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EFFECTS OF CONCRETELY ILLUSTRATED INSTRUCTION VERSUS ABSTRACTLY ILLUSTRATED INSTRUCTION ON ACQUISITION OF ABSTRACT CONCEPTS

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A dissertation
APPROVED FOR THE
DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

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ABSTRACT

The purpose of this study was to investigate the comparative effects of concretely illustrated instruction versus abstractly illustrated instruction on the acquisition of abstract concepts with immediate and delayed testing.

The participants in this study are junior and senior students enrolled in an undergraduate introductory instructional development course at a southwestern university. Students in the class were equally divided by visual ability into three treatment groups.

The materials of this study were three versions of a printed lesson based on the intellectual skills portion of Gagné's domains of learning outcomes. The first treatment contained text and abstract visuals, the second treatment contained text and concrete visuals and the third was text alone. An immediate and delayed test was given over the lesson.

The design of the study used a two by three multivariate analysis of variance (MANOVA) The illustration variable had three levels: none, concrete and abstract. The dependent variables were immediate and delayed post-test scores.

Results were not significant, concluding the effects of concretely illustrated and abstractly illustrated instruction for this study had no differential effect on learning abstract concepts. This finding points to further study with more proven instruments.

EFFECTS OF CONCRETELY ILLUSTRATED INSTRUCTION VERSUS ABSTRACTLY ILLUSTRATED INSTRUCTION ON ACQUISITION OF ABSTRACT CONCEPTS

CHAPTER I

INTRODUCTION TO THE STUDY

Instructional researchers are continually investigating the teaching-learning process through experimentation. One of the areas investigated is the role of illustrations in learning concepts. This study narrowed the focus of this subject to learning abstract concepts via abstract illustrations.

Research Problem

The purpose of this study was to investigate the general problem "What are the characteristics of effective instructional illustrations?" Specifically, the study investigated whether abstract or representational (i.e., concrete) illustrations were more effective in supporting the acquisition and transfer of abstract concepts.

Background of the Problem

Illustrations have been used in printed instructional materials for hundreds of years. The first known attempt at illustrating the text of a book was Orbis Sensualium Pictus produced in 1658 (the first American edition 1810) by Comenius, a Moravian bishop. Orbis Sensualium Pictus was illustrated with pictures that were explained in the text. It also contained an illustrated alphabet with each letter accompanied by a picture of an animal and a sentence describing the animal or sound it makes (Mulcahy and Samuels, 1987). Comenius' text was a milestone in book illustration because until this time, illustrations were inserted into books mostly for their decorative, rather than for their instructional purposes.

In the early nineteenth century several changes took place in the evolutionary progression of illustrations in text. Textbooks such as those by William Homes McGuffey, Samuel Goodrich, and Jacob Abbott used representational illustrations as an integral part of the written lesson, often referring to the illustrations within the body of the text.

During the twentieth century, illustrations have become pervasive in instructional text, not only because of their assumed educational value, but because of their aesthetic value (Berlyne, 1971, 1974). Despite the rising cost of reproducing illustrations, resulting from the use of color, photography and special papers, books today are filled with elaborate illustrations.

Although illustrations are widely used in instructional text (Dwyer, 1987), the relative benefits and optimum nature of these illustrations are still unclear (Levie, 1987). However, research that has compared illustrated text with nonillustrated text has indicated that learning is generally greater when text is accompanied by illustrations. Levie and Lentz (1982) reviewed 46 studies of illustrations, that compared illustrated versus non illustrated text, and summarized: "Learning illustrated text information was better with illustrated text than with text alone in 98% of the experimental comparisons. For 85% of the comparisons this difference was statistically significant" (p. 213). Despite these results that support assertions of the effectiveness of illustrations in instruction, it is still unclear from the literature why and how illustrations support learning. Indeed, there are many unanswered questions regarding the characteristics of effective illustrations: When should illustrations be used? What kind of educational content should illustrations contain? What should the proximity of illustrations be to the text? What degree of detail should be used? Should illustrations be realistic? Should illustrations be in color? What should be the relationship between illustrations and text? How should content and execution of illustrations be varied depending upon type of learning outcome?

The issue of how content and execution of illustrations should be varied depending upon type of learning outcome has been a potentially confounding factor in much of the research on illustrations in instructional text (Levie, 1987). Many researchers in the area of illustrations have not recognized that different learning outcomes require different conditions of learning support (E. Gagné, 1985), and that this varying support may be communicated in illustrations. Also, much of the research on illustrations in instructional text has not carefully identified the learning outcome involved. It is conceivable that presentation of illustrations and, in particular, specific types of illustrations might be more effective for certain kinds of learning outcomes (Hurt, 1987; Levin, 1989). For example, Dwyer (1978) conducted a series of experiments investigating the characteristics of illustrations to support a specific type of learning. The learning outcome he focused upon was "verbal information learning:" the ability to label and describe parts and functions of the heart. He found an advantage of line drawing over realism because the simplified drawing (i.e., the illustration that eliminated unnecessary information) made it easier for the learner to identify the critical portions of the heart. Instruction for a different type of learning outcome, for instance, trouble shooting malfunctions of the heart, might require a totally different type of illustration, such as a realistic image. The issue of the nature of effective illustration for particular types of learning tasks had not yet been thoroughly investigated with empirical research.

Instruction for one particular learning outcome, concept acquisition, was often accompanied by an illustration. In general, studies of concept acquisition had found illustrations were beneficial to learning, (Anglin 1987; Dwyer, 1978). However, Levie (1987) observed that concept acquisition studies had involved the learning of concrete concepts: No studies were located that have studied the effects of illustrations on abstract concept learning. An abstract concept is a rule that classifies objects, events, or ideas into categories, by their definitions, rather than by their physical attributes, (R. Gagné, 1984). For example, "quality," "truth," or "help " are abstract concepts. Abstract concepts were often taught in instructional texts through the use of illustrations.

However, it was unclear whether illustrations were beneficial or what form of illustrations were beneficial to the learner in learning these abstract concepts. This study addressed this specific gap in the research. It contrasted the benefits of three versions of a lesson to teach abstract concepts: an abstractly illustrated version, a concretely illustrated version and a nonillustrated version.

Theoretical Rationale

The following theoretical rationale includes five proposed predictions about the potential effects of abstract illustrations to affect the learning of abstract concepts.

Prediction 1: Concrete Illustrations

On immediate testing over the content, the students from the concrete visuals group may score higher on near transfer questions than the abstract visuals group. The concrete visuals group was presented with a visual representation of a "best example," which epitomizes the critical attributes of the concept. Such a prototype may promote the immediate recall of the critical features of an abstract concept. It was expected that recollection of the prototype example would easily stimulate recall of the critical attributes of a concept class immediately after instruction. The relationship of the critical features of the prototype to the critical features of the abstract concept class should still be memorable immediately following instruction. The prototype illustration, because of its concreteness should serve as a superior retrieval cue (to the cue strength of the abstract illustration) immediately after instruction, similar to the way the verbal "best example" has cued the recall of concrete concepts (Tennyson, Chao & Youngers, 1981).

Prediction 2: Abstract Illustration on Delayed Performance

It was expected on delayed near transfer testing the abstract visuals group would show a smaller decrement in recall (from immediate posttest to delayed posttest) than the concrete visuals group. This result was expected because it was believed that over time, the relationship of the critical attributes to the concept class would be more memorable for students who received the abstract illustration because the abstract illustration itself embodies the critical attributes without extraneous features. Even the best prototype examples have noncritical features which could, over time, obscure the tie between the example and the critical attributes. In other words, the prototype was predicted to lose over time its power to cue critical attributes because learners would forget which attributes were the critical ones. Although the abstract visual may have been less memorable than its more concrete counterpart, it may have served better over time as a cue to the critical attributes of the concept class. However, this was not supported with empirical results from verbal studies.

Prediction 3: Abstract on Far Transfer

It was expected that on far transfer questions, both on immediate and delayed tests, learners who received the abstract visuals may have performed better than those who received the concrete visuals. This effect was expected because of the anticipated function that the abstract visuals would play: that of an organizing schema for the concept class. Far transfer was dependent upon having a well organized and elaborate schemata. The concrete illustration only represented a subordinate point within a schema as opposed to what the abstract illustrations attempted to do. The abstract illustration attempted to provide a superordinate, all encompassing description, of the critical attributes of the concept, which when triggered, may have activated a more elaborate schema providing flexibility of use of the concept class.

Prediction 4: Interaction of Visual Decoding Skills

It was expected that the abstract illustrations would be differentially effective for learners with varying levels of ability to interpret abstract illustrations. This effect was predicted because it was anticipated that learners who score poorly on the "Diagraming Relationships Test" would not benefit as much from the abstract illustrations either in immediate or delayed testing for both near and far transfer.

Prediction 5: Benefits of Illustrations

Although of lesser interest, it was expected that in the comparison of the illustrated versus the nonillustrated version of instructional text, the illustrated versions would be more effective than the nonillustrated version both on immediate and delayed tests for both near and far transfer. This effect was expected as a result of two theoretical cognitive mechanisms of illustrations. The first was that illustrations provide redundant processing, interpretation and transformation functions that promote dual coding schemata and more retrieval cues (Levin, 1989). The second was the attentional function of illustrations to the information represented within them (Peeck, 1987, Duchastel, 1978). Much previous research on types of learning, such as verbal information and concrete concepts, had supported the illustrated over nonillustrated versions of instruction on the bases of these two cognitive functions (Levie & Lentz, 1982, Merrill, Tennyson & Posey, 1992, and Dwyer, 1978). Consequently, it seemed that these benefits would also support acquisition of abstract concepts.

One primary mechanism for the advantage of illustrated over nonillustrated text was the retentional support that illustrations provide. Illustrated instruction was usually easier to remember over longer periods than text alone (Paivio, 1979) because of the dual coding function. Studies had suggested that the visual portion of information was better remembered than the verbal portion, especially in delayed performance (Levie & Lentz, 1982). These findings suggested that the processing of visual information provided an added benefit to text alone.

General Research Question

What were the comparative effects of abstract illustrations versus concrete illustrations on learning abstract concepts?

Specific Exploratory Research Questions

When investigating learners' ability to interpret abstract visuals on an abstract concept learning task:

1. Will immediate, near transfer posttest performance of those who receive concrete illustrations be superior to the performance of those who receive abstract illustrations?

2. Will delayed, near transfer posttest performance of those who received abstract illustrations be superior to the performance of those who received concrete illustrations?

3. Will immediate, far transfer posttest performance of those who received abstract illustrations be superior to the immediate far transfer of those who receive concrete illustrations?

4. Will delayed far transfer posttest performance of those who received abstract illustrations be superior to those who received concrete illustrations?

5. Will posttest (immediate, delayed, near, and far transfer) performance of those who received abstract illustrations be superior to the performance of those who received no illustrations?

6. Will posttest (immediate, delayed, near, and far transfer) performance of those who received concrete illustrations be superior to the performance of those who received no illustrations?

7. Will posttest (immediate, delayed, near, and far transfer) performance of those who received abstract illustrations show differential benefit for different levels of ability (low, medium, and high) as demonstrated on the "Diagraming Relationships" test?

Definitions Of Terms

abstract concept - (also referred to as "defined concept") A rule that classifies objects, events, or ideas into categories by definition. (E. Gagné, 1985, p. 113).

abstract illustration - (sometimes called "arbitrary illustration") Visuals that do not look like the things that they represent but are related abstractly or conceptually to them.

abstract visual interpretation skill - performance on the "Diagraming Relationships" test.

concept - "...ordered information about the properties of one or more things-- objects, events, or processes-- that enables any particular thing or class of things to be differentiated from and also related to other things or classes of things" (Klausmeier, Ghatala, & Frayer, 1974, p. 4).

concrete illustration - (sometimes called representational or realistic graphic) Visuals which have physical resemblance to the objects they represent. (Alesandrini, 1987)

delayed test of concept application - test given two weeks after the presentation of instruction on concepts, in which learners classify examples and nonexamples.

far transfer ability - performance on a test of ability to transfer knowledge to a previously unencountered situation removed from easy interpretation of the concept application to an inference that is extrapolated from the information given.

illustration - a line drawing representing a concept, idea or object.

immediate concept application ability - performance on a test given immediately after presentation of instruction, which classifies examples and nonexamples.

near transfer ability - performance on a test of ability to transfer knowledge to a previously unencountered examples and nonexamples.

Significance of the Study

It is clear from the discussion of related research presented earlier in this section that there is a gap in existing research on the qualities of illustration that support the learning of abstract concepts. This study examines one feature of illustrations: degree of abstractness, as it is related to the learning of abstract concepts.

The results of this study will add to the research base on critical conditions for learning abstract concepts. The study's results will also extend theory regarding the usefulness of one illustration feature -- level of abstractness -- on learning abstract concepts.

Levin describes research that follows the design used in this study as "strong." Levin (1989) has classified research on picture effects into eight levels ranging from weak to strong evidence (Table 1). The strongest designs are those that show how pictures A, B, C differentially facilitate performance of learner I, J, K on outcomes X, Y, Z (Transfer-Appropriate Processing).

Table 1. Weak versus strong evidence for the specification of picture types and characteristics that facilitate learning from text.

1.	Picture A facilitates performance on Outcome X	Weak
2.	Picture A facilitates performance on Outcomes X, Y, Z	Relatively Weak
3.	Pictures A, B, C facilitate performance on Outcome X	Relatively Weak
4.	Pictures A, B, C facilitate performance on Outcomes X, Y, Z	Relatively Weak
5.	Picture A differentially facilitates performance of Learners I, J, K on Outcome X	Relatively Strong
6.	Pictures A, B, C differentially facilitate performance [of Learners I, J, K] on Outcome X	Relatively Strong
7.	Picture A differentially facilitates performance [of Learners I, J, K] on Outcomes X, Y, Z	Relatively Strong
8.	Pictures A, B, C differentially facilitate performance [of Learners I, J, K] on Outcomes X, Y, Z (Transfer-Appropriate Processing)	Strong

The traditional method of research on pictures (level 1) has been rated as weak by Levin. This method compares text-plus-picture to text-only with a single outcome measure, not specifying characteristics or type of picture in the equation. The inability to identify the type of picture and picture characteristics with only a single outcome measure is the reason for this lowest rating.

Levels 2-4 have only a small advantage in design over Level 1. Level 2 increases outcomes adding the ability to generalize beyond one outcome measure. Level 3 has three text-plus-picture factors to generalize to picture variations. Level 4 includes both picture variations and performance on outcomes, which is an improvement over Levels 2 and 3, however, none of these three levels includes the unique picture characteristics or learner processes that would cause a specific performance.

Most research up to this point has used these first four weak or relatively weak models to investigate picture effects in learning from texts. Levin rates Levels 5, 6, and 7 as relatively strong and use differential (selective or interactive) effects of pictures along with specifiable learner characteristics (Level 5), different picture types and characteristics (Level 6) or different outcome measures (Level 7). Even though these last three have been stronger than the first 4 Levels, only Level 8 incorporates all of these together in one design, making it the strongest level of research of the eight categories.

This research study fits into the Level 8 category. This level incorporates the Pictures A, B, C (Abstract, Concrete, and none) lesson illustration types and learner types I, J, K (high, medium and low performance on Diagraming Relationships test) on outcomes X, Y, Z (performance on far and near transfer questions on immediate and delayed testing).

CHAPTER II

REVIEW OF RELATED LITERATURE

Overview

This study examines the effects of two types of illustrations (abstract and concrete) on acquisition of abstract concepts. There are a number of bodies of literature pertinent to the research questions: theories of information processing, role of illustration in learning, concept acquisition, and visual reasoning skills. This review of the literature will endeavor to summarize the research in these areas.

Information Processing and Illustrations

Information Processing Theory serves as the general theoretical framework for this study. The structure of information processing can be understood through Information Processing Theories as a flow of information from an external stimulus through the sensory registers to "short-term" and "working memory" and then encoding of this information into the long-term memory for later retrieval and use (J. R. Anderson and Bower, 1973; Atkinson and Shiffrin, 1968; E. Gagné, 1985; Rumelhart, Lindsay, and Norman, 1972).

Cognitive Structures

Information processing theory postulates cognitive structures: receptors, sensory register, short-term memory, working memory, and long term memory. The flow of information from the external environment is received by the learner through receptors (senses) and is transformed to neural information.

The sensory register is the structure which receives this information. For example, when viewing illustrations, visual input is received through the eyes. This information is then passed from the sensory registers to the short-term memory (STM). Short-term memory is awareness of the current use of information (E. Gagné, 1985). Short-term memory has limited capacity and duration. This memory is referred to as short-term because information passes out of it in such a short duration of time (about 10 seconds) (Murdock, 1961). Short-term memory holds seven (plus or minus two) units of information according to Miller (1956).

Short-term memory and working memory are being used interchangeably by many psychologists. However, according to Ellen Gagné (1985) these terms emphasize different aspects of the concept. "Short term" emphasizes the duration of the information whereas "working" emphasizes its function or where the conscious mental work is done. Several forms of storage in working memory have been theorized: (1) An acoustic form, where the information is internally "heard" by the learners, (2) an articulatory form, where the learners "hear themselves saying the information" (R. M. Gagné, 1984; Lindsay & Norman, 1977), (3) a visual form where the learner "sees" the information, such as a practice of mentally visualizing the information (Pressley, 1977) and (4) a semantic form, in which propositions are organized in a logical manner (Anderson 1983; R. M. Gagné, 1987). Of course, it is this visual form of temporary storage through which illustrations are thought to pass. Working memory will rehearse, match for recognition, or integrate the new and old information that is retrieved temporarily from long term memory. Working memory is responsible for the development of new schemata or the fine tuning of old schemata to be stored in the long-term memory for later reference. Long term memory is a major information processing structure. Information can be permanently stored there by being encoded from working memory. This encoding process transforms the information into a conceptual form. The main characteristic of encoded material is that it is semantically, or meaningfully, organized so it can be retrieved when needed. The exact nature of long-term memory storage of visuals is controversial. Storage models will be discussed later in this chapter under "text and illustration processing models." At present, the retrieval of stored information is the only way to know that learning of "school" tasks has taken place (Driscoll, 1994; Gagné, Briggs, & Wager 1988).

Cognitive Processes

In addition to the structures hypothesized by Information Processing Theory, a number of processes are proposed: perception, selective perception, attention, encoding, storage and retrieval. Information must first be perceived before it can be processed and this perception of illustrations is achieved through the visual channel. The perception of an illustration is highly dependent upon the physical characteristics of that illustration, such as legibility and the physical features of the surrounding environment, such as illumination.

Selective Perception/Attention

Attention is given only to a small part of the environment at any one time and prior learning, maturity and attitude will influence the amount and direction of this attention. This directed attention is termed "selective perception." Selective perception refers to the transformation of perceived information into patterns of neural stimulation as it leaves the sensory register and goes into the working memory, with only certain information making the transition. Selective perception is the learner's tendency to attend to certain features of the content, such as attending to the roundness of an object not the background, which allows learners to ignore that which may be unnecessary information in a specific learning situation. The details to which a learner attends will influence the amount and type of learning (Fleming & Levie, 1978). Selective attention to illustrations is often measured by measuring the length of time, number of fixations, and location of fixations of the eye on certain parts of the illustration.

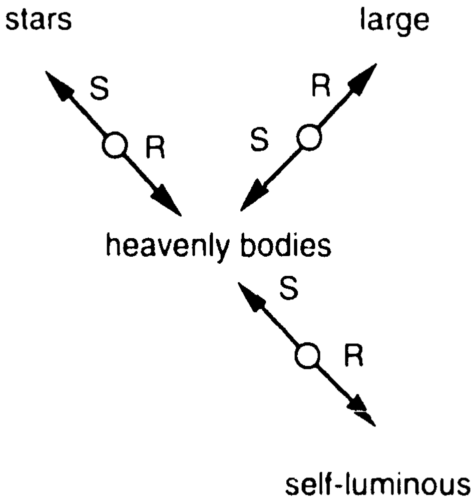
Selective perception is influenced in a "feed forward" manner by information, attitudes, purposes, and expectations that are stored in long-term memory (Fleming & Levie, 1978). Any previous knowledge about the content can potentially affect the learner's perception. Another factor affecting the learner's perception is the situation in which the illustration will be used (directing attention to a specific area to be learned for the desired learning outcome). If an illustration of a man and a boy riding a bicycle is shown, the learner could attend to the two wheels if the concept being learned is "bi" as meaning "two." Another possibility is attention could be centered on the people, if an affective message such as the relationship of a father and his son doing activities together is the focus. A third possibility is attention could be directed to the gears and peddles to learn the concept of "energy." To ensure that illustrations are perceived as they were intended, appropriate interpretation of the illustration is often promoted by the text (Bransford & Johnson, 1972). Thus, captions and labels for illustrations are often used to help direct a student's interpretation or attention. An illustration is only perceived as expected if the student has the same perception of the content as the instruction intended.

Encoding and Storage

Winn (1982) states that "little is learned from a picture whose features are perceived, but whose meaning is not understood"(page 7). In this statement, he is referring to the process through which graphic information is encoded into a form that can be assimilated and combined into a mental representation for storage in long-term memory. Encoding is the process through which information is transformed from working memory to long-term memory and integrated with existing information. Meaningfulness of information is a key to this process. Only that information that can be related to information already stored in long-term memory is meaningful and can, therefore, be stored. Many theorists postulate that the information stored in long-term memory is stored in the form of schemata. Rumelhart (1980) explains that a schema is a network of ideas surrounding one central, superordinate idea. He explains that schemata can be embedded, one within another. For example, most individuals have stored a "face" schema which dictates what they expect to see in a face. The depth to which information is understood will be determined by the number of related and progressively more complex schemata at an individual's disposal. Schemata can to be developed from two different processes: conceptually-driven, from a whole to a part (top to bottom) or data-driven, from a part to a whole (bottom to top). The ability for schemata to aid processing in both directions is called "schema-directed processing."

John Anderson (1983) does not believe this form of information storage fully explains the way in which knowledge is stored. Hence, he has developed, over the years, the ACT* (Adaptive Control of Thought) theory of cognitive architecture. Anderson (1983) suggests that there are two types of knowledge: (a) declarative (factual) represented as a semantic network and (b) procedural (rules for how to do some task) represented as production rules. Anderson believes these types of knowledge are stored in the same storage systems. He argues for three types of cognitive units or representational types: temporal strings, spatial images and abstract propositions. These cognitive units are activated from long term memory by links connecting source nodes of information. The level of activation will vary according to the relevance of the information being encoded to the information already stored in long term memory. The more the links between information are used, the stronger the links become and also, the greater the capacity of working memory, due to an increased familiarity of concepts. Inversely, there is a natural decay of information over time if a source node remains inactivated.

Propositions and productions work together and are both forms of knowledge representations used to explain the way information is stored in long term memory. In organizing information in a proposition, the information is divided into groups with nodes in the center and links going out to the subsets, each with their own major idea and connecting subsets, each one building onto the next. In retrieval of information, the subsets are drawn upon to build the new information onto the old, expanding the knowledge base (E. Gagné, 1985).



A propositional network representation for "Stars are large, self-luminous heavenly bodies."

Figure 1

Productions are condition-action pairs, also known as "pattern recognition and action sequences." Productions are a form of cognitive representation of knowledge explained by Anderson (1983) to show the organization of knowledge. They provide the connection between declarative knowledge and behavior. Performance based on productions is achieved first by pattern recognition and then by an action sequence.

An example of a pattern recognition is

"IF ANIMAL has four legs
and ANIMAL is green
and ANIMAL is slimy
and ANIMAL is size of fist
THEN Classify ANIMAL as a frog.

An example of an action sequence is:

IF GOAL is to keep ANIMAL alive
and ANIMAL has four legs
and ANIMAL is green
and ANIMAL is slimy
and ANIMAL is size of fist
THEN Put ANIMAL near water
and catch flies
and feed ANIMAL flies." (E. Gagné, 1985, p 105)

Figure 2

When, both the pattern recognition and action sequences are put together they form a relationship between declarative and procedural knowledge.

An earlier network model was developed by Collins and Quillian (1972) called TLC (teachable language comprehender) using units, properties and pointers. Units being words that represent the subject or one thing, properties being words that represent characteristics (very much like criterion attributes) of the unit and pointers being relationships of different types among units and properties. The structure resembles a concept tree with the broadest concept at the top and the more specific concepts at the bottom. The goal of these researchers is to computerize this model. This model has been updated by Collins and Loftus (1975) and is called "spreading activation model."

In 1970 Meyer also proposed a model of concept storage and retrieval which consists of lists of subsets or features, not unlike a list of criterion attributes for each concept. It has been theorized that these lists are compared for overlapping attributes and when there is an overlap the statement is true or the concept has been described.

As stated several times above, visual information is translated from working memory into a more abstract form in long-term memory. As noted, there is quite a disagreement among theorists as to the form of this abstract storage and whether these semantic storage models can describe visually perceived information.

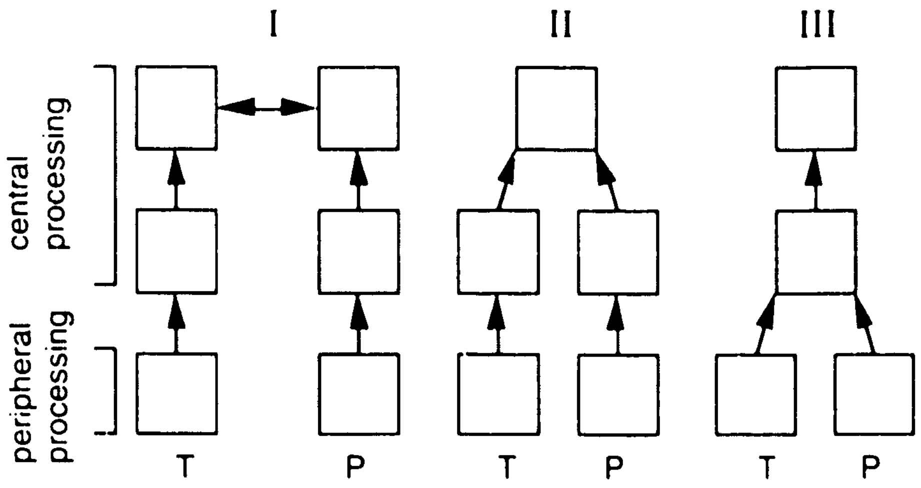
Retrieval - Recall and Delayed Recall

In order to obtain evidence that information has been learned, it must be retrieved from long-term memory and used in some observable way. (Recall of information from working memory can be immediate such as the temporary ability to recall a telephone number. This is not considered to be learning: It is not a permanent change in cognition.) Recall of information from long-term memory must be cued in some way in order to activate the nodes of information stored in long-term memory. This cueing will bring specific information into working memory to be used, combined with new information, and then reencoded again for storage in the long-term memory (E. Gagné, 1985). Memory of visuals is more resistant to forgetting than is memory of verbal information (Paivio, 1975). Illustrations form an iconic plan for the learner, much as headings form a verbal plan (Duchastel, 1978). These iconic plans can be recalled for longer periods of time than verbal information, thus the delayed recall of information that has been stored iconically is more durable than information stored verbally. In the review by Levie and Lentz, (1982) research was found to support this contention in findings of 19 out of 24 cases where facilitation as a result of illustration could be directly compared (pictures verses text). In these studies, pictures facilitated delayed recall more than immediate recall.

The recall of pictures known as "hypermnesia" has been known to happen in situations where the depth of processing of visuals is deep. Hypermnesia is the increased recall of information with repeated testing over time (Roediger, Payne, Gillespie & Lean, 1982). This phenomenon is found to occur primarily with pictures and sometimes with prose, if instructions to encode into images has been followed (Erdelyi, Finkelstein, Herrell, Miller, & Thomas, 1976). This hypermnesia affect should make both the delayed recall of the concrete and abstract visuals in this study increase if the processing of the visual is greater than at a superficial level.

Text and Illustration Processing Models

Several different pictorial processing models are viewed by researchers to be viable in reference to textual and visual information processing. Three of these are the dual coding model (Figure 3, model I), single coding model (Figure 3, Model III) and sensory-semantic model (Figure 3 Model II). These three processing models (cognitive architectures) presented in Mandl and Levin (1989) by Molitor, Ballstaedt and Mandl and illustrated below were adapted from Farah (1989) as possible approaches for describing text processing and picture input.



Memory Models for "processing text (T) and Pictures (P). They all assume modality-specific peripheral processing. However, the central processing systems (I) assumes two modality-specific processing systems, (II) assumes a uniform processing system, and (III) assumes a two-stage processing system. (reproduced from Farah, 1989)" Note. From Knowledge acquisition from text and pictures (page 8), by Molitor, Ballstaedt & Mandl, Mandl and Levin, Eds., 1989, North-Holland: Elsevier Science Publishers B.V.

Figure 3

In each of the models, the external input of text (T) and pictures (P) enters the sensory registers then moves into working memory where peripheral processing is executed via separate entry paths. This peripheral processing is achieved by comparing previously acquired knowledge with newly encountered knowledge. According to Model I, information from text and visuals continue to be processed separately and stored in long term memory in two separate storage structures. The processing for Model III is the single-code approach. It postulates that initial processing is separate but there is common processing of text and visual information and central processing (both short and long term memory) as propositions and a common storage. Model II conjectures that text and visuals are processed differently but are stored in a common storage system. All three models are explained in further detail below.

Paivio's dual coding model, which follows a Model I theory, postulates two independent paths of coding -- verbal and visual, which function independently but are interconnected. He believed that the visual can cue recall of the verbal, and the verbal can stimulate recall of the visual. Paivio proposed that this cueing effect is stronger for visual cueing verbal than verbal cueing visual information. Empirical studies have supported this cueing benefit. For example, Jenkins, Neale and Deno (1967) conducted an experiment in which picture recall of familiar objects was higher than recall of their concrete-noun labels. Also, when pictures were used in both the presentation and test portion, the recall performance was higher than when either presentation or test, or both, contained words. Paivio and Csapo (1973) explained that pictures are remembered much more than words and for a longer period of time than verbal information in the long-term memory because of the method in which it is stored. Illustrations do not need the same kind of coding system as words which have a more complicated encoding and retrieval system. Paivio (1979) conjectured that sequential processing is done via the the verbal system and parallel processing is spatially organized capable of receiving, transmitting and processing information in a spatial array. In other words, it is a symbolic system specialized for parallel processing of information.

A second model for processing and storage of text and images is the single code model (Figure 3, Model III). Pylyshyn (1981) is most closely associated with this theory. Pylyshyn proposed that all images are controlled by propositions. The single code model advocates propose that there is only one coding system with different activations of that system and all information is coded as abstract propositions (Levie, 1987). In other words, the supporters of the single code model believe that all information is ultimately coded as verbal propositions in long-term memory, and there is no separate path or storage pattern for visual images (Anderson, 1983). Because this theory comes from the Artificial Intelligence community, it is conceivable that they support this model as every memory will be a proposition, making the representation of memory more easily programmable.

According to the third model (Figure 3, Model II), the sensory-semantic model, even though pictorial and linguistic information are processed separately at the beginning of the internal cognitive processing, eventually the information will be stored in the same form. Thus, people recognize and process pictures more rapidly than words when they are trying to categorize such things as concrete concepts. In this model the sensory codes for pictures are more distinctive than any words that might be used to represent these images (Levie, 1987, Nelson, 1979).

Application of Information Processing to This Study

The architecture of information processing will have a bearing on interpreting and predicting learners' ability to learn abstract concepts. Some concepts appear to be learned more easily than others. For example, Clark (1971) found that concrete objects were more easily learned than concepts of spatial forms and in turn that concepts of spatial forms were more easily learned than the more abstract concepts of numbers. This study will investigate the comparative advantage of two types of illustrations (one concrete, one abstract) in supporting encoding of abstract information so that it can be easily retrieved and applied in both near and far transfer tasks. Concrete illustrations serve as a better retrieval cue for critical attributes in the short term. However, it is expected that abstract illustrations may serve as a better retrievable cue over time. In other words, on immediate testing students in the concrete group will score higher on near transfer questions than the abstract group because the illustrated prototype "best example" will be easily recalled in short term. However, in the long term and far transfer it is hypothesized that the abstract visual may be recalled best because of its ability to encapsulate the critical attributes of the concept which will be processed into a larger schemata with a greater number of links to support retrieval.

Role of Illustration in Instruction

The following section will summarize the literature that has examined the function of illustration in instruction through discussion of the role of illustration in learning, functions of illustrations (representational, organizational, interpretational, transformational and decorative), and the application of illustration research to this study.

Role of Illustration in Learning

There are two major bodies of literature in the research on the role of illustration in instruction: One is in the area of illustrations and the act of "learning to read" and the other is illustrations and the act of "reading to learn." Although the findings of research on "learning to read" are interesting, the focus of this research review is only on the role of illustration when "reading to learn."

Levie and Lentz (1982), summarized 55 experiments within 23 studies comparing learning from illustrated text with learning from text alone. They reviewed both normal representational pictures coinciding with the written material and also nonrepresentational pictures including learner-produced drawings and mental imagery. They reported that of the 23 total studies, 46 comparisons were made of learning illustrated text information from illustrated text versus text alone. Only one comparison found the text alone group was superior to the text with illustration and the difference was not statistically significant. Of the other 45 studies, 39 comparisons had statistically significant differences ($p \leq .05$) in favor of the illustrated instruction. The average group score for the illustrated text group was 36% higher than for text-alone groups. Levie and Lentz concluded that there was overwhelming evidence to support the inclusion of pictures in learning material.

Although it is clear that illustrations generally do support learning better than text alone (Levie and Lentz, 1982), it is somewhat unclear why they do so and what illustration characteristics best support learning.

Some of the reasons why illustrations might support learning cognitively are suggested by the functions that researchers have posited that illustrations play in learning.

Functions of Illustrations

Representation, organization, interpretation and transformation are the four main functions of illustrations as categorized and defined by Levin (1989).

The representational function of illustration or redundancy of text and illustration, overlaps the content of the text and visual. The visual often repeats the same content of the text, offering a reinforcement of the material and an alternate coding system.

The organizational function of illustration reduces the ideas in the text to a more visual condensed version of the text, allowing the reader to have a more visually organized view of the relationship of the elements in the text. This function is sometimes rendered in the form of procedural diagrams, maps or organizational charts.

The interpretational function of illustration renders text more easily understood by the use of analogies, visual metaphors or concrete examples. Visualization of the water cycle is an example of interpretational function.

The transformational function of illustration uses a mnemonically useful form of recoding, usually of single words and sometimes larger groups of words to a single visual form. This function is sometimes used in foreign language vocabulary instruction and is called "keyword" or "hook" technique (Shriberg, Levin, McCormick, & Pressley, 1982).

Another function, not included in Levin's list of the four above, is the decorative function. The decorative function of illustration is used solely for the purpose of motivation. Levin (1989) suggested that such illustrations have either no positive effect or even a slightly adverse effect on the retention and comprehension of material.

Concrete illustrations, such as those used in this study, have an interpretational function, such as exemplifying a concept. Both the organizational function, which adds structure and coherence, and the transformational function, which is memorable and transfers the concept into a more mnemonic form, can be abstract in character. The abstract visual can have an interpretational function as well. In this study this is demonstrated in the lesson (Appendix B) by using an abstract visual to encapsulate the concept and make it more memorable to support delayed recall and far transfer.

Review on Illustration Effects

Peeck (1987) categorized research on illustration effects into four categories: interactions of learner characteristics, picture characteristics, picture-text and interface, and text characteristics. Although there is much research in these areas, this review will include only research pertinent to this study. The learner characteristic of age appears to interact with the characteristics of illustration. For example, young children preferred realistic pictures with color and relatively simple design, whereas older children and adults preferred more complex pictures (Travers & Alvarado, 1970), possibly because the older learners have at their disposal more propositions, productions, and elaborations. The learner characteristic of prior knowledge is also potent in use of visuals as it may allow inference about picture content that is not visually present but only inferred.

Not only the learner characteristics, but also picture characteristics affect the learners' ability to interpret illustrations. The more complex the illustration, the more cognitive processing is needed to decipher the intended message. Some additions to complex illustrations that may improve the ability of the learner to interpret the illustrations are cues, such as lines, arrows, color, shading, size or encircling an object to increase attention to the critical content area (Dwyer, 1978). Picture characteristics such as degree of realism or abstractness will also influence interpretation of the message in concept teaching (Evans, Watson & Willows, 1987).

Visual reasoning or the ability to interpret abstract visuals may have an influence on the ability to learn abstract concepts from abstract visuals. Architects and other professionals have been taught how to interpret abstract visuals. This ability to interpret abstract visuals comes more easily to some people than to others (Levie, 1987). Visual reasoning skills will be further expounded upon later under "learner characteristics."

Text-picture interface also influences the effects of illustrations on learning. Studies have compared intentional attention to illustrations (telling the reader to pay attention to certain details in the illustration) with incidental attention (no specific instruction with regard to the illustration). Guiding the reader's attention to the picture (intentional attention) does not necessarily mean knowledge will be gained from it (Fleming & Levie 1978). However, there appears to be no adverse effect from intentional attention, and the practice of directing attention to the illustration is still a sound educational practice (Hayes & Readance, 1983). On the other hand, encouraging the reader's interaction with the illustration will increase the likelihood of learning from it. This effect has been documented by research requiring readers to label parts of drawings being studied as compared to the illustrations already having the labels (Dean & Kulhavy, 1981). Also, the use of captions may enhance the effects of illustrations by directing attention to specific aspects of the picture (Fleming, 1979). Much research on cueing attention has been addressed and documented by Dwyer (1978). The cueing techniques that have repeatedly surfaced in the literature to increase understanding and awareness of the illustrations are arrows, lines, labeling, size, encircling, textual questions, texture, advanced organizers and suggested imagery strategy.

The function of an illustration with relationship to text also affects its impact. When the understanding of the text is dependent upon the illustration for clarification or understanding, then the comprehension of the text is substantially supported by illustrations, (Bock & Milz, 1977), especially if the illustration depicts spatial-structural relationships in a text (Dwyer, 1972; Levie & Lentz, 1982). Yet, if the illustration does not enhance the text but, is redundant, the effects of the illustration are less. In this study it is hypothesized that abstract illustrations will suggest a structural relationship and enhance comprehension.

Abstract Versus Concrete Illustrations

Salomon (1976) postulated that one of the factors that could affect learning is the symbolic code into which the instructional message is encoded. Codes differ as to the degree of concreteness or abstractness. Salomon stated that symbols, a type of visual code, rank along a continuum, ranging from realistic symbols (iconicity) to standardized symbols (abstract images). The difference between the depiction (or representation) and the description is the semantic relationship between a symbol and its referent. A symbol that does not resemble its referent or a symbol which stands for an abstract idea (because it has been abstracted from its referent) is referred to as descriptive (abstract), whereas, one that represents the idea closely is referred to as depictive (concrete). Salomon (1979), stated that additional translations, conversions, or elaborations are required when the modes between internally represented information and presentation are not close. He also suggested that each person converts the information into the internal form that is most retrievable for that person. Also, when communication is better with illustrations it is so because the symbolic system more closely resembles the referent. So, according to Salomon, one system does not have an advantage over another.

This study has incorporated both types of illustrations along this continuum from concreteness to abstractness. The types of illustrations used in this study will be realistic symbols, best examples and nonrepresentational, "abstract" illustrations. The function of each type of the illustrations in this study is to assist in both encoding and retention of information. The best example will be representational examples of content referred to in the text. The abstract illustration will represent the concept class with abstract symbol type. The function of the abstract visual is to graphically represent the class and its critical attributes rather than any one member of the class.

The "best example" will facilitate the near-transfer, immediate-testing, realistic symbol system and the accessibility of the visual information in the short term. By contrast, the more abstract symbol system is encapsulated in the different facets of the referent without including extraneous critical generalization. This may enable the abstract symbol to support retrieval and far transfer in the long term (in this case, two weeks).

Application of Illustration Research to this Study

The aforementioned illustration research applies to the current study in a number of ways: (a) The age of the learner will allow the use of abstract visuals in this study because only small children have a need for only concrete illustrations. (b) The type of visuals can be classified according to function [(interpretive and transformative)(Levin, 1989)],which should lead to the generalizability of the results. (c) Prior knowledge of the learner will affect the learners' ability to learn from abstract visuals. (d) Therefore, references to the illustrations in the text (Fleming, 1979) will be used because of the positive influence they will have on learning. (e) The relationship of the illustration to the text in reference to the physical proximity will follow recommended standards of practice. (f) The abstractness or concreteness of the illustration (Dwyer, 1987) are two of the factors influencing the outcome of the study [Merrill & Tennyson(1977), Smith & Ragan(1992)]. (g) As stated before, the effect of the abstract illustrations on the outcome of this study may be positive in relationship to the abstract content because according to Salomon (1979) the relationship of the coded message to the processing of the message is a factor that can make one mode of presentation superior to another. All of these considerations have been taken into account in the design of the materials of this study.

Concept Learning

This section on concept learning will discuss research and theory on concepts, learning concepts, instruction for learning concepts within best example strategy and definitional strategy, role and nature of illustrations in teaching concepts, measuring near and far transfer of concept learning and application of concept learning to this study.

Concepts

A concept is "a set of objects, symbols, or events grouped together by a common set of attributes" (Merrill & Tennyson, 1977). There are other definitions of concept learning which reflect the declarative knowledge nature of concepts (Tessmer, Wilson & Driscoll, 1990). However, this study will focus on the pattern - recognition, classifying rule, production-based nature of concepts. R. Gagné (1984) and others (Klausmeier, Ghatala, Frayer, 1974) have suggested that there are two types of concepts: Concrete and abstract. A concrete concept is a concept whose critical attributes are based upon the physical characteristics that the members of the class have in common, such as color, shape, etc., even though other characteristics may differ greatly. Examples of concrete concepts are the concepts "telephone," "wrist watch," or "drum."

The critical attributes of abstract concepts are not their physical features, but their definitions. An example of an abstract concept is the concept "aunt." The concept aunt can be defined as a person who is related to one by being one's uncle's wife or one's mother's or father's sister and this definition may even vary by culture. There is no way of telling whether a person is an aunt by her physical attributes, only by determining how closely a person's relationship matches those described in the definition. Other examples of abstract concepts are the concepts "history," "love," and "social status."

Learning Concepts

When concepts are defined as classifying rules, a concept is said to be "learned" when an individual can identify which of a set of unencountered instances belong to a particular class or concept (Merrill & Tennyson, 1977). Concepts make it possible for an individual to identify an object or idea as a member of a class having one or more critical attributes in common, even though other attributes in common may be irrelevant (noncritical attributes). 'Car' is an example of a concept. It can be any color, size, style, or cost. All of these different, irrelevant attributes do not matter, in its classification. It will still be classified as a 'car' if it has the relevant attributes of traveling on the ground, having wheels, moving, requiring fuel, and being used for transportation. The difference between learning a concrete concept and an abstract concept is whether the critical attributes are visually distinguishable physical attributes or abstract, as in a definition that includes abstract, rather than physically perceivable features. Because concrete concepts have physical attributes that may be seen, it would appear that a concrete illustration would be preferable for learning the physical attributes. Whereas, abstract concepts do not really have physical attributes and may better be represented by an abstract visual. This abstract visual should encompass the critical attributes of the abstract concept which should be picked out and remembered.

A concept is learned by generalization and discrimination (Merrill & Tennyson, 1977), (two competing processes). Generalization occurs when a response is given to a new example of a concept class which is acquired from a similar example of that concept class. Discrimination occurs when a learner exhibits a particular response to an example of one concept class but a different response to an example of another concept class. Correct classification behavior will be exhibited if overgeneralization or undergeneralization does not occur.

In the case of abstract concept learning, under the rules of categorizing, learners should not overgeneralize the concept by mistakenly including noncritical attributes within their classifying rule. Examples of noncritical attributes, which would encompass other concepts besides the concept of "actor", could be listed as: a person who talks before large groups of people, a person who dresses in expensive clothing, demonstrates affection for strangers, and appears on television. These same noncritical attributes could also be mistaken for the concept of "politician."

Many authors (R. Gagné, 1977; Merrill & Tennyson, 1977) warn that concept learning is not to be confused with learning the definition of a concept. Concept learning is manifested by the ability to make decisions on the classification of previously unencountered instances as to membership in a concept class or not. This ability requires procedural knowledge, rather than more inert declarative knowledge.

Instruction for Learning Concepts

Many authors have described features of concept teaching (Fleming & Levie, 1978; E. Gagné, 1985; Merrill & Tennyson, 1977; Smith & Ragan, 1992). According to Merrill and Tennyson, teaching of concepts may be broken down into a systematically designed procedure of, (a) analyzing the concept learning task, (b) defining the concept, (c) providing examples and nonexamples of the concept, (d) having learners classify examples and nonexamples, (e) providing remediation and feedback, (f) providing newly encountered instances, and (g) revising.

Generally a designer should analyze the task to ensure that a concept learning lesson is the targeted learning outcome. The learning task may or may not be a concept learning task (identification of critical attributes) depending upon the ability required. The required ability might only be recall of the definition of the concept or description of the relationship of one concept to another - which is more declarative.

According to Merrill and Tennyson (1977), the instructional strategy suggested for learning a concept includes providing a definition of the concept and stating the concept's name or label using common words that take on a special limited meaning with the critical and variable attributes included in this concise definition. The instruction also can provide matched examples and nonexamples of the concept, pointing out critical attributes and helping learners determine non-relevant, variable attributes under consideration. The sequence could be different for an inductive or deductive approach depending on whether the definition is presented to, or induced by, the learners. For practice, learners should be required to classify previously encountered examples and nonexamples. To reinforce this, correct remediation feedback should be provided for over-generalization and under-generalization of the answers with attribute isolation and why an instance was correct or incorrect. When a concept is known, correct classification can be exhibited. This skill should be tested by unencountered instances.

Merrill and Tennyson's (1977) approach may be described as "definitional" in that it attempts to convey the critical attributes by a verbal statement (a definition). Merrill and Tennyson also recognize that instruction includes attribute isolation. Attribute isolation techniques include using attention-focusing devices to direct students' attention to critical attributes present in the specific example or omitted in a nonexample. There also is a need to point out possibly confusing, irrelevant, or variable attributes. The techniques for attribute isolation in print media include prompting, feedback, and attention focusing devices, such as color, exploded drawings, special symbols, written notes, and (most relevant to this research) simplified illustrations. Often pictures are too complicated to isolate the critical attributes of a concept and need simplification by removing extraneous details. This visual segregation of attributes in an illustration is vital to the teaching of concepts. Merrill and Tennyson's (1977) strategy is consistent with R.M. Gagné's theories on instruction, which suggest external instructional events that can support the necessary internal processing of information. In the current study, the instructional designer tries to isolate the critical attributes of the abstract concepts by pointing out how the abstract illustrations represent the critical attributes.

Definitional Strategy

Merrill and Tennyson (1977) recommend that the instructional design strategy for concept learning should include defining the concept and stating the concept's name or label with special limited meaning given to the concise definition with the critical and variable attributes included in this definition. This approach will be referred to as a "definitional strategy." Attributes that are shared with superordinate class and attributes that distinguish a concept from other concepts of this class should be used in its definition. Example: Car is a form of transportation (superordinate) that moves, has four wheels, a motor, travels on the ground (usually a highway), attributes distinguishing it from other forms of transportation.

A linguistic definition expresses certain categories of relationships such as cause to effect, of means to ends and objects to their use, also the relationship of an abstraction to its reference - of words, signs, and symbols to that which they represent (Jeffers, 1974). Robert M. Gagné (Personal communication November 15, 1990) suggested that an abstract illustration should reflect in abstract form what a definition does in verbal form. In this study the abstract illustrations will be used the same way as an image definition. The abstract illustrations are an image which embodies a definition, whereas, the concrete (representational) illustrations are analogous to the verbal best example (see description of best example strategy that follows).

<u>Best Example Strategy</u>

An alternative to the "definitional" approach to teaching concepts is a best example strategy. A best example is a "prototype." A prototype has been defined as a composite of specific instances of representations of conceptual categories into a single best example (Rosch, 1978). Rosch proposed that good examples are learned naturally before poor ones. Rosch concluded from her research that a general category is best defined by the features of a good prototype, that emphasizes critical attributes and has a minimum of distracting noncritical attributes. Empirically, a best example can be indicated by the amount of time that subjects take to rate or respond to a particular instance as a member of a category – the faster the response time, the better the example.

Tennyson, Chao, and Youngers (1981), investigated concept learning in a study involving acquisition of a prototype and development of generalization and discrimination skills. In the lesson using a prototype, they predicted that the concept is retained because the participants have a clear prototype and skill to compare the presence or absence of critical attributes between the prototype and newly encountered examples and nonexamples. In the Tennyson, Chao, and Youngers (1981) study the concrete concept was the "equilateral triangle" and the design strategy was written according to the guidelines of Merrill and Tennyson (1977). The two independent variables of presentation form (expository [definition], interrogatory [practice], expository-interrogatory) and formative evaluation (with and without) were tested using a two-way factorial design with six treatment conditions. Tennyson, Chao, and Youngers (1981) found prototype strategy to be effective. They concluded that concept learning in the expository or interrogatory presentation form alone caused learning drop-off: whereas a combination of expository-interrogatory presentation helped with the retention of critical attributes and prototype. They concluded that concept learning involves the development of both a prototype and the necessary generalization and discrimination skill at which point they suggest the five-step process of concept teaching presented earlier.

In a later study, Tennyson, Youngers and Suebsonthi (1983), hypothesized that a presentation of a best example would be more effective in concept learning than a presentation of an "operational rule," better known as definition by critical attributes. A definition was included in each lesson presented in the four groups of the study. Participants in the study were 107 male and female third grade students randomly assigned to one of four instructional treatment conditions. Groups 1 and 2 were given the best example and Groups 3 and 4 were given operational rule. Groups 1 and 3 were given an expository set of examples and an interrogatory set of examples, while Groups 2 and 4 were given only the interrogatory set of examples. The students were given a posttest and a retention test. Under each treatment condition the participants did slightly better on the retention test. The results for the main effect of the two conceptual-information conditions on the posttest were significant, $F\ (1, 68) = 9.45$, $p < .003$. The subjects in the best example groups achieved 85% correct items and the operational-rule groups achieved 68%. The posttest was given the day after the lesson and the retention test was given two weeks later. The retention test correct scores were also significant, $F\ (1, 68) = 6.87$, $p < .01$, with the best example mean of 17.5 and operational-rule mean of 14.1.

Protocols from this study seemed to indicate that children learned mathematical concepts better from encoding a prototype that is abstracted from the best example rather than critical attributes. However, no transfer tasks were indicated and the age level was third grade whereas the students in this study will be young adults indicating a different cognitive development level and the posttest and delayed posttest will include near and far transfer questions.

Role and Nature of Illustrations in Teaching Concepts

Illustrations have a prominent role in teaching concepts. They can encourage motivation, assist retention, direct attention, clarify points, and focus on vital aspects (Peeck, 1987) The predominant role for illustrations in concept instruction (Merrill & Tennyson, 1977) is to draw attention to the critical attributes of the concept. Attention can be directed to these attributes through size, color, darkness, centering, lines, arrows, and focus or detail. Other techniques for directing attention to critical features of concepts, thus making them more memorable, could include labeling parts, placing description within the text or locating visuals in relationship to the text referring to it.

Members of a concept class may be referred to as "exemplars," "positive instances," or "positive examples." Merrill and Tennyson (1977), stated that instances are of three forms: referent, isomorphic representation, and symbolic representation. A "referent" is the actual object, event or symbol in real life or the imaginary world as it exists. An "isomorphic representation" is a picture, model, simulation, or other representation of the attributes of the referent in which the referent itself is not present. The attributes of the referent and the representation have some concrete correspondence between them. A "symbolic" representation describes the referent in words or uses special symbols substituting for the referent. Merrill and Tennyson did not state an advantage of one type over another, but suggested that all types should be used in teaching concepts if the designer can include the critical attributes within the illustration. However, they also stated that it is not always possible to use all three forms of illustration, noting that learning abstract concepts had a disadvantage when concrete illustrations were used because they did not include all of the critical attributes and included other attributes that are irrelevant, and potentially misleading.

Assessing Concept Acquisition and Transfer

Transfer is the flexible use of knowledge and skills in new context under new conditions (E. Gagné, 1985). Near transfer is the application of knowledge in circumstances similar to the circumstances under which learners acquired the knowledge. For example, in this study near transfer will be measured by a series of items in which learners must classify previously unencountered instances/noninstances of a concept as representative of that concept or not. Far transfer is the ability to apply knowledge under unencountered and unrelated situations where the concepts may be used in ways that require inferences, extending beyond that demonstrated or practiced (Butterfield & Nelson, 1989). For example, in this study, far transfer will be measured by the following kinds of items: Making predictions and inferences based on concepts, explaining answers on categorization examples, explaining distinguishing characteristics in concept examples, generating examples, explaining relationships among the related concepts, and drawing a concept tree.

Application of Concept Learning Research to this Study

Concept learning research directly affects the way this study is designed. Indeed, this chapter contains many references to the connection between the literature and the design of this study.

The learning of concepts can be facilitated by verbal definition (Levie, 1987), by verbal best example prototype (Medin & Schaffer 1978), concrete visual best example or abstract visual, but should follow an instructional design which gives good exemplars and which increases the likelihood of transfer. Any teaching of concepts should include instruction to promote both generalization and discrimination and the other steps mentioned in detail in Chapter 3.

Central to learning concepts is understanding and recall of critical attributes of the concept class, so that learners do not over- or under-generalize. A number of devices have been used in the past to promote this understanding and recall (Merrill and Tennyson,1977). Two key devices that have been used are definition and best example. Research has suggested that best example promotes initial and delayed learning better because of ease of visualization on concrete examples. However, research with verbal definition and best example may differ with abstract concepts. This study will determine if this finding remains stable when best example and definitional are visually portrayed -- thus supporting concreteness over abstractness or whether abstract concepts are better supported by abstract illustrations. Also, this research using young adults will extend to include far transfer tasks to assess ability to manipulate knowledge in new situations.

CHAPTER III

METHODOLOGY

This study investigated the comparative effects of concretely illustrated instruction versus abstractly illustrated instruction on the acquisition of abstract concepts. This chapter outlines the methodology used to investigate this cause and effect relationship.

Participants

The participants in this study were sophomores, juniors, seniors, and graduate students enrolled in education courses at a south western state university. The classes in educational psychology, media technology, and research methods in education were selected because of the content relevance, availability of students, and the typically print-based method of presenting content. All students in the classes were asked to volunteer for the study, and those who agreed were stratified into three groups according to test results on the visual relationship test and randomly assigned to one of the three treatment groups (no illustration, concrete illustration, and abstract illustration.)

Demographic data was collected at the beginning of the study via a survey given before the lesson (see Appendix A). Participants finishing the study had the following characteristics: 45 males, 145 females; 10 sophomores, 65 juniors, 101 seniors, 12 graduate students and 2 of unknown classification. The most common majors were elementary education, early childhood education, and science and language arts in secondary education. The participants' ages ranged from 19 to 49, with the largest group of participants in the 21 year old age group. Although it was expected that none of the students would be familiar with the content, 10 percent were eliminated from the study because of prior content knowledge of Gagné's Conditions of Learning [determined by the entry questionnaire/pretest (see Appendix A)].

The only requirement for participants to be eligible for this study was enrollment in the education courses, willingness to participate, and availability for delayed testing.

Variables

There are three types of variables in this study: independent, attribute, and dependent. The following sections will explain these variables for this study.

Independent Variables

The independent variable in this study was type of illustration with three levels: None, concrete, and abstract. These variables are embodied in three print-based instructional versions of a lesson on one of Gagné's domains of learning outcomes, that of intellectual skills. Each lesson was identical except for the type of illustration included: abstract, concrete "best example," or no illustrations, with references to the illustrations in the two illustrated versions. The section on the design of treatment versions will further explain these variables.

Attribute Variable

The attribute variable of abstract visual reasoning was measured by an instrument called "Diagraming Relationships." This instrument was taken from the "Research on Assessing Human Abilities" created in 1975, which came from what was historically called the "French Kit" by the Educational Testing Service, Princeton, N. J.. The Diagraming Relationships instrument was used to evaluate the participants' ability to interpret and derive meaning from abstract visuals. This instrument is further described in the materials section.

This variable was included in the research because of suggestions in the literature that learners are not equally skilled in interpreting abstract visuals. The experimenter searched for an instrument that would allow the audience's skill to be ascertained in interpreting abstract visuals, and Diagraming Relationships was the best instrument currently available that could be found. This instrument was developed to test reasoning which is mediated through visuals. Because of its use of abstract visuals and the requirement that learners decipher conceptual relationships, it was used in this study to ascertain the ability of the research participants to interpret and derive meaning from abstract visuals. This instrument could give some measure of the type of skill used to evaluate and use abstract visuals in an instructional lesson. The participants' ability to interpret an abstract visual would certainly be a factor in whether the abstract version of the experimental materials was effective. It was expected that the participants receiving the abstract visuals version of the lesson would score high on the immediate and delayed posttest, if they scored high on the abstract reasoning test. This test was administered to all participants and correlated to all performance measures. However, the only prediction regarding this instrument is an interaction between scores on the visual reasoning test and treatment variable on retention and transfer tasks.

Dependent Variables

The five dependent variables in this study were immediate posttest performance scores-near transfer, immediate posttest performance scores-far transfer, delayed posttest performance scores-near transfer, delayed posttest performance scores-far transfer, and the retention score (difference between the immediate and delayed posttest scores). The retention score was used to ascertain if there was any effect of hypermnesia over time. Hypermnesia is a net improvement in memory performance that occurs over time and/or test trials when given only one study trial. These test scores were based on instruments discussed later in this chapter. The instructional objective of the lesson is: "Given a description of a learning task, the learner will be able to identify which of the intellectual skills (i.e., discrimination, concept, rule or problem solving) it represents." The possible range of scores of each test is (immediate) 0 to 34 and (delayed) 0 to 36. On each test, the number of near transfer questions is 24. The number of far transfer questions is 10 for the immediate and 12 for the delayed. In analysis, near transfer and far transfer data were analyzed separately, if no significant differences in effects on these two dependent measures were found, these sub-test scores were pooled. The reasoning for the separate analysis was to investigate the effects, if any, of abstract visuals on far transfer as compared to near transfer because of the prediction that the abstract visuals might better support the processing required for far transfer learning.

Materials

Materials used for this study are (a) three versions of a printed lesson teaching learners to recognize examples within one of Gagné's domains of learning outcomes, intellectual skills, and assessment instruments; (b) entry questionnaire, (c) Diagraming Relationships instrument, (d) immediate posttest (near and far items), and (e) delayed posttest (near and far items).

The Diagraming Relationships instrument consists of three pages: One page of instructions and examples and the other two pages of 15 test items each. Each item has three options listed. At the top of each page are five abstract visuals. The correct relationship among the three groups is to be selected from these abstract diagrams in the instrument. To evaluate the content validity of the Diagraming Relationships test along with 27 other factor-referenced scales, the tests were field tested on 4000 men at the Naval Training Center, San Diego. This was achieved by placing the items in 30 booklets (with repetitions) to achieve a balance of the 87 sub-scales on 320 items tested. Additionally, the total battery of 1400 items was administered to students at the University of Oregon. No reliability data was available on the Diagraming Relationships instrument, so, the data was collected in the current study, and a reliability estimate was calculated.

The topic of Gagné's intellectual skill was chosen because of the abstract nature of the concepts. Also, the topic filled the need for a subject that would be of value to the participants in the study, but did not assume much prerequisite knowledge or skill, thus increasing the motivation to learn the content. In addition, the content is sometimes difficult for students at this level to acquire, so one might anticipate some variation in skill levels. This topic might also benefit from the clarification function of illustration in text.

Instructional Materials

The instructional objective of the lesson was: "Given a description of a learning task, the learner will be able to identify which of the intellectual skills (i.e., discrimination, concept, rule or problem solving) it represents." The lesson followed the sequence of Gagné's events of instruction: objective of the lesson, presentation of definitions and examples and nonexamples of each learning outcome, and practice with feedback. It also incorporated Merrill and Tennyson's (1977) instructional design guidelines for teaching concepts. (The three versions of these materials can be found in Appendix B)

Each set of materials for the study contained the same textual content with the exception of sentences (one or two) that specifically referred to the illustrations [as traditionally recommended (Brody & Legenza, 1980)]. These caption sentences were constructed to convey no new content information. The first treatment had text and abstract visuals, which visually represented each of the four categories of intellectual skills. The second treatment had concretely illustrated "best examples" of each learning category. The third treatment served as a calibration or control group and did not contain any visual illustrations. However, due to the powerful effect of prototypes in concept learning (Tennyson, Youngers & Suebsonthi, 1983) every version explained the best example verbally as part of the lesson.

Overall Lesson Design

The lesson design used Gagné's nine events of instruction. The nine events are numbered and listed below along with the explanation of how each one was achieved in the stimulus lesson:

1. Gaining attention:

The fact that this is not a normal classroom situation will help to capture the attention of the students. The researcher verbally explained the importance and relevance of the lesson content to the class and the instructions to be followed.

2. Informing the learner of the lesson objective:

The objective was written in the fourth paragraph of the lesson in the following form:

> "This lesson will focus on the Intellectual
> Skills category of Gagné's five learning

domains. Intellectual skills are of four types: Discrimination, concept, rules and problem solving. You will be able to differentiate among the different types of learning."

3. Stimulating recall of prior learning:

In the first paragraph of the lesson a reference to prior learning was made.

> "From your experiences in learning in all your years of public education as well as in the University you have probably noticed that there is a difference among learning tasks that have been assigned. Not only are some tasks harder, some take more time, and some use different types ot learning techniques."

4. Presenting the stimulus material with distinctive features:

The lesson provided a description of learning outcome and showed examples of each distinctive feature of all of the learning outcomes and examples of each, such as:

> "Questions used to test discriminations are stated in the form of: "Which one smells like this?, Which one looks like this? etc."

5. Providing learning guidance:

Different concrete instances and noninstances of the abstract concepts were given within the lesson along with verbal prompts to focus attention on critical attributes. For example the following:

> "In learning discriminations the names of the things are not used."

was used to help teach the concept "discriminations." Directions in interpreting illustrations provided guidance such as:

> "use this example to help you remember"

6. Eliciting performance:

At the end of each section there was a review of the concepts being learned and also feedback to the questions such as the one for "concepts:"

> **Practice:**
> Please circle the numbers of the following examples which require new concept learning.
> 1. Several materials are placed in a brown paper bag. Students are asked to feel a piece of material. Without looking the students are then ask to find the one in the bag that feels like it and remove it.

2. Students are asked to read several paragraphs about the government and to pick out which one is an example of "propaganda."

[Note to reader: number 1 is a discrimination and number 2 is an example of concept learning.]

In addition, there was a cumulative practice with interspersed practice on all four concepts at end of the lesson.

7. Providing informative feedback:

Informative feedback was placed at the end of each of the review sections and at the end of the practice section.

> "Questions 2, 3 and 4 are examples of concept learning because students must classify according to characteristics and identify by the names 'propaganda,' 'Datsun,' and 'barn.' Question 1 is an example of a discrimination because no name or label to the objects was given. If you missed these, please go back and review this section."

8. Assessing performance:

This was achieved by the use of the immediate posttest and the delayed posttest.

9. Enhancing retention and learning transfer:

The opportunity for learning transfer and reinforcement comes in the lesson, practice, review, immediate posttest, and delayed posttest. The postquestionnaire may also help retention and transfer by having the students think about the use of the visuals in remembering the content of the lesson and how to use them in the future with formerly unencountered situations.

Treatment Versions

This study utilizes three treatment groups: abstract, concrete, and no illustration. The illustrated versions of the instruction include either abstract or concrete illustrations.

Abstract illustration treatment. Each visual was designed to graphically represent the critical attributes of each concept. For example, a "rule," which is the ability to apply a proposition that relates two concepts, usually in an "if..., then" arrangement, was abstractly illustrated (see Figure 4 below) by circles (representing concepts), arrows (representing the relationship between concepts) and a rectangle enclosing them (representing the newly formed rule).

Rules

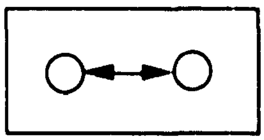


Figure 4

All abstract illustrations were accompanied by textual descriptions for example:

> "Figure 5 graphically illustrates that people who have learned a discrimination are mentally able to separate things into those that are alike and different according to some physical characteristic (dots versus no dots). Use this illustration to help you to remember discriminations."

Discriminations

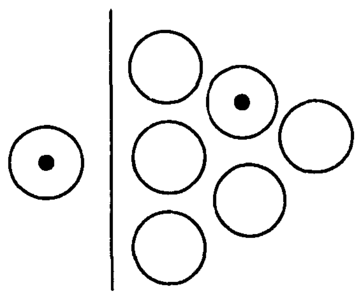


Figure 5

The initial draft of the abstract illustration resulted in illustrations that were so abstract that the researcher feared they could not be recalled. The illustrations by themselves did not appear to be meaningful. The abstract visuals needed a relationship to their concepts by means of a definition. The strategy for development became the relationship of the abstract visual to the critical attributes by way of visually representing these attributes. An attempt was made, as in linguistic literature, to define the concept, not only verbally, but also with an abstract visual which embodied the critical attributes visually as a member of a class. A definition identifies a general class and how this member of the class differs from other members of the same general class. For example, the critical attributes of "discrimination" are determining whether things are "alike " or "not alike" through the use of one of the five senses. The abstract treatment embodied these concepts by use of the circles with and without the dots. The addition or exclusion of the dots formed the basis for discrimination between the two visuals (see Figure 6 below).

Discriminations

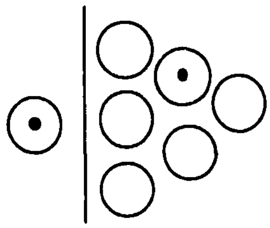


Figure 6

In the abstract treatment of "concept" the critical attributes include the ability to discriminate between an object and other objects as well as the ability to name the concept which places it into a certain class with other, like phenomena. This is abstractly illustrated in the example (see Figure 7 below) by showing the concepts and naming them "Zerts" and "Non Zerts."

Concepts

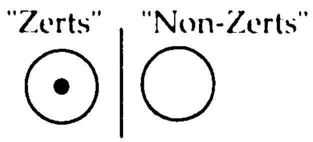


Figure 7

The concept "rules," as explained earlier, shows that two or more concepts relate to form a rule. This was abstractly illustrated by the rectangle formed around the two circular concepts connected by the arrows showing the relationship between the two (see Figure 8 below).

Rules

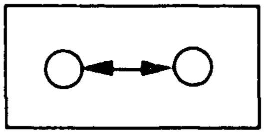


Figure 8

The concept "problem solving" incorporates previously learned rules or principles which are made up by concepts to solve previously unencountered problems. A tree type chart with circles at the bottom leading to rectangles and then to a square at the top represented the relationship between concepts, rules and problem solving, and was used for the abstract problem solving illustration (see Figure 9 below).

Problem Solving

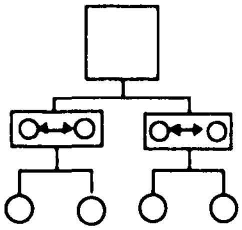


Figure 9

Concrete illustration treatment. The development of the concrete visuals was also a long process with the final illustrations not resembling the first draft. The concrete or representational (Alesandrini, 1987) graphic for each concept was a representation of a "best example" for the concept class. A "best example" embodies the critical attributes of the concept with as few nonessential attributes as possible (Merrill & Tennyson, 1977).

Two of the original concrete visuals had humorous content that would add another unnecessary and distracting element, consequently, they were eliminated. One of the concrete visuals was so subtle it was easy to overlook its meaning. The finalized concrete illustration for discrimination, was four fishes (one not like the rest); for concepts, a cow was used; for rules, a hot air balloon rising; and for problem solving, a car needing repair (see Figure 10 all four concrete visuals).

The concrete "best example" for a rule was a hot air balloon rising as it was being heated. The rule was stated as, "If air is heated, then it expands and rises"(see Figure 10, Rules below).

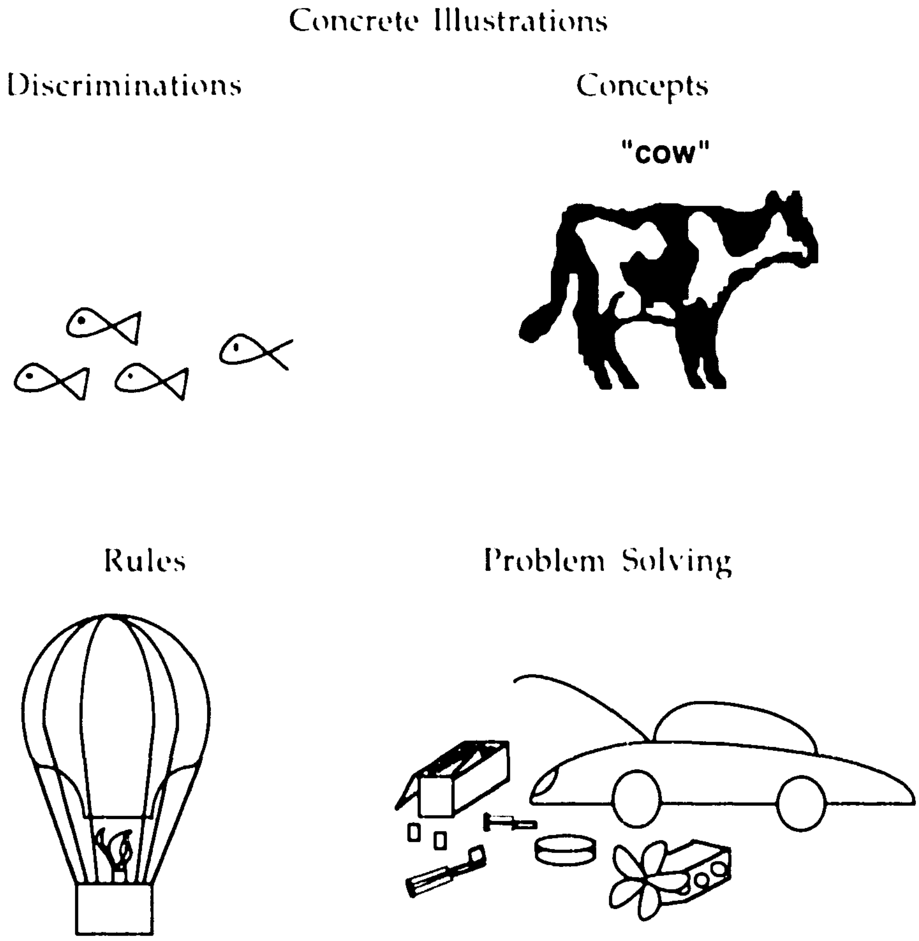


Figure 10

The four concrete visuals and the textual reference to the visuals are what distinguished the concretely illustrated version from the nonillustrated version. For example the text that accompanied the concepts' concrete illustration of a cow was: "Note that if a person can point to the picture in Figure 10 and say 'cow', then (s)he has learned the concept 'cow.' Use this illustration to help you to remember concepts." Each one of the concrete illustrations had an equivalent description of its illustration.

Nonillustrated treatment. The content and wording of the nonillustrated version was identical to the illustrated lessons except for the concrete or abstract illustrations and verbal references to their respective illustrations. As use of "best example" has been a highly effective device in concept instruction (Tennyson, Chao, Youngers, 1981), in all three versions the concrete "best example" was explained verbally in the text. For example the text that accompanied the discrimination's concrete illustration of fish was modified to a verbal description: "When given three objects on the left side of a page and one object on the right side; being able to match up which objects on the left are the same or different from the object on the right is knowing how to discriminate. Use this example to help you remember discriminations."

Validation of Materials

Validation of the materials consisted of expert review, pilot study and the validation of the illustrations. Existing materials could not be found to use in the study, so development of new materials was required. Validation of these materials was necessary to insure that the content was appropriate and valid.

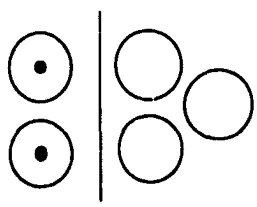
Validation of Abstract Illustration

The abstract illustrations were evaluated in several ways: "Read-think-aloud," "abstract illustration rating," "abstract illustration-matching concepts and illustration," "abstract illustration - draw your own," and "abstract illustration-best representation of intellectual skills."

Each of these methods and the changes that were made as a result of these evaluations will be explained in the following section.

Read-think-aloud. Three graduate student volunteers from the educational psychology department participated in a read-think-aloud evaluation of the content and illustrations of the abstract lesson (A). As they read the lesson, including "reading" the illustrations, each one of them verbally stated what they were thinking as they read. As a result of this activity, small changes were made in the discrimination and concept abstract visuals to simplify them or better represent the critical attributes of the concepts (see the figures below).

Discriminations



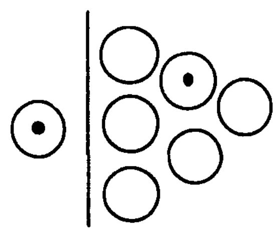


Figure 11 was changed to Figure 12

The changes from Figure 11 to Figure 12 were made because the separation of the objects on the left of Figure 11 did not include picking out an object from a group of other objects (as in Figure 12) but already had them separated into groups.

Concepts

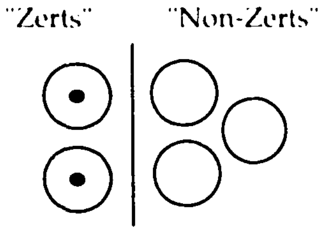


Figure 13 was changed to

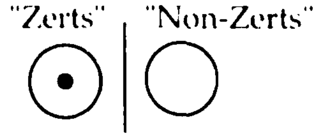


Figure 14

The changes from Figure 13 to Figure 14 were made because the unnecessary extra circles in Figure 13 did not help in learning the concept of 'concepts'.

Illustration Matching. Still questioning whether the illustrations actually conveyed content as planned, the researcher further validated the abstract illustrations in several ways. A class of graduate educational technology students familiar with the four types of learning, discriminations, concepts, rules, and problem solving, were divided into four groups. Two of the groups received the abstractly illustrated lesson without the illustrations, but with the textual description of the abstract illustrations (no posttest was administered). One of these two groups received an "Abstract Illustration Rating" sheet (Appendix K), which included the four abstract visuals, which represented each type of learning. The following directions were included: "Rate the abstract visual of each learning outcome (Discriminations, Concepts, Rules and Problem Solving) on a scale from 1 to 5 (one being the poorest representation of the concept and 5 being the best representation of the concept) by circling the number on the scale which best represents your rating of the abstract illustration." (In other words, the purpose of this activity was to determine whether learners could correctly match the abstract illustration with the type of outcome that it was developed to represent.) The result of this exercise was that each abstract illustration was correctly rated the highest score as being illustrative of its correct concept by five out of five evaluators.

The second group, which received the same abstract lesson without the illustrations, also received an "Abstract Illustration-Matching Concepts and Illustration" sheet (Appendix K) with the following directions: "Match the names of the learning outcomes (Discrimination, Concept, Rule and Problem Solving) by writing the correct name next to the visual which best represents that outcome." All of the illustrations were mixed up and the students were required to match the concept name to the correct illustration Everyone in the group correctly filled in the name of the abstract illustration.

Groups three and four received the nonillustrated lesson (B). The third group was required to draw their own illustrations on the "Abstract Illustration - Draw your own" sheet (Appendix K). On the top of the sheet they were provided with a small example of an abstract visual of "verbal information." As the students had little development time and were not well versed in illustration design and research on learning from illustration, no new illustrations were developed that appeared to be superior to those already developed.

The fourth group was given the "Abstract Illustration-Best Representation of Intellectual Skills" sheet (Appendix K). This sheet consisted of twenty visuals, five visuals for each of the four intellectual skills. The group prioritized each set of five visuals according to what they felt best visually represented that intellectual skill. The results showed the following illustrations rated the highest:

Discrimination

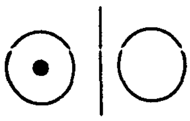


Figure 15

Concept

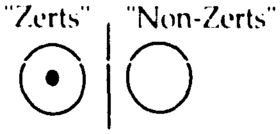


Figure 16

Rule

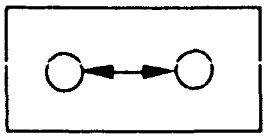


Figure 17

The problem solving illustration resulted in a tie between the following two:

Problem solving

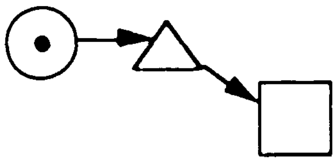


Figure 18

and

Problem solving

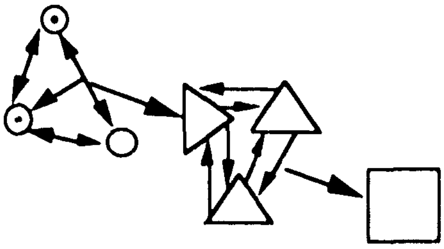


Figure 19

<u>Conclusions and revisions.</u> After much consideration, the final conclusion was that the concept (Figure 16) and rules (Figure 17) illustrations were good visuals, but the discrimination visual (Figure 15) left out the attribute of selection of the same or different and should be changed to (Figure 20).

discriminations

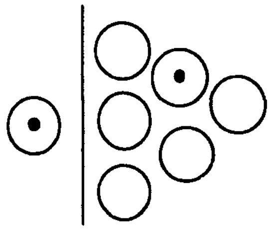


Figure 20

Both of the problem solving illustrations had a few problems such as being too simple or entirely too complex, so the final drawing (Figure 21) below was selected because it incorporated the previously learned illustrations of concepts and rules into the problem solving illustration.

Problem Solving

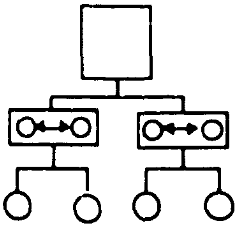


Figure 21

Expert review. The materials were reviewed by three content experts in the field of education technology. Each person was given the objectives, the complete set of all three treatment materials and posttest and delayed posttest. They were asked to evaluate the content for clarity of communication and tests and instruction in terms of whether the objectives, instructional materials and tests were congruent across the whole range of materials. (See Appendix B for copies of these materials.) They were also given an explanation of good design principles in accordance to the guidelines in Merrill and Tennyson's (1977) work on concept teaching. These design procedures are: Define the concept, collect an instance pool, develop diagnostic classification test, provide concept attribute isolation, teach coordinate concepts, provide feedback and conduct formative and summative evaluation.

Pilot study. A pilot study of this research was conducted for the purpose of resolving the logistical problems of the research study, to field test instructions, and to identify and reduce any reliability and validity problems within the researcher-developed instruments.

The pilot study was conducted with 68 students enrolled in an undergraduate educational design and development course in a southwestern university. Due to attrition, only 52 participants finished the study, seventeen in the abstract illustration group, nineteen in the concrete illustration group, and sixteen in the no illustration group. The same procedures described in the procedures section, forthcoming in this chapter, were used in the pilot except a one week delay between immediate and delayed was imposed in the pilot, instead of the two weeks that would be employed in the actual study. Both an agreement to participate form, to be signed, and a demographic data/pre-questionnaire were given to the participants before the experiment, as explained in the participant section of this chapter. During the first week, directions, the lesson, an immediate posttest and written postquestionnaire were given, followed by individual oral interviews with a 10% sample of participants from each of the three groups. One week later, the delayed posttest was administered. As can be noted in Table 2 (see below), the abstract illustrations (A) group had a mean score of 21.65 on the immediate posttest and a mean score of 23.24 on the delayed posttest (Table 3, see below). The no illustration (B) group had a mean score of 21.44 on the immediate posttest and mean score of 22.63 on the delayed posttest. The concrete illustrations (C) group had a mean score of 23.68 on the immediate posttest and a mean score of 23.79 on the delayed posttest. On the immediate posttest the standard deviation and range shows that the test scores for the abstract and no illustration groups have a wider distribution of scores than the concrete illustration group. On the delayed test no such tendency can be observed.

Table 2. Pilot Immediate Posttest Overall Means and Standard Deviations

Illustration Treatment	n	M	SD
Abstract	17	21.65[a]	4.21
None	16	21.44[b]	4.2
Concrete	19	23.68[c]*	2.71

Note. Possible Score 30. $N = 52$

[a]Range = 11-28

[b]Range = 11-28

[c]Range = 20-28

($F = 2.0$, $df = 2,49$, $^{*}p = < .15$)

Table 3. Pilot Delayed Posttest Overall Means and Standard Deviations

Illustration Treatment	n	M	SD
Abstract	17	23.24[a]	3.73
None	16	22.63[b]	3.88
Concrete	19	23.79[c]	3.31

Note. Possible Score 31. N = 52

[a]Range = 14-30

[b]Range = 14-28

[c]Range = 18-29

($F = 0.45$, $df = 2, 49$, $p = <.64$)

Another way of looking at data is by the use of a box graph because it allows the comparison of distributions by corresponding percentiles. Note that the 50th percentile of the abstract immediate posttest was lower than the other two groups (see Figure 22 below), while in the delayed posttest this percentile was about the same as the other two groups (see Figure 23 below) showing that in comparison to the concrete and no illustration groups, the raw scores of the abstract group had a tendency to move up higher on the scale, losing less in raw points over time. A separate analysis for near and far transfer was not conducted in this pilot study. The separation of the near and far transfer was added after this study, along with other questions.

Pilot Immediate Post Test - Raw Scores

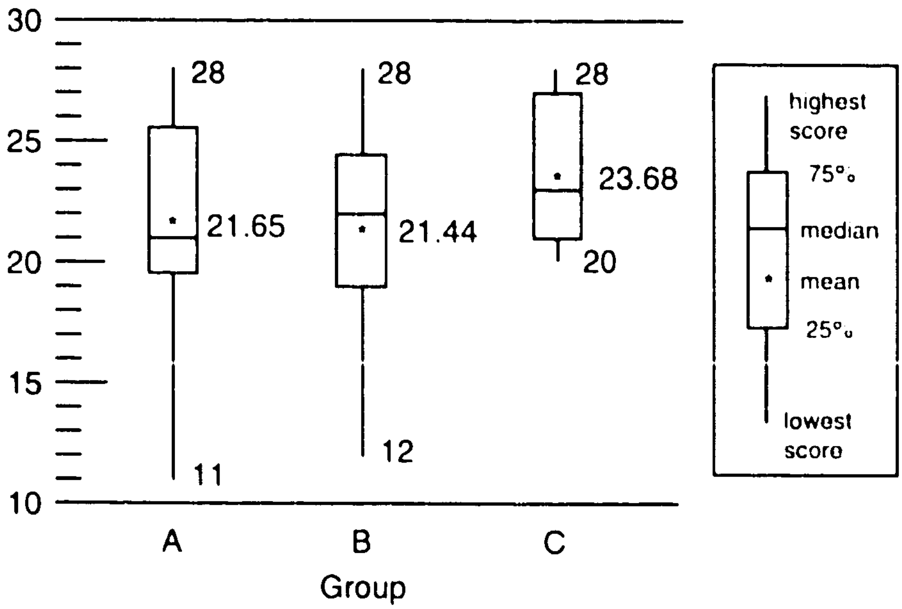


Figure 22

Pilot Delayed Post Test - Raw Scores

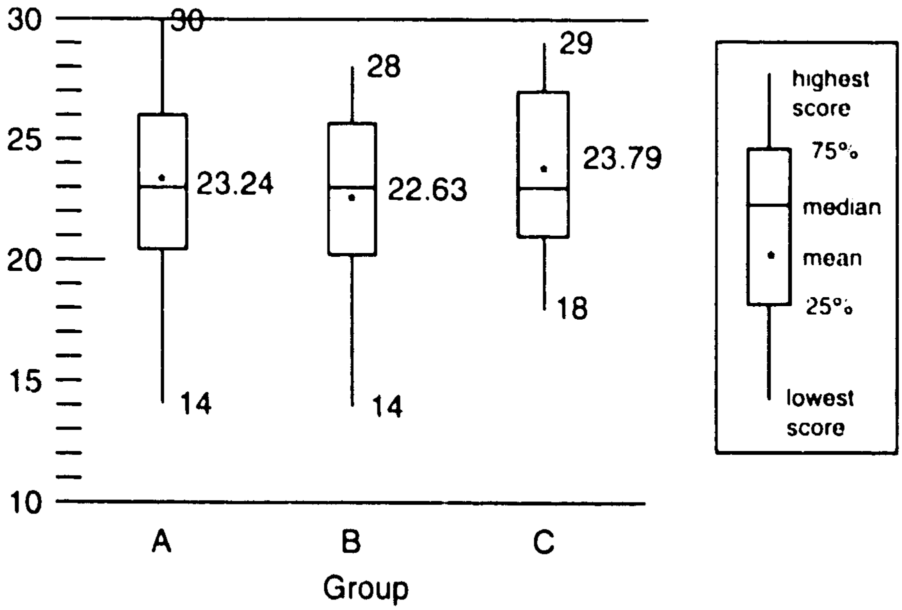


Figure 23

Table 4 shows the raw data of each participant's paired immediate posttest and delayed posttest scores in each group and the gain or loss from the immediate to the delayed, as well as the means of each group. These data show an interesting trend of the abstract groups' mean difference gaining more over time than both the concrete and nonillustrated groups. In other words, there was a greater increase in mean scores from the immediate to the delayed test scores in the abstract group than there was in both the concrete and nonillustrated groups. The nonillustrated group also gained more than the concretely illustrated group. The differences among group means was not statistically significant (at .05 level) on either immediate ($F = 2$, $p = .15$) or delayed ($F = .45$, $p = .64$) posttest. Although, there were noted differences in variances, a test of homogeneity of variance did not reveal a significant difference in variances across the three treatment groups.

Table 4. Pilot- Individually Paired Raw Scores, the Means of Immediate and Delayed Posttest of the Three Groups Over a One Week Period

	Abstract[a]		No[b]		Concrete[c]	
	Immediate	Delayed	Immediate	Delayed	Immediate	Delayed
			Means			
	17	23	28	27	25	22
	24	23	18	21	25	29
	21	19	23	25	26	27
	21	21	27	25	27	27
	20	22	23	22	27	28
	21	23	26	28	23	25
	17	19	19	14	22	19
	26	26	12	17	20	23
	22	22	23	24	22	28
	19	26	21	24	28	26
	25	30	19	20	25	22
	21	26	22	19	24	27
	28	27	22	27	20	23
	26	26	25	26	23	21
	11	14	19	21	20	22
	26	23	16	22	23	18
	23	25			21	20
					21	21
					28	24
Total	368	395	343	362	450	452
M	21.65	23.24	21.44	22.63	23.68	23.79

Treatment

Note. [a]n = 17. [b]n = 16. [c]n = 19.

There were no statistically significant effects in the pilot but interesting trends were observed such as, what appeared to be the abstract visual treatment resulting in less of a decrement in retention overtime. Note, that beside some additional questions, such as the treatments' effect on near and far transfer, that were examined in the study, the one week delay was increased to two weeks, hoping that if there were some retentional effects in the abstract version it would be exaggerated with a greater delay. Some of the illustrations and old test items were changed and a pretest and visual reasoning predictor test was added.

Testing Instruments

The testing instruments for this study were developed by the researcher and the following section explains the development procedures in detail.

Design of Instruments

The testing instruments, both immediate and delayed, for the instructional materials consist of parallel forms of questions assessing ability to classify examples and nonexamples of each of the four concepts. The participants were given example assessment questions with their answers in common school subjects with the following directions:

> Instructions: Label each of the following test items in terms of which of the four types of intellectual skills the test item represents:

(a) discriminations, (b) concepts, (c) rules or
(d) problem solving.
Test item: ___ "Correct this sentence. The boy and him went to the park. (i.e. pronoun usage)"
[correct answer: rule]
Test item: ___"Select the hammer from the tool box."
[correct answer: concept]

The tests assess conceptual knowledge that can be acquired from the text content only. The illustrations were expected to assist the students in recalling the information but there was no reference to the illustrations on the tests and no skill/knowledge assessed on the tests that could only be gained from illustrations. Similar questions (e.g. based on same objectives) were given on both the immediate and delayed tests. Both immediate and delayed tests contained 24 near transfer questions, while the immediate posttest contained 10 far transfer questions and the delayed posttest contained 12 far transfer questions (See Appendix C & D for copies of these instruments.)

The first 24 test items on each test evaluated near transfer of the instructional objective by asking the students to select one of the four intellectual skills that the statement represents (classifying by concept). The following is an example of a near transfer test item:

Instructions: Label each of the following test items in terms of which of the four types of intellectual skills the test item represents by filling in the blanks with the letter representing that category: (d) <u>discriminations</u>, (c) <u>concepts</u>, (r) <u>rules</u> or (ps) <u>problem solving</u>.

"How do you locate and fix the source of a problem of no sound in an audio system?"

The final part of each test was far transfer items that required students to make predictions and inferences based on the newly acquired concepts: explaining answers on categorization examples, explaining distinguishing characteristics in examples, supplying their own examples and explaining relationships among the related concepts with such questions as:

> Which of these would be the best strategy for learning the rule on use of pronouns? (Tom gave the bike to Bill and me.)
>
> ____a. Making flash cards with written statement of the grammar rule.
>
> ____b. Explaining the rule in written form.
>
> ____c. Developing your own examples of the use of the rule.
>
> ____d. Writing the rule 20 times.

The immediate posttest score was chosen as a dependent variable to test learning immediately after the lesson. The delay period of two weeks was a logical choice for delayed testing because the information being tested would normally need to be stored in memory for about two weeks for use in class. There seemed to be a delayed effect with the abstract visuals in the pilot study, hopefully this effect would be increased with the extension from a one week delay to a two week delay.

Pretest

A four question pretest was added to the information sheet's 11 existing pretest questions, making a total of 15 pretest questions to determine the prior knowledge of the students. The same type of questions were asked on this test and on the posttests. Note the following pretest example.

> **Instructions**: Label each of the following test items in terms of which of the four types of intellectual skills the test item represents by filling in the blanks with the letter representing that category: (d) discriminations, (c)concepts, (r) rules or (ps) problem solving. (Hints have been placed for you in parenthesis so you don't need to know the content in order to answer the test items.)
>
> **test**
>
> ____ A small reddish breasted bird sat on a fence. What type of bird was this? (the type of bird was a robin)

Diagraming Abstract Visuals Test

In addition to the posttests, a test was given to evaluate the ability of the students to interpret abstract visuals. This test is titled Diagraming Relationships. The test for measuring abstract visual reasoning has been explained under "attribute variable" earlier in this chapter. The results of this test were analyzed to determine if there was any positive interaction between the performance on this instrument and treatment group. In the researcher's validation process, the test was illustrated with one incorrect illustration making at least six of the questions unanswerable. There was no reliability estimate calculated on this pilot data for this reason.

The Diagraming Relationships instrument was used to determine the ability of a student to interpret and derive meaning from abstract illustrations. The following is a verbal explanation of the visual instrument and illustrates what cognitive processes must occur in order to respond to this assessment. At the top of the page are five diagrams of relationships of three things. They consist of interlocking or free standing circles either, inside, outside, or interlocking with each other in different configurations. The diagrams are followed by several test items. Each item in the test names three groups of things. The one diagram that shows the correct relationships among the three groups of things must be chosen from the five diagrams at the top of the page This should test the ability of the person to read the abstract visuals at the top of the page and understand the relationship presented by the visuals as they relate to the group of three things being tested. An example of the three things might be, teacher, mother, and tractor. The relationship is a teacher could be a mother, and a mother could be a teacher, but not all mothers are teachers, and not all teachers are mothers and neither is a tractor. The diagram could be two circles that partly overlap with a free standing circle next to them.

Validation of Test Instruments

Validation can provide support to the assertion that the instrument tests what it intends to test or not.

Expert review. The instructions, the lesson, and the immediate and delayed posttests were given to three experts in the field of instructional development and criterion reference tests, and they were asked to evaluate them for instructional design, content, appropriate near and far transfer questions, and even distribution of distracters across concept types and across posttests. As a result of the expert review, the two pilot studies and the abstract illustrations evaluation, changes in the wording of the lesson, the abstract illustrations, the concrete illustrations, the instructions, and the posttests were made.

Reliability Assessment Posttest

Immediate posttest and delayed posttest data from a pilot test of the study (see previous section this chapter) were used to obtain an initial evaluation of the reliability of the test instruments (including both near and far transfer questions). In addition, response patterns on each individual item were examined to identify confusing items. A Cronbach's Alpha reliability estimate was calculated for the data of the pilot study to determine the degree of internal consistency of response patterns. The reliability estimate was found to be .70 on both tests. This was deemed a minimally acceptable value for the reliability of the instrument, however, seven questions were reworded or discarded and replaced with new ones as a result of item analysis information. Hence, the reliability estimate of the instrument in the final study was expected to be somewhat higher.

Post-Questionnaire

Post-questionnaires were given to all students (immediately after the delayed posttest) for use by the experimenter when interpreting results of the study. The post-questionnaire was given to each student from the illustrated treatment groups asking them to use a five-point Likert scale stating if they strongly agree, agree, are neutral, disagree, or strongly disagree with the following statements.

> "It was easy to learn from this lesson."
>
> "I would like to have instruction presented like this again."
>
> "I found the pictures helpful."
>
> "I used the pictures to help me learn."

They were also asked to respond to the following:

> "If you used the pictures: describe how you used them as you read."
>
> "Describe how you used them during the practice after each section."
>
> "Describe how you used them during the test."
>
> "Draw any of the illustrations that you can remember."

Students with the no illustration group also received a post-questionnaire with the following statements:

"It was easy to learn from this lesson."

"I would like to have instruction presented like this again."

"Pictures would have been helpful."

"Explain where pictures would have been useful in the lesson."

"Did you create mental images (pictures) to help you remember each category of learning."

"If you said yes, please sketch or describe the images you used to remember each outcome."

Ten percent of the students from each treatment group were interviewed regarding their understanding of the use of the illustrations after the delayed posttest (see Oral Post Questionnaire in Appendix I).

Procedure

Data collection occurred on three separate days. The first day consisted of the collection of demographic data/pretest questionnaire for use in reporting information about the participants in the study, completion of an agreement to participate, and the Diagraming Relationship Test. The second day (which need not be contiguous) consisted of presentation of directions, administration of the written lesson, and administration of immediate testing. The last day (two weeks later) consisted of delayed testing, post-questionnaires and debriefing interview with 10% of the sample.

Informed Consent Form

The agreement to participate form requested permission to use the data in an experiment where the participants would not be identified. It also stated that participation was strictly voluntary. (Appendix E)

Obtaining Demographic Data and Pre-Questionnaire

The demographic data and pretest (Appendix A) was given on the first day to determine the demographic variation of the students in the classes and to describe population to which results may be generalized and determine whether data from groups from several classes can be pooled. The contents of this questionnaire are discussed in the participants' section.

Assignment to Treatment Groups

The diagraming relations test was used to separate the participants into three groups of high, medium, and low visual ability. The participants were arranged into a ranked list according to their scores and were assigned to treatment groups starting with the highest score. The first person in the list was assigned to the abstractly illustrated treatment, the second to the nonillustrated treatment and the third to the concretely illustrated treatment and so on. This resulted in a stratified assignment to groups with approximately equal abstract visual ability in each group. Due to the large numbers of participants, a generally random distribution of learner characteristics was achieved across all three treatment groups. As a result of knowledge of the content on the pretest and natural attrition, 39 people were eliminated as participants in the study. The 190 participants remaining fell into groupings of 66 in the abstract illustrations treatment, 64 in the no illustrations treatment and 60 in the concrete illustrations treatment.

Administration of Materials

The entry assessment and demographic questionnaire was given during one of the regular class periods. The remaining materials were administered by the researcher at a prearranged time. The directions and the purpose for the lesson were explained before the lesson started. The lesson was distributed with the materials in a brown envelope with the person's name and the last four digits of his/her social security number on the outside. The materials inside were given a unique number identification. The materials were color coded by treatment type, lesson, and test to help with the directions and to insure that students completed the materials in the desired order and did not refer back to the lesson during testing. When the students had completed the lesson, they replaced it in the envelope before removing the immediate posttest. When the posttest was completed the students could leave.

The delayed posttest and the postquestionnaire were given two weeks after the immediate posttest. These materials were also placed in the same envelopes in which the lesson and immediate posttest were placed and were assigned the same packet's unique number to pair up that data with the posttest results.

A ten percent sample of the population was interviewed after the delayed posttest to gain more information on the way in which the participants used/did not use the visuals in the lesson. The questions asked in the oral interview were taped for accuracy in reporting. (Appendix I, Sample questions). The students were presented with instructional material to review. The questions to elicit information consisted of the students' use and need for the visuals in remembering the lesson content, for example, "Did you visualize any pictures to help you remember the information?" The questions also included asking the students to explain how the illustrations represented the concepts learned.

Design

This study followed a posttest-delayed posttest control group design. The illustration variable had three levels: none, concrete and abstract. There was one attribute variable: the ability to interpret abstract visuals. The dependent variables were the immediate posttest near transfer, immediate posttest far transfer, delayed posttest near transfer, delayed far transfer scores and retention scores (immediate/delayed). The nonillustrated group had the role of being the control group. Figure 25 illustrates the design matrix of the study.

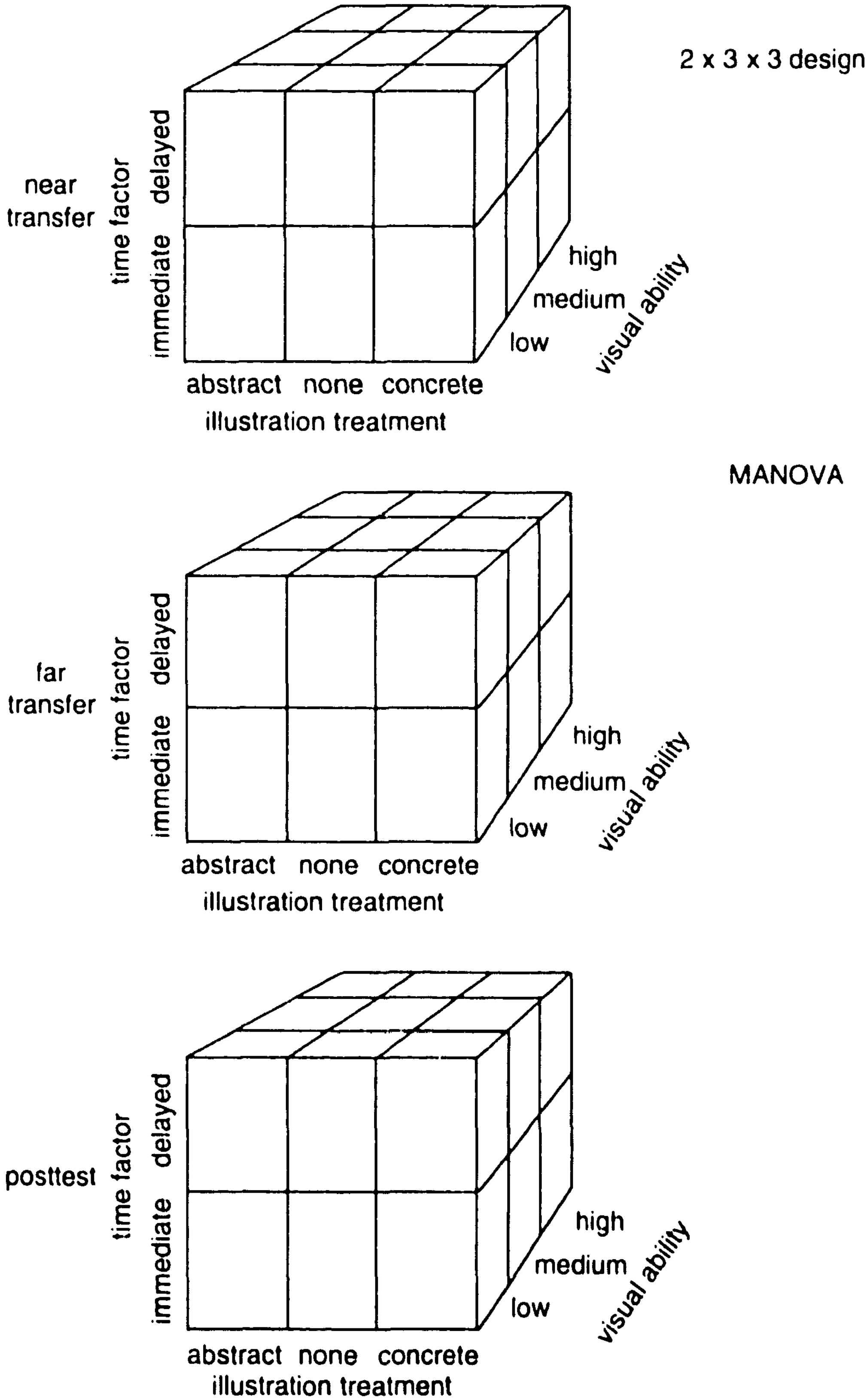


Figure 25. Design of research

Data Analysis

The design of this study used a two by three way multivariate analysis of variance (MANOVA) The Illustration variable has three levels: none, concrete, and abstract. The dependent variables are immediate and delayed post-test scores. The alpha level (probability of a Type 1 error) was set at a level appropriate for an exploratory study ($p \leq .10$). A Type 1 error occurs whenever the null hypothesis is actually true and it is mistakenly rejected. The power of the test was set at about .8. An effect size of .3 is a medium effect size and will be detectable with about 50 participants in each of the three treatment groups. The abstract illustration group had 66, the no illustration group had 64 and the concrete illustration group had 60 participants. The pretest scores were used to eliminate the participants with prior knowledge and the Diagraming Relationships test is used in Post hoc analysis making this part of the analysis a two by three by three-way design.

CHAPTER IV

RESULTS

Introduction

The descriptive, inferential, and post hoc results will be discussed in this chapter in relationship to the hypothesis and specific exploratory research questions. Descriptive statistics provide summary descriptions of the research. Inferential statistics determine whether the observed results generalize to other situations or perhaps can infer causality - whether effects are due to more than pure chance. This chapter will cover the results of the general research question: What were the comparative effects of abstract illustrations versus concrete illustrations on learning abstract concepts? The five predictions (later in this chapter stated as hypotheses in order to perform statistical analysis) and the seven specific exploratory research questions will be discussed under their appropriate hypotheses.

Specific Exploratory Research Questions

When investigating learners' ability to interpret abstract visuals on an abstract concept learning task:

1. Will immediate, near transfer posttest performance of those who receive concrete illustrations be superior to the performance of those who receive abstract illustrations?
2. Will delayed, near transfer posttest performance of those who received abstract illustrations be superior to the performance of those who received concrete illustrations?

3. Will immediate, far transfer posttest performance of those who received abstract illustrations be superior to the immediate far transfer of those who receive concrete illustrations?

4. Will delayed far transfer posttest performance of those who received abstract illustrations be superior to those who received concrete illustrations?

5. Will posttest (immediate, delayed, near, and far transfer) performance of those who received abstract illustrations be superior to the performance of those who received no illustrations?

6. Will posttest (immediate, delayed, near, and far transfer) performance of those who received concrete illustrations be superior to the performance of those who received no illustrations?

7. Will posttest (immediate, delayed, near, and far transfer) performance of those who received abstract illustrations show differential benefit for different levels of ability (low, medium, and high) as demonstrated on the "Diagraming Relationships" test?

Predictions

Prediction 1: Concrete Illustrations

On immediate testing over the content, the students from the concrete visuals group may score higher on near transfer questions than the abstract visuals group. The concrete visuals group was presented with a visual representation of a "best example," which epitomizes the critical attributes of the concept. Such a prototype may promote the immediate recall of the critical features of an abstract concept. It was expected that recollection of the prototype example would easily stimulate recall of the critical attributes of a concept class immediately after instruction. The relationship of the critical features of the prototype to the critical features of the abstract concept class should still be memorable immediately following instruction. The prototype illustration, because of its concreteness should serve as a superior retrieval cue (to the cue strength of the abstract illustration) immediately after instruction, similar to the way the verbal "best example" has cued the recall of concrete concepts (Tennyson, Chao, & Youngers, 1981).

Prediction 2: Abstract Illustration on Delayed Performance

It was expected on delayed near transfer testing, the abstract visuals group would show a smaller decrement in recall (from immediate posttest to delayed posttest) than the concrete visuals group. This result was expected because it was believed that, over time, the relationship of the critical attributes to the concept class would be more memorable for students who received the abstract illustration because the abstract illustration itself embodies the critical attributes without extraneous features. Even the best prototype examples have noncritical features which could, over time, obscure the tie between the example and the critical attributes. In other words, the prototype was predicted to lose over time its power to cue critical attributes because learners would forget which attributes were the critical ones. Although the abstract visual may have been less memorable than its more concrete counterpart, it may have served better over time as a cue to the critical attributes of the concept class. However, this was not supported with empirical results from verbal studies.

Prediction 3: Abstract on Far Transfer

It was expected that on far transfer questions, both on immediate and delayed tests, learners who received the abstract visuals may have performed better than those who received the concrete visuals. This effect was expected due to the anticipated function that the abstract visuals would play: that of an organizing schema for the concept class. Far transfer was dependent upon having a well organized and elaborate schemata. The concrete illustration only represented a subordinate point within a schema as opposed to what the abstract illustrations attempted to do. The abstract illustration attempted to provide a superordinate, all encompassing description, of the critical attributes of the concept, which when triggered, may have activated a more elaborate schema providing flexibility of use of the concept class.

Prediction 4: Interaction of Visual Decoding Skills

It was expected that the abstract illustrations would be differentially effective for learners with varying levels of ability to interpret abstract illustrations. This effect was predicted because it was anticipated that learners who score poorly on the "Diagraming Relationships Test" would not benefit as much from the abstract illustrations either in immediate or delayed testing for both near and far transfer.

Prediction 5: Benefits of Illustrations

Although of lesser interest, (because past research has supported role of illustration in text), it was expected that, in the comparison of the illustrated versus the nonillustrated version of instructional text, the illustrated versions would be more effective than the nonillustrated version both on immediate and delayed tests for both near and far transfer. This effect was expected due to two theoretical cognitive mechanisms of illustrations. The first was that illustrations provide redundant processing, interpretation and transformation functions that promote dual coding schemata and more retrieval cues (Levin, 1989). The second was the attentional function of illustrations to the information represented within them (Peeck, 1987, Duchastel, 1978). Much previous research on types of learning, such as verbal information and concrete concepts, had supported the illustrated over nonillustrated versions of instruction on the bases of these two cognitive functions (Levie & Lentz, 1982, Merrill, Tennyson & Posey, 1992, and Dwyer, 1978). Consequently, it seemed that these benefits would also support acquisition of abstract concepts.

Descriptive Statistics

Overall Scores

Mean and standard deviations were calculated for the Pretest, Visual Relationships Test, Immediate Posttest, Near and Far Transfer and Delayed Posttest, Near and Far Transfer for the total population of 190 participants. These scores are displayed, as well as, the range and total possible for each test in Table 5.

Table 5. Pretest, Immediate and Delayed Posttest, and Visual relationships Test - Mean and Standard Deviation

	Test Scores	
Pretest		
M	3.77^{ab}	
SD	2.30	
Posttest	Immediate	Delayed
Near		
M	20.21^{cd}	18.19^{ij}
SD	2.78	4.08
Far		
M	7.11^{ef}	7.97^{kl}
SD	2.00	2.22
Total		
M	27.31^{gh}	26.16^{mn}
SD	4.15	5.67
Visual relationships		
M	22.16^{op}	
SD	5.15	

Note. N =190. Range: a = 0-9, c = 10-24, e = 1-10, g = 12-34, i = 4-24, k = 2-12, m = 8-35, o = 7-30. Total possible score: b = 15, d = 24, f = 10, h = 34, j = 24, l = 12, n = 36, p = 30.

Pretest and Entry Questionnaire

The pretest and entry questionnaire was administered before Gagné's Learning Study in order to eliminate the participants with prior knowledge of the subject content. The possible score on the pretest was 15, however participants scoring 10 or more on the pretest were eliminated from the study making the range 0-9 and bringing the total participant number down by 17, leaving the final participant pool at 190. As shown in Table 6, the final results reflect the fact that, despite random allocation to treatment groups, the groups were not the same. This factor was controlled through analysis of covariance used to adjust for initial differences.

Table 6. Pretest Mean and Standard Deviation by Treatment

Illustration Treatment	n	Pretest
Abstract	66	
M		3.14[ab]
SD		2.03
None	64	
M		4.33
SD		2.48
Concrete	60	
M		3.87
SD		2.24
Total	190	
M		3.77
SD		2.30

Note. [a]Maximum possible score = 15. [b]Range 0-9.

Visual Relationships Test

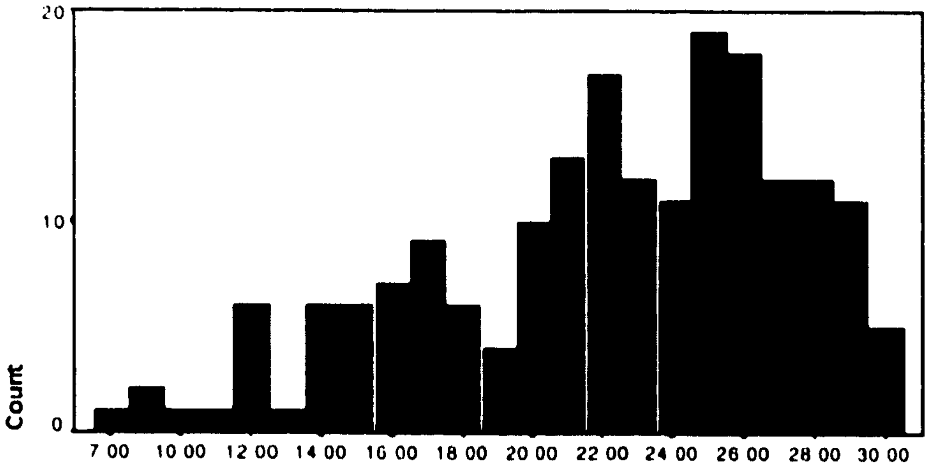
The visual relationships test was given before the lesson and used to equally distribute the participants into high, medium and low visual aptitude across treatments. The participants' scores ranged from 7 to 30 with 30 possible. The mean, standard deviation, and size of each visual ability group are listed in Table 7. A histogram of frequency of test scores is displayed in Figure 26.

Table 7. Mean Scores of Visual Relationships Test by Visual Ability

Visual Ability	n	Visual Relationships Scores
High	58	
M		27.54[a]
SD		1.34
Medium	72	
M		23.08
SD		1.48
Low	60	
M		15.87
SD		3.28
Total	190	
M		22.16
SD		5.15

Note. [a]Maximum score = 30

Visual Relationships Test



Total possible score 30

Figure 26. Frequency -Visual Relationships Test Scores - Total Population

This independent visual relationships variable was blocked into three groups using the scale of 26 to 30 as high ability, 21 to 25 as medium ability and 0 to 20 as low ability to interpret abstract visuals. This was determined by taking all of the visual ability tests scores, prior to attrition and the elimination of the pretest, and dividing them into three equal groups. The score of 67% or lower became the low visual ability group, 68% to 84% the average visual ability group and 85% to 100% the high visual ability group.

As can be recalled from group assignments in Chapter 3, the results of the visual test were placed into a ranked list and were assigned to treatment groups with the highest to lowest alternately starting with Groups A, B, C, A etc. until they were all assigned to a group with relatively equal visual ability. The total mean for all groups on the visual ability test was 22.16. The mean for the pretest for the high visual group was 3.79, the medium 3.76 and the low 3.75 with the total population at 3.77 showing that there were no differences in pretest groups across visual ability.

Immediate and Delayed Test Scores

With a mean of 27 out of a possible 34 on the Immediate Posttest, all groups (Table 8) appear to have learned the content reasonably well. These scores are also displayed in histogram form in Figure 27.

The Delayed Posttest which was given two weeks later showed a considerable retention rate. These scores (Table 9) are also visually displayed in Figure 28 in the form of a histogram.

The Near and Far Transfer tests are a break down of the Immediate Posttest and the Delayed Posttest as shown by the mean in Table 10. The total combination of Near and Far Transfer learning on the Immediate Posttest is 80% indicating a high degree of learning has taken place as compared to the Pretest at 25%. The Immediate Far Transfer results are not so high, as might be expected. Still, at 71%, they are somewhat impressive, considering the demands of a delayed far transfer test. The Immediate Near Transfer Posttest has the highest total at 84% correct, as might be expected. The Delayed Posttest is lower, at 72%, than the Immediate Posttest. The delayed measures show the same relationship of the Delayed Near at 76% being higher than the Delayed Far at 66%.

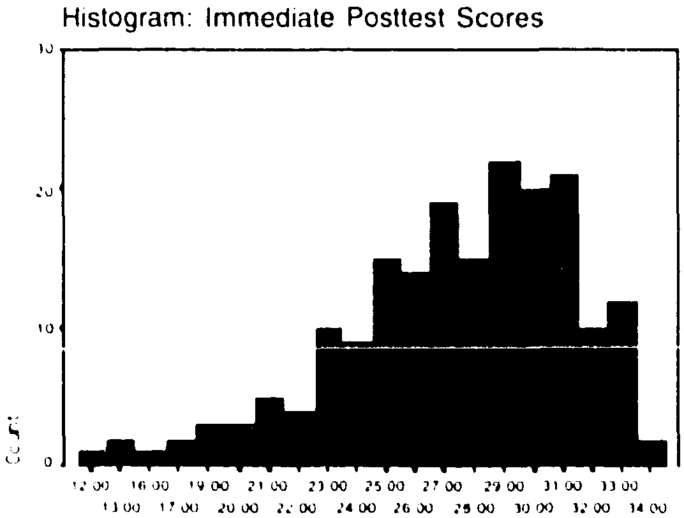


Figure 27. Frequency of Immediate Posttest Scores for Total Population

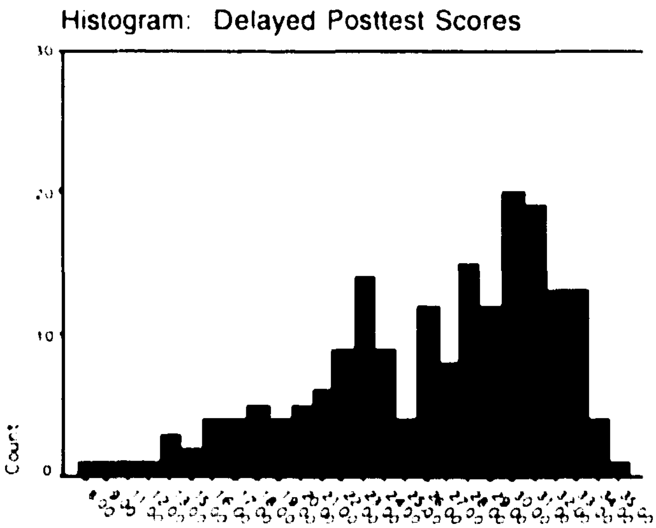


Figure 28. Frequency of Delayed Posttest Scores for Total Population

Table 8. Immediate Near and Far Posttest Mean and Standard Deviation by Treatment Group

		Immediate Posttest Scores		
Treatment	n	Near	Far	Total
Abstract	66			
M		20.40[a]	7.12[b]	27.50[c]
SD		2.64	2.16	4.03
None	64			
M		19.98	6.97	26.95
SD		2.86	1.95	4.10
Concrete	60			
M		20.23	7.25	27.48
SD		2.89	1.90	4.37
Total	190			
M		20.21	7.11	27.31
SD		2.78	2.00	4.15

Note. Total possible score: a = 24, b = 10, c = 34.

Table 9. Delayed Near and Far Posttest Mean and Standard Deviation by Treatment Group

		Delayed Posttest Scores		
Treatment	n	Near	Far	Total
Abstract	66			
M		18.09[a]	7.61[b]	25.70[c]
SD		3.99	2.28	5.49
None	64			
M		18.19	8.19	26.39
SD		4.10	2.12	5.74
Concrete	60			
M		18.30	8.13	26.41
SD		4.22	2.24	5.84
Total	190			
M		18.19	7.97	26.16
SD		4.08	2.29	5.67

Note. Total possible score: a = 24, b = 12, c = 36.

Inferential Analysis -- A Test of Research Hypotheses

The Statistical Programs for the Social Sciences (SPSS) statistical package was used to analyze the data via computer.

Data were analyzed using an alpha level of .10 for determining statistical significance because of the exploratory nature of the questions instead of the common .05 used in many research studies. In order to test the effects of different types of illustrations with multiple dependent measures, a MANOVA was run on the data to determine if an interaction was found among the three treatment groups on the Immediate and Delayed Near and Far Transfer Tests. A MANOVA or Multivariate Analysis of Variance is a statistical technique for determining whether several groups differ on more than one dependent variable (Borg & Gall, 1989).

Univariate Homogeneity of Variance Tests were run on the Posttest scores as shown in Table 10. A Cochran's test for homogeneity of variance, one of the assumptions of MANOVA was conducted. Level of significance (p) was found to be greater than .45, suggesting that this assumption was met.

Table 10. Univariate Homogeneity of Variance Tests Posttest Scores by Treatment

Posttest	Cochrans	p
Immediate Posttest (34 possible)	C(62,3) = .37,	p = .75
Near Transfer (24 possible)	C(63,3) = .35,	p = .97
Far Transfer (10 possible)	C(62,3) = .39,	p = .43
Delayed Posttest (36 possible)	C(62,3) = .35,	p = 1.00
Near Transfer (24 possible)	C(62,3) = .35,	p = 1.00
Far Transfer (12 possible)	C(62,3) = .35,	p = 1.00

Note. p is an approximation.

The Pearson Product Moment Correlation Statistic was computed on the Immediate and Delayed Posttests and found to be at .67. This measures the linear association between the variables displayed in Table 11. There was an expected high correlation (.91) between Immediate Near Transfer and Immediate total and also, (.81) between Immediate Far transfer and Immediate total. In the Delayed tests a high correlation (.95) between Delayed Near Transfer and Delayed total and (.82) Delayed Far Transfer and Delayed total was also expected because the far and near transfer questions are part of the total test. However, the other correlations involving Immediate Near to Immediate Far and Delayed Near to Delayed Far correlate at .49 and .59, respectively, suggesting they are indeed assessing different capabilities. The Immediate and Delayed tests correlated at .67, which is a moderate correlation between the two posttests. All of the correlations were significant to the < .01 level.

Table 11. Pearson Product Moment Correlation Statistic, Immediate and Delayed Posttest Scores

	Correlation					
	Immediate			Delayed		
	Transfer			Transfer		
Tests	Near	Far	Total	Near	Far	Total
Immediate Transfer						
Near	--	.49	.91	.60	.51	.63
Far		--	.81	.45	.50	.51
Total Immediate			--	.62	.57	.67
Delayed Transfer						
Near				--	.59	.95
Far					--	.82
Total Delayed						--

Note. N=190. $p < .01$.

Test of Hypotheses

For the purposes of this study, the researcher tested the predictions in terms of statistical hypotheses. A MANOVA was run on the body of data and the results are presented as follows:

Hypothesis 1

H_0 1. (null hypothesis) There will be no difference between the concrete and abstract visual groups on near transfer immediate testing.

H_1 1. (alternate hypothesis) On immediate testing over the content, the students from the concrete visuals group may score higher on near transfer questions than the abstract visuals group.

The specific exploratory research question coinciding with hypothesis 1 is:

1. When investigating learners' ability to interpret abstract visuals on an abstract concept task: will immediate, near transfer posttest performance of those who receive concrete illustrations be superior to the performance of those who receive abstract illustrations?

A univariate F-test was calculated on the Immediate Near Transfer Posttest and the results are displayed in Table 12 showing that there was no statistically significant difference between the abstract and concrete treatments groups on the near transfer questions, so findings failed to reject the null hypothesis.

Table 12. Univariate F-tests - Immediate Near Transfer Posttest by Treatment

Univariate F-tests	d.f.	SS	MS	F
Between Groups (ABC)	2	8.46	4.23	.68
Within Groups	185	1146.67	(6.20)	

Note. Value enclosed in parentheses represent mean square error.
$p = <.51$.

Hypothesis 2

H_0 2. (null hypothesis) On delayed near transfer testing, the abstract visuals group would show no difference in decrement in recall (from immediate posttest to delayed posttest) from the concrete visuals group.

H_1 2. (alternate hypothesis) It was expected on delayed near transfer testing the abstract visuals group would show a smaller decrement in recall (from immediate posttest to delayed posttest) than the concrete visuals group.

The specific exploratory research question coinciding with hypothesis 2 is:

2. When investigating learners' ability to interpret abstract visuals on an abstract concept task will, delayed, near transfer posttest performance of those who receive abstract illustrations be superior to the performance of those who receive concrete illustrations?

A t-test was run on the difference in means between the abstract immediate and delayed near transfer posttest, and the difference in means between the concrete immediate and delayed near transfer posttest. A t-test allows comparisons of the means of two groups split on one independent variable. The t-value for (1, 124) degrees of freedom should have been 1.66 at alpha $<.10$ for 2 tailed critical values (Harris, 1985). As shown in Table 13, there is no significant difference in the two groups' decrements in recall from immediate to delayed near transfer posttest resulting in a failure to reject the null hypothesis.

Table 13. Differences Between Immediate and Delayed Near Transfer Posttest for Group's Abstract and Concrete

T-test for Equality of Mean			
Variances	t-value	2-tail sig	SE of difference
difference	.64	.52	.57

Note. df = 1, 124. Abstract mean difference = 2.3, Concrete mean difference = 1.93, Mean difference between the two groups .37.

Hypothesis 3

H_0 3. (null hypothesis) On far transfer questions, both on immediate and delayed tests, the learners who received the abstract visuals will perform no better than those who received the concrete visuals.

H_1 3. (alternate hypothesis) It was expected that on far transfer questions, both on immediate and delayed tests, learners who received the abstract visuals may have performed better than those who received the concrete visuals.

The specific exploratory research questions coinciding with hypothesis 3 are:

3. Will immediate, far transfer posttest performance of those who received abstract illustrations be superior to the immediate far transfer of those who received concrete illustrations?
4. Will delayed far transfer posttest performance of those

who received abstract illustrations be superior to those who received concrete?

The Univariate F-Tests found no statistically significant difference in the posttest scores of the concrete and abstract treatment groups on the far transfer questions on either immediate and delayed tests, resulting in a failure to reject the null hypothesis.

Table 14. Univariate F-tests, Immediate and Delayed Far Transfer Posttest

Univariate F-tests				
Far Transfer Posttest	d.f.	SS	MS	F
Immediate				
Between Groups	2	3.05	1.53	.45[a]
Within Groups	185	621.59	(3.40)	
Delayed				
Between Groups	2	10.90	5.45	.1.29[b]
Within Groups	185	800.97	(4.33)	

Note. Values enclosed in parentheses represent mean square errors.

a: $p = < .64$, b: $p = < .29$.

Hypothesis 4

H_0 4. (null hypothesis) The abstract illustrations will not be differentially effective for learners with varying levels of ability to interpret abstract illustrations.

H_1 4. (alternate hypothesis) It was expected that the abstract illustrations would be differentially effective for learners with varying levels of ability to interpret abstract illustrations.

The specific exploratory research question coinciding with hypothesis 4 is:

7. Will posttest (immediate, delayed, near, and far transfer) performance of those who received abstract illustrations show differential benefit for different levels of ability (low, medium, and high) as demonstrated on the "Diagraming Relationships" test?

Table 15 shows the mean of the posttests of the Abstract Illustration treatment group separated into high medium and low visual ability upon which a MANOVA was run.

Table 15. Mean and Standard Deviation, Abstract Treatment, Near and Far, Immediate and Delayed Posttest by Visual Ability

Abstract Treatment	Visual Ability					
Posttest	High		Medium		Low	
Immediate	M^a	SD	M^b	SD	M^c	SD
Near	21.95	1.58	20.12	2.73	19.36	2.74
Far	8.05	1.31	6.88	2.28	6.59	2.42
Total Test	30.05	2.46	27.00	3.95	25.86	4.27
Delayed	M	SD	M	SD	M	SD
Near	19.74	3.46	18.48	3.28	16.23	4.51
Far	8.47	1.95	7.40	2.42	7.09	2.27
Total Test	28.21	4.57	25.88	5.05	23.32	5.88

Note. N = 66 a = 19, b = 25, c = 22.

A MANOVA for both the Total Immediate and Total Delayed Posttests was run on the data and found to be significant to the < .02 level rejecting the null hypothesis (Table 16).

Table 16. Multivariate Analysis of Variance, Immediate and Delayed Posttest by Abstract Treatment and Visual Ability

	Abstract Treatment			
Posttest	SS	MS	F	p
Immediate	188.96	94.48	6.87	.00
Delayed	245.37	122.68	4.51	.02

Note. $N = 66$. $df = 2, 63$.

An ANOVA also was run on each of the outcomes of the Immediate and Delayed Near and Far Transfer Posttests and results are shown in Table 17 as significant to the < .07 level except for the subset test of Delayed Far Transfer which was < .13 level of significance. The general findings indicate the participants in the abstract treatment group scoring high on the Diagraming relationships Test scored high on the Immediate and Delayed Posttest and the participants scoring low on the Diagraming Relationships Test scored low on both Immediate and Delayed Posttests.

Table 17. Analysis of Variance, Immediate and Delayed, Near and Far Transfer Posttest by Abstract Treatment and Visual Ability

Posttest	Abstract Treatment			
Immediate	SS	MS	F	p
Near	71.08	35.54	5.88	.00
Far	24.13	12.06	2.73	.07
Delayed				
Near	131.67	65.83	4.60	.01
Far	21.20	10.60	2.11	.13

Note. $N = 66$. $df = 2, 63$.

Hypothesis 5

H_0 5. (null hypothesis) In the comparison of the illustrated versus the nonillustrated version of instructional text, there would be no difference in effectiveness between the nonillustrated and illustrated versions on both immediate and delayed test for both near and far transfer.

H_1 5. (alternate hypothesis) Although of lesser interest, it was expected that in the comparison of the illustrated versus the nonillustrated version of instructional text, the illustrated versions would be more effective than the nonillustrated versions both on immediate and delayed tests for both near and far transfer.

The specific exploratory research questions coinciding with hypothesis 5 are:

5. Will posttest (immediate, delayed, near, and far transfer) performance of those who received abstract illustrations be superior to the performance of those who received no illustrations?

6. Will posttest (immediate, delayed, near, and far transfer) performance of those who received concrete illustrations be superior to the performance of those who received no illustrations?

The Univariate F-Tests found no statistically significant difference in the posttest scores of the illustrated and nonillustrated versions of the treatment groups on either near or far transfer questions on either immediate or delayed tests, resulting in a failure to reject the null hypothesis as displayed in Table 18.

Table 18. Univariate F-Tests for Immediate and Delayed Near and Far Transfer by Treatment

Transfer Posttests	SS	MS	F	p
Immediate Near				
Between Groups (ABC)	5.52	2.76	.35	.70
Within Groups	1457.18	(7.79)		
Delayed Near				
Between Groups (ABC)	1.37	.69	.04	.96
Within Groups	3137.80	(16.78)		
Immediate Far				
Between Groups (ABC)	2.46	1.23	.30	.74
Within Groups	756.22	(4.04)		
Delayed Far				
Between Groups (ABC)	13.37	6.69	1.36	.26
Within Groups	916.44	(4.90)		

Note. N = 190. df = 2, 187. Values enclosed in parentheses represent mean square errors.

Post Hoc Analysis

Introduction

Post hoc analysis includes data gathered during and after the research pertaining to influences that could possibly have a bearing on the outcome of the research. These data may not be a part of the five research hypotheses but may have an effect on them. They include the time factor, the visual factor, the posttest questionnaire, and the oral post questionnaire.

Time Variable

During the study, the students were asked to record the time required to complete each section of the study. Included in the time records were: Diagraming Relationships Test, Lesson, Immediate Posttest and Delayed Posttest.

The amount of time each participant spent to complete each part of the study was recorded. As the range of time required to read the lesson reveals (Table 19), there is a large variation in the verbal ability of the group as a whole which may have had a bearing on the outcome of the study. In contrast, the time spent reading may have been an indication of the amount of time used to study the content in the lesson portion of the experiment. An analysis of variance was conducted investigating the relationship among the following variables: Diagraming Relationships Test time, Immediate Posttest time, Delayed Posttest time and Lesson time as compared to the scores of the Immediate Posttest and Delayed Posttest to ascertain if the length of time spent effected the results of the tests.

A multivariate Test of Significance was run on ali the recorded times and the Wilks' lambda resulted in an F value of .88, with a non-significant level of $p = <.53$. Further univariate tests were run on each of the four recorded times and the posttests and the only one of significance was the time - lesson with a t-value of 1.69, and a $p = <.09$ level of significance. The relationship between the time taken to complete the lesson, specifically, and the posttest scores may have had a bearing on the outcome because of more intense studying of the content material.

Table 19. Mean, Standard Deviation, Range, Time Variable in Minutes by Treatment Group and Visual Ability

Treatment	Time Variable in Minutes			
Visual Ability	Diagraming		Immediate	Delayed
Treatment	Relationships	Lesson	Posttest	Posttest
High	M	M	M	M
Abstract	8.53	16.89	13.26	14.26
None	8.60	14.05	11.25	11.40
Concrete	7.79	14.11	11.21	13.47
Medium				
Abstract	8.04	16.80	11.28	14.48
None	7.44	15.40	12.12	14.36
Concrete	7.91	16.27	12.27	13.29
Low				
Abstract	7.95	14.95	10.82	12.81
None	7.95	15.26	13.11	13.39
Concrete	6.84	13.42	11.83	12.53
M	7.89	15.30	11.87	13.39
SD	2.32	5.32	4.15	5.67
Range in Minutes	3 - 18	6 - 45	12 - 34	8 - 35

Note. N = 190.

Diagraming Relationships Test

The Diagraming Relationships Test was analyzed to determine if there was a correlation between the results of the relationships test and the posttests. Table 20 displays the means and standard deviations of the Visual Relationships Test.

Table 20. Visual Relationships Test, Mean and Standard Deviation by Treatment Group and Visual Ability

Variable	M	SD	n
Abstract Illustration			
High	27.84	1.46	19
Medium	23.16	1.43	25
Low	16.64	2.87	22
Total Abstract	22.33	4.91	66
No Illustration			
High	27.40	1.31	20
Medium	23.16	1.57	25
Low	15.53	2.74	19
Total Illustration	22.22	5.10	64
Concrete			
High	27.37	1.26	19
Medium	22.91	1.48	22
Low	15.32	4.11	19
Total Concrete	21.92	5.51	60
Entire Population	22.16	5.15	190

A Post Hoc Main Effect analysis was done on the Diagraming Relationships Test with the Immediate, Delayed, Near and Far Transfer Tests' scores. The abstract, concrete and nonillustration groups did correlate with the original diagraming relationships groupings of high, medium and low visual ability. The participants scoring high on the diagraming relationships test, also scored high in the abstract, concrete and nonillustration groupings' posttests. Conversely, the participants scoring low on the diagraming relationships test scored low on the abstract, concrete and nonillustration treatment groupings' posttests. The significance level of all four of the $\underline{F}$ - Tests was <.01. The results are displayed in Table 21.

Table 21. Univariate F-Tests, Effect of Visual Relationships Test on Immediate, Delayed , Near and Far Transfer Tests

Univariate F-tests

Transfer Posttest	d.f.	SS	MS	F
Near		Immediate		
Between Groups	2	310.80	155.40	25.07*
Within Groups	185	1146.67	(6.20)	
Far				
Between Groups	2	134.67	67.34	20.04*
Within Groups	185	621.55	(3.36)	
Near		Delayed		
Between Groups	2	576.84	288.42	20.84*
Within Groups	185	2560.96	(13.84)	
Far				
Between Groups	2	115.48	57.74	13.34*
Within Groups	185	800.97	(4.33)	

Note. Values enclosed in parentheses represent mean square errors.

*$p = < .01$.

Post Questionnaire

After the study the entire population completed a post questionnaire used to gather information about their attitudes and use or non use of illustrations.

One of the three forms of the post questionnaire (Appendix H) corresponding to the treatment type, was given after the delayed posttest to each participant. The Abstract Illustration findings will be discussed first, then the NonIllustration findings and last, the Concrete Illustration findings.

Post Questionnaire Form (A) Abstract Illustration Group

The results are displayed in Table 22 for the Form (A) Abstract Illustration version of the questionnaire. One fourth of the Abstract Illustration group stated on question number four of the survey that they did not use the illustrations to learn the lesson and an additional 36% felt neutral about the abstract illustrations, which might indicate they may or may not have used them in learning the lesson or retrieving the concepts on the posttests.

Table 22. Post Questionnaire Form (A) Abstract Illustration Group

	strongly agree	agree	neutral	disagree	strongly disagree
1. It was easy to learn from this lesson.	15%	60%	22%	1.5%	1.5%
2. I would like to have instruction presented like this again.	12%	48%	28%	8%	4%
3. I found the pictures helpful.	20%	35%	37%	7%	1%
4. I used the pictures to help me learn	19%	22%	36%	19%	4%

After a two-week period, no one remembered the abstract visuals well enough to draw all four of them, however some of the participants drew similar illustrations capturing the meaning of the abstract concepts. About 54% could not remember how to draw any of the abstract visuals. For the people who recalled them, the first two abstract illustrations were the most memorable. Two of the participants did not remember seeing any pictures at all in the lesson. Twelve people did not answer question number five: "If you used the pictures: Describe how you used them as you read; Describe how (or if) you used them during the practice after each section; Describe how (or if) you used them during the test," leading the researcher to believe that they did not use them at all.

From the participants in the abstract illustration group who stated they used visuals, some comments reported were: "made mental pictures of the concepts," "mental notes of what the pictures represented," and "redrew the pictures and pictured them in my mind as I worked." Others said: "they helped me have a spatial view of concepts," "I read the material and looked at the pictures for clarification and reinforcement," "took all of the information presented and organized it in appropriate categories," and "they helped me have a visual in my mind that explained what each discrimination, concept, rule, & problem solving was about." From these and similar statements, it is inferred that the participants who actually used the abstract visuals were in keeping with the intent of the lesson plan. Most of the participants used the visuals to learn. They also used them to remember the concepts on the tests, but some stated that when it came to the delayed posttest, they could not remember them.

Post Questionnaire Form (B) Nonillustration Group

Post Questionnaire Form (B) was given to the No Illustration Group. Only 46% responded with "pictures would have helped me learn" (Table 23).

Table 23. Post Questionnaire Form (B) Nonillustration Group

	strongly agree	agree	neutral	disagree	strongly disagree
1. It was easy to learn from this lesson.	16%	54%	25%	5%	0%
2. I would like to have instruction presented like this again.	14%	47%	31%	8%	0%
3. Pictures would have helped me learn.	13%	33%	35%	19%	0%

The nonillustration group in response to question number four: "Explain where in the lesson would pictures have been useful", 23% stated no visuals were needed in the lesson, 22% left this question blank and 28% wanted them to be used for all of the concepts, 13% requested discrimination and concept category, and one wanted them only for problem solving. Six percent wanted a visual for the concept map which was one of the questions in the immediate posttest. One of the participants suggested that demonstrations would be more helpful than visuals.

Question number five on the nonillustration questionnaire asked: "Did you make up mental images (pictures) to help you remember each category of learning?" Forty-five percent stated they had used visuals images and 55% stated they did not. Forty-two percent drew at least one image when asked to "draw or describe the illustrations from the lesson that you can remember."

Post Questionnaire Form (C) Concrete Illustration Group

In the Post Questionnaire Form C used with the Concrete Illustration group, 61% of the participants said they used the visuals to learn (Table 24). When asked in question 6, "If you said yes to the use of pictures, please sketch or describe the images you used to remember each outcome," 41% used images in discrimination, 31% used them in concepts, 28% in rules and 26% in problem solving. These percentages encompassed the visuals in each category that could be recalled after a two-week period. The higher use of images in discriminations and concepts may indicate remembrance of these images as easier. However, most of the images drawn were not the concrete images supplied as "best example." Some were of other images used as verbal examples in the lesson, examples in the questions used in the posttests, or examples developed by the participants.

Table 24. Post Questionnaire Form (C) Concrete Illustration Group

	strongly agree	agree	neutral	disagree	strongly disagree
1. It was easy to learn from this lesson.	18%	61%	18%	0%	3%
2. I would like to have instruction presented like this again.	16%	38%	36%	8%	2%
3. I found the pictures helpful.	28%	36%	26%	8%	2%
4. I used the pictures to help me learn	26%	35%	23%	13%	3%

Oral Post Questionnaire

The Oral Post Questionnaire (Appendix I) was administered to 10 percent of the population directly after the research packets were completed. Five participants were from the abstract group, seven from the concrete group and seven from the nonillustration group, totaling 19 participants. The order of discussion will be abstract, concrete and nonillustrated group results.

Four out of the five abstract illustration group participants stated that the abstract illustrations assisted them in remembering the concepts. Four utilized the abstract illustrations in remembering the concepts during reading and practice and two employed them during the testing. The abstract group was asked the question: "In answering the test questions did you recall the images that were in the lesson?" Three responded "no" and two recalled them during the immediate posttest but not during the delayed posttest. These responses triggered another question asked in the questionnaire: "Other than the illustrations did you use any other techniques to remember the types of learning outcomes?" The abstract group responded: "previous knowledge in remembering the abstract concepts; memorization; grouping the questions together, if similar to each other; knew definitions and applied each of the definitions."

Of the seven participants responding to the concrete oral questionnaire, all of them employed the visual at the time of reading, five during studying, six during immediate testing and three during delayed testing. When ask about the concrete illustrations, six remembered the "fish," five the "cow," three the "hot air balloon" and one the "car and tools." It appears that as the illustrations became more complicated, the difficulty in remembering increased. When asked what other techniques were employed, the participants replied: "previous knowledge, repeated the definitions to myself for each question and put concepts in order of easiest to most difficult."

In response to the oral questionnaire, three participants of the nonillustration group stated they created images (mental pictures) to help them recall the information, four did not. The ones that used images did so in all phases: time of reading, practice, and testing. Some of the images employed were: "panda, ducks, colors, pins, and different shapes" for discrimination; "basketball game and colors" for concepts; "grammar and math problems" for rules; and "how to fly a kite, if it is broken, how to fix it" and "testing chemicals in chemistry class" for problem solving. A portion of these images had been used as verbal examples in the lesson or the immediate posttests.

The next chapter will cover the results of these findings and possible reasoning behind the results.

CHAPTER V

DISCUSSION

This chapter will present the summary of the study, discussion of the results, limitations, post questionnaire, post hoc findings, and future recommendations.

Summary

This exploratory study investigated the comparative effects of concretely illustrated instruction and abstractly illustrated instruction on the acquisition of abstract concepts using a nonillustration control group. In addition, the study investigated potential relationships between the ability to read abstract visuals using the Diagraming Relationships Test scores: (H) high, (M) medium, and (L) low and the concreteness of illustrations using the three treatment groups' test results: (A) Abstract Illustration, (B) No Illustration, and (C) Concrete Illustration.

Two hundred and twenty students seeking degrees in the College of Education at a south western university participated in this study. Attrition and pretesting reduced the number to 190, loosing 14% of the original population. The participants were assigned to the three treatment groups (A) Abstract Illustration, (B) No Illustration, and (C) Concrete Illustration by ranking the visual aptitude test and equally distributing them into the three groups before the attrition took place. After attrition and elimination of participants with prior knowledge by use of the pretest, the groups consisted of 66, 64 and 60 participants, respectively.

Discussion of Results

This section discusses the results of the study and differences and similarities of the 190 participants. General findings indicated there were no significant differences as a result of the three treatments. The interactions were not significant.

Hypothesis 1

H_0 1. (null hypothesis) There will be no difference between the concrete and abstract visual groups on near transfer immediate testing.

H_1 1. (alternate hypothesis) On immediate testing over the content, the students from the concrete visuals group may score higher on near transfer questions than the abstract visuals group.

The specific exploratory research question coinciding with hypothesis 1 is:

1. When investigating learners' ability to interpret abstract visuals on an abstract concept task, will immediate, near transfer posttest performance of those who receive concrete illustrations be superior to the performance of those who receive abstract illustrations?

In the alternate hypothesis it was expected that the Concrete Illustration group would remember more than the Abstract Illustration group because of the use of the best example with the critical attributes of the concept being more memorable upon immediate testing.

The results of Hypothesis 1 showed that on immediate near transfer testing over the content, the mean of the abstract treatment group was 20.4 and the mean of the concrete treatment group was 20.2, resulting in no statistically significant difference $\underline{F} = .68$, $p < .51$, resulting in a failure to reject the null hypothesis. The results may have been the same because the visual examples were explained verbally in both the concrete and abstract treatments and having the visuals present made no difference. Another possibility was the lesson was easily remembered in immediate near transfer testing using multiple choice questions.

Hypothesis 2

H_0 2. (null hypothesis) On delayed near transfer testing, the abstract visuals group would show no difference in decrement in recall (from immediate posttest to delayed posttest) from the concrete visuals group.

H_1 2. (alternate hypothesis) It was expected on delayed near transfer testing the abstract visuals group would show a smaller decrement in recall (from immediate posttest to delayed posttest) than the concrete visuals group.

The specific exploratory research question coinciding with hypothesis 2 is:

2. When investigating learners' ability to interpret abstract visuals on an abstract concept task, will delayed, near transfer posttest performance of those who receive

abstract illustrations be superior to the performance of those who receive concrete illustrations?

The results of Hypothesis 2 exhibited no statistically significant difference ($p < .52$) between the abstract visuals group and the concrete visuals group in decrement of recall from immediate posttest to delayed posttest on near transfer knowledge, resulting in a failure to reject the null hypothesis. The abstract visuals group decrement of recall in immediate to delayed was 2.3 while the concrete visuals group was 1.9, leaving a mean difference of .37. The researcher expected both groups to recall less over time in near transfer testing; and because the abstract visuals had more memorable critical attributes without extraneous features, it was also expected that the decrement would be less for the abstract than the concrete over time. This expected outcome did not prove to be the case in this experiment, perhaps due to the ability to apply name labels to concrete illustrations (e.g., cow) without having to recall specifics of cow drawing as contrasted with having to recall specifics of abstract drawing, as the lack of a "class name" would allow learners to recall the entire illustration.

Hypothesis 3

H_0 3. (null hypothesis) On far transfer questions, both on immediate and delayed tests, the learners who received the abstract visuals will perform no better than those who received the concrete visuals.

H_1 3. (alternate hypothesis) It was expected that on far transfer questions, both on immediate and delayed tests, learners who received the abstract visuals may have performed better than those who received the concrete visuals.

The specific exploratory research question coinciding with hypothesis 3 is:

3. Will immediate, far transfer posttest performance of those who received abstract illustrations be superior to the immediate far transfer of those who receive concrete illustrations?

4. Will delayed far transfer posttest performance of those who received abstract illustrations be superior to those who received concrete?

On far transfer questions, both on immediate and delayed tests, the learners who received the abstract visuals performed no better than those who received the concrete visuals, resulting in no statistically significant difference at $p < .64$ for the immediate far transfer and $p < .29$ for the delayed far transfer, so this experiment failed to reject the null hypothesis. In other words, performance by the group who received the abstract visuals was no different than the performance of those who received the concrete visuals on far transfer questions. Although this researcher expected the abstract illustrations to have more memorable criterion that would carry into far transfer learning, this did not seem to be the case. This outcome was possibly a result of subjects' ability to put a name to the concrete illustration without having to recall every fine detail of it as is required by recall of the abstract illustration.

Hypothesis 4

H_0 4. (null hypothesis) The abstract illustrations will not be differentially effective for learners with varying levels of ability to interpret abstract illustrations.

H_1 4. (alternate hypothesis) It was expected that the abstract illustrations would be differentially effective for learners with varying levels of ability to interpret abstract illustrations.

The specific exploratory research question coinciding with hypothesis 4 is:

7. Will posttest (immediate, delayed, near, and far transfer) performance of those who received abstract illustrations show differential benefit for different levels of ability (low, medium, and high) as demonstrated on the "Diagraming Relationships" test?

The only true difference in scores was shown in the high, medium and low separation of the participants into visual ability groups. This relationship of high, medium, and low continued through the Immediate and the Delayed Posttests with a significance level of $p < .01$. These findings might indicate that the Visual Relationships Test may be more of a general reasoning test than an abstract visual reading factor test. These findings resulted in the researcher rejecting the null Hypothesis 4: It was expected that the abstract illustrations would not be differentially effective for learners with varying levels of ability to interpret abstract illustrations. Although the null hypothesis was rejected, it does not inversely mean that the abstract illustration would be differentially effective for learners with varying levels of ability to interpret abstract illustrations. To accept this alternative without further study may also cause false conclusions.

Hypothesis 5

H_0 5. (null hypothesis) In the comparison of the illustrated versus the nonillustrated version of instructional text, there would be no difference in effectiveness between the nonillustrated and illustrated versions on both immediate and delayed tests for both near and far transfer.

H_1 5. (alternate hypothesis) Although of lesser interest, it was expected that, in the comparison of the illustrated versus the nonillustrated version of instructional text, the illustrated versions would be more effective than the nonillustrated version both on immediate and delayed tests for both near and far transfer.

The specific exploratory research question coinciding with hypothesis 5 is:

5. Will posttest (immediate, delayed, near and far transfer) performance of those who received abstract illustrations be superior to the performance of those who received no illustrations?

6. Will posttest (immediate, delayed, near and far transfer)

performance of those who received concrete illustrations be superior to the performance of those who received no illustrations?

An F test showed no significant difference between the illustrated and the nonillustrated groups in near and far transfer on immediate and delayed testing. The immediate near results were $F = .35$, $p < .70$, delayed near were $F = .04$, $p < .96$, immediate far at $F = .30$, $p < .74$ and delayed far were $F = 1.36$, $p < .26$. The results may have been influenced by a well-designed lesson causing learning to be easy whether there were visuals or not. Some of the participants also stated in the posttest survey that they used the verbally described visuals as learning aids.

Limitations

Levie and Lentz (1982) reviewed studies comparing illustrated with nonillustrated text, finding the illustrated was significantly better than text alone in 85% of the studies reviewed. However, this present study did not result in the same findings, showing no difference in illustrated and nonillustrated text. Studies have also been conducted using verbal descriptions in the text and beneath the pictures that have assisted in learning (Winn, 1989). In all three versions of the lesson presented in this study, the concrete illustrations were explained in the text, making the presence of the concrete illustrations known in all versions. Although this is an outstanding instructional design technique, the possibility of it having an influence on the outcome of the study is also present.

There are many factors that may have limited adequate testing of these hypotheses. Although an attempt was made to develop lean instruction, the lesson was, nevertheless, designed with careful use of instructional development principles in such a way that it was easy to learn with or without visuals. In a post hoc interview, one of the students commented "this was the best lesson I have ever studied and if all my lessons had been taught that way it would have been easier to learn." Another possible factor may have been that some of the students were familiar with the material, even though they failed the pretest (the mean score on the pretest was 3.77 out of a possible 15). The study was conducted over two semesters and, despite efforts to coordinate, some students may have received instruction on related content in other classes, so there may have been some contamination of findings.

The biggest factor however, may involve the lack of attention the participants paid to the abstract illustrations as shown in the results of the post questionnaire, despite special instructions before the lesson to pay close attention to the illustrations in the lesson.

Post Questionnaire

The results from the Post Questionnaire, given after the delayed posttest, showed that 75% of the abstract group, 70% of the nonillustration group and 79% of the concrete illustration group agreed or strongly agreed that it was easy to learn from this lesson, indicating that whether or not they used the visuals, they still felt the lesson was easy to learn. However, some participants in the abstract group said they chose to use the text and ignore the abstract visuals all together and one person said "pictures confused me." All together there were 37% who answered question 5 on the Post Questionnaire (Form A) by saying they did not use the abstract visuals provided to help them learn the abstract concepts. The abstract illustration group only reported use of the visuals to help them learn 41% of the time, while the concrete illustration group reported use of the visuals 61% of the time. This admitted non-use of the abstract visuals in itself may be part of the reason for the failure to reject the null hypotheses. The participants simply did not follow directions and ignored the use of the visuals, possibly skewing the results. This finding may be due to difficulty of interpreting abstract visuals or to the learners' lack of motivation to spend time and effort using illustrations.

A debriefing interview with 10% of the sample testing population was conducted and revealed that some of the participants found the abstract illustrations unhelpful and a little confusing. A few of the people said that they used the concrete ideas of illustration as guides to learn, even though they were assigned to the abstract illustration group. Some in the no illustration group simply used the verbal examples in the lesson which were also concrete illustrations.

Post Hoc Findings

The Post Hoc analysis was conducted after the experiment for further understanding of the data. The outcome of the data may have been influenced by the time factor. Time was analyzed in relationship to length of time spent studying the lesson compared to the outcome of the study. The oral post questionnaire was gathered for evaluation from the viewpoint of the students about the content of the lesson, general attitude about the study, and their attitude and use of the visuals.

Time

The time variable may have had an influence on the outcome of the data. Some of the participants took an inordinate amount of time, as much as 45 minutes to study the lesson. Others took only six minutes. None of the time to treatment relationships were significant except the length of time taken to study the lesson versus the visual treatment, which had a t-value of 1.69 and a level of significance of $p < .09$. Possibly the length of time used to study may have had an influence on the outcome (i.e., more time spent studying the higher the score and the less time the lower the score). The lesson had a practice session for each concept and if the participants used this feature, more time was spent on the lesson.

Oral Post Questionnaire

Nineteen participants equaling ten percent of the total population responded to the oral questionnaire given directly after the study. The abstract, concrete and nonillustrated groups' responses will be discussed in that order.

Five participants responded to the oral post questionnaire from the abstract treatment group. The learning strategies used by the abstract group appear to be triggered by knowledge learned in class or from the lesson, mostly using verbal knowledge transfer, (E. Gagné, 1993) building from discrimination to problem solving.

Seven participants from the concrete illustration group responded to the oral post questionnaire. These participants, as a group, remembered the concrete illustrations with higher recall than the abstract group's recall of the abstract illustrations. The concrete group also used verbal cues, previous knowledge, sequencing, and repetition as learning strategies for recall of the concepts.

Seven participants from the nonillustration group responded to the oral post questionnaire. A portion of the nonillustration group developed images as a learning strategy for remembering the four concepts in the lesson. The participants recalling the self-developed illustrations recalled them during all phases of the lesson and testing. The illustrations developed were concrete in nature, and some were derived from the lesson.

With the employment of the different types of learning cues, examples and non examples, practice and feedback, and the explanation of the concrete visuals in all three of the lesson treatments included in the highly developed lesson presentation, it is not surprising that the different treatments displayed no apparent difference in the outcome of the study.

Recommendations

After completing this study and reflecting on the type of research in the field, further studies on selection and use of abstract and concrete visuals are recommended. The current study suggests that both types of visuals can be effective. This outcome may have been the result of the high quality of the carefully designed lesson and the ability to learn from any version with ease.

Effective use of visuals with less carefully designed instruction are worth studying. For example, investigations of conventional academic texts, such as mathematics texts, could be performed in which different forms of visuals could be utilized. Possibly, a longer lesson leaving out the practice could be tested for a more realistic teaching situation.

The subject matter of the study did not possess the difficulty level anticipated, even though it was originally selected because of the perceived difficulty level. Therefore, a replication of this study with more difficult subject matter is likely to result in a different outcome.

Another option might be to change the population to participants studying architecture, art, or visual communication programs because of the visual ability of the people choosing these fields. They also would be less likely to have prior knowledge of the existing content of this study (if the same content was used) and possibly a higher likelihood of using the illustrations to assist in learning.

From the wide variety of illustrations that subjects drew when asked to draw the illustrations during the post questionnaire, this researcher believes that a study may be needed in the area of students' development of their own visuals to use in the learning of abstract concepts and what they perceived as being memorable abstract illustrations and memorable concrete illustrations. This self development of illustrations may support the relevancy of content in relationship to interest and motivational factors in the learning process.

The transfer-appropriate-processing of visuals (Levin, 1989, Paivio, 1971) with text needs further study in relationship to the critical features of abstract illustrations. The need for further research using more difficult or extensive/complex subject material is also suggested by this study.

Further questions bearing on selection and use of abstract visuals should be generated and investigated. For example, differences in efficiency, interest, past knowledge, testing skills, and motivation may exist and have a great influence on the learning of abstract concepts.

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APPENDIX

APPENDIX A

DEMOGRAPHIC DATA AND ENTRY QUESTIONNAIRE/PRETEST

Demographic Data and Entry Questionnaire/Pretest for Learning Study

(Please print)
Name _
Female ___ Male ___ Age ___ SS# _ _ _ - _ _ - _ _ _ _
Classification: Fresh.__ Soph.__ Jr.__ Sr.__ Grad. Student___
Major _

Have you ever heard of Gagne's Learning outcomes?
Yes___No___ If yes, please list Gagne's types of learning outcomes and briefly explain them.

Have you ever heard of Bloom's Taxonomy? Yes___ No___
If yes, what is Bloom's Taxonomy? Please list the categories of the taxonomy and briefly explain them.

What courses have you had that discuss how people learn?

Demographic Data and Entry Questionnaire/Pretest for Learning Study

Instructions: Label each of the following test items in terms of which of the 4 types of Intellectual skills the test item represents by filling in the blanks with the letter representing that category:
(d) discriminations, (c)concepts, (r) rules or (ps) problem solving.
(Hints have been placed for you in parenthesis so you don't need to know the content in order to answer the test items.)

test

_ _ _ _ A small reddish breasted bird sat on a fence. What type of bird was this? (the type of bird was a robin)

_ _ _ _ When passing a car in front of you the lines in the middle of the road must be dashed lines. What other guidelines must you follow when passing a car? (The on-coming traffic must be far enough away for you to go around the car in front of you and pull back in your lane with plenty of time without breaking the speed limit laws.)

_ _ _ _ The mall closes at 9:00p.m.. You are leaving the mall at 8:45p.m.. Leaning against your car is a suspicious looking person. Do you go ahead and get into your car or do you walk back into the mall to get a guard to walk to your car with you? (you go into the mall)

_ _ _ _ John taped the sounds he heard in the woods in late May. In August he returned to the woods to hear the same sounds. How could he identify these sounds? (He would play back the sound and compare)

APPENDIX B

THREE VERSIONS OF THE LESSON: A,B AND C

Please record the time you started________

SS # 0 0 0 - 0 0 -_ _ _ _

LESSON - FORM A

Gagne's Intellectual Skills

Note to Learners: In this lesson you will from time to time see an icon (picture of a key or something). This icon indicates a suggestion for a study technique to use to help you learn the material. When you see this icon, pay careful attention to the directions and make an extra effort to do what the directions suggest.

From your experiences in learning in all your years of public education as well as in the University you have probably noticed that there is a difference among learning tasks that have been assigned. Not only are some tasks harder, some take more time, and some use different types of learning techniques.

These differences have been studied by various educators and psychologists because not only are these different kinds of learning tasks learned differently, they should also be taught differently. It is important that you are familiar with these differences so that you can adjust your learning strategies to the kind of learning task that you may encounter.

You may have heard about Bloom's Taxonomy. This system is used by many teachers to talk about different kinds of learning. However, we find another way of classifying learning works best in the classroom. This system is called Gagne's Learning Outcomes. Gagné divides his learning outcomes into five major categories: verbal information, intellectual skills, cognitive strategies, attitudes, and psychomotor skills.

This lesson will focus on the Intellectual Skills category because it encompasses the majority of school learning tasks. Intellectual skills are of four types: Discriminations, concepts, rules and problem solving. After studying this lesson you should be able to differentiate among these four different types of school learning.

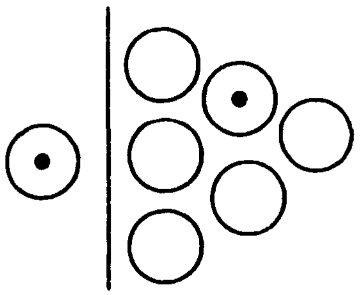
Most school learning in math, science, social studies and language arts are intellectual skills learning. This is the kind of learning that enables learners to apply learning to many situations.

Discriminations

A student has learned to make a **discrimination** if (s)he can distinguish between two stimuli, such as two sights, two sounds, or two smells. A person has learned a discrimination if (s)he is able to tell whether two stimuli are the same or different.

Discriminations generally are learned at an early age. For instance, learning to distinguish between the letters "b" and "d" is a discrimination. The learning task is **not** to learn the names of these letters, that comes later, but to learn to visually tell the difference between the characteristics of two or more objects, sounds, smells, etc.

Another example of a discrimination is if, when shown four pictures of fishes, you can discriminate among the pictures of the fishes by selecting the one that is different from all the others. Remember the names of the objects or forms do not need to be known to be able to learn discrimination. People who have learned a discrimination are mentally able to separate things into those that are alike and different according to some physical characteristic. Use the example of selecting the fish which is different to help you to remember discriminations.



As you can see in Figure 1 the object to the left of the line is different from all the objects on the right of the line except one. In this way Figure 1 represents the important aspects of discrimination of alike and different. Make sure you notice this aspect of the Figure before you continue. Now try to picture the Figure in your mind. Use this illustration to help you to remember discriminations.

Other examples of discriminations might involve other visual discriminations such as distinguishing similarities and differences in size, volume, thickness, direction and shading; auditory discriminations such as distinguishing similarities and differences in pitch, tone, notes, rhythm; tactile discriminations such as softness, hardness, roughness, smoothness, hot and cold temperature; olfactory discrimination such as distinguishing similarities and differences in odors; or gustatory discriminations such as sourness, sweetness or bitterness. These senses are used to make discriminations among things that are alike or different, nothing more than this.

Questions used to test discriminations may first ask the learner to see, smell, hear, taste or feel something and then ask them to identify, out of a group, similar or different objects, smells, sounds, or tastes. For example, you might show a child a lug nut and send him to the garage to "find one like this". If he returns, with another lug nut, instead of a screw, washer, or a nail, you can say he has learned a discrimination. Remember, for this lower level discrimination learning the name of the thing is not necessary. You must first be able to discriminate in order to grasp the idea of concepts, which does involve name labels.

Practice:

Please circle the numbers of the following examples that are discrimination learning tasks.

1. The teacher plays a note, asking the students, "which one sounds like this?" and then plays several notes for the students to pick from including the original note.
2. Shoppers participate in a taste test in which they are asked to pick out the soft drink that tastes like the one in the blue cup.
3. A child is shown a toy plane, train, car and boat. The child is asked which one is a boat?
4. A student is shown several tools and is asked, "Which of these is a Phillips screwdriver?"

Item 1 and 2 are examples of discriminations because individuals are asked to pick out what is alike or different about the sounds and the tastes without naming them. The last two items include naming the objects of "boat" and "Phillips screwdriver". Naming these objects takes them out of the discrimination category and into the concept category. If you missed these please go back and review this section.

Concepts

Learning a discrimination is learning to tell whether things are different or alike but without naming them. Learning a **concept** is learning to identify something as a member of a class with a **name**: for example, "Which of these is a vegetable?" "Which of these is a dog?" A person learns to make these classifications by grouping things together that have similar properties, attributes or characteristics. Concepts make it possible for an individual to identify a thing as a member of a class having one or more characteristics in common, even though the thing may have many other characteristics that are quite different. "House" is an example of a concept. The house can be any color, size, material, location, style or cost. All of these different characteristics do not matter as long as it includes the critical features of a house-- an opening that serves as a door, a floor, a roof, living space and sleeping space.

Some concepts are classified by physically perceivable characteristics such as color, shape, etc. An example of this kind of concept is "cow". A cow does not look like a dog or a cat. It has its own unique characteristics and shape. Even though a cow can be different sizes and colors, it is still a cow.

It looks, sounds, feels and smells like a cow. Members of this group that sound, smell, look and feel the same are called "cows". Note that if a person can mentally separate things into groups of alike and different, according to some characteristics by virtue of having one or more characteristics in common such as shape or function and can give the name of the things in the alike category, such as "cow", then (s)he has learned the concept. Use this example to help you to remember what concepts are.

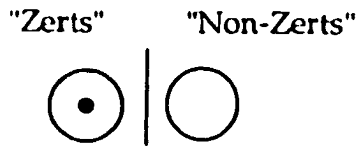


Figure 2 graphically illustrates that a learner has learned a concept "Zerts" by its attributes -- circle with a dot -- and can give the name of the thing in the alike category ("Zerts" in this case), by classifying it into a group or class by virtue of having one or more characteristics in common. In this way, Figure 2 represents the important aspects of concept. Make sure you notice this aspect of the illustration before you continue. Now try to picture Figure 2 in your mind. Use this illustration to help you to remember the type of learning called concept learning.

Another example of a concept is the class of "owl". In order to learn the concept "owl" a learner must first be able to tell that the shape of an owl is unlike other animals. This is a discrimination. Then to show you have learned the concept "owl" you must be able to identify these birds by their names, for example when asked to "find the owls" to be able to select several "owls" with varying sizes, colors and shapes out of a group of other birds. A learner does this by knowing the characteristics of an owl are -- that it is a bird with a broad head and large eyes which only move when its head moves. Other characteristics such as the shade of brown or white coloring of its feathers are not critical features and are not used to determine whether a bird is an owl. Other examples of concepts are "ball", "tree", "computer", "jar" and "insect".

Other concepts differ from the previously described concepts in that they are more abstract. The critical characteristics of these abstract concepts are not their <u>physical</u> features but their <u>definitions</u>. An example of an abstract concept is the concept "cousin." The concept "cousin" can be defined as a person who is related to you by being your aunt or uncle's son or daughter. Even though your cousins, Thomas and Karen, can be seen or heard, the actual concept "cousin" is only a definition used to classify persons into a like group. Other defined concepts are "theory", "alien", "family", "city", and "justice".

Practice:

Please circle the numbers of the following examples which are concept learning tasks.

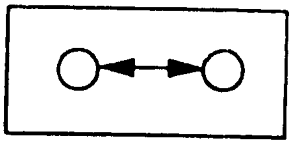
1. Several materials are placed in a brown paper bag. Students are asked to feel a piece of material. Without looking the students are then asked to find the one in the bag that feels like it and remove it.
2. Students are asked to read several paragraphs about the government and to pick out which one is an example of propaganda.
3. Students are shown several pictures of cars and asked to pick out the one that is a picture of a Datsun.
4. Students are shown several pictures of buildings of varying sizes and shapes and asked, "Which one of these is a barn?"

Items 2, 3 and 4 are examples of concepts because students must classify according to characteristics and identify by the names "propaganda," "Datsun," and "barn." Item 1 is an example of a discrimination because no name or label was given. If you missed these, please go back and review this section.

Rules

Rules (sometimes called principles) describe the relationship between two or more concepts. The relationship of $E=mc^2$ is a rule. It shows the relationship among the concepts energy, mass and the speed of light. Rules allow learners to make predictions about how a change in one concept will affect others.

Another example of a rule is "If air is heated, then it expands and rises" combines the concepts "air", "heat", "expand" and "rises" and explains the relationship among these four concepts. A learner who has learned this rule can explain what happens if the air is heated in a hot air balloon: It rises off the ground. The important aspect of a rule is the relationship between or among the concepts. Use this example to help you remember what a **rules** is.



The illustration in Figure 3 shows how two or more concepts (such as "air" and "heat") represented by circles, may be related. The arrows show how the concepts relate to each other to form a rule as represented by the rectangle enclosing the two concepts. Make sure you notice this aspect of the figure before you continue. Now try to picture Figure 3 in your mind. Use the illustration to help you remember what rules are.

When human learners have acquired a rule, they are able to exhibit behavior that is "rule-governed." For example learning a language is full of learning rules. "Nouns" and "verbs" are concepts, but there are rules that govern how they must relate in sentences. For instance, there is a rule that nouns and verbs must agree in number, such as a plural noun requiring a plural verb. A learner who has learned this rule is able to determine which of the following sentences is correct: "John runs home." or "John run home." Rules can either show cause and effect (such as the balloon example) or relationships between two or more concepts (such as the noun and verb example).

Practice:

Please circle the numbers of the following examples which are rule learning tasks.

1. What will happen to demand for a product, if the supply goes up?
2. After being given several scents to smell, the student is asked "Which one smells like this one?", (as the student is given one more scent to smell.)
3. Which pronoun is correct? "The dinner club was too expensive for Jim and me/I".

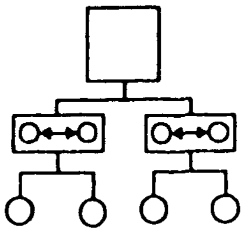
4. From a choice of several wrenches the student is to pick out the box end wrench.

Items 1 and 3 are examples of tasks that require knowing rules. To answer item 1 the learner must know the law of supply and demand; if supply goes up, demand usually goes down. The concepts "supply" and "demand" are related in the rule. To answer item 3 the nominative and subjective case rules need to be known, "when the first person noun is in the subjective case use the referent pronoun me." Item 2 is a discrimination of smells. (It does not name the smell so is not a concept.) Item 4 is a concept task. It is not a rule because it does not require the application of a rule that explains the relationship of a box end wrench with any other concept. If you missed these, please go back and review this section.

Problem Solving

Higher-order rule learning or **problem solving** uses previously learned rules or principles to solve previously unencountered problems. Problem solving requires a learner to select from all the rules that (s)he has learned in a particular subject matter area and to apply those rules in a particular order to solve a problem. If a learner has an assignment to design a company logo, the process of design would be a problem solving task. First the learner would need to apply marketing rules to find out what image the company would like to project and who the target population is. Then the learner would have to apply advertising principles (rules) to decide what message and treatment should be used. Then the learner would have to use visual design principles (rules), and color principles (rules). Then (s)he would apply rules on selection of materials to physically make the logo. The designer would have to select from all rules and principles related to marketing, advertising, and visual design only those that were appropriate to this task. Then (s)he would have to apply these rules in the right order to solve the problem.

Repairing a car that has broken down in the driveway can be a problem solving task. The task can be solved using several different rules such as, the car requires fuel to go; the car requires electricity to start; and the engine needs oxygen to start. So there are several types of rules that apply to the functioning of a car. The interaction of these rules with each other pertain to the successful solution of the problem of a broken down car. This example represents the important aspects of problem solving which is to apply two or more rules to solve a problem. Use this example to help you remember problem solving.



The illustration in Figure 4 shows that to perform a problem solving task (represented by a square) a learner must be able to apply together two or more rules (represented by the rectangles). (S)he must also know the concepts (represented by the circles) forming these rules. In this way Figure 4 represents the important aspects of problem solving. Make sure you notice this aspect of the Figure before you continue. Now try to picture Figure 4 in your mind. Use the illustration to help you remember what problem solving is.

Here is another example of problem solving. Problem solving is used in the field of medicine when a medical doctor makes a diagnosis and prescribes treatment. In order to make a diagnosis and prescribe treatment a doctor must know all the principles (rules) about how particular organs and systems relate to each other and to outside environmental factors. Other examples of problem solving are writing a lesson plan, repairing a clock and writing an advertising campaign. A problem solving task is any previously unencountered situation where two or more learned rules must be applied to solve a problem. Solving a simple math problem often only requires the application of one rule and is not a problem solving task.

Practice:

Please circle the numbers of the following examples which are problem solving tasks.

1. An engagement ring is dropped down the bathroom sink. How could it be retrieved?
2. If you went on a field trip to a farm and saw several animals could you pick out the mammals?
3. How do you stack and tie down a load of hay on a flat bed truck?
4. Your room is full of furniture and you have acquired an antique cabinet. How do you decide where to place it.

One, three and four are examples of problem solving. They require that learners apply multiple rules to solve problems. For example in item 1 you may want to start with removing the drain stop to see if the ring could be removed from the top without taking apart the pipes under the sink. If removing the pipes becomes an option, rules about water pressure,valves and leverage would be useful. In item 3 knowledge of the rules of gravity, rules of balance, rules of knot tying and their relationships form a problem solving solution. Item 4 requires you to know rules about how to estimate the visual space of your room, rules about lifting, and rules about addition of feet and inches. Item 2 is a concept task recognizing examples of mammals. If you missed these please go back and review this section.

Review

The following items are a practice test over the 4 intellectual skills you just learned.

Match these categories: (d) discriminations, (c) concepts, (r) rules or (ps) problem solving, to the following examples by filling in the blanks with the letter of the category.

______1. Which of the following persons might be classified as extroverts: Madonna, Henry Thoreau, Muhammad Ali, Emily Dickinson?

______2. If you leave a hot iron in one place on your cotton shirt too long, what will happen?

______3. Students in a management course plan how to ensure that employees adopt an innovative procedure.

______4. Which tone sounds like this?

______5. How would you go about conducting a market survey of a new product?

______6. If you have a fire in the pan on the stove, and the lid was setting next to it, what would you do?

The answers to the practice test are as follows:

answers: _c_ 1, _r_ 2, _p-s_ 3, _d_ 4, _p-s_ 5, and _r_ 6

- The answer to item 1 is concept because the learner is required to recall the critical characteristics of the concept labeled "extrovert" and match these characteristics to possible examples and by stating the name "extrovert" this statement is put into the concept category.
- The answer to item 2 is a rule which relates concepts in a cause and effect relationship - heat and the lack of movement of the iron on a cotton shirt will cause a brown spot the shape of the iron.
- The answer to item 3 is problem solving because there are several rules which need to be followed in order for new procedures to be adopted such as informing employees of the new procedure, teaching everyone how to use it, rewarding employees for using the new procedure and follow up to insure that it is done correctly.
- The answer to item 4 is discrimination because you determine whether a sound is alike or different to another sound without naming it.
- The answer to item 5 is problem solving because you need to follow several already established rules

in order to accomplish this task.

- The answer to item 6 is a <u>rule</u> relating the 4 concepts of fire, pan, oxygen and lid "if there is a fire in a pan on the stove you put the lid on the pan and it will go out because it is deprived of oxygen."

Please record the time you finished this lesson.

________. Thank you.

You are ready for the post test. Good luck.

Sources:

Bloom, B. S., M. D. Englehart, E. J. Furst, W. H. Hill, and D. R. Krathwohl. (1956). Taxonomy of Educational Objectives: Handbook I, Cognitive Domain. New York: McKay.

Smith, P. L. and Ragan, T. J. (in press) Instructional Design.: Columbus: MacMillan.

Gagné, R. M., Briggs, L.J. and Wager, W. W. (1988). Principles of Instructional Design 3rd edition. New York: Holt, Rinehart and Winston, Inc.

Please record the time you started________

SS # 0 0 0 - 0 0 -_ _ _ _

LESSON - FORM B

Gagne's Intellectual Skills

Note to Learners: Pay careful attention to the directions and make an extra effort to do what the directions suggest.

From your experiences in learning in all your years of public education as well as in the University you have probably noticed that there is a difference among learning tasks that have been assigned. Not only are some tasks harder, some take more time, and some use different types of learning techniques.

These differences have been studied by various educators and psychologists because not only are these different kinds of learning tasks learned differently, they should also be taught differently. It is important that you are familiar with these differences so that you can adjust your learning strategies to the kind of learning task that you may encounter.

You may have heard about Bloom's Taxonomy. This system is used by many teachers to talk about different kinds of learning. However, we find another way of classifying learning works best in the classroom. This system is called Gagne's Learning Outcomes. Gagné divides his learning outcomes into five major categories: verbal information, intellectual skills, cognitive strategies, attitudes, and psychomotor skills.

This lesson will focus on the Intellectual Skills category because it encompasses the majority of school learning tasks. Intellectual skills are of four types: Discriminations, concepts, rules and problem solving. After studying this lesson you should be able to differentiate among these four different types of school learning.

Most school learning in math, science, social studies and language arts are intellectual skills learning. This is the kind of learning that enables learners to apply learning to many situations.

Discriminations

A student has learned to make a **discrimination** if (s)he can distinguish between two stimuli, such as two sights, two sounds, or two smells. A person has learned a discrimination if (s)he is able to tell whether two stimuli are the same or different.

Discriminations generally are learned at an early age. For instance, learning to distinguish between the letters "b" and "d" is a discrimination. The learning task is **not** to learn the names of these letters, that comes later, but to learn to visually tell the difference between the characteristics of two or more objects, sounds, smells, etc.

Another example of a discrimination is if, when shown four pictures of fishes, you can discriminate among the pictures of the fishes by selecting the one that is different from all the others. Remember the names of the objects or forms do not need to be known to be able to learn discrimination. People who have learned a discrimination are mentally able to separate things into those that are alike and different according to some physical characteristic. Use the example of selecting the fish which is different to help you to remember <u>discriminations</u>.

Other examples of discriminations might involve other visual discriminations such as distinguishing similarities and differences in size, volume, thickness, direction and shading; auditory discriminations such as distinguishing similarities and differences in pitch, tone, notes, rhythm; tactile discriminations such as softness, hardness, roughness, smoothness, hot and cold temperature; olfactory discrimination such as distinguishing similarities and differences in odors; or gustatory discriminations such as sourness, sweetness or bitterness. These senses are used to make discriminations among things that are alike or different, nothing more than this.

Questions used to test discriminations may first ask the learner to see, smell, hear, taste or feel something and then ask them to identify, out of a group, similar or different objects, smells, sounds, or tastes. For example, you might show a child a lug nut and send him to the garage to "find one like this". If he returns, with another lug nut, instead of a screw, washer, or a nail, you can say he has learned a discrimination. Remember, for this lower level discrimination learning the name of the thing is not necessary. You must first be able to discriminate in order to grasp the idea of concepts, which does involve name labels.

Practice:

Please circle the numbers of the following examples that are <u>discrimination</u> learning tasks.

1. The teacher plays a note, asking the students, "which one sounds like this?" and then plays several notes for the students to pick from including the original note.
2. Shoppers participate in a taste test in which they

are asked to pick out the soft drink that tastes like the one in the blue cup.

3. A child is shown a toy plane, train, car and boat. The child is asked which one is a boat?

4. A student is shown several tools and is asked, "Which of these is a Phillips screwdriver?"

Item 1 and 2 are examples of discriminations because individuals are asked to pick out what is alike or different about the sounds and the tastes without naming them. The last two items include naming the objects of "boat" and "Phillips screwdriver". Naming these objects takes them out of the discrimination category and into the concept category. If you missed these please go back and review this section.

Concepts

Learning a discrimination is learning to tell whether things are different or alike but without naming them. Learning a **concept** is learning to identify something as a member of a class with a **name**: for example, "Which of these is a <u>vegetable</u>?" "Which of these is a <u>dog</u>?" A person learns to make these classifications by grouping things together that have similar properties, attributes or characteristics.

Concepts make it possible for an individual to identify a thing as a member of a class having one or more characteristics in common, even though the thing may have many other characteristics that are quite different. "House" is an example of a concept. The house can be any color, size, material, location, style or cost. All of these different characteristics do not matter as long as it includes the critical features of a house-- an opening that serves as a door, a floor, a roof, living space and sleeping space.

Some concepts are classified by physically perceivable characteristics such as color, shape, etc. An example of this kind of concept is "cow". A cow does not look like a dog or a cat. It has its own unique characteristics and shape. Even though a cow can be different sizes and colors, it is still a cow. It looks, sounds, feels and smells like a cow. Members of this group that sound, smell, look and feel the same are called "cows". Note that if a person can mentally separate things into groups of alike and different, according to some characteristics by virtue of having one or more characteristics in common such as shape or function and can give the name of the things in the alike category, such as "cow", then (s)he has learned the concept. Use this example to help you to remember what <u>concepts</u> are.

Another example of a concept is the class of "owl". In order to learn the concept "owl" a learner must first be able to tell that the shape of an owl is unlike other animals. This is a discrimination. Then to show you have learned the concept "owl" you must be able to identify these birds by their names, for example when asked to "find the owls" to be able to select several "owls" with varying sizes, colors and shapes out of a group of other birds. A learner does this by knowing the characteristics of an owl are -- that it is a bird with a broad head and large eyes which only move when its head moves. Other characteristics such as the shade of brown or white coloring of its feathers are not critical features and are not used to determine whether a bird is an owl. Other examples of concepts are "ball", "tree", "computer", "jar" and "insect".

Other concepts differ from the previously described concepts in that they are more abstract. The critical characteristics of these abstract concepts are not their <u>physical</u> features but their <u>definitions</u>. An example of an abstract concept is the concept "cousin." The concept "cousin" can be defined as a person who is related to you by being your aunt or uncle's son or daughter. Even though your cousins, Thomas and Karen, can be seen or heard, the actual concept "cousin" is only a definition used to classify persons into a like group. Other defined concepts are "theory", "alien", "family", "city", and "justice".

Practice:

Please circle the numbers of the following examples which are concept learning tasks.

1. Several materials are placed in a brown paper bag. Students are asked to feel a piece of material. Without looking the students are then asked to find the one in the bag that feels like it and remove it.
2. Students are asked to read several paragraphs about the government and to pick out which one is an example of propaganda.
3. Students are shown several pictures of cars and asked to pick out the one that is a picture of a Datsun.
4. Students are shown several pictures of buildings of varying sizes and shapes and asked, "Which one of these is a barn?"

Items 2, 3 and 4 are examples of concepts because students must classify according to characteristics and identify by the names "propaganda," "Datsun," and "barn." Item 1 is an example of a discrimination because no name or label was given. If you missed these, please go back and review this section.

Rules

Rules (sometimes called principles) describe the relationship between two or more concepts. The relationship of $E=mc^2$ is a rule. It shows the relationship among the concepts energy, mass and the speed of light. Rules allow learners to make predictions about how a change in one concept will affect others.

Another example of a rule is "If air is heated, then it expands and rises" combines the concepts "air", "heat", "expand" and "rises" and explains the relationship among these four concepts. A learner who has learned this rule can explain what happens if the air is heated in a hot air balloon: It rises off the ground. The important aspect of a rule is the relationship between or among the concepts. Use this example to help you remember what a **rules** is.

When human learners have acquired a rule, they are able to exhibit behavior that is "rule-governed." For example learning a language is full of learning rules. "Nouns" and "verbs" are concepts, but there are rules that govern how they must relate in sentences. For instance, there is a rule that nouns and verbs must agree in number, such as a plural noun requiring a plural verb. A learner who has learned this rule is able to determine which of the following sentences is correct: "John runs home." or "John run home." Rules can either show cause and effect (such as the balloon example) or relationships between two or more concepts (such as the noun and verb example).

Practice:

Please circle the numbers of the following examples which are rule learning tasks.

1. What will happen to demand for a product, if the supply goes up?
2. After being given several scents to smell, the student is asked "Which one smells like this one?", (as the student is given one more scent to smell.)
3. Which pronoun is correct? "The dinner club was too expensive for Jim and me/I".
4. From a choice of several wrenches the student is to pick out the box end wrench.

Items 1 and 3 are examples of tasks that require knowing rules. To answer item 1 the learner must know the law of supply and demand; if supply goes up, demand usually goes down. The concepts "supply" and "demand" are related in the rule. To answer item 3 the nominative and subjective case rules need to be known, "when the first person noun is in the subjective case use the referent pronoun me." Item 2 is a discrimination of smells. (It does not name the smell so is not a concept.) Item 4 is a concept task. It is not a rule because it does not require the application of a rule that explains the relationship of a box end wrench with any other concept. If you missed these, please go back and review this section.

Problem Solving

Higher-order rule learning or **problem solving** uses previously learned rules or principles to solve previously unencountered problems. Problem solving requires a learner to select from all the rules that (s)he has learned in a particular subject matter area and to apply those rules in a particular order to solve a problem. If a learner has an assignment to design a company logo, the process of design would be a problem solving task. First the learner would need to apply marketing rules to find out what image the company would like to project and who the target population is. Then the learner would have to apply advertising principles (rules) to decide what message and treatment should be used. Then the learner would have to use visual design principles (rules), and color principles (rules). Then (s)he would apply rules on selection of materials to physically make the logo. The designer would have to select from all rules and principles related to marketing, advertising, and visual design only those that were appropriate to this task. Then (s)he would have to apply these rules in the right order to solve the problem.

Repairing a car that has broken down in the driveway can be a problem solving task. The task can be solved using several different rules such as, the car requires fuel to go; the car requires electricity to start; and the engine needs oxygen to start. So there are several types of rules that apply to the functioning of a car. The interaction of these rules with each other pertain to the successful solution of the problem of a broken down car. This example represents the important aspects of problem solving which is to apply two or more rules to solve a problem. Use this example to help you remember problem solving.

Here is another example of problem solving. Problem solving is used in the field of medicine when a medical doctor makes a diagnosis and prescribes treatment. In order to make a diagnosis and prescribe treatment a doctor must know all the principles (rules) about how particular organs and systems relate to each other and to outside environmental factors. Other examples of problem solving are writing a lesson plan, repairing a clock and writing an advertising campaign. A problem solving task is any previously unencountered situation where two or more learned rules must be applied to solve a problem. Solving a simple math problem often only requires the application of one rule and is not a problem solving task.

Practice:

Please circle the numbers of the following examples which are problem solving tasks.

1. An engagement ring is dropped down the bathroom sink. How could it be retrieved?
2. If you went on a field trip to a farm and saw several animals could you pick out the mammals?
3. How do you stack and tie down a load of hay on a flat bed truck?
4. Your room is full of furniture and you have acquired an antique cabinet. How do you decide where to place it.

One, three and four are examples of problem solving. They require that learners apply multiple rules to solve problems. For example in item 1 you may want to start with removing the drain stop to see if the ring could be removed from the top without taking apart the pipes under the sink. If removing the pipes becomes an option, rules about water pressure,valves and leverage would be useful. In item 3 knowledge of the rules of gravity, rules of balance, rules of knot tying and their relationships form a problem solving solution. Item 4 requires you to know rules about how to estimate the visual space of your room, rules about lifting, and rules about addition of feet and inches. Item 2 is a concept task recognizing examples of mammals. If you missed these please go back and review this section.

Review

The following items are a practice test over the 4 intellectual skills you just learned.

Match these categories: (d) discriminations, (c) concepts, (r) rules or (ps) problem solving, to the following examples by filling in the blanks with the letter of the category.

______1. Which of the following persons might be classified as extroverts: Madonna, Henry Thoreau, Muhammad Ali, Emily Dickinson?

______2. If you leave a hot iron in one place on your cotton shirt too long, what will happen?

______3. Students in a management course plan how to ensure that employees adopt an innovative procedure.

______4. Which tone sounds like this?

______5. How would you go about conducting a market survey of a new product?

______6. If you have a fire in the pan on the stove, and the lid was setting next to it, what would you do?

The answers to the practice test are as follows:

answers: _c_1, _r_2, _p-s_3, _d_4, _p-s_5, and _r_6

- The answer to item 1 is concept because the learner is required to recall the critical characteristics of the concept labeled "extrovert" and match these characteristics to possible examples and by stating the name "extrovert" this statement is put into the concept category.
- The answer to item 2 is a rule which relates concepts in a cause and effect relationship - heat and the lack of movement of the iron on a cotton shirt will cause a brown spot the shape of the iron.
- The answer to item 3 is problem solving because there are several rules which need to be followed in order for new procedures to be adopted such as

informing employees of the new procedure, teaching everyone how to use it, rewarding employees for using the new procedure and follow up to insure that it is done correctly.

- The answer to item 4 is discrimination because you determine whether a sound is alike or different to another sound without naming it.
- The answer to item 5 is problem solving because you need to follow several already established rules in order to accomplish this task.
- The answer to item 6 is a rule relating the 4 concepts of fire, pan, oxygen and lid "if there is a fire in a pan on the stove you put the lid on the pan and it will go out because it is deprived of oxygen."

Please record the time you finished this lesson.

_________. Thank you.

You are ready for the post test. Good luck.

Sources:

Bloom, B. S., M. D. Englehart, E. J. Furst, W. H. Hill, and D. R. Krathwohl. (1956). Taxonomy of Educational Objectives: Handbook I, Cognitive Domain. New York: McKay.

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Please record the time you started__________

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LESSON - FORM C

Gagne's Intellectual Skills

Note to Learners: In this lesson you will from time to time see an icon (picture of a key or something). This icon indicates a suggestion for a study technique to use to help you learn the material. When you see this icon, pay careful attention to the directions and make an extra effort to do what the directions suggest.

From your experiences in learning in all your years of public education as well as in the University you have probably noticed that there is a difference among learning tasks that have been assigned. Not only are some tasks harder, some take more time, and some use different types of learning techniques.

These differences have been studied by various educators and psychologists because not only are these different kinds of learning tasks learned differently, they should also be taught differently. It is important that you are familiar with these differences so that you can adjust your learning strategies to the kind of learning task that you may encounter.

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This lesson will focus on the Intellectual Skills category because it encompasses the majority of school learning tasks. Intellectual skills are of four types: Discriminations, concepts, rules and problem solving. After studying this lesson you should be able to differentiate among these four different types of school learning.

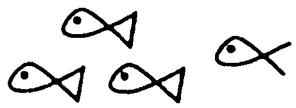
Most school learning in math, science, social studies and language arts are intellectual skills learning. This is the kind of learning that enables learners to apply learning to many situations.

Discriminations

A student has learned to make a **discrimination** if (s)he can distinguish between two stimuli, such as two sights, two sounds, or two smells. A person has learned a discrimination if (s)he is able to tell whether two stimuli are the same or different.

Discriminations generally are learned at an early age. For instance, learning to distinguish between the letters "b" and "d" is a discrimination. The learning task is **not** to learn the names of these letters, that comes later, but to learn to visually tell the difference between the characteristics of two or more objects, sounds, smells, etc.

Another example of a discrimination is if, when shown four pictures of fishes, you can discriminate among the pictures of the fishes by selecting the one that is different from all the others. Remember the names of the objects or forms do not need to be known to be able to learn discrimination. People who have learned a discrimination are mentally able to separate things into those that are alike and different according to some physical characteristic. Use the example of selecting the fish which is different to help you to remember discriminations.



Note in Figure 1 that if you can pick out the one which is different you have learned discrimination. In this way figure 1 represents the important aspects of discrimination. Make sure you notice this aspect of the figure before you continue. Now try to picture the figure in your mind. Use this illustration to help you to remember discriminations.

Other examples of discriminations might involve other visual discriminations such as distinguishing similarities and differences in size, volume, thickness, direction and shading; auditory discriminations such as distinguishing similarities and differences in pitch, tone, notes, rhythm; tactile discriminations such as softness, hardness, roughness, smoothness, hot and cold temperature; olfactory discrimination such as distinguishing similarities and differences in odors; or gustatory discriminations such as sourness, sweetness or bitterness. These senses are used to make discriminations among things that are alike or different, nothing more than this.

Questions used to test discriminations may first ask the learner to see, smell, hear, taste or feel something and then ask them to identify, out of a group, similar or different objects, smells, sounds, or tastes. For example, you might show a child a lug nut and send him to the garage to "find one like this". If he returns, with another lug nut, instead of a screw, washer, or a nail, you can say he has learned a discrimination. Remember, for this lower level discrimination learning the name of the thing is not necessary. You must first be able to discriminate in order to grasp the idea of concepts, which does involve name labels.

Practice:

Please circle the numbers of the following examples that are discrimination learning tasks.

1. The teacher plays a note, asking the students, "which one sounds like this?" and then plays several notes for the students to pick from including the original note.
2. Shoppers participate in a taste test in which they are asked to pick out the soft drink that tastes like the one in the blue cup.
3. A child is shown a toy plane, train, car and boat. The child is asked which one is a boat?
4. A student is shown several tools and is asked, "Which of these is a Phillips screwdriver?"

Item 1 and 2 are examples of discriminations because individuals are asked to pick out what is alike or different about the sounds and the tastes without naming them. The last two items include naming the objects of "boat" and "Phillips screwdriver". Naming these objects takes them out of the discrimination category and into the concept category. If you missed these please go back and review this section.

Concepts

Learning a discrimination is learning to tell whether things are different or alike but without naming them. Learning a **concept** is learning to identify something as a member of a class with a **name**: for example, "Which of these is a vegetable?" "Which of these is a dog?" A person learns to make these classifications by grouping things together that have similar properties, attributes or characteristics. Concepts make it possible for an individual to identify a thing as a member of a class having one or more characteristics in common, even though the thing may have many other characteristics that are quite different. "House" is an example of a concept. The house can be any color, size, material, location, style or cost. All of these different characteristics do not matter as long as it includes the critical features of a house-- an opening that serves as a door, a floor, a roof, living space and sleeping space.

Some concepts are classified by physically perceivable characteristics such as color, shape, etc. An example of this kind of concept is "cow". A cow does not look like a dog or a cat. It has its own unique characteristics and shape. Even though a cow can be different sizes and colors, it is still a cow. It looks, sounds, feels and smells like a cow. Members of this group that sound, smell, look and feel the same are called "cows". Note that if a person can mentally separate things into groups of alike and different, according to some characteristics by virtue of having one or more characteristics in common such as shape or function and can give the name of the things in the alike category, such as "cow", then (s)he has learned the concept. Use this example to help you to remember what concepts are.

"COW"

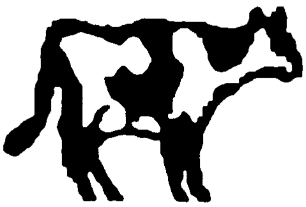


Figure 2 represents the important aspects of concept. Make sure you notice this aspect of the figure before you continue. Now try to picture figure 2 in you mind. Use this illustration to help you to remember concepts.

Another example of a concept is the class of "owl". In order to learn the concept "owl" a learner must first be able to tell that the shape of an owl is unlike other animals. This is a discrimination. Then to show you have learned the concept "owl" you must be able to identify these birds by their names, for example when asked to "find the owls" to be able to select several "owls" with varying sizes, colors and shapes out of a group of other birds. A learner does this by knowing the characteristics of an owl are -- that it is a bird with a broad head and large eyes which only move when its head moves. Other characteristics such as the shade of brown or white coloring of its feathers are not critical features and are not used to determine whether a bird is an owl. Other examples of concepts are "ball", "tree", "computer", "jar" and "insect".

Other concepts differ from the previously described concepts in that they are more abstract. The critical characteristics of these abstract concepts are not their physical features but their definitions. An example of an abstract concept is the concept "cousin." The concept "cousin" can be defined as a person who is related to you by being your aunt or uncle's son or daughter. Even though your cousins, Thomas and Karen, can be seen or heard, the actual concept "cousin" is only a definition used to classify persons into a like group. Other defined concepts are "theory", "alien", "family", "city", and "justice".

Practice:

Please circle the numbers of the following examples which are concept learning tasks.

1. Several materials are placed in a brown paper bag. Students are asked to feel a piece of material. Without looking the students are then asked to find

the one in the bag that feels like it and remove it.

2. Students are asked to read several paragraphs about the government and to pick out which one is an example of propaganda.

3. Students are shown several pictures of cars and asked to pick out the one that is a picture of a Datsun.

4. Students are shown several pictures of buildings of varying sizes and shapes and asked, "Which one of these is a barn?"

Items 2, 3 and 4 are examples of concepts because students must classify according to characteristics and identify by the names "propaganda," "Datsun," and "barn." Item 1 is an example of a discrimination because no name or label was given. If you missed these, please go back and review this section.

Rules

Rules (sometimes called principles) describe the relationship between two or more concepts. The relationship of $E=mc^2$ is a rule. It shows the relationship among the concepts energy, mass and the speed of light. Rules allow learners to make predictions about how a change in one concept will affect others.

Another example of a rule is "If air is heated, then it expands and rises" combines the concepts "air", "heat", "expand" and "rises" and explains the relationship among these four concepts. A learner who has learned this rule can explain what happens if the air is heated in a hot air balloon: It rises off the ground. The important aspect of a rule is the relationship between or among the concepts. Use this example to help you remember what a **rules** is.

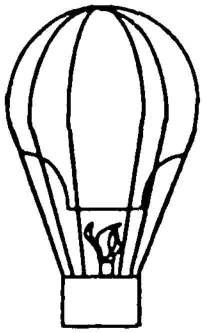


Figure 3 illustrates this relationship with the hot air balloon. Note this aspect of the figure before you continue. Now try to picture figure 3 in your mind. Use this illustration to help you remember rules.

When human learners have acquired a rule, they are able to exhibit behavior that is "rule-governed." For example learning a language is full of learning rules. "Nouns" and "verbs" are concepts, but there are rules that govern how they must relate in sentences. For instance, there is a rule that nouns and verbs must agree in number, such as a plural noun requiring a plural verb. A learner who has learned this rule is able to determine which of the following sentences is correct: "John runs home." or "John run home." Rules can either show cause and effect (such as the balloon example) or relationships between two or more concepts (such as the noun and verb example).

Practice:

Please circle the numbers of the following examples which are rule learning tasks.

1. What will happen to demand for a product, if the supply goes up?

2. After being given several scents to smell, the student is asked "Which one smells like this one?", (as the student is given one more scent to smell.)

3. Which pronoun is correct? "The dinner club was too expensive for Jim and me/I".

4. From a choice of several wrenches the student is to pick out the box end wrench.

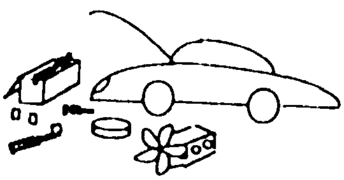
Items 1 and 3 are examples of tasks that require knowing rules. To answer item 1 the learner must know the law of supply and demand; if supply goes up, demand usually goes down. The concepts "supply" and "demand" are related in the rule. To answer item 3 the nominative and subjective case rules need to be known, "when the first person noun is in the subjective case use the referent pronoun me." Item 2 is a discrimination of smells. (It does not name the smell so is not a concept.)

Item 4 is a concept task. It is not a rule because it does not require the application of a rule that explains the relationship of a box end wrench with any other concept. If you missed these, please go back and review this section.

Problem Solving

Higher-order rule learning or **problem solving** uses previously learned rules or principles to solve previously unencountered problems. Problem solving requires a learner to select from all the rules that (s)he has learned in a particular subject matter area and to apply those rules in a particular order to solve a problem. If a learner has an assignment to design a company logo, the process of design would be a problem solving task. First the learner would need to apply marketing rules to find out what image the company would like to project and who the target population is. Then the learner would have to apply advertising principles (rules) to decide what message and treatment should be used. Then the learner would have to use visual design principles (rules), and color principles (rules). Then (s)he would apply rules on selection of materials to physically make the logo. The designer would have to select from all rules and principles related to marketing, advertising, and visual design only those that were appropriate to this task. Then (s)he would have to apply these rules in the right order to solve the problem.

Repairing a car that has broken down in the driveway can be a problem solving task. The task can be solved using several different rules such as, the car requires fuel to go; the car requires electricity to start; and the engine needs oxygen to start. So there are several types of rules that apply to the functioning of a car. The interaction of these rules with each other pertain to the successful solution of the problem of a broken down car. This example represents the important aspects of problem solving which is to apply two or more rules to solve a problem. Use this example to help you remember problem solving.



If the learner can repair the malfunctioning car in Figure 4, (s)he has correctly selected the electric or mechanical rules to locate and correct the problem. Figure 4 represents the important aspects of problem solving. Make sure you notice this aspect of the figure before you continue. Now try to picture figure 4 in your mind. Use this illustration to help you to remember what problem solving is.

Here is another example of problem solving.

Problem solving is used in the field of medicine when a medical doctor makes a diagnosis and prescribes treatment. In order to make a diagnosis and prescribe treatment a doctor must know all the principles (rules) about how particular organs and systems relate to each other and to outside environmental factors. Other examples of problem solving are writing a lesson plan, repairing a clock and writing an advertising campaign. A problem solving task is any previously unencountered situation where two or more learned rules must be applied to solve a problem. Solving a simple math problem often only requires the application of one rule and is not a problem solving task.

Practice:

Please circle the numbers of the following examples which are problem solving tasks.

1. An engagement ring is dropped down the bathroom sink. How could it be retrieved?
2. If you went on a field trip to a farm and saw several animals could you pick out the mammals?
3. How do you stack and tie down a load of hay on a flat bed truck?
4. Your room is full of furniture and you have acquired an antique cabinet. How do you decide where to place it.

One, three and four are examples of problem solving. They require that learners apply multiple rules to solve problems. For example in item 1 you may want to start with removing the drain stop to see if the ring could be removed from the top without taking apart the pipes under the sink. If removing the pipes becomes an option, rules about water pressure,valves and leverage would be useful. In item 3 knowledge of the rules of gravity, rules of balance, rules of knot tying and their relationships form a problem solving solution. Item 4 requires you to know rules about how to estimate the visual space of your room, rules about lifting, and rules about addition of feet and inches. Item 2 is a concept task recognizing examples of mammals. If you missed these please go back and review this section.

Review

The following items are a practice test over the 4 intellectual skills you just learned.

Match these categories: (d) discriminations, (c) concepts, (r) rules or (ps) problem solving, to the following examples by filling in the blanks with the letter of the category.

______1. Which of the following persons might be classified as extroverts: Madonna, Henry Thoreau, Muhammad Ali, Emily Dickinson?

______2. If you leave a hot iron in one place on your cotton shirt too long, what will happen?

______3. Students in a management course plan how to ensure that employees adopt an innovative procedure.

______4. Which tone sounds like this?

______5. How would you go about conducting a market survey of a new product?

______6. If you have a fire in the pan on the stove, and the lid was setting next to it, what would you do?

The answers to the practice test are as follows: answers: __c__1, __r__2, __p-s__3, __d__4, __p-s__5, and __r__6

- The answer to item 1 is concept because the learner is required to recall the critical characteristics of the concept labeled "extrovert" and match these characteristics to possible examples and by stating the name "extrovert" this statement is put into the concept category.
- The answer to item 2 is a rule which relates concepts in a cause and effect relationship - heat and the lack of movement of the iron on a cotton shirt will cause a brown spot the shape of the iron.
- The answer to item 3 is problem solving because

there are several rules which need to be followed in order for new procedures to be adopted such as informing employees of the new procedure, teaching everyone how to use it, rewarding employees for using the new procedure and follow up to insure that it is done correctly.

- The answer to item 4 is discrimination because you determine whether a sound is alike or different to another sound without naming it.
- The answer to item 5 is problem solving because you need to follow several already established rules in order to accomplish this task.
- The answer to item 6 is a rule relating the 4 concepts of fire, pan, oxygen and lid "if there is a fire in a pan on the stove you put the lid on the pan and it will go out because it is deprived of oxygen."

Please record the time you finished this lesson. ________. Thank you.

You are ready for the post test. Good luck.

Sources:

Bloom, B. S., M. D. Englehart, E. J. Furst, W. H. Hill, and D. R. Krathwohl. (1956). Taxonomy of Educational Objectives: Handbook I, Cognitive Domain. New York: McKay.

Smith, P. L. and Ragan, T. J. (in press) Instructional Design.: Columbus: MacMillan.

Gagné, R. M., Briggs, L.J. and Wager, W. W. (1988). Principles of Instructional Design 3rd edition. New York: Holt, Rinehart and Winston, Inc.

APPENDIX C

IMMEDIATE POSTTEST

Posttest

Last four digits of SS# 000-00-__ __ __ __ record

time____________

Instructions: Label each of the following test items in terms of which of the 4 types of Intellectual skills the test item represents by filling in the blanks with the letter representing that category: (d) discriminations, (c)concepts, (r) rules or (ps) problem solving. (Hints have been placed for you in parenthesis so you don't need to know the content in order to answer the test items.)

Examples:

__r__ Correct this sentence. Tom and me are going to the movies. (Note to research participant: Verb and subject agreement)

__c__ Given a list of words the students will label the adjectives in the following list: big, brown, toe, tight, building.

Test

____ 1. Here is a dress pattern. Make a blue dress with white trim.

____ 2. You are working in a piano factory. You tune pianos so that the pitches are the same as a correctly tuned piano.

____ 3. Your screen door is broken. The material it is made out of is aluminum and the only tools you have are wood working tools. How do you fix it?

____ 4. Students are given several pictures of interior designs and asked to select the ones with the warm color schemes.

_ _ _ _ 5. Which ones are the same? @ * @ % # $

_ _ _ _ 6. If Shaquil (Shaq) O'Neal is fouled and successfully shoots a free shot, how many points does he make?

_ _ _ _ 7. High school Future Farmers of America are asked to plan and build a cattle guard which will keep cattle in a field without a gate.

_ _ _ _ 8. Where can Paula and Dad sit to balance the teeter totter? The teeter totter is ——6′——▵——6′—— Paula weights 60 lbs., Dad weights 180 lbs. (Note to research participant: Paula's distance X Paula's weight = Dad's distance X Dad's weight).

_ _ _ _ 9. Show me the hammer, the screw driver and the saw from the tool box.

_ _ _ _10. You have given your architect the requirements for your house. He sits down and designs the plans.

_ _ _ _11. Is the following description of a situation in the former USSR an example of "glasnost?"

_ _ _ _12. Home Economics students are sewing a project out of wool. Should they iron the material with steam and an ironing cloth or with a dry iron? (Note to research participant: A steam iron will not flatten out the material where the seams will show.)

_ _ _ _13. Susie works in a factory. Labels are placed on jars to be sold. Each label should look the same. If they do not look the same she should throw out the ones that are different.

_ _ _ _14. You have run out of sand paper and go to the store to buy more of the same, but you forgot to find out what grade of paper you were using, so you feel and look at the sand paper to locate the one which feels and looks like yours.

____15. Label the following written descriptions of the government of fictitious countries as a democracy or a dictatorship or a socialist republic.

____16. You have been given a wire recording which needs to be transferred to tape. How do you go about finding an antique wire recorder?

____17. A student is given several pieces of different kinds of wood and asked "Which of these pieces are alike?"

____18. What causes popcorn to pop? (Note to research participant: The liquid trapped in the kernel expands and causes it to pop open)

____19. A child wants to cross a street. (S)he decides to go to the crosswalk.

____20. John works for a perfume company. His job is to smell bottles of perfume and make sure each one smells the same.

____21. There are several boxes in the room. Pick out the square box.

____22. You have been given an assignment to develop a budget for a new company. How do you go about developing it?

____23. If you are typing on your own correctable typewriter and type the wrong letter, how do you correct it?

____24. Given several statements, the students are asked to pick out the statement that is a theory.

Extension of Learning

Instructions: Check the correct response (there may be more than one correct response).

25. Which of the following would be prerequisite learning for rules?

____a. discrimination

____b. concept

____c. problem-solving

____d. none of the above

26. Which of the following would be prerequisite learning for concepts?

____a. discrimination

____b. rules

____c. problem-solving

____d. none of the above

Instructions: Check the correct response.

27. Which of the following is the best strategy for learning the concept sharp?

____a. Teacher defines sharp and uses the word sharp in a sentence.

____b. Teacher explains what sharp is.

____c.Show several objects and explain which ones are sharp and why.

____d. Have students write the definition for sharp 10 times..

28. Which of the following is the "best" method for learning the problem solving strategy of buying a new car?

____a. Teacher explains a strategy of buying a new car.

____b. Learners study the approaches that several "good car buyers" have used.

____c. Teacher defines what a "strategy" is.

____d. Make a list of all the new cars you would like to buy.

Instructions: Fill in the blanks

29. Write your answer and explain why you picked the answer you did for the following example: You are working on a computer and had just saved your data when your computer locked up. How do you fix it?

outcome: (d, c, r, ps)________________________________

explanation:____________________________________

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30. State your answer and explain why you picked the answer you did for the following example: When you hand a pair of scissors to a child which way does the handle go? (towards the child)

outcome: (d, c, r, ps)________________________________

explanation:____________________________________

31. Give an example of a concept task (not one that was given in the lesson).

32. Give an example of a discrimination task (not one that was given in the lesson).

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time stopped ____________

APPENDIX D

DELAYED POSTTEST

Delayed Posttest

Last four digits of SS# 0 0 0 - 0 0 -__ __ __ __ record

time____________

Instructions: Label each of the following test items in terms of which of the 4 types of Intellectual skills the test item represents by filling in the blanks with the letter representing that category: (d) discriminations, (c) concepts, (r) rules or (ps) problem solving. (Hints have been placed for you in parenthesis so you don't need to know the content in order to answer the test items.)

Examples:

__r__ Correct this sentence. Tom and me are going to the movies. (Note to participant: Verb and subject agreement)

__c__ The students will label the adjectives in the following list of words: big, brown, toe, tight, building.

Test

____ 1. Write a business proposal to develop and sell a new product.

____ 2. If a farmer had a red Jersey cow and a black Angus bull, how would a geneticist determine the color of the calf? (Note to research participant: Recessive and dominate traits should both be considered).

____ 3. You are taking a course in safety. You are shown several chemicals that look the same and are asked to pick out the one which is different.

____ 4. If you are painting a room which requires two gallons of paint to complete the job and you have one gallon of blue paint and one gallon of yellow which you mixed together, what color would you make? (Note to research participant: Blue and yellow are primary colors. When mixed together, they make a secondary color of green).

____ 5. A student is given several glass containers and asked to "select the 'beakers' out of a group of lab equipment."

____ 6. George has grown more far sighted. Do his glasses' lenses need to be more or less convex? (Note to research participant: the more convex, the more far sighted a person becomes).

____ 7. You work for a department store and your job is to sort out the items on the shelves after customers have mixed them up.

____ 8. Your Aunt Pearl has a large plot of land that is not used for anything. Develop an idea and proposal for the use of this land.

____ 9. You are trying to fix a piece of equipment and you lost the screw you removed. A can filled with many screws of varying sizes and shapes may have one like you lost. Find the one that is the same.

____10. Categorize the following teacher's statements as <u>directive</u>, <u>non-directive</u> or <u>inappropriate</u>?

____11. A student is asked to look up McGregor in the card catalog. Would it be listed before Mary or after?

____12. Circle the ones which are the same in this list: 4,6,5,7,4,8,2,,4

____13. Students are assigned to prepare a class to teach mathematics using a particular instructional technique. Wow do they implement the learning theory?

____14. In Chemistry class you are asked to neutralize an acid. Do you add vinegar or baking soda? (Note to research participant: Add baking soda to neutralize the acid)

____15. Students are given pictures of amphibians and reptiles and asked to stack the pictures in piles of amphibian pictures and piles of reptile pictures.

____16. Students in band class are asked to listen to a certain rhythm, then several rhythms. They are then asked to pick out the one that sounds like the first one they heard.

____17. How do you develop and run a political campaign?

____18. Which of the following is correct grammar? "How do you done this?" "How do you do this?" (Note to research participant: Verb tense)

____19. How do you locate and fix the source of a problem such as no sound in an audio system?

____20. Which of the following statements is negative? "Yes, you may go." "No, you may not go."

____21. Your family is moving to another city in three months. What is the best way to go about selling your house?

____22. Do you smell a natural gas leak?

____23. Which one of these looks different? [ ] [ ] [ ] ( ) [ ] [ ]

____24. Students are given several paragraphs to read about economics, then asked to pick out the one describing free enterprise.

Extension of Learning

Instructions: Check the correct response (**there may be more than one correct response**).

25. Which of the following would be prerequisite learning for problem solving?

____a. discrimination

____b. rules

____c.concept

____d. none of the above

26. Which of the following would be prerequisite learning for discrimination?

____a. rules

____b. concept

____c.problem-solving

____d. none of the above

Instructions: Check the correct response.

27. Which of these is the best strategy for learning the rule on use of pronouns? (Tom gave the bike to Bill and me.)

____a. Have students make flash cards with written statement of the grammar rule.

____b. Have students rewrite the rule in your own words.

____c.Have students develop their own examples of the use of the rule.

____d. Have the students write the rule 20 times.

28. Which of the following is the "best" test item for the concept "art deco"?

____a. Teacher defines art deco.

____b. Teacher explains art deco.

____c. Student identify examples of art deco in an architecture book.

____d. Students make an art deco vase.

Instructions: Fill in the blanks

29. State your answer and explain why you picked the answer you did for the following example: Given a series of paintings by different artists, the student is asked to pick out the ones of the Post Impressionistic style.

outcome: (d, c, r, ps)________________________________

explanation:____________________________________

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30. Write your answer and explain why you picked the answer you did for the following example: The baker is topping his cake with colored icing and runs out before he has finished. He mixes up some more and examines it to see if it is the same.

outcome: (d, c, r, ps) ________________________________

explanation: ________________________________

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31. Give an example of a problem solving task (not one that was given in the lesson).

____
____
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____
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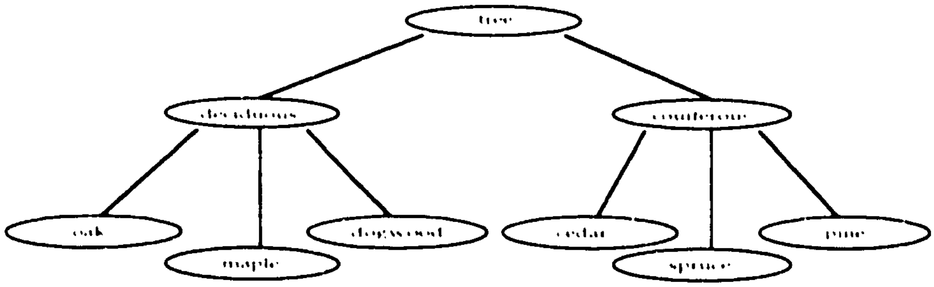
____
____

32. Give an example of a rule task (not one that was given in the lesson).

--

33. Make a "concept tree" for the 4 learning outcomes that you have learned. An example of a concept tree for the concept of "tree" looks like this



Please record time stopped________

APPENDIX E

INFORMED CONSENT FORM

Jan./Feb. 1996

INFORMED CONSENT FORM FOR PARTICIPANTS IN LEARNING STUDY

Dear Student:

You are being asked to participate in an educational research study being conducted by Margaret Ann Smith, a doctoral graduate student in the Department of Educational Psychology in the College of Education. This study will investigate the effects of illustration on learning. The study will hopefully increase the knowledge base of information on how people learn from visuals. Research is an important part of higher education. It helps in the ongoing procedure of updating and reevaluating the teaching/learning process.

The research will be conducted in three sessions. You must participate on all three days to complete the research. All three meeting times together will be 1 1/2 hours to 2 1/2 hours depending on your personal speed. (If it is not possible to meet all three times listed below please call me at 325-4205 or come by Colling Hall room 231, before the second meeting time **for alternative dates and times** because the last two dates need to be exactly two weeks apart.) If you do not complete the study you will not receive the complete credit. The sessions are as follows: All in **Collings Hall**, all from **1:00 p.m. to 4:00 p.m.** Flexible between these times.

Tuesday Jan. 30, Room 139
and **Tues. Feb. 6, Room 139**
and **Tues. Feb. 20, Room 140, all three days together**

Or

Wednesday Jan. 31, Room 140
and **Wed. Feb. 7, Room 140**
and **Wed. Feb. 21 Room 140, all three days together**

Or

Thursday Feb. 1, Room 229
and **Thurs. Feb. 8 , Room 139**
and **Thurs. Feb. 22, Room 229, all three days together**

Your performance on tests associated with the study will not be revealed on an individual basis to your professor. The results of the study will in no way affect your course grade. When the research is completed you will be given summary information about the study if you are interested.

I understand that by agreeing to participate in this research and signing this form I do not waive any of my legal rights. I understand that I am free to refuse to participate in any procedure or to refuse to answer any questions at any time without prejudice to me. I understand that I am free to withdraw my consent and to withdraw from the research at any time without prejudice to me.

It is your decision to choose to participate. Please sign and return indicating your decision. Thank you for your assistance.

_____ YES, I am willing to participate in this instructional study and give my consent to use my information in any research where my name is not used.

_____ NO, I prefer not to participate in the study.

Social Security # ___ ___ ___-___ ___-___ ___ ___ ___ Phone ___ ___ ___-___ ___ ___ ___

Printed Name____

Date______________Signature______________________________

APPENDIX F

INSTRUCTIONS FOR PRETEST, LESSON AND IMMEDIATE POSTTEST

Instructions for Pretest : Please read this page before removing any of the materials from the packet. Thank you.

The packet you have received contains part of the materials for the research project. Remove **only one** color coded section at a time from the packet. When you have completed that section, check it off of the list below, put it back in the packet and remove the next one.

1) Please make sure you have signed a white agreement to participate form before you open the packet
2) Please check the your social security number for correctness.
3) Remove the pink sheet fill it out and return it to the packet.
4) Remove the yellow sheet, fill it out and return it to the packet.
5) Remove the purple Diagraming Relationships section.
6) Note the time where indicated and complete the three pages.
7) Note the time in the space provided.
8) Please Return this section to the packet.
9) Close the packet and hand it in.

Note the next 2 dates and times you need to return to complete the research

Thank you for your help with the first part of my research.

Margaret Ann Smith

If you know that you can not return on the same day of the week exactly two weeks from today please return the packet before you open it and make other testing arrangements with the experimenter. Thank you.

Instructions for Lesson and Posttest Packet : Please read this page before removing any of the materials from the packet. Thank you.

The packet you have received contains the second set of materials for the research project. Remove **only one** color coded section at a time from the packet. When you have completed that section, check it off of the list below, put it back in the packet and remove the next one. There are three different forms of this lesson, the form you are reading may be different from those of others in the class. The purpose of the lesson is to learn to distinguish among several types of cognitive learning tasks.

1) Please check your name and the last four digits of your social security number on the outside of your packet for correctness.
2) Remove the blue "Lesson" sheets from the packet. Please note the time in the space provided when you begin the "Lesson" section. Read this section paying close attention to the illustrations.
3) When you have completed the "Lesson" section note the time in the space provided.
4) Return it to the packet before removing the pink "Posttest" sheets. Note the time.
5) Respond to questions on the pink "Posttest" sheets.
6) Record the time and place them back in the packet.
7) Close the packet and hand it in.

Please come back in exactly 2 weeks from today to complete the research.

Thank you for your help with my research,
Margaret Ann Smith

APPENDIX G

INSTRUCTIONS FOR DELAYED POSTTEST

Instructions for Delayed Posttest and Post Questionnaire: Please read this page before removing any of the materials from the packet. Thank you.

The packet you have received contains the last of the materials for the research project. Remove only one color coded section at a time from the packet. When you have completed that section, check it off the list below, put it back in the packet and remove the next one.

1) Check the number on the outside to make sure you have the same packet as before.
2) Remove the yellow "Delayed Posttest" section from the packet and take the test.
3) When you have completed this yellow "Delayed Posttest" section return the pages to the packet
4) Remove the green "Post Questionnaire".
5) Complete the green sheets and place them back in the packet.
6) Close the packet and hand it in.
7) Write your Professor's name and the time of your class here

   ----

   ____________and I will give her/him a list of people who have completed the research experiment or if I need to sign something I will.

Thank you for your help in my research,

Margaret Ann Smith

APPENDIX H

POST-QUESTIONNAIRE FORM A/C AND B

Post Questionnaire-Form A and C

Last four digits of Social Security # 0 0 0-0 0-__ __ __ __

Please answer the following questions.

For each statement check (√) the one with which you agree most

	strongly agree	agree	neutral	disagree	strongly disagree
1. It was easy to learn from this lesson.	__	__			
2. I would like to have instruction presented like this again.	__	__	__	__	__
3. I found the pictures helpful.	__	__	__	__	__
4. I used the pictures to help me learn	__	__	__	__	__

5. If you used the pictures:
   Describe how you used them as you read.

   Describe how (or if) you used them during the practice after each section.

   Describe how (or if) you used them during the test.

6. Draw (and or describe) the illustrations from the lesson that you can remember.

1) Discrimination
2) Concept
3) Rules
4) Problem solving

Post Questionnaire-Form B

Last four digits of Social Security # 0 0 0-0 0-__ __ __ __

Please answer the following questions.

For each statement check (√) the one with which you agree most

	strongly agree	agree	neutral	disagree	strongly disagree
1. It was easy to learn from this lesson.	__	__	__	__	__
2. I would like to have instruction presented like this again.	__	__	__	__	__
3. Pictures would have helped me learn.	__	__	__	__	__

4. Explain where in the lesson would pictures have been useful?

5. Did you make up mental images (pictures) to help you remember each category of learning? ___yes ___no

6. If you said yes, please sketch or describe the images you used to remember each outcome.

1) Discrimination
2) Concept
3) Rules
4) Problem solving

APPENDIX I

ORAL POST-QUESTIONNAIRE - FORMS A / C AND B

ORAL POST QUESTIONNAIRE-FORM A and C

1. Did you have lesson A (abstract), B (no-visuals), or C (concrete)?
2. Did the illustrations help you remember the information?
3. Did you use the illustrations in any way to help you remember the four learning outcomes?
4. How did you use them?
   - -at the time of reading
   - -at the time of practice
   - -at the time of testing
6. What confuses you about discriminations?
7. What was the illustration for 'discriminations'?
8. Did it help you learn what 'discrimination' was?
9. Did you remember what 'discrimination' was?
10. What was there about the visual that made you remember the concept of 'discrimination'?
11. What confuses you about concept?
12. What was the illustration for 'concept'?
13. Did it help you learn what 'concept' was?
14. Did you remember what 'concept' was?
15. What was there about the visual that made you remember the concept of 'concept'?
16. What confuses you about the concept of rules?
17. What was the illustration for 'rules'?
18. Did it help you learn what 'rules' were?
19. Did you remember what 'rules' were?
20. What was there about the visual that made you remember the concept

of 'rules'?

21. What confuses you about problem solving?

22. What was the illustration for 'problem solving'?

23. Did it help you learn what 'problem solving' was?

24. Did you remember what 'problem solving' was?

25. What was there about the visual that made you remember the concept of 'problem solving'?

26. In answering the test questions did you recall the images that were in the lesson?

27. Other than the illustrations did you use any other techniques to remember the types of learning outcomes?

ORAL POST QUESTIONNAIRE-FORM B

*1. Did you have lesson A, (abstract) B (no-visuals), or C (concrete)?

*2. What strategies did you use to remember the 4 learning outcomes?

*3.Did you make up images (mental pictures) to help you remember the information?

*No_____ yes_____

4. Did your visualized illustrations help you remember the four learning outcomes?

5. How did you use them?

-at the time of reading

-at the time of practice

-at the time of testing

6. What did you visualize for 'discriminations'?

7. Did it help you learn what 'discrimination' was?

*8. Did you remember what 'discrimination' was?

10. What did you visualize for 'concept'?

11. Did it help you learn what 'concept' was?

*12. Did you remember what 'concept' was?

14. What did you visualize for 'rules'?

15. Did it help you learn what 'rules' were?

*16. Did you remember what 'rules' were?

18. What did you visualize for 'problem solving'?

19. Did it help you learn what 'problem solving' was?

*20. Did you remember what 'problem solving' was?

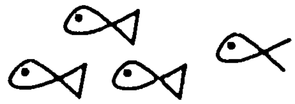
22. In answering the test questions did you recall the images that you visualized?

APPENDIX J

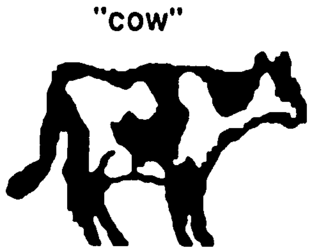
ABSTRACT AND CONCRETE REPRESENTATION OF INTELLECTUAL SKILLS

Concrete "Best Example" of
Gagne's learning outcomes
Intellectual Skills

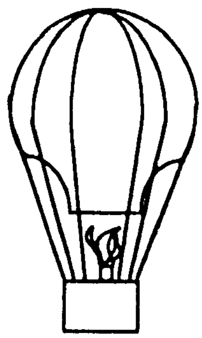
Discrimination



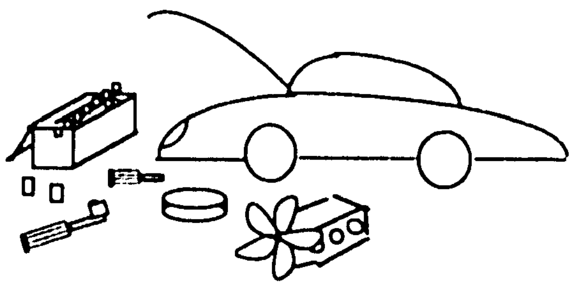
Concepts



Rules

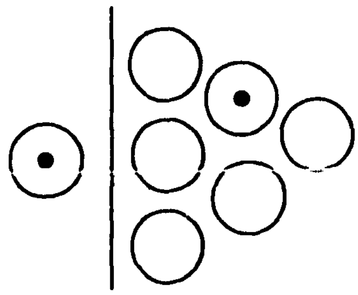


Problem Solving

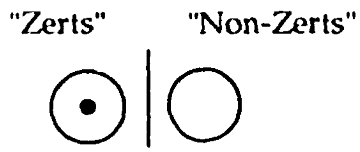


Abstract Representation of
Gagne's learning outcomes
Intellectual Skills

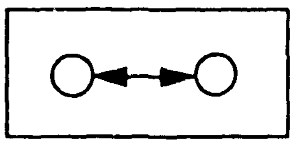
Discriminations



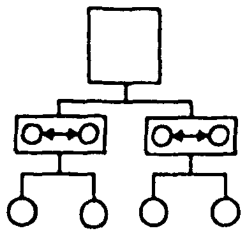
Concepts



Rules



Problem Solving



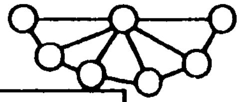
APPENDIX K

ABSTRACT VISUALS EVALUATION

Abstract Illustration - Draw your own

An abstract illustration, also referred to as arbitrary or logical illustration do not look like the things that they represent but are related abstractly or conceptually to them. Please sketch an abstract images for each of the following learning outcomes.

Example of abstract illustration for Verbal Information.



1) Discrimination

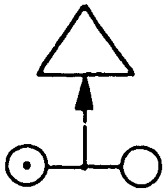
2) Concept

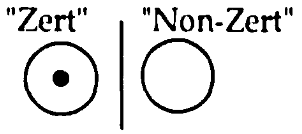
3) Rules

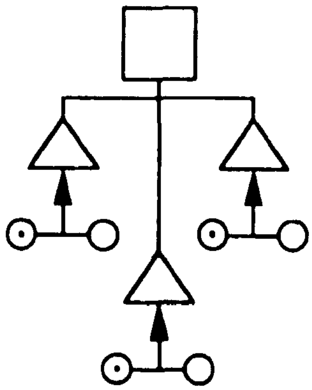
4) Problem solving

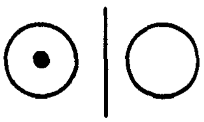
Abstract Illustration - Matching Concepts and Illustration

Directions: Match the names of the learning outcomes (Discrimination, Concept, Rule and Problem Solving) by writing the correct name next to the visual which best represents that outcome.





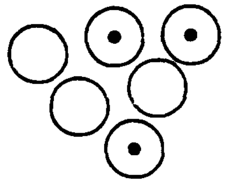




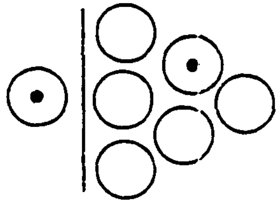
Abstract Illustration - Best Representation of Intellectional Skill

The following examples represent Discrimination. Letter them best representation (A), next best representation (B) etc. in the space provided ( ).


( )


( )


( )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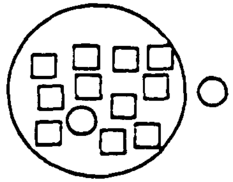
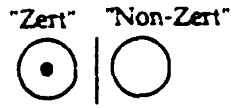

( )

The following examples represent Concepts. Letter them best representation (A), next best representation (B) etc. in the space provided ( ).


( )



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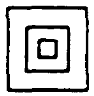
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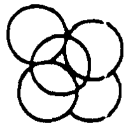
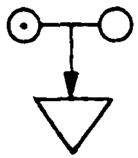

( )


( )

The following examples represent Rules. Letter them best representation (A), next best representation (B) etc. in the space provided ( ).


( )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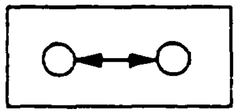
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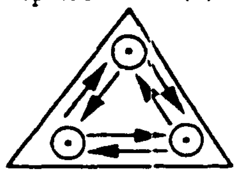
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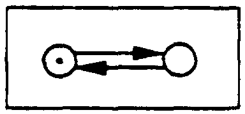
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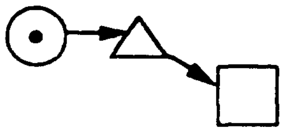
The following examples represent Problem Solving Letter them best representation (A), next best representation (B) etc. in the space provided ( ).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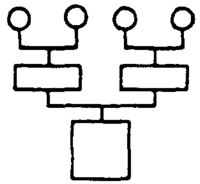
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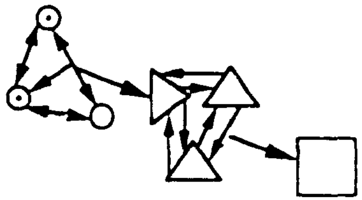
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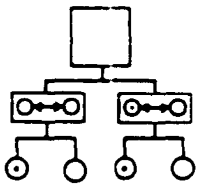
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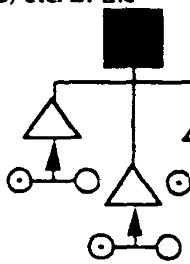
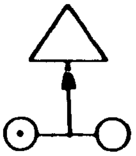
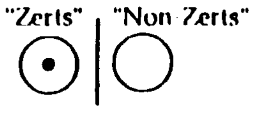

( )

Abstract Illustration Rating

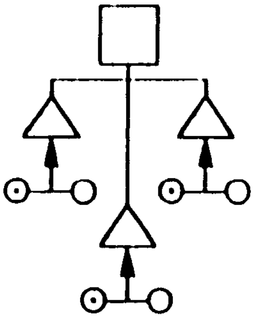
Directions: Rate the abstract visual of the learning outcome (Discriminations, Concepts, Rules and Problem Solving) on a scale from 1 to 5 (one being the poorest representation of the concept and 5 being the best representation of the concept) by circling the number on the scale which best represents your rating of the abstract illustration.



	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5



	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5

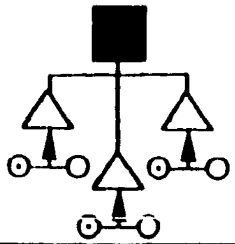


	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5

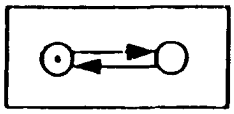
	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5

Abstract Illustration Rating Form B

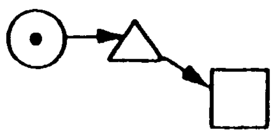
Directions: Rate the abstract illustration according to how it best represents each of the learning outcomes (Discriminations, Concepts, Rules and Problem Solving) on a scale from 1 to 5 (one being the poorest representation of the concept and 5 being the best representation of the concept) by circling the number on the scale which best represents your rating of the abstract illustration.



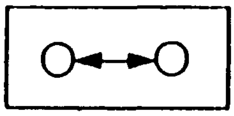
	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5



	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5

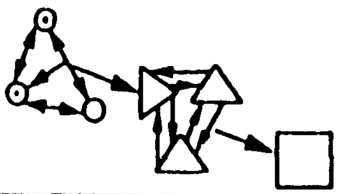


	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5



	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5

	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5



	poorest representation				best representation
Discriminations	1	2	3	4	5
Concepts	1	2	3	4	5
Rules	1	2	3	4	5
Problem Solving	1	2	3	4	5