribute to knowledge concerning the specific area investigated.

CHAPTER 2

Literature Review

The three major objectives of media research are:

- (1) To increase our understanding of the psychological effects of media on learning.
- (2) To obtain knowledge about the instructional effectiveness of a chosen medium.
- (3) To enhance the practise of education through providing and evaluating improved media, materials, procedures and technologies.

In this chapter, each of these areas will be examined in the context of picture/prose research. Finally, this study will attempt to address these aims of educational research in the design of an instructional segment.

Picture/Prose Research

Evidence of a Functional Role for Pictures

As mentioned earlier, recent research has made substantial headway in the area of pictorial information processing. In his review of research on how adults learn from pictures, Snowman (1973) cites consistent increases in performance with pictorial stimuli, as opposed to corresponding written stimuli in paired associate learning research. Pictorial recognition memory research is

characterized by the remarkable accuracy (far exceeding typical verbal performance) that people exhibit in recognizing pictures they have seen before. There is little doubt then, that adults remember pictures better than words. The effects of pictures on adults prose learning, however have not been established to any extent. This is due in part to the scarcity of research addressing the question. Indeed, the bulk of picture/prose research has concerned children's learning.

In her review of the research on illustrations in books for children, Concannon (1975) concluded that "pictures serving as motivating factors actually do not contribute significantly to the child's ability to decode" (p. 256). Many of these early studies compared standard textbooks with and without the existing illustrations (eg. Weintraub (1960), covered the illustration for the no picture condition). These results discredit the use of expensive text illustrations for motivational purposes only and point to the need for a more functional approach to the design of text illustrations (i.e. based on their relation to the learning process).

Levin & Lesgold (1978) applied a systematic approach to the review of children's picture/prose literature, the bulk of which appeared after Concannon's review. An important aspect of their review is the consolidation of results from studies which did employ a functional approach to the selection of illustrations. The function of pictures in the Levin and Lesgold review was to overlap the story content in order to

"concretize" the ideas in the story. This function is described by Duchastel (1978) as explicative and by Levin (1979) as reiterative or representational. Levin and Lesgold concluded that there is solid evidence that pictures facilitate prose learning in children.

The Levin & Lesgold review holds promise for the selection of text illustrations based on their relation to the learning process. Most of these children's studies, however, use prose materials and methodologies which make generalization to adult learning difficult, if not impossible. Typically, the children's studies examined the learning effects of pictures accompanying story-like prose presented orally. Results of these studies supply little information regarding the learning effects of pictures accompanying expository, often dry prose read silently - the usual adult learning situation. The following works provide some information regarding the psychological functions of pictures in adult prose learning and the related implications for instructional design.

Psychological Functions of Pictures

The work of Alan Paivio on the role of higher mental processes in human learning (1971) supplies perhaps the strongest psychological evidence of the potential learning benefits of pictures in prose. According to his "dual-coding" theory, there exists two independent storage systems, one for verbal symbolic processes and the other for non-verbal imagery processes. This hypothesis, which continues to gain empirical

support, assumes that pictures are encoded both as visual images and as verbal codes whereas words are not always encoded in a dual manner.

Concrete words which easily evoke referent images are encoded in a similar fashion to pictures (i.e. dual codes). The increased availability of both codes (or coding redundancy) increases the probability of item recall because the response can be retrieved from either code. More abstract words however, do not evoke referent images and are therefore encoded only verbally making retrieval more difficult. Thus, memory performance increases as a function of the availability of both codes (from abstract words to concrete words, to pictures presented alone, to pictures plus words).

Although few in number, the following studies provide additional information regarding the psychological functions of pictures in prose for adult learning. Using undergraduates, Royer and Cable (1976) studied the effects of five versions of an initial physics passage on the comprehension of a subsequent abstract passage related in content to the first. These five versions were, abstract with analogies, concrete, unembellished abstract or a control passage. The first three conditions were significantly more effective than the remaining two in facilitating recall of the ensuing abstract text. Of particular importance here was the fact that the illustrated passage was as effective a "knowledge bridge" as the concrete passage and the passage containing verbal analogies.

Bernard, Petersen and Ally (1981) also found similar "knowledge bridge" effects of an image and its verbal counterpart. Using content from the sciences, they found no immediate effect with a verbal and pictorial organizer versus no organizer, but on a delayed test (2 weeks later) significant differences were found between the organizer treatments, control, and placebo groups. These findings provide support for Paivio's (1971) work on the retentive effects of pictures over time.

In the two above studies, pictures, whether alone or embedded in a pre-passage, were used for the same general purpose. When placed before the material to be learned, they served a retentional function (Duchastel, 1978) or in Levin's (1979) terminology, an interpretation function. These functions are supported by Ausubel's (1960) advance organizer theory that to understand new knowledge, one must relate it to existing knowledge. Results of these studies are important in that they point to an instructional role for pictures in adult prose learning.

Finally, a study using undergraduates was conducted by Schwartz, Kulhavy, and Finlay (Note 2). They investigated the learning effects of spatially organized verbal material embedded in a map. On a map of an imaginary island, 16 features were either spatially referenced (map group), listed outside the island (list group), or excluded from the map (control group). All subjects studied the map before they listened to a "sensible narrative" about events on the

island. The map group significantly outperformed the list and control groups on the factual recall of the narrative. These authors feel that their results support the contention that when the spatial arrangement of map information is meaningfully related to passage content, people appear to use the specific figural information as a device for storing related textual information. Levin's (1979) description of the function of the organization image in prose learning very closely approximates the function Schwartz, Kulhavy and Finlay achieved with their map.

Functional Design of Pictures for Instructional Texts

This evidence from psychological investigations of the effects of pictures on prose learning provides guidelines for the design of pictures for instructional texts. The current study attempted to apply some of these guidelines to the design of an instructional segment.

The above studies and, in fact, most childrens' studies have emphasized materials based on math and the sciences. In order to represent other content studied in most universities, this study used content from the Humanities. The prose passage used in this experiment was a comparative discussion of three major theories of learning. As dictated by the nature of the passage, illustrations were designed to correspond to each theory.

Organizational Function

Due to the comparative nature of the passage, pictures were designed to serve an organizational function (Levin, 1979). In order then to make the text information more integrated, major concepts of each of the three theories discussed in the text were placed within the corresponding picture. In keeping with the results of the Schwartz, Kulhavy and Finlay study (Note 2), spatial arrangement of these concepts were meaningfully related to the passage content.

Representation Function

Levin (1979) and Duschastel (1978), in outlining their functions for pictures in prose, make it clear that these functions are not mutually exclusive. Thus, the orchestration of roles is an important factor when designing pictures to illustrate text. In addition to the organizational role discussed above, two other functions were served by the pictures in this study as dictated by the passage character. Due to the abstract nature of the passage content, (i.e. learning theory), pictures also served a representation function. According to Levin, a representational picture provides a second modality through which the text information can be represented in the brain (i.e. visually in the right brain and verbally in the left). This picture function helps to render abstract prose more concrete (Paivio, 1971). According to Paivio, this dual-coding of information would also serve to increase the strength of the memory trace. Thus, the representation function of the pictures should serve to aid long term retention of the prose.

Transformation Function

Until recently, little, if any, attention has been paid to pictures serving a transformation function. According to Levin, these picture types serve as mnemonic devices and are hypothesized to yield the very greatest prose learning benefits by making text information more memorable. Based on associative learning theories, a nominal stimulus is "transferred" into something more memorable (e.g. picture). The transformation type of picture is hypothesized to be particularly appropriate for easy to understand but difficult to remember prose. This function was utilized here to mnemonically code the major characteristics of each theory.

Retention Across Time

Given the psychological research evidence of the retentive effects of pictures over time, a functional picture designed to aid learning of prose information, when reproduced at recall, could assist the learner in remembering elements of that information. In order then to investigate the effects of pictures on prose learning over time, the current study was designed to measure immediate and long term retention. One problem with this method of analysis is that generalizations are limited by the confounding of history in the intervals between tests (Snow, 1974). This history effect exists in nature however, and is therefore representative of most school learning situations.

Mathemagenic Effects of Pictures

While the functional design of pictures is an important element in any picture/prose study, this alone cannot ensure prose learning effects. What the subject does with this carefully designed aid to processing determines, to a great extent, what he will learn (remember the horse and the water). Rothkopf (1970) has defined three classes of mathemagenic activities. Classes I and II are directly observable and controllable, consisting of orienting the student into the vicinity of the educational objects and having him procure them. Class III activities refer to what is commonly called reading and consist of the translation, segmentation and processing of instructional materials. These activities are not as observable or controllable. Although Rothkopf applies his theory to learning from reading, mathemagenic activities are of particular concern to this study which investigates learning from pictures.

There are a few studies using college students which do shed some light on the mathemagenic functions of pictures in prose. Snowman and Cunningham (1973) conducted the first investigation of the use of pictorial illustrations within a mathemagenic framework. As measured by factual recall, they found that having students generate their own pictures can have the same mathemagenic effect as answering questions after a learning segment. The authors postulated that direction to overtly answer a question or generate a picture forced the subject to review what he had just read in order to respond.

Mathemagenic effects were also found by Brody and Legenza (1980). In their study, overview type pictures or pictures depicting a specific incident were placed before or after a narrative passage. When placed after the passage, both picture types resulted in significant increases in learning of factual information and content specific incidences. These authors also suggested that pictures served a review function in that they promoted the covert rehearsal of the just read materials.

A final study involving mathemagenic behavior and of particular relevance to this thesis was conducted by Dean and Kulhavy (1981). They employed a strategy involving the manipulation of the degree to which subjects were forced to process a spatial organizer (map) and measured the resulting effect on comprehension of the accompanying prose passage. Results showed that subjects who were required to overtly label each feature on the map outperformed subjects who processed the same map with the features already included. These results support the interpretation of Snowman and Cunningham (1975) that learning is facilitated when overt responses are required; providing such a response is relevant, it increased attention to that which is to be learned.

Thus, students may not process a given aid to prose learning merely because it is there. In order for the deeper, Class III mathemagenic behavior to occur, the learners' attention must first be drawn to the aid. The above studies support Rothkopf's contention that deeper mathemagenic activities

can be modified by direction. The current study took this into consideration by attempting to influence mathemagenic behavior in the processing of the pictorial aids. This was done for some experimental groups by placing a question under each picture. This question was intended to encourage subjects to look at the illustration. In an attempt to influence the degree to which subjects processed the pictures (i.e. engaged in mathemagenic activity), directions to overtly answer the questions were included for one experimental group.

Regarding the positioning of pictures in prose, these studies found that a pictorial aid stimulated mathemagenic activity in the post-condition. It caused the learner to overtly or covertly review just read material and attempt to tie it in with the picture (Brody & Legenza, 1980), construct a picture (Snowman & Cunningham, 1975) or label a picture (Dean & Kulhavy, 1981). In well controlled studies, it is easy to dictate when a subject views a picture. A student reading his text at home however, may demonstrate numerous idiosyncratic behaviors which could thwart any intended positioning effects of pictures (eg. leafing through to "see" the pictures before reading).

In keeping with the practical aims of this study, pictures were not placed in "pre" and "post" conditions but were interspersed. Interspersion represented the layout of most college texts and also acknowledged individual student learning styles. Based on formative evaluation of the

materials, an attempt was made to place the pictures appropriately. They were placed so as not to interfere with the presentation of verbal ideas and break the subjects "train of thought". In order to adhere somewhat to Rothkopf's guidelines, the corresponding picture appeared after presentation of the main idea of each theory.

Methodological Issues in Educational Research

While the improved quality of educational research has begun to deepen our understanding of the psychological functions of pictures and how to use pictures in instruction, other aspects of the research discussed make practical application of this new knowledge difficult (eg. unrepresentative passages). Salomon and Clark (1977) described this lack of representativeness as the major reason for the failure of educational research to improve educational practice:

One of the major purposes of media research is to deepen the understanding of what functions media attributes can accomplish for different tasks. It must emphasize, first and foremost internal validity. If the researcher wishes to ascribe a particular effect or function to a particular attribute, neatness of experimental comparison is necessarily called for. This calls for carefully arranged experiments in which only the desired variables are allowed to vary according to the researcher's rationale. However, when such is carefully done according to the canons of methodology, something of utmost importance is lost - namely, representativeness of external validity. (Salomon & Clark, 1977, p. 106)

Identification of this need for more representative research began with Brunswick's concern that laboratory psychological research which isolated perceptual cue variables from their natural context was misleading (Snow, 1974). Brunswick felt that the experimenter must adapt his research methodology to fit the phenomenon rather than trying to force the phenomenon to adapt to the experimenter. Brunswick's ideas, however, remain largely ignored in experimental research. These methodological issues were relevant to the aim of this thesis in that they offered valuable guidelines for creating more representative educational experiments.

A number of papers have been addressed to this issue (eg. Bracht & Glass, 1968, Shulman, 1970, and Snow, 1974). These reviewers agree that true representative design, with regards to population validity for example, is practically unattainable due to the inaccessibility of the target population. As a compromise, Snow (1974) offers helpful strategies for quasi-representative designs. Below is a discussion of how some of these strategies were applied to the methodology of this thesis.

Intraexperiment observation - It is quite possible that the habitual note taker or underliner would find treatments requiring passive reading unnatural, even disruptive. In the Brody & Legenza (1980) study, for example, subjects were not allowed to mark pages or turn back. When encouraged to use their usual study habits, approximately 75% of pilot test subjects for the current study underlined or took notes.

Thus, in order to reduce the artificiality of study conditions in the current investigation, subjects for the main experiment were not restricted in the way they studied the passage.

Extraexperiment observation - Snow (1974) notes that many experiments are inserted into midyear school days with no thought to the content into which they are intruding. Often, the material to be learned in the experiment is not continuous with the subject matter of the course. In order to avoid these novelty effects, the subject matter was relevant to the course content of the Organizational Behavior classes used. In addition, every attempt was made to insert this relevant material at the appropriate time in the school year as deemed by the course instructors.

Subject aptitudes - In spite of the fact that subject aptitudes may have substantial effects on subsequent performance on learning tasks, most research in the realm of prose processing has rarely taken aptitudes into account (Gellner, Note 3). The investigator should at least include those student variables which are reasonably relevant to his experimental and dependent variables (Snow, 1974). This is important for adding information about generalizations and also helps to explain the effects achieved (Bernard, Note 4). Reading ability is one aptitude that has been isolated as a powerful contributor to overall variance amongst subjects (Gellner, Note 3) and is particularly relevant to the present study of prose learning. Thus, the Nelson Denny Reading Test was administered as an aptitude measure in this study.

Duration of treatment - Frequently, experiments are reported in which subjects have been engaged with the learning material for only a few minutes (Snow, 1974). This is another area where conventional research is almost consistently unrepresentative. Ideally, having subjects study the passage at home as they would most reading assignments would provide the most representative duration of treatment. Although not practical here due to the possibility that some subjects would not "do their homework", this more representative duration of treatment is a methodological avenue which should be explored in the future. As a compromise to Snow's advice and in an attempt to avoid rushing subjects, a strict time limit was not announced. A pilot test indicated that 20 minutes was adequate reading time.

Analysis of treatment - With respect to the analysis of treatment, there are two areas where current research lacks representativeness. One limitation of the research to date is that most studies measure learning in terms of factual recall alone. Perhaps the most important factor in determining how much subjects retain from a prose passage is comprehension (eg. Royer & Cable, 1975) rather than mere factual regurgitation. In this study, total free recall and comprehension was measured along with factual recall.

Secondly, there is scant research attention given to retention across time. "It is of little value to the practicing educator to discover that a given aid has only an effect on immediate learning" (Gellner, Note 3). An important practical aspect of this study was the investigation of the effects that pictures have on memory and comprehension over time. Retention data was collected immediately after subjects read the passage and three and six weeks later.

Hypotheses

This study examined the effects of functionally designed pictures on prose learning. The mathemagenic effects of the manipulation of the degree to which subjects were encouraged to process the pictures and the effects of the pictures on memory over time were also examined. Based on the relevant theory and related research, the following hypotheses were made to guide the experiment:

1. It was expected that subjects receiving pictures embedded in a prose passage would display greater overall learning of the passage than subjects who received the passage alone. The functional design of the illustrations was expected to facilitate the memory and comprehension of the accompanying prose.

2. It was expected that this increased learning effect (for groups receiving pictures interspersed in the passage) would be greatest in the delayed posttest. The dual-coding of information was expected to aid long term retention by concretizing the information thus making it more memorable.
3. It was expected that performance would be affected by the degree to which subjects were encouraged to attend to and process the pictures (i.e. engage in mathemagenic activity). It was thought that subjects who were directed to overtly respond to the pictures would engage in a deeper level of processing and consequently outperform subjects in the covert response and no question conditions.

In closing, it was intended that application of the previously discussed methodological guidelines would serve to make any outcomes of this educational research more applicable to practise.

CHAPTER 3

Method

Sample

The experimental sample for this study consisted of two intact Organizational Behavior classes at Concordia University. For the immediate posttest, this sample comprised 78 subjects. This number was reduced to 59 for the three week delayed posttest and 58 for the six week delayed posttest due to student absence. Approximately 80% of subjects assessed their prior knowledge of the passage content as low to mildly familiar. Twenty percent reported slightly greater familiarity. No one indicated expert knowledge of the passage contents. Subjects ranged in age from 19 to 27 years with a mean age of 21 years. The sample contained 39 females and 39 males. Approximately 50% of subjects listed their mother tongue as English, 20% as French, 20% as Italian and 10% listed another language besides English, French or Italian. The mean score assessed by the Nelson Denny Reading Test was 29.4 which placed this sample as a whole on the 29th percentile in reading ability compared with the norms of the test.

Experimental Design

The design of this experiment was a four types of presentation (prose + pictures vs. prose only vs. prose +

pictures with overt response questions vs. prose + pictures with covert response questions) x three test intervals (immediate vs. delay 1 vs. delay 2) factorial design (see Figure 1). This design also included the possible use of a covariate.

Materials

Instrumentation

Multiple-Choice Dependent Measure. At each testing interval during this experiment, subjects were administered a 32 - item multiple choice test (Appendix D). Two randomized versions were produced in an attempt to minimize test-retest effects. The first randomized version was administered at the immediate and six week retention intervals and the second version was administered at the three week interval.

All questions were based on the text information and half of the questions were knowledge type, (Bloom, 1956) with stems which directly cued subjects to specific information contained in the text. The other half were comprehension questions (Bloom, 1956). These questions attempted to measure subjects' comprehension of the essence of the passage. All multiple choice questions consisted of a main stem with four options including only one correct choice. The response location was randomized within each item.

TREATMENT GROUPS

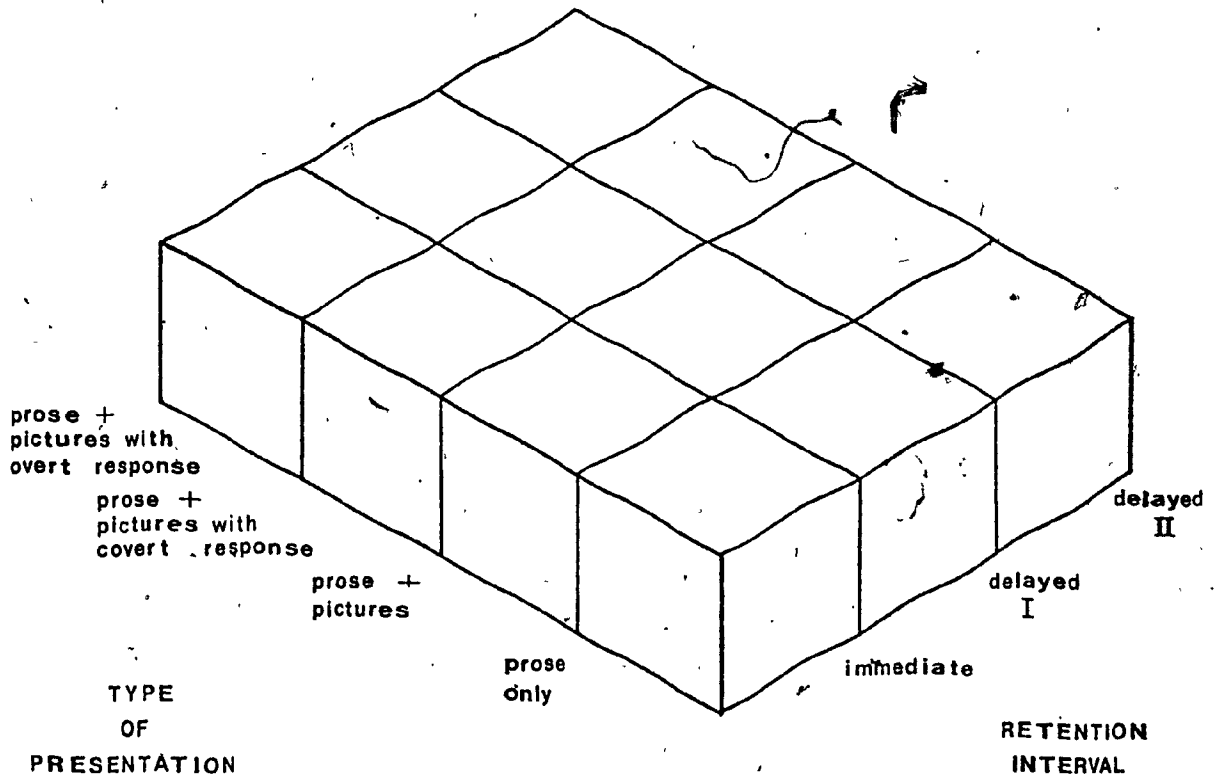


FIGURE I : THE EXPERIMENTAL DESIGN

Twenty items of this 32 item multiple choice test were developed by Gellner (Note 3). These 20 items were used as the dependent measure in the pilot study for this experiment. Inspection of the immediate and two week delayed posttest means of the pilot study however suggested the possibility of a test-retest increase over time (immediate $\bar{X} = 12.4$, delayed $\bar{X} = 12.5$).

While the use of parallel multiple choice test forms would have been an ideal solution for avoiding test-retest effects, their development and administration for a three repeated measures study would have been impractical. Thus, as a compromise, twelve additional items (6 knowledge type and 6 comprehension type) were developed. A lengthier test and the three week intervals between administrations would serve to reduce any test-retest effects. As mentioned above, two randomized versions of this 32 item test were assembled also in an attempt to minimize test-retest effects.

Content validity of this final test was confirmed by two subject matter experts in the education department. The reliability coefficient (Cronback's) for this test used during the main experiment was calculated to be .71 on the immediate posttest.

Free Recall Dependent Measure. A free recall question was administered to all subjects as part of the immediate and three week delayed posttest. This question asked that subjects "write down all that you can remember" (Appendix C).

The scoring of recall protocols was done by comparing them with preestablished "idea units" based on the passage content. These idea units included those identified by Gellner (Note 3, p 43) and 28 additional idea units which resulted from expanding and reorganizing the initial passage developed by Gellner. For the purposes of this study, an idea unit was defined as a single complete idea or block of information consisting of a sentence, clause, or phrase (Dean & Kulhavy, 1981). A total of 195 idea units were identified for the passage.

A subject's score on free recall was the total number of correctly recalled idea units for the entire passage. Errors in spelling and grammar were allowed. No points were given for written descriptions of the illustrations included in some versions of the passage or incorrect interpretation of the written information. All protocols were blindly scored by the main experimenter. Eleven protocols were randomly selected from the immediate posttest and eleven from the delayed posttest and blindly rescored by a trained rater. The reliability estimate was .96 for the sample of 22 protocols. An F-test revealed no difference between raters.

Evaluative Questionnaires. In addition to the two dependent measures described above, two different evaluative questionnaires were completed by subjects. The first evaluative questionnaire was administered as the interpolated task during the initial session of the main experiment.

This questionnaire, initially used during pilot testing for this study, solicited subjects evaluation of the passage and pictures. It was a 14 item form which asked subjects how they perceived the organization, appropriateness, and effects on learning of the passage and pictures.

Because questionnaire responses obtained during the pilot test provided helpful information for the preparation of the final version of the passage and pictures, this evaluative questionnaire was used as the interpolated task for the main experiment. Responses to these 14 items might provide useful information to the main experiment regarding the subjects' perceptions of the nature and effects of the experimental materials.

Additionally, this interpolated task was logically related to the nature of the experiment but, at the same time, would eliminate the effects of short term memory.

Because subjects appeared willing to complete this first questionnaire and to offer information which could help to explain results of this study, additional evaluative information was collected. This was done using a second evaluative questionnaire which was administered at the end of the six week delayed testing period. This form consisted of nine items (Appendix K) and accompanied a final report to students (Appendix E).

As discussed in the literature review, this study attempted to apply some methodological guidelines (Snow, 1974) for creating more representative educational research. Thus, four of these nine items questioned the subjects' perceptions of the methodology of this experiment. These items attempted to evaluate; the relevance of the materials to course content (extraexperiment observation), the nature of the study conditions (intraexperiment observation), amount of time to study (duration of treatment), and whether there was a test-retest effect with the multiple choice test. The remaining five items attempted to evaluate how students processed the pictures. These questions asked the students if they spent time trying to understand the pictures, if they tried to use them to recall passage content and if they noticed certain aspects of the pictures.

Nelson Denny Reading Test. In view of the fact that the experiment was concerned with the learning of prose material, the Nelson Denny Reading Test was administered. These test results would serve as good predictors of performance to reduce subject variability and also provide important information about student aptitudes. Due to limitations of time and in order to avoid tiring the subjects, only the vocabulary section (Special Adult Cut Time Version - 7½ minutes) was administered. Nelson and Denny (1973) report that the scores of a norming groups of some 450 grade 12 students show that the vocabulary section corresponds very

well with the accompanying comprehension section ($r = .70$). More importantly, the vocabulary test seems to be an excellent predictor of total reading ability ($r = .93$).

Materials

Prose Passage. The article A Learning Controversy, was adapted from Gellner (Note 4) and was a comparison of three major theories of learning; Behaviorism, Cognitivism, and Humanism (Appendix A). It was typed and double spaced on 12, 8½ x 11 inch pages of white paper for the three picture + prose conditions and 9 pages for the prose only condition. The passage was written in an expository style representative of most college texts and the length of the passage was in keeping with typical lengths used in adult studies (approximately 1,700 words). In total, approximately one third of the written material was directed toward each theory.

In order to make the organization of information in the passage more representative of college texts, (eg. Hilgard and Bower, 1980), some initial changes were made by the experimenter and two subject matter experts. The six attributes of each theory discussed in the passage were grouped under heading and a brief closing paragraph was added. Thus, the information content of the original version of the passage remained virtually the same but there was less intermingling of ideas. The readability level (Fry, 1968) of the passage was within the Grade 13-15 category, which matched the expected level of the sample.

During pilot testing for this study, opinions of the subjects were solicited regarding the organization, understandability, memorability, etc. of the article (Appendix B). Based upon their responses, minor refinements were made to produce the final version of the experimental materials.

Illustrations. As discussed in Chapter 2, each of the three theories outlined in the passage was illustrated by a corresponding picture (see Appendix A for an example of one picture condition). The instructional role of these pictures was dictated by the nature of the passage content. Each picture was generated by the author to serve three functions; organization, representation and transformation (Levin, 1979).

To serve the organization function, five, one to three word, major concepts from each theory were embedded within the corresponding picture. Spatial arrangement of these concepts was meaningfully related to the passage content, (Schwartz, Kulhavy and Finlay, Note 2). For example, the term "self-actualization", an important concept to the Humanistic theory of learning appeared at the top of a mountain. The representation function operated in that some aspects of an abstract theory like Humanism were represented in a concrete pictorial illustration. The transformation function operated as a result of, for example, superimposing an "H" over a figure climbing toward "self-actualization". The presence of the "H" was intended to make the concept Humanism more memorable and to distinguish it from the two other theories, Behaviorism and Cognitivism.

For the Prose + Pictures (Overt) and Prose + Pictures (Covert) conditions, a question was typed in a box drawn under each picture. This question was designed to draw the learners' attention to the above illustration by asking what was happening in the picture. For the Prose + Pictures (Overt) condition, instructions were given to write a brief answer to the question.

As was the case in the development of the final version of the prose passage, pilot subjects' opinions were solicited in an attempt to refine the intended picture functions (Appendix B). A list of their suggestions was compiled and given to a graphic artist who produced the final versions of the illustrations.

Procedure

Pilot Study

The pilot study was conducted approximately two months prior to the main experiment. This study was used to try out experimental procedures and to evaluate the passage and illustrations. A two week delayed posttest was administered to check for possible test-retest effects of the multiple choice dependent measure.

The subjects for this pilot were adults enrolled in an Educational Technology course at Concordia University. Although it was expected that this group would have more knowledge of the topic of the experimental passage than the subjects to be used in the main experiment, these students would be particularly helpful for evaluating the experimental

materials. Additionally, the effect of procedures during the pilot study would provide an accurate indication of how procedures would effect the main study. Accordingly, this pilot group provided helpful information for production of the final version of the materials. The procedure during the pilot study also appeared sufficiently naturalistic in that about 70% of subjects felt free to take notes or underline as they studied. The possibility of a test-retest effect was also noted due to an increase on overall means scores from the immediate ($\bar{X} = 12.4$) to the delayed ($\bar{X} = 12.5$) posttest.

Primary Experiment

Data collection for this experiment took place during normal class time. There was a one week interval between the commencement of the initial phase of the experiment for the two classes. Delayed posttesting took place three and six weeks after the initial phase.

The initial phase began with the researcher providing a general introduction to the research area that she was currently investigating. Subjects were advised that they had the right not to participate in the study. No one declined participation.

Envelopes containing the Nelson Denny Reading Test and the experimental materials were distributed by a monitor in accordance with a process of block randomization. This process sorted the subjects from each class into the four experimental conditions (i.e. Prose + Pictures, Prose Only, Prose + Pictures (Overt) and Prose + Pictures (Covert)). This

process ensured that if expected subject numbers did not appear, the experimenter at least maximized the numerical equality of treatment conditions for those who did take part.

The Nelson Denny Reading Test was administered first using the directions laid down in the "Examiners Manual". Subjects were told that they would receive their scores in a week. Upon completion of this test, subjects were told what was about to happen in the experiment. The experimenter encouraged them to try to use their normal study habits as they read the ensuing article about learning. They were advised that they would have as much time as they needed to study and that they would be tested afterwards.

Subjects then began to read the experimental passage. When everyone had finished (20 minutes), they completed the interpolated task. The free recall test followed the interpolated task. For this test, there was a ten minute time limit. When the ten minutes were up, subjects were directed to complete the multiple choice test. There was no time limit for this test and subjects were allowed to leave as they finished. As subjects turned in their experimental materials before leaving, they were thanked for their co-operation and advised that they would receive all of their marks in a week.

One week after the initial session, the experimenter gave the multiple choice and Nelson Denny scores to the instructors for each class who then passed them on to their students. The instructors also told their students that the experimenter would return in two weeks. This was done in order to help

subjects maintain a positive and co-operative attitude toward the study.

Three weeks after the initial session, the experimenter returned and administered a delayed posttest. This consisted of a free recall and multiple choice test. After testing, subjects expressed a growing dislike for the free recall test. The experimenter also answered students' questions concerning their Nelson Denny scores and referred them to the reading courses offered by Concordia's Guidance Services.

Due to the subjects' expressed opinions regarding the free recall test, this test was omitted for the six week delayed test. Administrations of a free recall test at this time would negatively affect subjects' attitudes toward the study and would thus not contribute any relevant information.

Finally, six weeks after the initial session, the experimenter returned and administered the third posttest (i.e. multiple choice test). After testing, subjects were given a written report of the preliminary results of the study. In addition, they were asked to fill out a questionnaire designed to evaluate their feelings as subjects and how they processed the pictures.

CHAPTER 4

RESULTS

The purpose of this study was to examine the effect on prose learning of manipulating the degree to which subjects were encouraged to process functionally designed illustrations interspersed in the prose. In addition, the effects of pictures on memory and comprehension of prose over time were examined.

Regression Analysis

Two major criteria for using a covariate in a study are:

- 1.(a) The independent variable (Nelson Denny scores) significantly predicts the criterion (Multiple choice scores).
- (b) The predictor accounts for a reasonable percentage of the criterion variance.
2. There is no interaction between treatments and the covariate by criterion regression lines. For this study, tests were conducted to determine whether the Nelson Denny Reading Test (NDRT) met these criteria.

Multiple regression analysis was used to determine whether verbal ability, as measured by the NDRT, predicted subject performance on the multiple choice and free recall tests. Analysis of treatment x covariate interaction was also conducted on each dependent measure in order to test for

regression parallelism (homogeneity of regression). Table 1 summarizes the results of the regression analysis and the tests for treatment x covariate interaction.

The NDRT was found to be a significant predictor of performance on the immediate multiple choice test, $F(1,36) = 12.7, p < .001$, six week delayed multiple choice test, $F(1,36) = 4.7, p < .05$, immediate free recall scores, $F(1,36) = 6.7, p < .01$, and the three week delayed free recall scores $F(1,36) = 5.6, p < .02$. Treatment x covariate interactions for these four dependent measures were not significant indicating that the assumption of homogeneity of regression was met. For scores on the three week delayed multiple choice test, the NDRT was not a significant predictor, $F(1,36) = 2.6, p < .11$. There was a treatment x covariate interaction for this administration ($p < .04$).

To determine which slopes differed from each other on the three week delayed multiple choice test, a follow up on this overall test for regression parallelism was conducted on all six possible combinations of slopes. Comparisons revealed treatment x covariate interactions on three of the six combinations. These three combinations involved the Prose + Pictures Group.

TABLE 1

Result of the Regression Analysis
for Nelson Denny Scores and the
Analysis of Treatment x Covariate Interaction
for all Dependent Variables.

Dependent Variable	Nelson Denny Reading Test			Treatment x Covariate Interaction	
	n	r ²	α	n	α
Immediate multiple choice test	38	.26	$p < .00$	74	$p < .75$
Three week delayed multiple choice test	38	.07	$p < .11$	57	$p < .04$
Six week delayed multiple choice test	38	.12	$p < .05$	58	$p < .39$
Immediate free recall	38	.16	$p < .01$	73	$p < .32$
Delayed free recall	38	.37	$p < .02$	47	$p < .76$

Inspection of the data revealed several possible reasons for these treatment x covariate interactions. The two subjects in the Prose + Pictures Group who scored highest on the Nelson Denny Reading Test scored lowest on the dependent measure. Indeed, their scores dropped by 12 and 14 correct from the immediate test. The Prose + Pictures Group also had the highest attrition (44%) on the three week delayed multiple choice test. Thus, the combination of a lower n and the dramatic drop in test scores for the two high scorers on the covariate was a unique characteristic of this group and quite probably accounted for the treatment x covariate interaction. It also may account for the lower correlation found with this dependent measure.

Because the NDRT was a significant predictor of performance on each administration except one, and, because only one of the treatment group slopes at this administration appeared to differ from the others, the NDRT was used as a covariate on all subsequent repeated measures analyses. This decision was justified based upon the fact that the probability of a Type 1 error was lowered because discrepancies in regression slopes have a conservative effect on the analysis of covariance F test. (Huitema, 1980).

This effect described above exists if there is no reason to suspect that the treatments have influenced administration of the predictor. One way analysis of variance across all treatments using the NDRT as the dependent measure yielded no differences indicating that treatments did not influence administration of the predictor.

Analysis of Multiple Choice Test Data

Inspection of the data revealed that, with an overall average of 63% correct, subjects performed well on the 32 item immediate multiple choice test (see Table 2). For all treatment groups, mean scores on the three and six week delayed tests differed by less than 1.5 points (see Tables 2 and 4).

As mentioned earlier, inspection of the data also revealed a very high attrition in the Prose + Pictures treatment group. An overall repeated measures analysis would have reduced the number of observations for this group from the original 19 to an unrepresentative 8. This would have resulted in greatly disproportionate cell sizes as two of the treatment groups retained 14 and 15 observations for an overall repeated measures analysis.

Thus, due to the possibility of a floor effect, and the high attrition in one treatment group, an overall analysis (ie. including all three tests at once) could have masked any real differences that may have been present between immediate and three week delayed tests and immediate and six week delayed tests. For this reason, the three sets of multiple choice scores were analyzed in pairs.

Means and standard deviations for the immediate and three week delayed multiple choice tests are reported in Table 2. Results of the analysis of covariance (ANCOVA) with repeated measures are detailed in Table 3. Table 3 shows a main effect for experimental groups $F(3,52) = 2.7$, $p = .05$. Figure 2 illustrates the changes in adjusted scores between the immediate and three week delayed multiple choice tests for the four experimental groups. As can be seen in Table 3, there was also a main effect over time $F(1,53) = 19.7$, $p < .001$. There was no Time x Group interaction.

Means and standard deviations for the immediate and six week delayed multiple choice tests are reported in Table 4. Results of the ANCOVA for these dependent measures, outlined in Table 5, also show that there was a main effect for experimental groups $F(3,53) = 3.0$, $p < .05$. Figure 3 represents the changes in adjusted scores between the immediate and six week delayed multiple choice tests for the

TABLE 2

Unadjusted and Adjusted Means and
Standard Deviations for Experimental
Groups on Immediate and Three Week
Delayed Multiple Choice Tests.

Experimental Group	n	Immediate			Three Week Delayed		
		\bar{X}	SD	\bar{X}_{adj}	\bar{X}	SD	\bar{X}_{adj}
G1	11	22.0	3.4	21.5	17.3	5.1	17.3
G2	16	20.0	4.7	20.1	16.2	5.8	16.2
G3	16	16.2	2.9	16.4	14.9	4.0	15.1
G4	14	19.0	4.8	19.1	16.2	5.4	16.6

G1 = Prose & Pictures
G2 = Prose Only
G3 = Prose + Pictures (Overt)
G4 = Prose + Pictures (Covert)

TABLE 3

ANCOVA Summary Table for
 Immediate and Three Week
 Delayed Multiple Choice Tests.

Source	SS	df	MS	F	p
Between Groups					
Groups (G)	191.0	3	63.7	2.7	= .05
1st Covariate	368.3	1	368.3	15.6	< .01
Error	1223.2	52	23.5		
Within Groups					
Time (T)	248.1	1	248.1	19.7	< .01
T x G	37.6	3	12.5	99	< .43
Error	667.1	53	12.5		

G = Experimental Group

T = Time Interval (Immediate and Three Weeks)

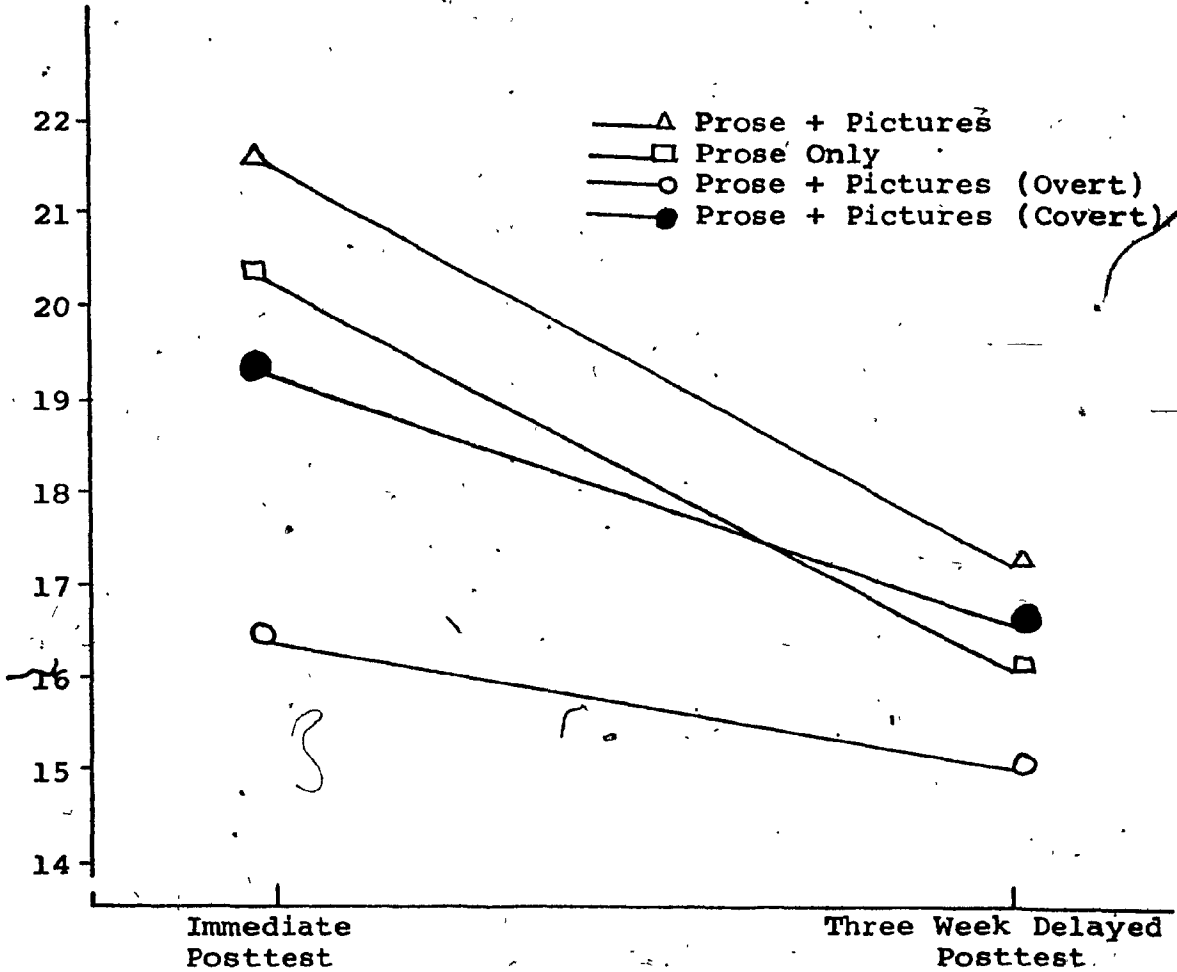


Figure 2. Changes in adjusted group means for the immediate and three week delayed multiple choice test. (Interaction effect not significant at .05 level.)

TABLE 4

Unadjusted and Adjusted Means
and Standard Deviations for
Experimental Groups on Immediate and
Six Week Delayed Multiple Choice Tests.

Experimental Group	n	Immediate			Six Week Delayed		
		\bar{X}	SD	\bar{X}_{adj}	\bar{X}	SD	\bar{X}_{adj}
G1	12	21.9	3.2	20.9	18.3	5.7	17.4
G2	14	20.9	5.2	20.8	16.9	5.4	16.8
G3	18	15.5	3.8	15.9	15.0	3.9	15.4
G4	14	19.3	4.9	19.6	15.1	4.7	15.4

G1 = Prose + Pictures
G2 = Prose Only
G3 = Prose + Pictures (Overt)
G4 = Prose + Pictures (Covert)

TABLE 5

ANCOVA Summary Table for Immediate
and Six Week Delayed Multiple
Choice Tests.

Source	SS	df	MS	F	p
Between Groups					
Groups (G)	233.6	3	77.9	3.0	<.05
1st Covariate	380.3	1	380.3	14.7	<.01
Error	1370.1	53	25.8		
Within Groups					
Time (T)	268.4	1	268.4	26.2	<.01
T x G	75.2	3	25.1	2.4	<.07
Error	552.9	54	10.2		

G = Experimental Group

T = Time Interval (Immediate and Six Weeks)

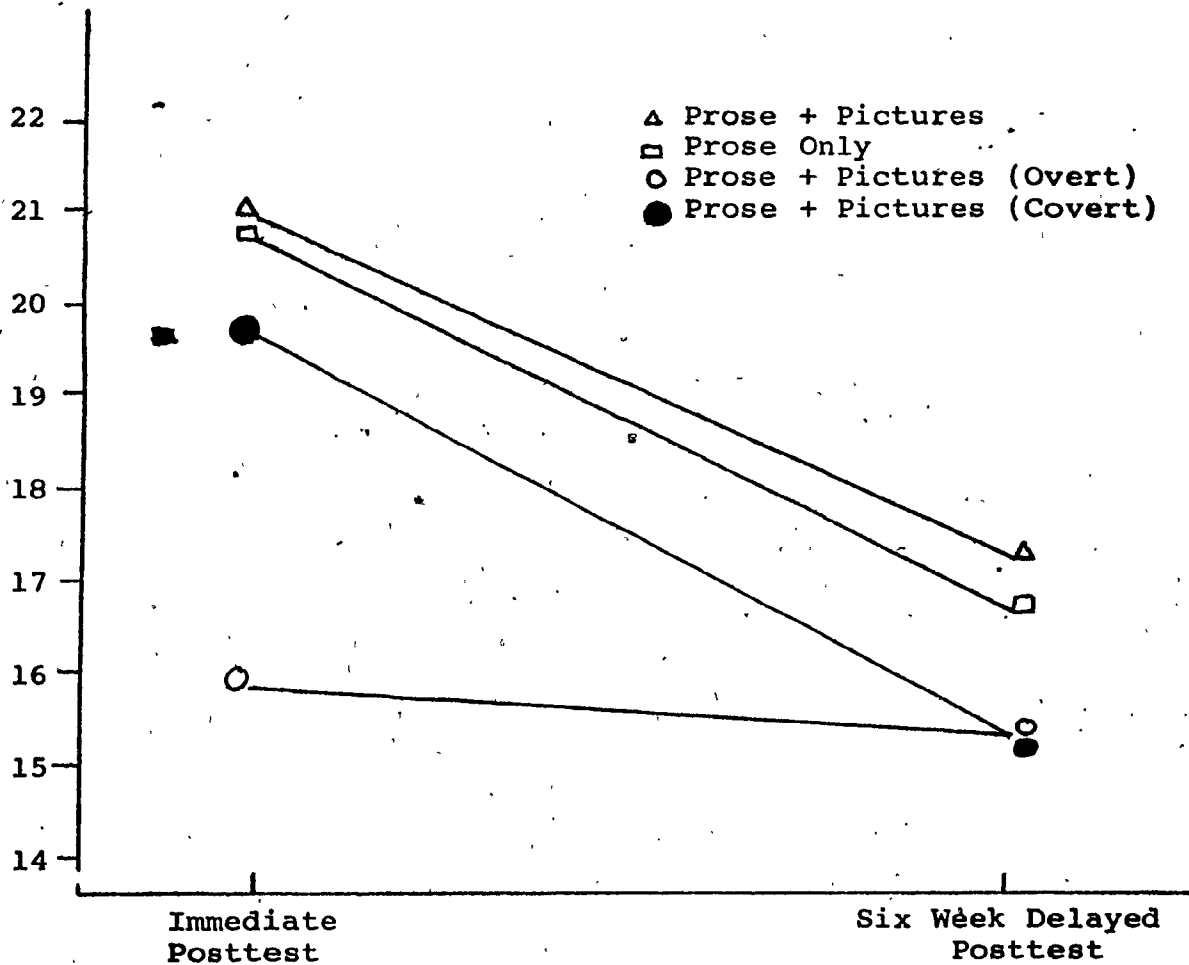


Figure 3. Changes in adjusted group means for the immediate and six week delayed multiple choice test. (Marginally significant, $p < .07$.)

four experimental groups. As reported in Table 5, there was also a marginal Time x Group interaction $F(3,54) = 2.4$, $p < .07$ and a main effect over time $F(1,54) = 26.2$, $p < .001$.

Post hoc Analysis of Multiple Choice Test

In order to determine where the differences among treatment groups occurred, two post hoc analyses were conducted across the treatment conditions. Due to the absence of Time x Group interactions in the repeated measures analysis, the mean trial scores for each subject (ie. immediate score + three week delayed score/2 = IMM3WK score and immediate score + six week delayed score/2 = IMM6WK score) were used in the post hoc analyses.

For the IMM3WK scores, post hoc analysis using Tukey's test yielded a difference ($p < .05$) between the Prose + Pictures and the Prose + Pictures (Overt) groups. Comparisons of the four group means for the IMM6WK scores using Tukey's test also yielded a difference ($p < .05$) between the Prose + Pictures and the Prose + Pictures (Overt) groups.

Thus, these analyses of the multiple choice dependent measure revealed that mean scores for the Prose + Pictures Group were higher than mean scores for the Prose + Pictures (Overt) Group (see Tables 2 and 4).

Analysis of Free Recall Data

Inspection of the data indicated that, on the immediate test, subjects remembered an average of only 8% of the idea units in the passage. During administration of the immediate post test, subjects appeared to be very co-operative and motivated. This observation is perhaps supported by the aforementioned performance on the immediate multiple choice test. During the free recall test, almost all subjects used the entire allotted ten minutes for writing. Thus, this researcher felt that the relatively low immediate free recall scores were due almost entirely to time constraints and did not reflect any lack of co-operation on the part of the subjects.

An analysis of covariance (ANCOVA) with repeated measures test was conducted as an overall test of the immediate and three week delayed free recall data. The means and standard deviations are provided in Table 6. Results of the ANCOVA are reported in Table 7. Table 7 reveals that there was a main effect for Time, $F(1,43) = 97.0$ $p < .001$. There was no main effect for experimental group. However, there was a Time x Group interaction for the free recall scores, $F(3,43) = 3.1$, $p < .05$. Figure 4 illustrates the changes in mean free recall scores over time for the four experimental groups. This interaction indicated that scores for at least two of the treatment groups changed at different rates.

TABLE 6

Unadjusted and Adjusted Means
and Standard Deviations for
Immediate and Three Week
Delayed Free Recall Test.

Experimental Group	n	Immediate			Three Week Delayed		
		\bar{X}	SD	\bar{X}_{adj}	\bar{X}	SD	\bar{X}_{adj}
G1	11	13.8	3.3	13.5	9.4	3.3	9.0
G2	11	16.5	5.4	16.5	6.5	2.9	6.5
G3	14	12.4	3.1	12.6	6.9	3.1	7.0
G4	11	14.9	5.4	14.0	8.5	4.4	8.5

G1 = Prose + Pictures
G2 = Prose Only
G3 = Prose + Pictures (Overt)
G4 = Prose + Pictures (Covert)

TABLE 7

ANCOVA Summary Table for Free
Recall Dependent Measure

Source	SS	df	MS	F	p
Between Groups					
Groups (G)	62.3	3	20.8	1.3	<.30
1st Covariate	181.1	1	181.1	10.9	<.01
Error	693.9	42	16.4		
Within Groups					
Time (T)	1018.8	1	1018.8	97.0	<.01
T x G	96.4	3	32.1	3.1	<.05
Error	451.4	43			

G = Experimental Group

T = Time Interval (Immediate and Three Weeks)

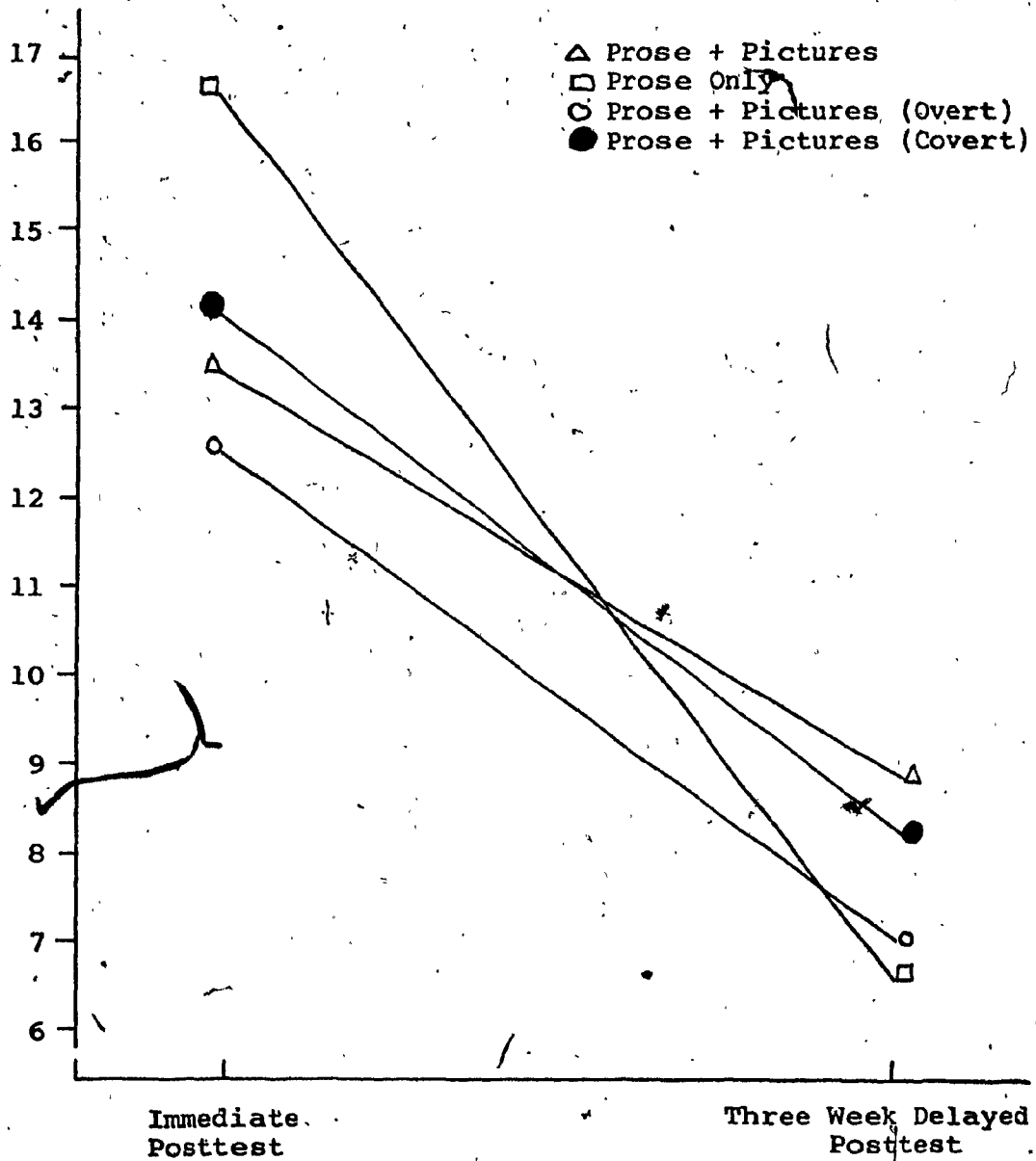


Figure 4. Changes in adjusted group means for the immediate and three week delayed free recall scores.

Post hoc Analysis of Free Recall Test

In order to determine where these differences occurred, simple effects comparisons (Bruning and King, 1978) were made on all six possible two group combinations of the four experimental groups. Table 8 summarizes the results of these comparisons.

Two of the six comparisons show differences in the rate of change in scores. In the post hoc comparison between the Prose + Pictures and the Prose Only groups, there was a difference in the rate of change in score, $F(1,43) = 6.3$, $p < .025$. Figure 4 indicates that the free recall scores of the Prose Only Group dropped more quickly than the scores of the Prose + Pictures Group. In the comparison between the Prose Only and Prose + Pictures (Overt) groups, there were also differences, $F(1,48) = 7.3$, $p < .01$. Figure 4 shows that, once again, scores of the Prose Only Group dropped more quickly. The remaining four two group comparisons yielded no differences.

Thus, in the three week interval between immediate and delayed tests, free recall scores for the Prose Only Group fell more quickly than scores for two of the remaining three treatment groups. The Prose Only Group was the only group that didn't receive pictures interspersed in the prose.

TABLE 8

Summary of Result of F-Tests
for Simple Effects for Free
Recall Dependent Measure

Group Comparison	df	F	P
G1 vs. G2	1,43	6.3	<.03
G1 vs. G3	1,48	.29	N.D.*
G1 vs. G4	1,43	.01	N.D.
G2 vs. G3	1,48	7.3	<.01
G2 vs. G4	1,43	2.6	N.D.
G3 vs. G4	1,48	.2	N.D.

G1 = Prose + Pictures

G2 = Prose Only

G3 = Prose + Pictures (Overt)

G4 = Prose + Pictures (Covert)

* N.D. indicates no difference at .05 level.

Analysis of Evaluative Data

For the interpolated task during the initial testing period, a 13 item evaluative questionnaire was administered. This questionnaire, originally used in the pilot study, solicited information concerning subject's evaluation of the prose passage and how they perceived the pictures. It was well received by the subjects and provided valuable information concerning their perceptions of the passage and pictures. Frequency responses for each of the 13 questions are reported in Tables 9 and 10.

Concerning evaluation of the prose passage, (see Table 9), approximately 72% of the subjects responded positively (ie. circled 1 or 2) to questions three and four. Thus, the majority of subjects found the text to be well organized and easy to understand. About 55% of subjects responded positively to questions 1 and 6 indicating that the passage was less interesting or easy to remember.

Subjects evaluation of the pictures interspersed in the passage (see Table 10) revealed that they felt that the pictures helped them to remember the content with 62% responding positively to question 1. Concerning the ability of the pictures to organize and clarify the content of the article, about 53% of subjects felt that this was true. Fewer subjects, (51%) liked the pictures and even fewer (37%) found them interesting.

TABLE 9
 Frequency Responses for the
 Evaluation of the Prose Passage

Question	n	% Response				
		yes 1	2	3	4	no 5
1. Was information easy to remember?	77	10.4	45.5	29.9	10.4	3.9
2. Were there any confusing areas?	78	5.1	21.8	23.1	29.5	20.5
3. Was the content easy to understand?	78	43.6	34.6	17.9	0	3.8
4. Was the article well organized	78	26.9	38.5	21.8	9.0	3.8
5. Did article contain unfamiliar terms?	78	7.7	6.4	16.7	32.1	37.2
6. Did you find the information interesting?	78	19.2	34.6	24.4	14.1	7.7
7. Was article hard to understand?	78	3.8	1.3	20.5	29.5	44.9

TABLE 10
 Frequency Responses for the
 Evaluation of the Pictures

Question	n	% Response				
		yes 1	2	3	4	no 5
1. Did pictures help you remember content?	59	28.8	33.9	20.3	8.5	8.5
2. Did the pictures help to organize the information for you?	59	22.0	32.2	22.0	13.6	10.2
3. Were the pictures interesting?	59	13.6	23.7	42.4	13.6	6.8
4. Did pictures help clarify content?	59	15.3	37.3	30.5	10.2	6.8
5. Did you like the pictures?	59	20.3	30.5	32.2	6.8	10.2
6. Did the pictures confuse you?	59	3.4	5.1	5.1	27.1	59.3

Additional evaluative information concerning how students felt as subjects in a study and how they processed the pictures was collected at the end of the six week delayed testing. Frequency responses for the four questions regarding students as subjects are reported in Table 11. Responses to question 1 showed that about half the subjects felt that answering the first multiple choice test helped them on subsequent ones. This indicated that there could have been a test retest effect. Judging from the positive response to question 2, students did not feel that the nature of the material was irrelevant to their course content. This questionnaire also showed that the majority of students felt that they did not have enough time to study the article and felt restricted while studying. Written comments indicated that they felt they had to hurry and preferred to study at home. Although no strict time limit was imposed, everyone had stopped reading after 20 minutes. It could have been the nature of the classroom environment and the testing situation itself which caused this sentiment.

Frequency responses for the five questions related to picture processing are reported in Table 12. These responses indicated that about 55% of subjects who received pictures with the passage spent time trying to understand them. Sixty percent of subjects said that they could remember which picture went with which theory. Although the letters superimposed over each picture were intended to help

TABLE 11
 Frequency Responses for Evaluation
 of Student's Feelings as Subjects

Question	n	% Response	
		Yes	No
1. Did answering the first multiple choice test help you answer the following ones?	69	52.2	47.8
2. Did the article contribute to your understanding of class material?	68	61.8	38.2
3. Did you have enough time to study the article?	67	44.8	55.2
4. Did you feel unduly restricted while studying the article?	69	56.5	43.5

TABLE 12
 Frequency Responses for Picture
 Processing Questions

Question	n	% Response	
		Yes	No
1. Did you spend time trying to understand the pictures?	51	54.9	45.1
2. As you were answering the test did you try to visualize the pictures?	51	60.8	39.2
3. Did you notice the letter B, C, or H superimposed over the pictures?	50	38.0	62.0
4. Could you remember which picture went with which theory?	50	60.0	40.0
5. Do pictures generally help you remember certain things?	51	80.4	19.6

subjects remember which picture went with which theory, only 38% of subjects said that they noticed the letters superimposed over each picture. Sixty percent of subjects said that they tried to visualize the pictures as they were answering the multiple choice test. Finally, 80% of the subjects felt that, generally, pictures help them to remember certain things.

This evaluative data provided information about how subjects perceived the methodology of this experiment. As mentioned in the Literature Review, this study attempted to apply methodological guidelines for making educational research outcomes more applicable to practise. Responses to the questions indicated that, to some extent, this attempt was successful. Additionally, information was also gained concerning how subjects perceived the passage and pictures. In the next chapter, some of this information will be used to help explain results of this study.

Following, in Table 13, is a summary of the results of this study. Outcomes for the primary and post hoc analyses are presented for the multiple choice and free recall dependent measures.

TABLE 13
Summary of Results

Comparisons	Results
N.D.R.T. as a predictor of performance (both dependent measures)	
	($p < .05$)*
<u>Multiple Choice Test (Primary Analysis)</u>	
Main Effect (T1 vs. T2)	($p < .05$)
Interaction (Time x Group)	($p < .43$)
Main Effect (T1 vs. T3)	($p < .05$)
Interaction (Time x Group)	($p < .07$)
<u>Multiple Comparison (T1 + T2 and T1 + T3)</u>	
G1 vs. G2	G1 = G2
G1 vs. G3	G1 > G3 ($p < .05$)
G1 vs. G4	G1 = G4
G2 vs. G3	G2 = G3
G2 vs. G4	G2 = G4
G3 vs. G4	G3 = G4

T1 = Immediate Test
T2 = Three Week Delayed Test
T3 = Six Week Delayed Test

G1 = Prose + Pictures
G2 = Prose Only
G3 = Prose + Pictures (Overt)
G4 = Prose + Pictures (Covert)

* most conservative p value

TABLE 13 (Cont'd)
Summary of Results

Comparisons	Results
<u>Free Recall Test (Primary Analysis)</u>	
Main Effect (T1 vs. T2)	(p < .05)
Interaction (Time x Group)	(p < .05)
<u>Multiple Comparison (T1 vs. T2)</u>	
G1 vs. G2	(p < .03)
G1 vs. G3	N.D.**
G1 vs. G4	N.D.
G2 vs. G3	(p < .01)
G2 vs. G4	N.D.
G3 vs. G4	N.D.

T1 = Immediate Test
T2 = Three Week Delayed Test
G1 = Prose + Pictures
G2 = Prose Only
G3 = Prose + Pictures (Overt)
G4 = Prose + Pictures (Covert)

** N.D. indicated No Difference at the .05 level.

CHAPTER 5

Discussion

In this study, experimental groups of college level students who received functionally designed illustrations inserted in a prose passage did not exhibit greater overall prose learning. Concerning picture effects over time, free recall scores for the prose only group fell more between the immediate and delayed posttests than scores for two of the prose + pictures conditions. Finally, overall multiple choice scores for the treatment group that received instructions intended to influence overt mathemagenic behavior were lower than scores for the group that received the pictures but no instructions. An interesting general outcome of this study was that different results were obtained from each dependent measure. In the following discussion by hypothesis, possible reasons for the results of this experiment will be explored. Recommendations for future research will also be drawn from this discussion.

Discussion by Hypothesis

1. Instructional Functions of Pictures

This hypothesis stated that subjects receiving functionally designed pictures embedded in a prose passage would display greater overall learning of the passage. According

to Levin (1979) and Duchastel (1978), a variety of functions can be served by prose pictures. Three of Levins' eight proposed functions were hypothesized to be operating in this study - representation, organization and transformation. These functions were dictated by the nature of the passage content. The representation function was intended to aid prose learning by providing a second (pictorial) modality through which the text information could be directly represented in the brain. This pictorial mode would render the verbal contents more "concrete" and memorable (Paivio, 1971). Because the passage compared three different learning theories, the organization function was used to distinguish the major concepts of each theory (Levin, 1979). In order to provide a device for storing related textual information, spatial arrangement of these concepts was meaningfully related to passage content (Schwartz, Kulhavy & Finlay, 1980). The transformation function was intended to make elements of the passage information more memorable by mnemonically coding the main characteristics of each theory. This study did not find greater overall prose learning effects for subjects receiving these functionally designed illustrations.

There was some evidence however that the representation function was operating in that the pictures helped them to remember the prose (see Table 10). Student feedback indicated that the pictures had only moderate organizational effects. The fact that only 32% of subjects noticed the letters superimposed over each picture indicated that effects of the

transformation function were negligible (see Table 12).

Thus, the pictures designed for this study did not effectively serve their intended functions. This is not surprising considering the scarcity of available information on how to design illustrations for instructional texts. While Levin and Duchastels' functions are a good start they are not detailed enough to provide comprehensive guidelines for design.

The fact that proposed picture functions are based on research with children also make generalizations to instructional design for adults difficult. A few recent studies (Royer & Cable, 1976, Bernard, Petersen & Ally, 1981 and Schwartz, Kulhavy & Finlay, Note 2) indicate that prose pictures may also serve instructional functions for older learners similar to those proposed by Levin and Duchastel for children. Much more research needs to be conducted however before a theory of the instructional roles of pictures for adult prose learning can be developed.

An indication of continued progress in understanding the learning effects of text illustrations is a recent review of research by Levie and Lentz (Note 5). These authors reviewed 155 experimental comparisons of learning from illustrated text

versus text alone. They reported significant advantages for learning illustrated text information for children and college level students. They also began to identify the effects of different types of illustrations and emphasized the need for future investigations to explicate the functional roles of illustrations. This type of systematic review offers valuable guides for practice and provides an information base for future, more definitive research.

2. Effects of Pictures over Time

According to the second hypothesis, the predicted increased learning effects for subjects receiving pictorial aids would be most pronounced on the delayed posttest. This hypothesis was based on two related areas of research. First, there is evidence from psychological research that pictures are retained in memory longer than words. Also, dually-coded information (pictures and words) tend to suffer less memory loss than information stored in either code (Paivio, 1971). Secondly, instructional design research is beginning to reveal functional roles for text illustrations (Levin 1979, Duchastel, 1978). As mentioned earlier, the pictures designed for this study were intended to serve three major functions to aid prose learning. It was expected that this functional approach, combined with the durability of pictures in memory, would result in greater long term retention of the passage information.

Results of this experiment showed that the picture groups did not outperform the no picture group on the delayed posttests. This lack of effect can be partly attributed to the aforementioned weak contribution of the intended picture functions to prose learning. Additionally, there was no evidence that the dual-coding of the information resulted in greater long term retention. While Paivio's research has contributed substantially to our knowledge of nonverbal imagery and verbal processes, most of his research is centered on the paired-associate learning situation. It is difficult to draw generalizations from this type of research on learning segmented fragments of information to classroom learning or independent study. Much more research is needed before we can begin to understand the role of dual-coding in learning from more extended passages such as the one used in this study.

While there were no overall differences among groups on the delayed posttests, there were pronounced differences between groups in the rate of change in scores over time (see Figure 4). As measured by free recall, mean scores for the Prose Only Group dropped more in the three week interval between tests than scores for the Prose + Pictures and Prose + Pictures (Overt) groups. Mean scores for the Prose Only Group dropped from the highest on the immediate posttest to the lowest on the delayed posttest. The multiple choice data revealed no such effects.

Differential advantages for illustrated text according to the nature of the dependent measure are not new to picture/prose research. Dwyer and his associates (Dwyer, 1978) have reported consistent differences in picture effects according to the way learning was measured. They found strongest effects when subjects were required to draw (a representative diagram of the heart) from memory. Picture effects were negligible for multiple choice tests of comprehension. The free recall test used in this study was a task comparable to Dwyer's drawing test in that it required construction of passage information from memory. The differential changes in free recall performance reported here lend some support to Dwyer's conclusion that the use of illustrations can improve achievement of specific educational tasks.

Levie and Lentz (Note 5) explain the advantages of Dwyer's drawing test for illustrated text groups as due to the emphasis the test places on spatial information provided in the pictures. There is some experimental evidence that free recall of text information may be similarly enhanced when spatial information is provided in pictures. The picture provides an interpretive or spatial framework for comprehending connected discourse (Royer & Cable 1976, and Dean & Kulhavy, 1981). "Correct discourse recall is far more likely when one also remembers the features" (Schwartz, Kulhavy & Finlay, Note 3).

In this study, the advantages for free recall of idea units exhibited by two of the picture groups may have been due

to the influence of the organizational function of the pictures. As mentioned earlier, five major concepts from each theory were spatially organized in the pictures (see Appendix A). This spatial arrangement hypothetically provided an interpretive framework thus increasing the probability of recall of related passage information. Unlike the multiple choice test which required restricted comprehension of passage information, the free recall test allowed the learner to display comprehension of a wider range of passage information. The effect of the organization function, for free recall, was to help spur recall of passage details.

3. Mathemagenic Effects of Pictures

This final hypothesis stated that performance would be affected by the degree to which subjects were encouraged to process the pictorial aids (i.e. engage in mathemagenic behavior). According to Rothkopf (1966, 1970), in most instructional situations, what is learned depends largely on the activities of the learner. For this experiment, an attempt was made to draw the learners' attention to the pictorial aids in order to encourage translation and processing. This was done by including directions to look at the pictures for one treatment group and directions to overtly respond to the question for another group. It was hypothesized that subjects in the overt response group would engage in a deeper level of processing and outperform the other groups. In the present study, the overt processing group, when compared to the group who received no mathemagenic based instructions actually performed worse on the multiple choice dependent measure (see

Figures 2 and 3). Thus, directions to overtly process the pictures clearly appear to have interfered with prose learning.

There are two related factors which could have contributed to this interference effect: lack of sufficient time to study and inappropriateness of the mathemagenic strategy. As illustrated in Table 11, more than half the subjects felt that they did not have enough time to study the article. Many subjects emphasized this in writing. As mentioned in the Results, this sentiment could have been due to the nature of the experimental setting. For the overt response group however, there exists the possibility that they spent more time than was intended constructing and writing answers to the questions. Although they processed the pictures as evidenced by their written responses, they may not have had time to fully process the prose. This would help to account for their poor performance on the multiple choice test which was based on passage information and information contained in both the passage and the pictures. Spatial organization of the main ideas provided by the pictures however, facilitated free recall performance for this group.

In addition to lack of sufficient time, the overt processing of information may also have constituted an inappropriate mathemagenic strategy for subjects in this experiment. In order to provide a more naturalistic experimental setting, this study used instructional materials which were relevant to course content. Thus, the nature of

the materials was somewhat familiar to subjects. This was confirmed by their responses to a question evaluating their prior knowledge. Tobias (1982) claims that achievement can be decreased when students are required to make overt responses to familiar material. Being required to spend more time and effort on material that could be mastered in less time consuming ways causes boredom and fatigue thus reducing achievement.

It would seem that, in this experiment, the behavior resulting from direction to overtly process the pictures constituted "mathemagenic negative" activities in the Rothkopfian sense. This finding is important in the context of mathemagenic research for this research is also concerned with identifying modes and patterns of instruction that produce limiting effects on learning (Wilson & Koran, 1976). Indeed the procedures employed to create more natural representative study conditions appear to have contributed to the mathemagenic negative effects found here. The work of Rothkopf (1970, 1971) using more restrictive procedures has shown significant improvements in learning due to mathemagenic activity. These opposing results illustrate the relevance of instructional situation to the concept of mathemagenic activities. Many more questions remain to be answered concerning student activities that affect what is learned in specified instructional settings.

Implications for Future Research.

In this experiment, feedback on how subjects processed the materials contributed useful information regarding the types of processing activities that occurred while they were studying. This information coincided logically with results and helped to explain some of the effects achieved.

A few educational researchers (eg. Marton, 1975 and Marton and Saljo, 1976) have successfully used student responses to help explain the relationships between the processes and outcomes of learning. Picture/prose research may well benefit by incorporating this strategy. Student responses concerning the processes they used during instruction could contribute substantially to the understanding of the effects of different methods.

While psychological and instructional research is slowly building theories of instructional design, there remains the need in schools and training sites for practical guides to the design of instruction. Perhaps educational research could further its practical objectives by considering student learning processes relevant to instruction.

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APPENDICES

APPENDIX A

PROSE + PICTURES (OVERT) TREATMENT

A LEARNING CONTROVERSY

One of the principal concerns in the field of psychology is the question of how humans learn and what factors influence learning. Many theories, or attempted explanations have come forth during the ongoing debate concerning this question. Today however, only three major theoretical positions remain. The purpose of this article is to outline and contrast the key attributes of these approaches to the study of learning.

THE THREE LEARNING THEORIES, BEHAVIORISM, COGNITIVISM AND HUMANISM

Two traditional viewpoints are readily discernible among scientists who study learning. One of these is that of the Behaviorist who maintains that complex learning phenomena can be reduced to simple stimulus-response (S-R) relationships. The S-R theorists claim, for example, that a hungry rat's run through a maze to a remote feeding box is controlled or influenced by the food reward and by food eating responses which are emitted as the rat runs through the maze. The other viewpoint, that of Cognitive psychology, proposes that there is much more to learning than merely chains of stimulus-response connections. The Cognitivists feel that there is such a thing as "insight" which allows the organism to make "cognitive leaps" when confronted by a new situation.

Cognitive theorists claim, for example, that apes who suddenly "see" the value of a stick for reaching a distant banana have engaged in higher mental processes (thinking) to reach the goal. Both types of learning theorists offer suggestions for controlling human learning behavior but differ in approach or method.

In recent years a new position has evolved which further complicates the learning issues addressed by Behaviorists and Cognitivists. This viewpoint is known as Humanism and its adherents reject outright the principles of Behaviorism and Cognitivism as being "dehumanizing". Rather than emphasizing the influence that the environment exerts on the human organism, Humanists emphasize the control that the human being attempts to exert on the environment. The remainder of this article will deal with how these three theories approach the context of human learning.

HUMAN VERSUS ANIMAL METHODOLOGIES

Both the Behaviorists and the Cognitivists have often used animals to test their theories of human behavior and learning. Behaviorists are particularly noted for their use of this experimental approach. The rationale for their experimental use of animals is the assumption that the basic laws of learning can be generalized to a wide range of species such as rats, dogs, pigeons, monkeys, and humans.

Few would question the learning similarities within species, but Humanists strongly oppose the notion that principles of animal learning can be applied to humans. Accordingly, Humanists argue that the human organism is far too complex to be studied with animal methodologies and stress the inviolable "inner space" of the individual. The generalizing of animal learning behavior to humans is considered an affront to human dignity. For these reasons, Humanists, unlike Behaviorists and Cognitivists focus exclusively on human subjects in their deliberation and research on human learning behavior.

WHAT IS THE LEARNER

Behaviorists see the learner as a mechanistic entity in that s/he is totally unresponsive until an environmental stimulus is applied. The learner is viewed as a receiver of various types of input (stimuli) which produces an appropriately programmed and predictable output (response). Behaviorists imply that the learner is passive although a better term may be "reactive" since the learner does neither more nor less than continually react to environmental events that are occurring. It is a completely determined system with no freedom of behavior.

This orientation to learning theory predisposes one to think in terms of mechanical models, physiological mechanisms, biological processes, or any system that is conceived in the image of the physical sciences.

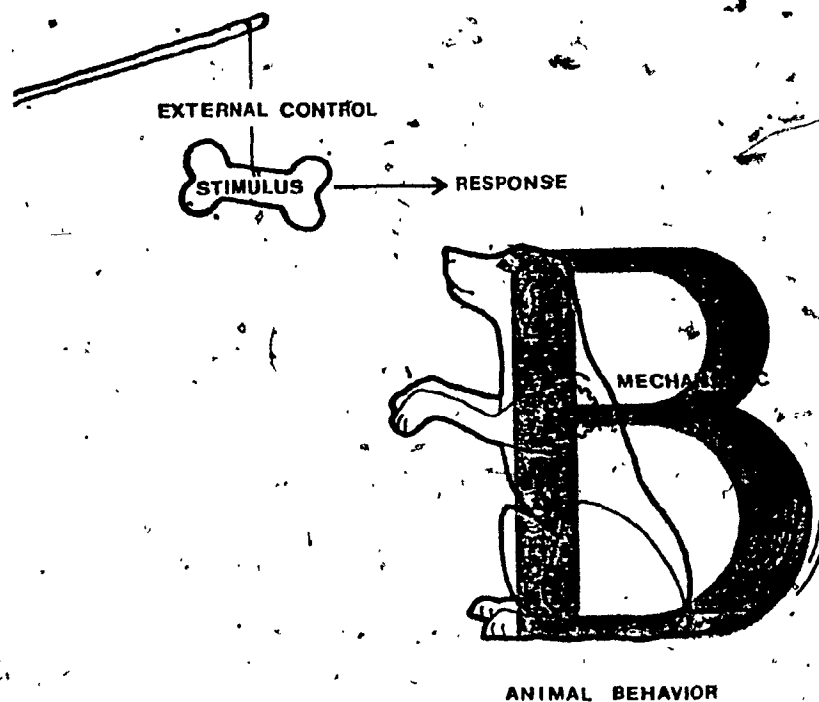


FIGURE 1: THE BEHAVIORIST'S HABITUAL THEORY OF LEARNING

In the space provided, please write a brief answer to the following question:
How is the character in the above picture learning?

Cognitive theories of learning are at odds with Behaviorism on several major points. Cognitivists see humans as purposive agents. In their view, the mind operates on a different set of principles than those evidenced in the physical world. Humans are active rather than reactive and as such, are not constrained to behave reflexively and automatically, but instead take some initiative in controlling their destiny. Understandably, Cognitivists reject the Behaviorist's deterministic models as being far too restrictive.

The Humanists are similar to the Cognitivists in that they also see the human organism as a purposive agent. It is their belief that human beings have a natural potentiality for learning; humans are born curious about their world and have an innate drive to develop and achieve. Humans possess an inner directing need to improve themselves in the direction of healthy, competent and creative functioning. Like the Cognitivists, the Humanists include insight and initiative in the natural repertoire of the human organism.

WHAT IS LEARNED

The Behaviorists and the Cognitivists provide different answers to the question; what is learned? Behaviorists argue that "habits" are learned. This is a common sense answer since few would deny that smooth-running skills are developed through practice.

On the other hand, Cognitivists maintain that "Cognitive Structures" or factual knowledge are what is learned. This is also a very common sense answer. If you can locate a house in your neighborhood from one starting point, you can find it from another point because you "know where it is". From the Cognitivist's viewpoint, you have learned and organized a set of interrelated facts. A smooth-running skill illustrates a learned habit; knowing alternative routes illustrates cognitive structure. Cognitivists point out that all behavior is not highly mechanical and stereotyped. Therefore, they argue that variable, non-habitual behavior indicates that cognitive structure must be part of what is learned. Behaviorists, on the other hand, are satisfied that the laws of habit formation adequately explain the whole learning process.

Humanists have an altogether different idea of "what" is learned. They stress two types of learning, relevant and irrelevant. Irrelevant learning is learning "from the neck up" and involves little feeling or personal meaning. The Humanists see true relevant learning as being the acquisition of knowledge which has a quality of personal involvement. This is experiential learning which is self-initiated, pervasive, and is evaluated by the learner.

Humanists do not view habits or facts as true learning. The essence of learning to the Humanists is whether or not the information to be acquired has meaning. Little attempt is made to specify the mechanics of this learning since the goal of the Humanist is to increase awareness of the elements which are involved in the meaningful and significant acquisition of knowledge.

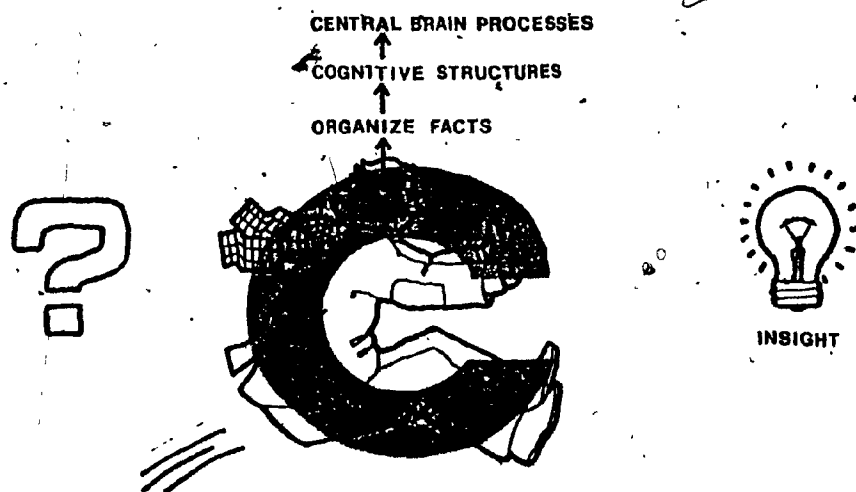
HOW ONE LEARNS

When confronted with a novel problem, how does the learner reach a solution? Behaviorists tend, by orientation, to look at the past history of the learner for the sources of solution. The Behaviorists would see the learner influenced by his/her past habits when confronted by a new problem such that he/she responds according to the elements that the new problem has in common with past situation. If these responses, which are often referred to as movement intermediaries, do not lead to a solution then the learner would resort to "trial and error".

A major tenet of Humanism is "learning by doing". The Humanist would look to the innate desire of the learner to motivate his/her approach to a problem. Humanists are generally unconcerned with the details of what is actually happening to the human organism when it is problem solving.

They are interested only in bringing to light the importance of the proper conditions for such behavior to naturally occur. The Humanist would expect the learner's innate desire for learning; for enlargement of knowledge and experience to be the energizing force behind his/her approach to a problem.

In answer to the question of how we learn, the Cognitivist would be apt to point out that even if the learner had all of the prerequisite experience and knowledge of the parts of the problem, there would still be no guarantee that s/he would be able to access the necessary information. The Cognitivist looks to the structuring of the problem for the sources of solution. They explain learning in terms of central brain processes such as memories or expectations. The learner, however, may be able to solve the problem presented in one form but not in another. According to the Cognitivist, the method of presentation of the problem which is preferred by the individual learner permits a perceptual structuring leading to "insight", that is, to the understanding of the essential relationships involved.



**FIGURE 2: THE COGNITIVIST'S HIERARCHICAL
THEORY OF LEARNING**

In the space provided, please write a brief answer to the following question:
How will the above character find the answer to his question?

SOCIAL IMPLICATIONS OF THE THREE THEORIES

The Behaviorists and the Humanists have long been locked in debate over the question of external control versus self-determination.

B.F. Skinner, a well known reinforcement Behaviorist, has pleaded for abandoning techniques of aversive control (i.e. punishment) and for consciously and openly applying techniques of positive control for the betterment of society. His novel "Walden Two" (1948) details a utopian society which was created through the application of behavior technology.

A prominent Humanist named Carl Rogers raises some points of disagreement with Skinner's proposed approach to societal control. He argues that Skinner does not take into account the potential abuse of power which could result. Skinner, on the other hand, assumes that techniques of control will be in the best interests of society. Rogers does not believe this to be possible due to man's inherent nature. Skinner also argues that, if behavioral scientists experiment with society, eventually the practices which make for the greatest biological and psychological strength of the group will presumably survive. Humanists contend that a society's goals should be concerned primarily with the process of becoming, achieving worth and dignity and being creative - in short, the process of self-actualization. The conflict herein described is between a position that favors human control through the thoughtful application of a science of behaviour and one which asserts that science should enhance our capacity for self-determination.

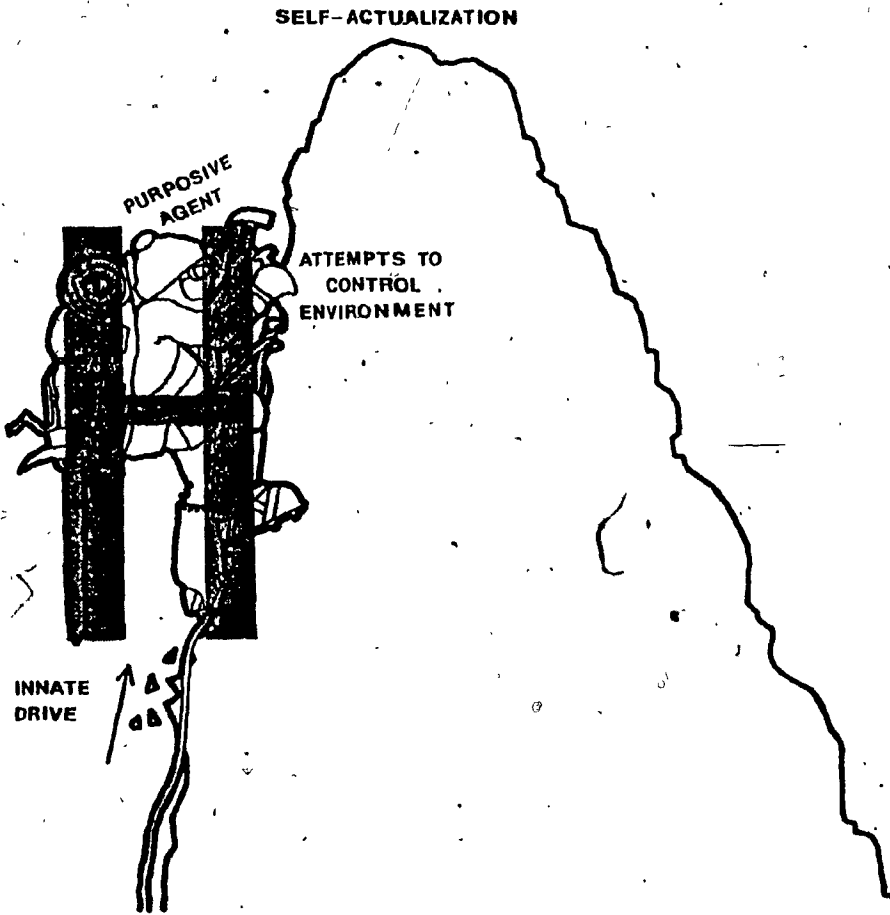


FIGURE 3: THE HUMANIST'S SELF-DETERMINISTIC THEORY OF LEARNING

In the space provided, please write a brief answer to the following question:
What is the above character trying to do?

Cognitivists would clearly be more supportive of Skinner's argument than that of Rogers as they too seek a method for controlling human learning behavior. Evidence of this is provided by the applications of hierarchical learning theories to instruction such as D.P. Ausubel's coding systems and Jerome Bruner's discovery learning.

These three learning theories as briefly described here, reflect the work of thousands of psychologists as they attempt to understand mental life. These theories are not mutually exclusive however, for there are many areas of overlap and many questions concerning human learning which cannot be answered by one theory alone.

APPENDIX B

INTERPOLATED TASK

Evaluation of article A Learning Controversy

- | | | |
|---|------------------|-----------------|
| 1. Was the information in the article easy to remember? | YES
1 2 3 4 5 | NO
1 2 3 4 5 |
| 2. Were there any confusing areas in the article? | YES
1 2 3 4 5 | NO
1 2 3 4 5 |
| 3. Was the content of the article easy to understand? | YES
1 2 3 4 5 | NO
1 2 3 4 5 |
| 4. Was the article well organized? | YES
1 2 3 4 5 | NO
1 2 3 4 5 |
| 5. Did the article contain terms unfamiliar to you? | YES
1 2 3 4 5 | NO
1 2 3 4 5 |
| 6. Did you find the information interesting? | YES
1 2 3 4 5 | NO
1 2 3 4 5 |
| 7. Was the article hard to understand? | YES
1 2 3 4 5 | NO
1 2 3 4 5 |

Evaluation of article A Learning Controversy (Cont'd)

If there were pictures in your copy of the article please answer the following questions.

- | | | |
|---|-----------|----|
| 1. Did the pictures help you remember the content? | YES | NO |
| | 1 2 3 4 5 | |
| 2. Did the pictures help to organize the information for you? | YES | NO |
| | 1 2 3 4 5 | |
| 3. Were the pictures interesting? | YES | NO |
| | 1 2 3 4 5 | |
| 4. Did the pictures help to clarify the content of the article? | YES | NO |
| | 1 2 3 4 5 | |
| 5. Did you like the pictures? | YES | NO |
| | 1 2 3 4 5 | |
| 6. Did the pictures confuse you? | YES | NO |
| | 1 2 3 4 5 | |

APPENDIX C

FREE RECALL TEST

Let us assume that the reading of the main passage "A Learning Controversy" was an in-class assignment on a course that you are now taking. Let us also assume that before this class one of your friends advised you that she would be unable to make it but wanted you to be able to tell her about it so that she would not fall behind.

Please write down here, in complete sentences, all that you can remember from the passage so that you would be able to provide a thorough briefing about the contents when your friend returned.

APPENDIX D

MULTIPLE CHOICE TEST

1. Which of the theories of learning would reject the idea that a human being is a system such as those conceived in the image of the physical sciences?
 - a. Humanists
 - b. Cognitivists and Humanists
 - c. Behaviorists and Cognitivists
 - d. Behaviorists

2. A mathematician was trying to solve a difficult problem. After hours of unsuccessful work he went to bed discouraged. Five minutes later, he sat up in bed and shouted Eureka! Suddenly, the solution had dawned upon him. This case provides an example of:
 - a. man's innate desire to influence the environment
 - b. man's natural problem solving instinct
 - c. cognitive restructuring leading to insight
 - d. operant external controls

3. Behaviorists view the human organism as a(n):
 - a. innately driven entity fully capable of taking initiative
 - b. innately driven entity easily represented by a mechanical model
 - c. mechanistic entity fully capable of independent thoughts and activity
 - d. mechanistic entity capable only of reactive behavior

4. Society's goals should be primarily concerned with the process of self-actualization.

This belief is characteristic of the:

- a. Cognitivists
 - b. Humanists and Cognitivists
 - c. Behaviorists
 - d. Humanists
5. A major distinction between Cognitivist and Behaviorist orientations is the fact that:
- a. Cognitivists believe that the human organism is capable of insightful behavior
 - b. Cognitivists emphasize the natural influence of the environment on human learning
 - c. Behaviorists emphasize that humans naturally act to influence their surroundings
 - d. Behaviorists sometimes use human subjects for experimentation
6. According to the Humanists, society's goals should be primarily concerned with the process of human:
- a. learning
 - b. improvement
 - c. self-actualization
 - d. control

7. Behaviorists and Cognitivists are alike in that both:
- are concerned with the specifics of human problem solving behavior
 - attempt to provide ideal environmental conditions for learning
 - infer central brain processes as integrators of problem-solving behavior
 - refer to movement intermediaries as integrators of learning behavior
8. A sports writer asked a famous mountain climber why he would risk his very life to climb treacherous Mount Everest. The climber responded calmly, "Because it's there."

This person and others of his demeanor provide some evidence supporting the beliefs of which theorists?

- Behaviorists
- Behaviorists and Humanists
- Cognitivists and Humanists
- Humanists

9. Which of the following correctly states a similarity between Cognitive and Behaviorist theories?
- Both emphasize exclusively animal behavior.
 - Both seek to somehow methodically control human learning behavior.
 - Neither stresses the insightful characteristics of human learning behavior.
 - Neither considers the study of reactive processes to be useful.
10. The Humanist would suggest that the degree to which a person can solve a novel problem depends to a great extent upon:
- whether or not the information to be acquired has personal meaning.
 - the configuration in which the problem is expressed.
 - whether or not the appropriate stimulus was applied.
 - the level and quality of background experience.
11. The idea that the learner is a mechanistic entity is proposed by the:
- Behaviorists and Cognitivists
 - Cognitivists
 - Cognitivists and Humanists
 - Behaviorists

12. Which of the following theorists would apply heirarchical theories of learning to instruction?

- a. D.P. Ausubel and J. Bruner
- b. Carl Rogers
- c. Jerome Bruner
- d. B.F. Skinner

13. A keynote to the Behaviorist tradition is the belief that complex learning phenomena can be:

- a. broken down into simple stimulus-response chains.
- b. deducted from the organisms attempts to control the environment.
- c. facilitated by a restructuring of the material to be learned.
- d. illustrated by simple portrayls of central brain processes.

14. The Cognitive psychologist would suggest that the degree to which a person can solve a novel problem depends to a great extent upon:

- a. the configuration in which the problem is expressed.
- b. the level and quality of background experience.
- c. whether, or not the problem has personal meaning.
- d. whether or not the learner has specific relevant experience.

15. An instructor believes that given the proper conditions, his students will be motivated to learn due to their innate desire for learning.

This instructor has adopted _____ viewpoint.

- a. a Cognitivist
- b. a Humanist
- c. either a Cognitivist or Humanist
- d. either a Behaviorist or Cognitivist

16. Humanists view the human organism as a(n):

- a. innately driven entity easily represented by a mechanical model.
- b. innately driven entity fully capable of taking initiative.
- c. mechanistic entity capable only of reactive behavior.
- d. mechanistic entity fully capable of independent thought and activity.

17. The idea that science should enhance our capacity for self-determination is proposed by the:

- a. Behaviorists and Cognitivists.
- b. Cognitivists.
- c. Cognitivists and Humanists.
- d. Humanists.

18. Carl Rogers would propose that true learning is the result of:
- cognitive learning.
 - aversive control.
 - positive control.
 - experiential learning.
19. Which learning theorists place little importance on the mechanics of learning?
- Behaviorists.
 - Behaviorists and Cognitivists.
 - Cognitivists and Humanists.
 - Humanists.
20. The Cognitivists would explain learning in terms of:
- the learner's innate desire.
 - habit formation.
 - central brain processes.
 - fact accumulation.
21. D.P. Ausubel is a theorist whose work provides evidence of the:
- Behaviorist belief that humans are born curious.
 - dependency of humans on external stimuli.
 - need for the instructional programming of stimuli.
 - Cognitivists desire to manipulate human learning.

22. Which of the following is an important difference between the Humanists and the more traditional approaches to learning theory?
- a. Humanists emphasize the control that the human exerts on the environment rather than vice versa.
 - b. Humanists make the assumption that the focus of concern should be on internal processes.
 - c. Traditional approaches focus all of their attention on animal learning behavior.
 - d. Traditional approaches view the external environment as being the major factor in learning.
23. Variable non-habitual behavior would force one to admit that _____ must account for part of what is learned.
- a. cognitive structures
 - b. individual personalities
 - c. innate drives
 - d. stimulus-response connections

24. A renowned scientist has proposed that it would be in the best interests of society to develop techniques of human control which would result in the emergence of a superior mankind.

Which learning theorists would likely be most opposed to such techniques?

- a. Behaviorists.
- b. Behaviorists and Cognitivists.
- c. Humanists.
- d. Humanists and Cognitivists.

25. Which of the theories of learning would visualize a human being as a system such as those conceived in the image of the physical sciences?

- a. Behaviorists.
- b. Behaviorist and Cognitivist.
- c. Cognitivist and Humanist.
- d. Cognitivist.

26. A teacher organizes her lesson so that all of the simple material precedes the complex. She hopes that, thanks to her sequencing, students will come to perceive the complex concepts before they are expounded upon in class.

This instructor has adopted _____ viewpoint.

- a. a Behaviorist
- b. a Cognitivist
- c. either a Behaviorist or a Cognitivist
- d. either a Cognitivist or a Humanist

27. A man is locked up and left alone in a prison cell.

Outside, well beyond reach, are the keys to the cell.

After several hours, the worried prisoner gets up from the hammock he has been resting on and paces his cell.

Suddenly, he realizes that the rope suspending his

hammock could be fashioned into a noose to draw in the keys.

This case provides an example of which type of learning?

- a. Stimulus-response.
- b. Instinctive.
- c. Insightful.
- d. Habitual.

28. If a Behaviorist were to describe a learned behavior, he would likely refer to such behavior as:

- a. cognitive structure formation.
- b. fact accumulation.
- c. habit formation.
- d. response structuring formation.

29. When space shuttle Columbia pilot John Young was asked why he risked his life to travel into space he answered simply, "I just had to experience it".

Which theorist's beliefs are evidenced in Young's reply?

- a. Humanists.
- b. Behaviorists and Cognitivists.
- c. Cognitivists and Humanists.
- d. Cognitivists.

30. A major spokesman for Humanist realm of thought is:

- a. B.F. Skinner.
- b. D.P. Ausubel.
- c. J. Bruner.
- d. C. Rogers.

31. According to Behaviorists, society's goals should be primarily concerned with the process of human:
- a. improvement.
 - b. learning.
 - c. control.
 - d. self-actualization.
32. B.F. Skinner is a theorist who believes in:
- a. the need for instructional programming of stimuli.
 - b. the control of humans through the application of behavior technology.
 - c. the process of self-actualization.
 - d. the insightful characteristics of human learning behavior.

- E N D -

APPENDIX E

REPORT TO STUDENTS

This study, like any other, was first and foremost an attempt to contribute to knowledge. The area being studied was that of pictorial information processing. In recent years this aspect of learning has been increasingly questioned. This is due in part to the ever growing costs of including pictures in textbooks and the mounting doubt that they contribute significantly to memory or comprehension of the prose or written material.

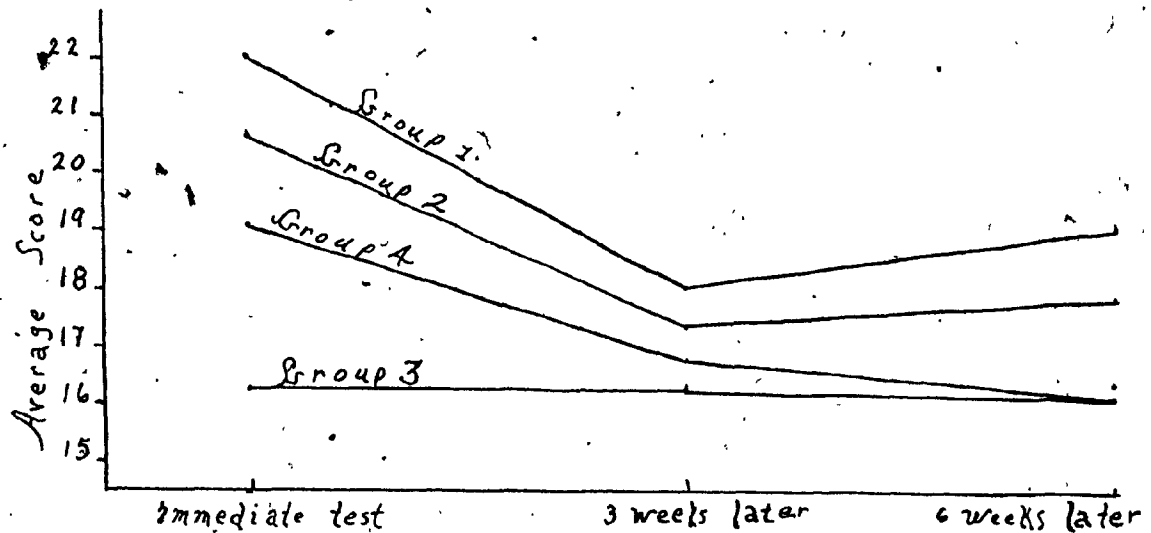
This researcher postulated that in order for pictures to aid the memory and comprehension of prose they:

- must be carefully designed to serve specific functions.
- must be processed (i.e. looked at) before they can have an effect on learning. Many adult students, being more verbally oriented, often ignore the pictures in their tests.

Thus, this study entailed 4 groups of 20 students formed from two management classes. These groups were:

1. prose and picture only
2. prose only
3. prose and pictures with instructions to look at the pictures and write a response (overt response).
4. prose and pictures with instruction to look at the pictures and think of a response (covert response).

The results showed that the prose and picture group (1) performed significantly better on the immediate test ($p < .01$).



While more analyses need to be done, it looks as if the instructions to look at the pictures interfered with the students usual processing or learning styles.

What do you think? Your feedback would contribute to the overall aim of this study by adding a unique and valuable insight into what actually happened during collection of data for this study. Following are a few questions, please feel free to add your own insights.

APPENDIX F

EVALUATIVE QUESTIONNAIRE

1. Do you think that answering the first multiple choice test helped you to answer the following ones? YES NO
2. Did the article A Learning Controversy contribute to your understanding of any material that you might cover in class? YES NO
3. Did you have enough time to study the article? YES NO
4. Did you feel unduly restricted while studying the article? YES NO

If you answered YES could you explain how.

If there were pictures in your copy of the article:

1. Did you spend time trying to understand the pictures? YES NO
2. As you were answering the multiple choice test did you try to visualize the pictures? YES NO
3. Did you notice the letters B, C or H superimposed over the pictures? YES NO

4. Could you remember which pictures went
with which theory? YES NO
5. Do you think that generally, pictures help
you to remember certain things? YES NO

Thank you once again for your valuable help!

Heather Lee

549-13

APPENDIX G

IDEA UNIT SCORING KEY

A LEARNING CONTROVERSY

(One of the principal concerns in the field of psychology) (is the question of how humans learn) and (what factors influence learning). (Many theories, or attempted explanations) (have come forth during the ongoing debate concerning this question). (Today however, only three major theoretical positions remain.) (The purpose of this article is to outline) and (contrast) the (key attributes of these approaches to the study of learning.)

(THE THREE LEARNING THEORIES, (BEHAVIORISM,) (COGNITIVISM) AND (HUMANISM)

(Two traditional viewpoints are readily discernible among scientists who study learning.) (One of these is that of the Behaviorist who maintains that complex learning phenomena can be reduced to simple stimulus-response (S-R) relationships.) (The S-R theorists claim, for example, that a hungry rat's run through a maze to a remote feeding box) (is controlled or influenced by the food reward) and (by food eating responses) (which are emitted as the rat runs through the maze.) (The other viewpoint, that of Cognitive psychology, proposes that there is much more to learning) (than merely chains of stimulus-response connections.) (The Cognitivists feel that there is such a thing as "insight") (which allows the organism to make "cognitive leaps") (when confronted by a new situation.)

(Cognitive theorists claim, for example, that apes who suddenly "see" the value of a stick for reaching a distant banana)(have engaged in higher mental processes)(thinking)(to reach the goal.) (Both types of learning theorists offer suggestions for controlling human learning behavior)(but differ in approach or method.)

(In recent years a new position has evolved)(which further complicates the learning issues addressed by Behaviorists and Cognitivists.) (This viewpoint is known as Humanism and its adherents reject outright the principles of Behaviorism and Cognitivism)(as being "dehumanizing"). (Rather than emphasizing the influence that the environment exerts on the human organism,)(Humanists emphasize the control that the human being attempts to exert on the environment.) (The remainder of this article will deal with how these three theories approach the context of human learning.)

(HUMAN VERSUS ANIMAL METHODOLOGIES)

(Both the Behaviorists and the Cognitivists have often used animals to test their theories)(of human behavior and learning.) (Behaviorists are particularly noted for their use of this experimental approach.) (The rationale for their experimental use of animals is the assumption that the basic laws of learning can be generalized to a wide range of species)(such as rats, dogs, pigeons, monkeys, and humans.)

(Few would question the learning similarities within species) (but Humanists strongly oppose the notion that principles of animal learning can be applied to humans.) (Accordingly, Humanists argue that the human organism is far too complex) (to be studied with animal methodologies) and (stress the inviolable "inner space" of the individual.) (The generalizing of animal learning behavior to humans is considered an affront to human dignity.) (For these reasons, Humanists, unlike Behaviorists and Cognitivists) (focus exclusively on human subjects) in (their deliberation and research on human learning behavior.)

(WHAT IS THE LEARNER)

(Behaviorists see the learner as a mechanistic entity) (in that s/he is totally unresponsive) (until an environmental stimulus is applied.) (The learner is viewed as a receiver of various types of input) ((stimuli)) (which produces an appropriately programmed) (and predictable output) ((response).) (Behaviorists imply that the learner is passive) (although a better term may be "reactive") (since the learner does neither more nor less than continually react to environmental events that are occurring.) (It is a completely determined system) (with no freedom of behavior.)

(This orientation to learning theory predisposes one to think in terms of mechanical models) (physiological mechanisms) (biological processes,) (or any system that is conceived in the image of the physical sciences.)

(Cognitive theories of learning are at odds with Behaviorism) (on several major points.) (Cognitivists see humans as purposive agents.) (In their view, the mind operates on a different set of principles) (than those evidenced in the physical world.) (Humans are active) (rather than reactive) (and as such, are not constrained to behave reflexively) (and automatically) (but instead take some initiative) (in controlling their destiny.) (Understandably, Cognitivists reject the Behaviorist's deterministic models) (as being far too restrictive.)

(The Humanists are similar to the Cognitivists) (in that they also see the human organism as a purposive agent.) (It is their belief that human beings have a natural potentiality for learning;) (humans are born curious about their world) (and have an innate drive to develop) (and achieve.) (Humans possess an inner directing need to improve themselves) (in the direction of healthy, competent and creative functioning.) (Like the Cognitivists, the Humanists include insight) (and initiative) (in the natural repertoire of the human organism.)

WHAT IS LEARNED

(The Behaviorists and the Cognitivists provide different answers to the question; what is learned?) (Behaviorists argue that "habits" are learned.) (This is a common sense answer) (since few would deny that smooth-running skills are developed through practice.) (On the other hand, Cognitivists maintain that "Cognitive Structures" (or factual knowledge are what is learned) (This is also a very common sense answer.) (If you can locate a house in your neighborhood from one starting point,) (you can find it from another point) (because you "know where it is") (From the Cognitivist's viewpoint, you have learned) (and organized) (a set of interrelated facts.) (A smooth-running skill illustrates a learned habit;) (knowing alternative routes illustrates cognitive structure.) (Cognitivists point out that all behavior is not highly mechanical and stereotyped.) (Therefore, they argue that variable, (non-habitual behavior) (indicates that cognitive structure must be part of what is learned,) (Behaviorists, on the other hand, are satisfied that the laws of habit formation) (adequately explain the whole learning process.)

(Humanists have an altogether different idea of "what" is learned.) (They stress two types of learning) (relevant) and (irrelevant.) (Irrelevant learning is learning "from the neck up") and (involves little feeling or personal meaning.) (The Humanists see true relevant learning as being the acquisition of knowledge) (which has a quality of personal involvement.)

(This is experiential learning)(which is self-initiated,)(pervasive)(and is evaluated by the learner.)(Humanists do not view habits or facts as true learning.)(The essence of learning to the Humanists is whether or not the information to be acquired has meaning.)(Little attempt is made to specify the mechanics of this learning)(since the goal of the Humanist is to increase awareness of the elements)(which are involved in the meaningful) and (significant acquisition of knowledge.)

HOW ONE LEARNS

(When confronted with a novel problem, how does the learner reach a solution?)(Behaviorists tend, by orientation, to look at the past history of the learner)(for the sources of solution.)(The Behaviorists would see the learner influenced by his/her past habits)(when confronted by a new problem)(such that he/she responds according to the elements that the new problem has in common with past situation.)(If these responses, which are often referred to as (movement intermediaries.)(do not lead to a solution then the learner would resort to "trial and error")

(A major tenet of Humanism is "learning by doing") (The Humanist would look to the innate desire of the learner)(to motivate his/her approach to a problem.)(Humanists are generally unconcerned with the details of what is actually happening to the human organism when it is problem solving)

(They are interested only in bringing to light the importance of the proper conditions for such behavior to naturally occur.) (The Humanist would expect the learner's innate desire for learning) (for enlargement of knowledge) (and experience) (to be the energizing force behind his/her approach to a problem.)

(In answer to the question of how we learn, the Cognitivist would be apt to point out that even if the learner had all of the prerequisite experience and knowledge of the parts of the problem,) (there would still be no guarantee that s/he would be able to access the necessary information.) (The Cognitivist looks to the structuring of the problem) (for the sources of solution.) (They explain learning in terms of central brain processes) (such as memories or expectations.) (The learner, however,) may be able to solve the problem presented in one form but not in another.) (According to the Cognitivist, the method of presentation of the problem which is preferred by the individual learner) (permits a perceptual structuring leading to "insight"), (that is, to the understanding of the essential relationships involved.)

(SOCIAL IMPLICATIONS OF THE THREE THEORIES)

(The Behaviorists and the Humanists have long been locked in debate) (over the question of external control versus self-determination) (B.F. Skinner,) (a well known reinforcement Behaviorist) (has pleaded for abandoning techniques of aversive control (i.e. punishment) and (for consciously and openly applying techniques of positive control) (for the betterment of society.) (His novel "Walden Two" (1948)) (details a utopian society) (which was created through the application of behavior technology.)

(A prominent Humanist named Carl Rogers) (raises some points of disagreement with Skinner's proposed approach to societal control.) (He argues that Skinner does not take into account the potential abuse of power) (which could result.) (Skinner, on the other hand, assumes that techniques of control will be in the best interests of society.) (Rogers does not believe this to be possible) (due to man's inherent nature.) (Skinner also argues that, if behavioral scientists experiment with society,) (eventually the practices which make for the greatest biological and psychological strength of the group) (will presumably survive.) (Humanists contend that a society's goals) (should be concerned primarily with the process of becoming, achieving worth and dignity and being creative) -(in short, the process of self-actualization.)

(The conflict herein described is between a position that favors human control) (through the thoughtful application of a science of behaviour) and (one which asserts that science should enhance our capacity for self-determination.)

(Cognitivists would clearly be more supportive of Skinner's argument) (than that of Rogers) as (they too seek a method for controlling human learning behavior.) (Evidence of this is provided by the applications of hierarchical learning theories) (to instruction) (such as D.P. Ausubel's) (coding systems) and (Jerome Bruner's) (discovery learning.)

(These three learning theories as briefly described here, reflect the work of thousands of psychologists) (as they attempt to understand mental life.) (These theories are not mutually exclusive however) (for there are many areas of overlap) and (many questions concerning human learning which cannot be answered by one theory alone.)