A COMPARISON OF COMBINED AND SEPARATE TEXT-PICTURE COMBINATIONS ON RECALL AND APPLICATION OF INFORMATION

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By

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TO MY MOM AND DAD,

FOR YOUR SUPPORT, ENCOURAGEMENT AND LOVE OVER THE YEARS,

THAT HELPED MAKE THE COMPLETION OF THIS THESIS A REALITY.

TO MY WIFE CAROL,

FOR PUTTING UP WITH ME DURING THE MANY HOURS

OF FRUSTRATION WHILE THIS WORK WAS BEING COMPLETED.

TO MY DAUGHTER ASHLEY,

JUST FOR BEING YOU.

ABSTRACT

The study investigated the effects of presenting learners with combined textual and pictorial information, using two different presentation techniques. The study also investigated the possible influence of certain background variables on each of these techniques. In particular, Gender, as well as Vocabulary Ability, Reading Ability, Visual Materials Ability and Language Usage as measured on a grade four Canadian Test of Basic Skills were used.

The two instructional treatments developed included a series of short descriptive text passages, each accompanied by a representative picture or illustration. Each treatment was then produced in two different formats, combined and separate referred to as Module 1C, Module 1S, Module 2C and Module 2S. The combined module in each treatment required that each text passage and associated picture be presented on the same page. The separate module required that the text passage and associated picture be presented on separate pages alternately.

Two grade nine classes were chosen for this study each containing twenty-eight students. The selection was done on the basis of students having no previous exposure to the

specific topics described in the study, and a random grouping of abilities in each class. Students were not placed in one group or the other based on any differences in their abilities. Both groups experienced Treatment 1 and Treatment 2, but not the same format for each. Group (A) received Module 1C (combined) and Module 2S (separate), while group B received Module 1S (separate) and Module 2C (combined).

Student achievement on tests of recall and application of knowledge was determined by investigator constructed instruments. Student ability in the areas of Vocabulary, Reading Ability, Visual Materials and Language Usage were determined from grade four CTBS scores. The achievement test scores were separated into simple recall and application of knowledge. The relationships among achievement variables were analysed using multiple linear regression. The dependent variables were recall scores on tests 1 and 2 and application scores on tests 1 and 2. The independent variables were Treatment 1, and Treatment 2. The background variables investigated to determine possible influences on the independent variables were Vocabulary, Reading Ability, Visual Materials Ability, Language Usage and Gender.

The results indicated that Treatments 1 and 2 produced

no significant effect on measures of either recall or application when analysed independently of other variables. Treatment 1 showed no significant effect on measures of application when analysed in combination with the background variables. Treatment 2 did however show a significant effect on measures of application when analysed in combination with certain background variables. This effect indicated that text and pictures viewed separately produced significantly greater achievement on a test of application than text and pictures viewed together, when the subjects were males who had scored higher on Reading Ability, Visual Materials, and Language Usage. Another very important finding was that the background variables generally had a greater influence on achievement of both recall and application measures than either Treatment 1 or Treatment 2. This is significant in light of the fact that these variables were collected from a CTBS instrument administered five years earlier when the students were in grade four.

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CHAPTER I

INTRODUCTION

Background to the Study:

Throughout history pictures have played an important role in the collection, transmission and ultimate understanding of information. Educational research has demonstrated repeatedly the advantages of using pictures to help communicate knowledge and understanding. A major review of research by Levie and Lentz, (1982), included the results of 55 experiments comparing learning from illustrated and non-illustrated text. They reviewed 46 comparisons of learning from illustrated and non illustrated text. "In all but 1 of these 46 cases, the group mean for those reading illustrated text was superior to that of the group reading text alone (the remaining case was reported as "no significant difference") (pp. 198)." In 39 of the 46 comparisons, the difference was statistically significant (p= .05 or less). In an earlier examination of similar research up to about 1976, Pressley, (1977), states; " There is no doubt that even very young children's recognition memory for pictures is very good " (pp. 600). In relation to

recall the research indicates: " Although the majority of experiments examining the difference in free recall of pictures versus the words indicate that pictures are better recalled than words, the performance increments produced by pictorial presentation of recall lists have been small " (pp. 601). Such pictures are usually presented in conjunction with associated textual information and most often are used to enhance the written words.

Perhaps at no other time in our history has the use of visual content been as widely used as it is today. Everywhere we turn we are bombarded with visual information. Instructional videos and CD Rom disks utilize pictures to educate learners on a vast array of topics. The advertising industry for example gives us many instances of the importance of pictures in conveying information. The use of television commercials as well as photographs in magazines and on roadside billboards are just a few examples.

Personal teaching experiences of the author and a review of the related literature point out that different students utilize pictures and text in different ways and to varying degrees (outlined in chapter 2). It was noted that a significant number of students who lacked ability in the use of written words demonstrated superior skill in the use of

pictures and illustrations. Many such students were found to have exceptional abilities in the graphic arts, some winning national awards for their talents.

In the area of science education some students invariably use well constructed diagrams and pictures in illustrating and communicating their ideas. So effective are their illustrations that it is often not necessary to give detailed attention to the written response in order to realize that the student has full knowledge of the required answer. Others use diagrams only when specifically instructed to do so and often they are of such poor quality as to be of little use or even detract from the answer.

These differences are likely the result of a variety of interrelated factors, both inherent and extraneous to the student. Factors such as the reading and comprehension level of the student, the ability of the student to represent ideas in the form of pictures or drawings, and the degree of importance that the student places on the value of the illustrations are all significant. Knowledge of and ability to control such factors is therefore of great importance to the production and use of educational curriculum materials and instructional methods.

A review of the literature revealed that extensive

research had already been done with many aspects of the use of pictures. Guttmann, Levin, and Pressley, (1977), showed that young children's recall of a prose passage increased when illustrations were present. Stone and Glock, (1981), explored the manner in which people read and use procedural directions for model assembly presented in the form of text and illustrations. Of three treatments used, text alone, illustration alone, and text and illustration together, the text and illustration treatment produced the least number of errors on assembly tasks and on part orientation during assembly tasks. Peeck, (1984), studied the cognitive effects of pictures on text comprehension and retention. This study suggested that a variety of factors such as the willingness to invest more time and cognitive effort studying the text, improved schematic processing, relevant prior knowledge, availability of an organizing scheme and the representing of spatial and structural relationships of elements in the text may contribute to higher achievement when text related illustrations were included. Mayer, (1989), performed a set of experiments involving labelled illustrations, unlabelled illustrations, labels without illustrations and no labelled illustrations. It was concluded that passages containing labelled illustrations contributed to greater recall of

explanative information but not non-explanative information and better performance on problem solving transfer but not on verbatim recognition.

One area of the research that was considered by the author to be deficient however concerned the effect of having both the text and the pictures viewed simultaneously as opposed to alternately. This study attempted to determine which, if either, of these arrangements would result in greater achievement among learners in terms of simple recall and application of knowledge.

Introduction to the Problem:

At present instructional materials in science employ a variety of arrangements of textual information and related pictorial information. It is not yet well understood how the combination of these two forms of communication can best facilitate learning. When pictures are included, both text and picture are presented on the same page in most science educational textbooks reviewed by the author. Sometimes however they are on separate pages and cannot be viewed simultaneously.

This variation is probably due, at least some of the time, to availability of space on the page and not to the application of any educational theory concerning the best positioning of text and pictures for optimum student achievement. Educational research indicates that the positioning of text and related pictures could have an effect on achievement. Koran and Koran, 1980, suggests that when pictures precede text, the pictures may help organize the textual information and direct attention to appropriate parts of the text. Pictures that follow text may prompt a review and reorganization of previous text or extraneous but related information. Arrangements of text and pictures may have to vary depending on the learners involved at the time. Different processes appear to be at work in the brain to process the two different forms of communication. Paivio, (1971), discussed a dual-code theory which proposes both a verbal and a visual process for encoding information. This theory suggests that information stored by both processes will be better remembered than if it were stored by only one process. These processes do not function equally for all students. In addition, these separate processing systems may become overloaded if too much information of both types is presented at once. Purnell, Solman, and Sweller, (1991),

examined the effects on cognitive load of separating illustrations and their descriptors as compared to having them combined. Superior results were obtained when the descriptors were combined. The study suggested that this method eliminated the cognitive load of having to connect physically separate information.

Purpose of the Study:

The purpose of this study was to investigate two specific methods of information presentation or treatments and to determine if there was any significant benefit for student achievement in using one or the other. These treatments involved the presentation of similar text and pictures, but in two different arrangements. One arrangement presented the text and the pictures together on the same page and the other arrangement presented the text on one page first and later the associated picture on a different page.

In addition, other factors such as Gender and student abilities in Vocabulary, Reading Ability, Visual Materials and Language Usage, that may affect student achievement in each of these situations were investigated. This was done to

determine whether one or more of these factors, in combination with either of the treatments, would have a significant benefit for student achievement.

Hypotheses:

In seeking answers to this problem the following hypotheses, stated in the null form, were tested:

Hypothesis 1: The organization of material with text and pictures combined will produce the same results as text and pictures separate when measured on a recall test.

Hypothesis 1.A: Treatment 1 produces no significant effect on achievement as measured by the recall section of test 1.

Hypothesis 1.B: Treatment 2 produces no significant effect on achievement as measured by the recall section of test 2.

Hypothesis 2: The organization of material with text and pictures combined will produce the same results as text and pictures separate when measured on an application test.

Hypothesis 2.A: Treatment 1 produces no significant effect on achievement as measured by the application section of test 1.

Hypothesis 2.B: Treatment 2 produces no significant effect on achievement as measured by the application section of test 2.

Hypothesis 3: The interaction of background variables and Treatment 1 will produce the same results as the interaction of background variables and Treatment 2 on a recall test.

Hypothesis 3.A: The interaction of Gender and Treatment 1 produces no significant effect on Recall 1.

Hypothesis 3.B: The interaction of Gender, Vocabulary and Treatment 1 produces no significant effect on Recall 1.

Hypothesis 3.C: The interaction of Gender, Reading Ability and Treatment 1 produces no significant effect on Recall 1.

Hypothesis 3.D: The interaction of Gender, Visual Materials and Treatment 1 produces no significant effect on Recall 1.

Hypothesis 3.E: The interaction of Gender, Language Usage and Treatment 1 produces no significant effect on Recall 1.

Hypothesis 3.F: The interaction of Gender and Treatment 2 produces no significant effect on Recall 2.

Hypothesis 3.G: The interaction of Gender, Vocabulary and Treatment 2 produces no significant effect on Recall 2.

Hypothesis 3.H: The interaction of Gender, Reading Ability and Treatment 2 produces no significant effect on Recall 2.

Hypothesis 3.I: The interaction of Gender, Visual Materials and Treatment 2 produces no significant effect on Recall 2.

Hypothesis 3.J: The interaction of Gender, Language Usage and Treatment 2 produces no significant effect on Recall 2.

Hypothesis 4: The interaction of background variables and Treatment 1 will produce the same results as the interaction of background variables and Treatment 2 on an application test.

Hypothesis 4.A: The interaction of Gender and Treatment 1 produces no significant effect on Application 1.

Hypothesis 4.B: The interaction of Gender, Vocabulary and Treatment 1 produces no significant effect on Application 1.

Hypothesis 4.C: The interaction of Gender, Reading Ability and Treatment 1 produces no significant effect on Application 1.

Hypothesis 4.D: The interaction of Gender, Visual Materials and Treatment 1 produces no significant effect on Application 1.

Hypothesis 4.E: The interaction of Gender, Language Usage and Treatment 1 produces no significant effect on Application 1.

Hypothesis 4.F: The interaction of Gender and Treatment 2 produces no significant effect on Application 2.

Hypothesis 4.G: The interaction of Gender, Vocabulary and Treatment 2 produces no significant effect on Application 2.

Hypothesis 4.H: The interaction of Gender, Reading Ability and Treatment 2 produces no significant effect on Application 2.

Hypothesis 4.I: The interaction of Gender, Visual Materials and Treatment 2 produces no significant effect on Application 2.

Hypothesis 4.J: The interaction of Gender, Language Usage and Treatment 2 produces no significant effect on Application 2.

Significance of the Study:

The bulk of educational research on the use of pictures and illustrations in instruction overwhelmingly supports the belief that the inclusion of such visual instruments enhance learning. There is still much debate over how pictures are such efficient communication devices and how they can be most efficiently presented to the learner. Glenberg and Kruley, 1992, state, "It is a fact that pictures help people to learn from texts (see Willows and Houghton, 1987, for reviews of the literature). What is less certain, is exactly

how pictures have this salutary effect" (page 461).

In most of our school systems, the textbook is still the common form of information transfer device. It is therefore important for the designers of these products to be aware of and implement the combination and arrangement of materials that is most efficient for learning. Since there are many times when teachers must go outside the regularly prescribed textbooks to find supplementary material, it is just as important for them to be aware of such efficiencies.

This study was designed to provide information about the arrangement of textual and visual information that maximizes student achievement. For this reason it should be of great value for the purposes described above.

Limitations of the Study:

1. The study was restricted to two grade nine classes from the same school. Generalizations must be based on assumed similarities between the sample and other populations.
2. The study was conducted over a three days period. A longer time frame would have allowed for testing of long term retention which was not done in this study.

3. The time allocated for viewing both the text and pictures was defined on the basis of ease of administering the treatments using a single uniform time frame and may not have been the optimum amount of time required for each section. It is possible that some students may have needed more time and some may have become disinterested in certain parts of the treatments.

4. The study was concerned with only one specific area of science. Generalizations concerning the effectiveness of these treatments in other areas of the curriculum could not be made.

5. The treatments consisted of very short descriptive passages followed by representative pictures. School books that these students are familiar with usually have much longer sections of text before a picture is included. Some books include few if any pictures.

6. The testing instruments were composed of ten multiple choice items each. Although this number of items was originally considered adequate to test such a short instructional unit, it was later decided to separate the responses into recall and application sections for the purpose of analysis. At this time it was realized that a larger number of test items in each group would have been

preferable.

7. The application section of the test consisted of four items while the recall section consisted of six items. Results may have been different if equal numbers of questions had been used for each type of measurement.

8. The reproduction quality of some of the pictures was not as high as would have been desired due to having to use a photocopier for multiple copies.

9. The CTBS scores used in the study were collected five years earlier when the participants were in grade four. More recent scores may have produced different results. No more recent scores were available for these groups.

Definitions of Terms:

CTBS	Canadian Test of Basic Skills
Module 1C	The presentation of the first instructional module with text and pictures combined so that they could be viewed simultaneously. (see appendix 1)

Module 1S	The presentation of the first instructional module with text and pictures separated so that they could no be viewed simultaneously. (see appendix 1)
Module 2C	The presentation of the second instructional module with text and pictures combined so that they could be viewed simultaneously. (see appendix 1)
Module 2S	The presentation of the second instructional module with text and pictures separate so that they could be viewed simultaneously. (see appendix 1)
Treatment 1	This consisted of Module 1C administered to group A and Module 1S administered to group B on the first day of the study.
Treatment 2	This consisted of Module 2S administered to group A and Module 2C administered to group B on the second day of the study.

Recall 1	Responses to recall type questions on test 1; Q1, Q2, Q3, Q4, Q6, Q10.
Recall 2	Responses to recall type questions on test 2; Q1, Q2, Q4, Q6, Q7, Q10.
Application 1	Responses to application type questions on test 1; Q5, Q7, Q8, Q9.
Application 2	Responses to application type questions on test 2; Q3, Q5, Q8, Q9.
Vocabulary	Scores on the Vocabulary section of the grade four CTBS instrument. The extent o breath of the student's Vocabulary and his/her ability to make fine distinction in word meaning were measured.
Reading Ability	Scores on the reading section of the grade four CTBS instrument. This test was designed to assess whether the student had understood what he/she had read. It included the following headings:

	recalling facts, making inferences, and generalizations.
Language Usage	Scores on the Language Usage section of the grade four CTBS instrument. This te was designed to test the use of words. indicated whether the student could use words according to the rules of correct written English. Items tested were: verbs, personal pronouns, modifiers, context/no mistake, concise/clarity, appropriateness, and organization.
Visual Materials	Scores on the Visual Materials section c the grade four CTBS instrument. This tes measured the student's ability to retrieve and use information from maps, graphs and tables.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction:

A picture is worth ..... ! This phrase is so common to us today that we can usually complete it quickly by adding, "a thousand words". Is it really true? If so under what conditions is it true? What is it about the way we observe and store information in our memory that allows the truth of this statement under certain conditions? How do various learning theories explain the usefulness of pictures in text?

To begin answering these questions, at least in a partial manner, it is important to give a brief review of the literature relating to the results of experiments conducted that integrate the effects of pictures to learning from textual material, the function that pictures and visual images play in learning from textual material, and an outline of some of the major models and theories of understanding textual information with the inclusion of visuals.

Peeck, (1984), regarding the cognitive effects of

pictures on text comprehension and retention, points out that a variety of causes may be considered, including a willingness to invest more time and cognitive effort studying the text, the enhancement or elaboration of schematic processing, the activation of relevant prior knowledge, the availability of an organizing scheme and the representing of spatial and structural relationships of elements in the text, and so on. Apart from these factors, "much of the retentional role may be the result of the fundamental characteristics of illustration: to give a visual image of information provided by the text" (pp. 128).

Pictures Facilitate Learning:

Do Pictures Facilitate Learning of Textual Information? It is generally accepted today that visual images, illustrations, line drawings, photographs, etc., facilitate learning from associated written text. A multitude of research studies have largely confirmed this. Pressley, (1977) gives a very good review of the research up to the mid-1970's. He begins his review by stating:

> The focus of this paradigmatic review of the effects of imagery on children's learning is the specification of conditions under which imagery increases children's learning of verbal materials. In particular, this paper

> examines the recurrent speculation that imagery is more effective at some developmental levels than at others (pp.585).

Up to the time of his review Pressley points out that the bulk of the experimental work relating to imagery and children's learning has been in the area of paired-associate learning. The discussion begins with recognition and recall and continues to more difficult concepts in prose learning. With respect to recognition he states; " There is no doubt that even very young children's recognition memory for pictures is very good " (pp. 600). This is supported by the research of Brown and Scott, (1971), Brown and Campione, (1972), Nelson, (1971), and Hoffman and Dick, (1976). Their work indicate the following trends:

(i) Preschool children performed at ceiling on a difficult recognition task involving a long list of perceptually similar pictorial stimuli.

(ii) This pictorial recognition continues to be very good throughout childhood.

(iii) Children 7 to 13 years of age performed at high levels when discriminating groups of realistic and abstract paintings from a long list.

(iv) Recognition memory in general improves with age, adults being better that 5 year old children.

In relation to recall Pressley, (1977), states, "Although the majority of experiments examining the difference in free recall of pictures versus the words indicate that pictures are better recalled than words, the performance increments produced by pictorial presentation of recall lists have been small " (pp. 601).

In a large number of studies involving pairs of pictures or words presented to a subject in which one member of the pair is arbitrarily labelled by the experimenter as correct, it has been discovered that learning is easier when the stimulus materials are pictorial rather than verbal, Ghatala and Levin, (1973); Ghatala, Levin, and Makoid, (1975); Rowe, (1972); Wilder and Levin, (1973). Wilder and Levin, (1973), indicated from their study that pictures become more effective, relative to words, with the increasing age of the subject.

Prose Learning comprises a more difficult level of learning than the pair associations described to this point. In reviewing the research up to 1970, Samuels, (1970), was led to conclude that pictures were of little or no benefit in prose learning. Many researchers since that time however have demonstrated that this conclusion needs modification.

Guttmann, Levin, and Pressley, (1977), showed that

young children recall more of a prose passage when presented with illustrations than children who did not have the illustrations present. Not until later years could the children use their own mental images to improve prose memory.

Levie and Lentz, (1982), conducted a major review of research in this area which supports strongly the idea that pictures have a positive influence on learning from illustrated text. This review includes the results of 55 experiments comparing learning from illustrated and non-illustrated text, summaries of some closely related areas of research and finally a discussion of research into how illustrations might promote learning. A very significant statement of the findings of this review comes with the following quote by Levie and Lentz, (1982):

> Table 1 lists 23 studies that produced a total of 46 comparisons of learning illustrated text information from illustrated text vs. text alone. In all but 1 of these 46 cases, the group mean for those reading illustrated text was superior to that of the group reading text alone (the remaining case was reported as "no significant difference") (pp. 198).

In 39 of the 46 comparisons, the difference was statistically significant (p= .05 or less)

It is interesting to note that in seven of the studies, it was generally found that illustrations had a "significant

positive effect on learning illustrated text information and no effect on learning nonillustrated text information". It was later pointed out by Levie and Lentz, (1982) that,

> In summary, the results of 46 comparisons of learning text illustrated information from passages with and without pictures reveal an overwhelming advantage for the inclusion of pictures. For 85% of the comparisons there was a statistically significant advantage for the illustrated-text condition, and in no case was the text-alone condition better. Subjects reading illustrated text learn an estimated one-third more (pp. 203).

Dwyer, (1967), developed a 2000 word text about the human heart, complete with a set of 37 illustrations. The illustrations included photographs, line drawings, and shaded drawings in both colour and black and white. The results of measurements using this arrangement in Dwyer, (1975), indicate that the use of illustrations were of great benefit to students when the test administered required the students to produce drawings. When the students had to identify various parts of the heart the results were not as good. When tested on terminology the illustrations had little positive effect and virtually no effect at all when comprehension was tested.

Further examination of Dwyers' results seem to indicate that the comprehension items tested were of such a nature as not to be easily represented in a still picture. Therefore

the information tested in the comprehension part of the test referred to largely nonillustrated text.

In their summary of the experimental findings, Levie and Lentz, (1982), state the following:

(I) Illustrations facilitate learning the information in the written text that is depicted in the illustrations.

(ii) Illustrations have no effect on learning text information that is not illustrated.

(iii) When the test of learning includes both illustrated and nonillustrated text information, a modest improvement may often result from the addition of pictures.

Stone and Glock, (1981), provides further insight into the usefulness of pictures in learning from textual material. They explore the manner in which people read and use procedural directions presented in the form of text and illustrations. University undergraduates assembled a model of a loading cart as they read the directions. The subjects were divided into three groups, one group using text without illustration directions, the second group using illustration without text directions and the third group using text and illustration together. The text with illustration group performed significantly better ($p < .0005$) than either of the other two groups ($p < .001$) in having the least number

of errors in the assembly task. No significant difference was found between the text only and the illustration only group ($p < .05$). Likewise the addition of illustrations to text produced significantly fewer errors in orientation of parts during assembly ($p < .001$, two tailed) when compared with the text alone condition. Significantly fewer errors were made by the illustration only as compared to the text only group ($p < .005$). No significant difference was found between illustration only and text with illustration conditions.

Mayer, (1989), carried out 2 experiments in which students who lacked prior knowledge about car mechanics read a passage about car braking systems that included either labelled illustrations, unlabelled illustrations, labels without illustrations or no labelled illustrations. It was reported that: "Students who received passages that contained labelled illustrations of braking systems recalled more explanative than nonexplanative information as compared to control groups, and performed better on problem solving transfer but not on verbatim recognition as compared to control groups" (pp. 240).

Peeck, (1984), points out that a number of studies conducted with mismatch situations involving some text

information depicted incorrectly in the accompanying illustration,

> these studies give an insight into the use that subjects make of the pictorial and verbal modes that is generally missing when text content is depicted correctly. The studies consistently show, (Peeck, 1974b, 1983, 1985.), that, especially with growing delay, subjects increasingly tend to base their retention-test responses on what they have seen in the pictorial supplements (pp. 128).

Peeck and Goud, as cited in Peeck, (1980), found that when subjects were required to write down in key words the first five things they remembered from the illustrated text that they had read a week before, many of the responses could be directly related to what they had seen in the pictures. Once again this suggests the importance of the availability of pictorial representation in memory for an illustrated text.

Hayes and Redeance, (1983), asks the questions, "What value do illustrations in text hold for children?". Evidence is scant that illustrations in text facilitate understanding when the text is read by the subjects for themselves (Radiance and Moore, 1981). However, only a handful of studies have been undertaken with school age children who actually read the experimental materials for themselves, rather than listened to them.

Different Processes Used to Extract Information from Text and Pictures:

Various theoretical positions suggest separate visual and verbal processing of information. Paivio, (1971), discussing the dual-code theory suggests that there exist two different memory stores, one visual and one verbal in nature, and predicts that information encoded in both stores will be better remembered that information encoded in only one. The verbal system specializes in the storage and retrieval of linguistic information, both verbal and written. The visual system specializes in nonverbal information in the form of spatial and mental imagery. Both systems, although separate in terms of the type of material encoded and the method of encoding, are still interconnected. The result of such an interconnected arrangement is to allow the individual to observe and store information in two distinctly different formats. Thus the information is now recorded in memory in two separate ways that can both be utilized for retrieval. This explains why most studies dealing with illustrated text vs non-illustrated text show superior learning with the illustrated version.

The two separate yet interconnected memory systems process information in different ways, producing a double imprint of the information in the brain. Paivio and Csapo, (1973), indicate that the pictorial image code may be "mnemonically superior" to the verbal information. Peeck, (1974), using mismatch-illustration studies shows that subjects increasingly tend to base their retention-test responses on what they have seen in the pictorial supplements and this becomes more pronounced with time.

Gibson and Levin, (1975), view the process of reading as extracting information from both pictures and text, likely using different processes for each. They refer to higher order structures during this process which include abstracting relationships, ignoring irrelevant information and using distinctive features.

Craik and Lockhart, (1972), propose that repetition is only beneficial in improving recall when the second presentation of the information can be processed in a different manner by the subject. In related studies involving mental imagery, Anderson, (1971), and Anderson and Hipple, (1971), demonstrated that learners directed to create mental images of the events described in sentences learned two to three times as much as learners who

repeatedly read the sentences aloud.

Ruch and Levin, (1977), discovered that oral prose and prose with pictures involved different recall patterns and therefore the use of different processing methods by the brain. Rohwer, (1968), stated for example that pictorials were superior to words in promoting learning and that pictures evoked imagery at all age levels he assessed, but that the ability to profit from the stored images was contingent upon the subjects ability to store an appropriate verbal representation of the object along with its image.

Toward the end of their article, Glenberg and Kruley, (1992), are still puzzled about why the subjects did not use the pictures when initial attempts at anaphor (a word or group of words referring to a preceding word or group of words) resolution failed. They suggest one possibility could be that the use of pictures while reading is a skill that must be learned.

> One hypothesis that is consistent with much of the data is dual code theory, (Paivio, 1986). The major benefit of the picture is to provide a mnemonic code that is useful in answering the comprehension questions, regardless of any on line effect of comprehension. Clearly, the fact that performance in the late picture condition exceeds performance in the no-picture condition (see Figure 3 and Experiment 3) is consistent with this hypothesis. Nonetheless there is also evidence that the pictures facilitate on-line comprehension processes. First, having pictures available during reading did result in better

> performance than did examination of the pictures only after reading. Second, pictures did affect on-line behaviour: the reading time for the far anaphor sentences was slower in the picture than in the no-picture conditions (pp. 470).

Stone and Glock, (1981), determined that the optimal performance of the text with illustration condition could not be explained by assuming "additional information" in this situation since both the text and the illustration were completely redundant. A study of the types of errors made by each group indicated that the difference was due to possible differences in the types of information communicated by text and illustration. It seems that illustrations convey spatial information more effectively than text, (fewer errors were found in orientation of parts with both groups that used illustrations compared to the non-illustration group).

Perceived Importance of Pictures:

With regard to the actual use of pictures by readers, Levie and Lentz, (1982), point out that the picture is often considered of little or no importance by the reader. As Olson, (1977), indicates "schools remain predominantly literary enterprises" (pp. 66), and students may consider pictures as unimportant when endeavouring to

learn what is also provided in text. Friedman, (1979), noted, most people do not study the detail in a picture, unless perhaps it is mentioned in the text or they have been specifically instructed to do so. Jahoda, Cheyne, Deregowski, Sinha, and Collingbourne, (1976), discovered that when students were tested on picture only information, "little if anything was learned of information presented in the picture but not also in the text" (pp. 311). It seems that cues as to what should be specifically noticed in the picture are required.

Peeck, (1984), remarks, concerning the amount of attention given to pictures by a reader:

> Of primary importance for the effect that illustrations may have is, of course, what the reader does with a picture that goes with the text. Does he or she look at the picture and, if so, for how long and what kind of inspection occurs? Though a brief glance is sufficient to recognize a picture at a later date, (Potter and Levy, 1969), longer inspection times are needed when more information has to be extracted than is necessary for simply identifying a picture well enough to distinguish it from others, (Potter, 1976). In this respect, it has been shown that it is not so much the length of viewing time per se, as the number of fixations the subject makes during that time that determines what is remembered, (Loftus, 1972; see also Spoehr and Lehmkuhle, 1982).

Reinking, Hayes, and McEneaney, (1988), studied good and poor readers' use of explicitly cued graphic aids in accompanying text. They suggest that the two main functions

of graphic aids in school textbooks are to augment the written text with additional information and to clarify the text content. However the effectiveness of such graphic aids often depends on the level of reading ability of the learner. " Due to differences in background and personal predilection, some readers may look at graphic aids with little awareness of their significance, while others may fail to inspect graphic aids at a moment during reading when they would be most helpful. Still others may not look at them at all" (pp.229). This study investigated supplying readers with explicit instructions in the text to attend to the graphic aids available.

> Poor readers' failure to put illustrative materials to good use has been generally attributed to attentional deficits characteristic of students who have persistent learning difficulties. These students are unable to allocate attention selectively and to distinguish extraneous material from relevant material, (Hallahan, 1975; Keogh and Margolis, 1976; Ross, 1976). Attempting to account for these deficits, a number of researchers, (Ceci, Lea, and Ringstrom, 1980; Perfetti and Lesgold, 1979; Torgeson, 1978) have suggested that the limited word knowledge of poor readers restricts the verbal coding required to activate appropriate semantic networks during reading. This restriction on verbal coding may similarly result in poor readers' failure to establish effective connections between the verbal and visual systems in cognition, (Swanson, 1984, 1986, 1987). A simpler explanation holds that the attentional resources of poor readers may be so much devoted to processing prose that they are depleted for relating graphic aids to the prose, (Harber, 1980, 1983). In either case, it is possible that poor readers do not know when during reading to shift attention to the

> graphic aids in text. It would seem that attending to graphic aids at critical junctures during reading would make an important difference in whether readers make appropriate connections between the prose and its accompanying graphic aids and thereby avail themselves to graphic aids' complementary informativeness, (Brody, 1982) (pp.230).

As predicted, the inclusion of graphic aids in text did improve the comprehension of text and recall of information presented in graphic aids. However the prediction that such cues would not enhance the performance of the good readers was false. Good readers also recalled more information presented in the graphic aids. Apparently cuing increases the attention of the good readers to the graphic aids as well.

Rasco, Tennyson, and Boutwell, (1975), reported that readers' attention is not automatically given to illustrations in text. The text characteristics of interest in this study was dependence on illustrations. The instructional conditions consisted of cuing readers to attend to a texts' illustrations and, in the absence of illustrations, directing readers to try to visualize the text content. The question was whether either of these conditions, in conjunction with varying degrees of a text's dependence on illustrations, would affect additional reading on the topic. It was hypothesised that if visual images

provide readers with an organizing context for understanding, such a context should facilitate assimilating additional related content from subsequent readings. It was further hypothesised that the instructiveness of visual images depends both on the readers using them and on the texts relying on them to clarify the content.

Interpreted in light of Kintsch and van Dijk's, (1978), notion that proportion of inferential recall reflects integration of text content with readers knowledge, the data indicate that illustrations facilitate readers engagement with the text and assimilation of the text content, if the text is seen as highly dependent on illustrations. Illustrations apparently serve their purpose by providing readers with otherwise unavailable material with which to construct an assimilative context. Within such a context reference points for thinking can be established. Thought can alternate between the particular and the general aspects of the text content and undergo discriminative operations which have been shown many times to instigate transfer to learning, (Harlow, 1959; Hayes and Tierney, 1982; Ward, 1937). Important is the organizing context provided by the illustrations. Once organized, material can be subjected to a succession of discriminations, which, without such an

organizing context, are not likely to occur, (Chiesi, Spilich, and Voss, 1979; Rumelhart and Norman, 1981; Schallert, 1976).

Rasco, Tennyson and Boutwell, (1975), used four treatment conditions to study effects of drawings on learning under different conditions. The conditions were strategy drawings, non-strategy drawings, strategy non-drawings and non-strategy non-drawings. The purpose of this study was to investigate the effect of instructional strategy (instructions directing the learner to form mental images of the prose materials) and relevant drawings, (drawings representing critical, conceptual, attributes of the adjacent prose) on a task requiring the processing of verbal information rather than direct recall. To replicate and extend the independent variables of instructional strategy and drawings, three school age groups (college, high school, and elementary) were selected for use in three experiments.

Analyses showed that the better treatments included instructional strategy and drawings, and the least effective condition was consistently the one without either strategy or drawings. Although instructions to attend to text illustrations did appear to enhance performance on transfer

tasks, such instructions did not significantly improve performance beyond what was achieved by the mere provision of illustrations in the most dependent texts. This result tends to support Tennyson's, (1978), suggestion that attention may be drawn to critical features of a text content by the illustrations themselves. However, it should be pointed out that since the attentional function of illustrations has hardly been studied, it should not be automatically assumed that readers will give attention to illustrations in text. As a matter of sound educational practice, teachers would be well advised to continue to call readers attention to illustrations in their texts. In the absence of illustrations, instructions to visualize the content did not significantly improve recall of the transfer passages. Few researchers have found positive effects for such instructions.

Cognitive Load Theory:

In their study Glenberg and Kruley, (1992), predicted that pictures should assist subjects who were trying to relate an anaphor to its antecedent, and that the effect would be greater if the distance between the anaphor and its

antecedent was greater. They assumed that the picture would reduce the load placed on working memory. Their study involved experiments where a picture was presented with the text, a picture was presented after the text and no picture was presented at all. Interestingly they discovered that in their study, the inclusion of the picture did not facilitate anaphor - antecedent resolution at all. However the late picture did facilitate comprehension of the text relative to reading with no picture, but was less effective than a picture that was available during reading. The results were considered consistent with dual-code theory and parts of working memory theory that did not involve anaphor resolution.

Purnell, Solman, and Sweller, (1991), examined the effects on "cognitive load" of splitting attention between technical illustrations and their descriptors in four experiments with high school students. It was demonstrated that superior results were obtained whenever the descriptors were incorporated into the diagram rather than separated from it in the form of a key. The reason given for this superiority of the incorporated descriptors was that this method required less expenditure of cognitive resources since integration of the descriptors and the diagram was

already done. Cognitive load theory, (Sweller 1988, 1989), also suggests that traditional instructional techniques, such as problem solving, place a heavy cognitive load on the student and are useless in developing schemas.

Functions of Pictures as Text Illustrations:

As numerous experiments have indicated, illustrations generally have a significant positive effect on how well subjects can learn from illustrated text. Now we turn our attention to just how the use of pictures in textual material might accomplish this. For example, Schallert, (1980), proposed three characteristics of text relevant illustrations:

1. The illustrations information must be central to the text.
2. The illustrations must be congruent with the text content.
3. The illustrations must provide a partial of schematic representation of the interrelations of the text content.

At the end of the review by Levie and Lentz, (1982), a summary of possible connections between the use of

illustrations and the level of learning achieved is given. It is referred to as "Functional Approaches To The Effects OF Text Illustrations". They summarize it in a list of Possible Functions of Text Illustrations:

Attentional:
1. Attracting attention to the material
2. Directing attention within the material

Affective:
3. Enhancing enjoyment
4. Affecting emotions and attitudes

Cognitive:
5. Facilitating learning text content via
   a. improving comprehension
   b. improving retention
6. Providing additional information

Compensatory:
7. Accommodating poor readers (pp. 218)

Relating to each of these points, Levie and Lentz make the following comments:

1. Attracting Attention: No examples of well-done research were found to support the idea that pictures attract attention to the material.

2. Directing Attention: Although research has shown that pictures have increased readership in "free-reading"

material such as magazines, and that readers recalled more content in articles accompanied by a large picture, Baxter, Quarles, and Kodak, (1978), in forced reading situations " there is little reason to believe that pictures have an important attention directing effect".

3. Enhancing Enjoyment: In a study by Samuels, Biesbrock, and Terry, (1974), second graders preferred stories with color pictures, black and white pictures, and finally no pictures in that order. Bryant, Brown, Silberberg, and Elliot, (1980), determined that college students rated illustrated texts more enjoyable that nonillustrated ones. Holliday, Brunner and Donais, (1977), preferred text accompanied by color drawings to text without drawings.

4. Affecting Emotions and Attitudes: Parish, Bryant and Prawat, (1977), point out the potential for illustrations to affect emotions and attitudes, particularly in areas of social concern such as sexism.

5.(a) Improving Comprehension: Rankin and Culhane, (1970); Bluth, (1972); and Wardle, (1977), using a cloze procedure with college students and sixth graders, second graders and seventh graders consecutively found that the pictures helped the college students more that for sixth graders, improved the second graders by 25½-30% and when subjects were allowed

to consult the material while taking the test, the illustrations helped poor readers but not good readers. This research indicates that the use of pictures can have at least a modest positive effect on facilitating comprehension.

5.(b) Improving Retention: Studies carried out to compare long term retention of information to short term retention for both illustrated text and nonillustrated text examples were carried out by the following: Dwyer, (1968); Peeck, (1974); Joseph, (1978); Haring and Fry, (1979); Rusted and M. Coltheart, (1979); and Bernard and others, (1981). Levie and Lentz, (1982), point out that, "Of the 24 comparisons, 19 showed that pictures helped more in delayed than in immediate recall. Overall the average group facilitation due to pictures was 45% in delayed testing, compared with 9% in immediate testing." (pp. 222.).

6. Providing Additional Information: Levie and Lentz, (1982), point out that in certain examples such as the depiction of a specific type of knot, a picture may replace written text as the primary medium of instruction.

7. Accommodating Poor Readers: The research in this area is generally did not produce statistically significant results, however some studies show that pictures may produce slightly

more improvement in poor readers over good readers, Levie and Lentz, (1982).

Levin, Anglin, and Carney, (1987), summarizes the literature on the effect of pictures on learning from prose in three general conclusions:

1. In cases where text-embedded illustrations are relevant to (i.e.,largely overlapping or redundant with) the to-be-remembered content, moderate to substantial prose-learning gains can be expected.
2. In cases where text-embedded illustrations are not relevant to the to-be-remembered prose content (i.e., they depict unrelated -- or worse, conflicting -- text information), no prose-learning facilitation is to be expected.
3. In cases where "pictures" consist of self generated visual images that are relevant to the to-be-remembered content, some positive effects can be expected, but these are much more modest and more variable than those associated with actual illustrations (pp. 53).

On the functions of pictures in prose Levin, Anglin, and Carney, (1987), list five "Picture Functions"

1. Decoration Function - This relates to text irrelevant

pictures. These pictures are included simply to make the text look more attractive and get the viewers interest.

2. Representational - These represent and reinforce the major narrative events. They tell basically the same story as the text itself.

3. Organization - Pictures can be used to give the text more coherence (i.e., illustrated maps are used in conjunction with geography text). How-to-do-it diagrams are another example as in Stone and Glock, (1981), cited earlier.

4. Interpretational - These help clarify difficult to understand passages and abstract concepts. They are very useful in the field of science where abstract concepts such as atomic structure have to be understood by the student.

5. Transformation - Such pictures are designed to impact on students' memory directly rather than indirectly as the other types of pictures just mentioned do. They do this by recoding the critical information into a more concrete and memorable form, by relating the separate pieces in a well organized context and by providing the student with a systematic method of later retrieving the information. This is referred as Associative Mnemonic techniques, (Levin, 1983).

The results of an analysis of the effectiveness of each

of these functions of pictures on subject learning are briefly summarized here. As was expected, pictures used for decoration purposes only did not facilitate learning at all. This is likely due to the fact that such pictures do not depict the subject matter of the text.

The other four functions provide at least modest facilitation of learning with the transformational function being the best. However it is important to note that the representational function produced a facilitation of learning effect as large as the organization and interpretation functions combined.

Peeck, (1984), states:

> Basically all functions and effects of illustrations may be derived from two characteristics of pictures in text. The first is that they depict some elements from the text; that is they show what something or someone treated in the text looks like. But in doing so, they will do something more, and this establishes the second characteristic; that of providing additional information. Thus, when a history text that relates, say, the execution of some historical person is accompanied by a picture of the event, the illustration necessarily contains all kinds of information about such aspects as how the occurrence took place and about the appearance, clothes, and behaviour of the people present (pp. 116).

Peeck goes on to suggest that functions of illustrations in text may be further divided into two broad categories. These are the "affective - motivational" and the "cognitive" effects. Peeck, (1984), suggests that all

functions and illustrations depend on two characteristics of the pictures in text. The pictures must depict elements in the text and provide additional information. In particular, research indicates that pictures may serve various cognitive roles in relation to text but there is little supporting evidence for the suggestions. Presented in advance of the reading passage they could serve functions (Bernard, Peterson, and Ally, 1981; Weisberg, 1970) somewhat akin to the "advance organizers" designed by Ausubel, (1960). In addition, they could act as "perspective inducing" devices, (Peeck and Goud, 1985), suggesting to the reader what a text is about and how the subject of the text is treated. Pictures may also serve to enhance the reality of the material for the reader, (Smith and Smith, 1966), enrich reading, (Dale, 1969; Jagodzinska, 1976), make reading material more concrete, add something that is not clearly expressible in words, (Duchastel, 1978; Travers and Alvarado, 1970; cf. Dald, 1969: "What is a bivouac? A picture may show it"), standardize the way a text is comprehended, (O'Donnell, 1983), and correct mistaken impressions, (Dale, 1954) (pp.118-119). Garrison, (1978), indicates that pictures may be most beneficial when the subject is called on to recall spatial relationships

included in the illustrations.

Building Mental Models:

Mayer, (1989), suggests illustrations may help readers focus attention on the relevant information by building useful mental models of the textual information which allow the reader to make internal and external transfers of information and to make predictions.

Mayer and Gallini, (1990), carried out three experiments in which students read expository texts concerning how scientific devices work. These passages contained either no illustrations (controls), static illustrations with labels of each 'part' of the device, static illustrations with labels for each major 'action' of the device, or dynamic illustrations showing the "off' and "on" states of the device along with labels for each part and each action.

> Results indicated that the parts-and-steps (but not the other) illustrations consistently improved performance on recall of conceptual (but not nonconceptual) information and creative problem solving (but not verbatim retention), and these results were obtained mainly for the low prior-knowledge (rather than the high prior-knowledge) students (pp. 715).

Mayer and Gallini point out that based on theories of

mental models (deKleer and Brown, 1985; Gentner and Stevens, 1983; Kieras and Bovair, 1984; Larkin and Simon, 1987; White and Frederiksen, 1987), two major features of illustrations could help readers build mental models. They are system topology and component behaviour. System topology refers to the depiction of each major part within the system. Component behaviour refers to interrelations between parts. Specifically how changes in one part cause corresponding effects on other parts.

Mayer, (1989), proposed that the results of his two experiments "support a model of meaningful learning in which illustrations can help readers to focus their attention on explanative information in text and to reorganize the information into useful mental models. He further states that understanding some kinds of expository text involves building a mental model (deKleer and Brown, 1981, 1983; Gentner and Gentner, 1983; Hegarty, Just and Morrison, 1988, Kieras and Boviar, 1986). This mental model includes such processes as focusing attention on the relevant information, and providing a context for the building of internal and external connections. The following are some of the specific conclusions from Mayer's study:

1. Illustrations improved recall of explanative but not

other information.

2. Illustrations improved transfer but not verbatim recognition. This would be an example of using mental models to build connections.

Mayer and Gallini, (1990), indicate "a straightforward implication of this work (the use of mental models to impart visual representations of how a system looks and functions) is that experience with qualitative models will allow students to acquire alternative conceptualizations of how a system works and to develop skill in predicting the causal behaviour of the system".

Glenberg and McDaniel, (1992), suggest that the integration of mental models and pictures with text is not only desirable but necessary for effective communication. They point out that much of what we learn comes to us through perceptual observation of spatial information and language is not well suited for a discussion of such information. In fact they indicate that the English language only contains some 80-100 prepositions to convey spatial relations, far fewer than would be required to list the multitude of possible spatial distinctions. "One straightforward idea is that the comprehension and memory of a communication can be augmented if nonlinguistic

transmission is exploited, perhaps by assisting in the construction of a model that serves as one product of comprehension", (Glenberg and McDaniel, 1992, pp.459). Gambrell and Jawitz, (1993), studied the connection between text illustration and individual mental imagery by using four treatment conditions: imagery, illustration, imagery and illustration, and a no-intervention control condition. Their hypothesis was that mental imagery and text-relevant illustrations play similar roles in comprehension processing, (Schallert, 1980). Results of the experiments indicate that the imagery - illustration condition produces significantly better results that either of the other conditions when subjects received instructions to use imagery and illustrations in the story comprehension. These results suggest that this combined strategy involves more complex mental processes than required by either imagery or illustration alone and suggests support for an imagery-illustration-nteraction theory.

Pictures as a Context for Learning:

Levie and Lentz, (1982), describe other possible cognitive processes by which the illustrations improve

learning. The first suggestion is that the illustration might serve as a "context for understanding" the material. Bransford and Johnson, (1972), conducted a study in which a group of high school students listened to a tape recording of a text passage with only part of the group seeing a "context picture". The group who saw the picture recalled over twice as many ideas from the passage as did the group that did not see the picture. Bransford, (1979), explained it this way, "the written passage was not simply a description of the context picture. Instead, the picture provided a basis for allowing people to interpret meaningfully and to connect or organize sentences they heard" (pp.132). Bransford and Johnson further points out that pictures seem to facilitate comprehension during learning rather that during recall.

Sherman, (1976), used two types of pictures in relation to the text. One type of picture gave a complete representation of the scene described in the passage and the other gave only a partial representation of the scene. Interestingly the subjects who were presented with the partial-context illustration recalled more idea units that the complete-context illustration group. Sherman concluded that the partial-context illustration caused the subjects to

study the text passage more thoroughly.

Pictures as Simple Repetition:

The first suggestion from the literature as to how illustrations and pictures facilitate learning from textual information is due to the factor of simple repetition. If the student is exposed to similar or related information more than once, greater retention of the information experienced will result. Studies indicate however that illustrations play a far more significant role in facilitating learning than simple repetition.

Levie and Lentz, (1982), offer some suggestions as to how pictures might produce long term retention, firstly because of simple repetition. Perhaps the pictures simply provide an opportunity to be exposed to the information twice.

Levin, Bender and Lesgold, (1976), however conducted an experiment in which children were presented with a prose passage twice, firstly each sentence presented twice in succession and secondly the sentence presented once, followed by a picture presented once. The pictures had a better effect on retention that the repeat of the prose.

Paivio and Csapo, (1969), found that presenting a concept once as a word and once as a picture was superior in recalling the concept than either presenting it twice as a word or twice as a picture.

Focal Attention Hypothesis:

Another possibility is that individuals differ in their ability to extract information that is communicated either by text or illustration.

In studies relating to the use of paired-associate techniques and recall of single words in young children, when familiar pictures are associated with new words that the child has not yet learned, the use of the pictures often serves as a blocking element to recall of the word. Singer, Samuels, and Spiroff, (1973), attribute this to a focal attention hypothesis in which the learning process is apparently selective, choosing the most salient or familiar factor for eliciting the correct response, being the picture in this case. Therefore, if the picture is removed, the child is unable to name the written word. Saunders and Solman, (1984), suggests that the additional stimulus of

including the picture with the text might increase information processing and temporarily overload young children's cognitive capacity.

Schema Theory:

Purnell, Solman, and Sweller,(1991), relate two relevant areas of research to their study. Schema theory involves a generalized cognitive construct that allows the reader to classify categories of tasks according to the mental actions appropriate to the task. This would require students to learn a large number of different schemas for a variety of tasks.

Secondly, ith respect to their research using diagrams with and without descriptors added, they concluded that the addition of the descriptor to the text reduces the cognitive load on the student and thereby improves the ability of the student to develop appropriate schemas by removing the necessity of mentally integrating material that is physically separate. A simple example would be to place labels of geographic features beside the appropriate regions on a map rather than having them in a separate key.

Rumelhart's, (1977), schema theory of reading and

comprehension suggests that readers generate hypotheses or schemata at various levels such as letter level, lexical level, syntactic level, and semantic level to account for incoming information. These schemata provide a context for the formation of lower level hypotheses. Illustrations may serve as a context in which the redundant text information could be absorbed and comprehended.

Working Memory Theory:

Glenberg and Kruley, (1992), submit that although pictures enhance our comprehension of written texts, the processes that underlie this effect have not been identified. They suggest that the effect of pictures in textual information may be to enhance our working memory. One way this can be done is if pictures serve as a temporary external memory which we can utilize instead of our own working memory. Glenberg and Langston, (1992), established that pictures can help us reorganize our information into a more manageable sequence. In their study subjects read a textual passage outlining a four step event with the descriptions of the steps appearing in the text in a particular order. In an accompanying picture the steps were

shown in the proper sequence they would occur when the procedure was executed. Without the picture, subjects represented the order of the steps in the same order they were described in the text. With the picture they represented them in the order they occurred when the procedure was executed. Thus the picture apparently allowed the subject to reorganize the information into a more effective sequence.

Location of Pictures in Text:

Location of pictures in text has been studied with a view to determining which arrangements of text and pictures are most productive for the learner. Peeck, (1984), indicates that several reasons have been given in the literature for possible differential effects. When the picture precedes the text, (Koran and Koran, 1980), suggests,

> "pictures may provide a scheme for organizing incoming textual material and may also have an attention-directing and controlling effect as the learner proceeds through the text" (p.478). Conversely, pictures at the end of a segment of text may stimulate "a selective review and covert reorganization of previously processed material" (p.478) or, alternatively, a review of "materials that are related to but not necessarily included in the picture", (Brody and Legenza, 1980 p.28), comparable to the general

backward or review process obtained with post questions (cf. Rickards, 1979).

Ability of the Learners:

Waddill and McDaniel, (1992), compared prose passages that had embedded illustrations to ones that had no illustrations using students of low, moderate, and high comprehension skill levels. It was demonstrated that details were recalled better by all skill levels when illustrations depicting details were used. Similarly relational information was better recalled when illustrations depicting those relationships were used for high and moderately skilled comprehenders but not for those with low skill. This suggests that illustrations are of more benefit to subjects who already have moderate to high skill at comprehending textual information and would not be helpful to those with reading deficits. "Although intuitively appealing, the idea that pictures serve a compensatory role for reading deficits has not been supported by the limited research conducted so far (e.g.,Harber, 1980; Rose, 1986)", (Waddill and McDaniel, 1992 pp.477).

Regarding good and poor readers, (Peeck, 1984), suggests that poor readers may direct more attention to the

pictorial than good readers because they get clues from the picture to help them process the text's meaning. In a study by Rusted and V. Coltheart, (1979), it was demonstrated that poor readers "frequently moved their eyes from the passage to the picture, apparently checking the features in the pictures as they read them. In contrast, the good readers paid little attention to the pictures during their reading" (pp.521-522). It is important to note here that this could have a negative impact if the picture is not representational of the text. Another possibility is that the pictures may simply provide motivation for the subjects to read the text in the first place.

Summary:

The literature review indicated strongly that the addition of pictures generally improved learning from text. The learning was most improved when the information in the written text was closely depicted in the picture. Explanative information tended to benefit more from the use of pictures than verbatim recall.

Several theories were considered in offering an explanation for these findings. It appeared that the brain

processes verbal and visual information separately and in distinctly different ways. Paivio's,(1986), dual-code theory suggested that such processes encode the information into two separate memory stores, one visual and one verbal, and predicts that information that is double imprinted will be better remembered. It has also been suggested that the pictorial image code may be mnemonically superior to the verbal code. Gibson and Levin, (1975), proposed that while different processes are at work studying picture-text combinations, higher order structures such as abstracting relationships, ignoring irrelevant information and using distinctive features were being used.

Cognitive load theory suggested that in the instance of using descriptors in a pictorial image, separating the descriptors from the image increased the cognitive load of the learner and was less effective than adding the descriptors to the picture. On the other hand, it appeared that cognitive load was also increased by presenting too much information to a learner simultaneously, particularly in the case of problem solving situations or for poor readers. Learners with attention deficits may not view the pictures long enough or pay enough attention to important details while eliminating irrelevant information.

It was also determined that many students do not consider pictures to be a very important addition to written prose. This may be partially due to the large degree of importance placed on written text by the school system. In any event, it results in less attention being given to the pertinent information contained in the picture. Peeck, (1984), suggested that the greater the amount of time a learner spends looking at a picture, the greater will be the amount of learning that is likely to occur.

The location of the picture with respect to the written information was also a consideration. Pictures that were embedded in the text tended to produce significantly greater learning than pictures that came before or after the text. When separated, there was little indication that pictures preceding text or pictures following text produced superior results over the other. It should be noted here however that it is uncertain whether or not the pictures and text in these cases could be reviewed during the presentation.

CHAPTER III

DESIGN OF THE STUDY

Introduction:

A review of selected research suggested that the inclusion of pictures in text seemed to generally improve learning from that text. It was also determined that a variety of specific factors, such as the amount of time the learner spent viewing the picture, the closeness of the relationship between the picture and the text, whether or not the pictures were presented together or separately to the learner and the reading and comprehension abilities of the learner may influence the amount of learning that occurs.

For the purpose of this study it was decided to investigate the effects, if any, of presenting text and pictures in a combined treatment as compared to a separate treatment on the recall and application of information presented to the learner. In the separate treatment, the text and pictures were physically separate and the students could not revisit either part of the treatment once the time limit for viewing that part had expired. In the combined

treatment, text and pictures were presented on the same page and viewed simultaneously. The possible influence of certain background characteristics of the participants on achievement was also investigated.

Sample used in the Study:

The sample used in the study consisted of two grade nine classes at St. Michael's High School on Bell Island. Each sample consisted of twenty-eight students. Two constraints influencing the selection of groups were: (1) these were the only two groups in the school that were approximately equal in numbers and considered large enough for a reliable study and (2) students were assigned to each group randomly from the total population of grade nine students in the school.

Instrumentation:

The study was originally intended to be carried out on level I physics students and based on the photography course elective. The physics program was not being offered at the school and due to class scheduling, it was impossible to

find two separate level I groups large enough to constitute meaningful samples. For this reason the study was redesigned to be administered to grade nine students.

Two instructional treatments were developed by the investigator. These treatments were designed to present information about two related aspects of photography utilizing both text and pictures. The title of Treatment 1 was The Effect of F-Stop on Depth of Field and the title of Treatment 2 was The Effect of Shutter Speed and Movement.

Treatment 1 consisted of eight text-picture combinations. Treatment 2 consisted of nine similar text-picture combinations. The text passages in Treatment 2 were generally shorter than those in Treatment 1, so one extra text-picture combination was added to Treatment 2 as compensation.

Each treatment was then reproduced in two parts. Part A consisted of the text passage and the associated picture reproduced on the same page so that the student could view each simultaneously. Part B consisted of the text passage and the associated picture being reproduced on alternate pages so that the student could view one or the other but not both at the same time. Copies of Treatment 1 and Treatment 2 are given in appendix 1.

Care was taken in the development of these treatments to ensure that the reading level was appropriate for grade nine students. This was accomplished by having a validation committee consisting of two junior high teachers in the school who were familiar with the grade nine program and the school educational therapist who was familiar with learning problems experienced by these students, review the treatments and recommend changes where necessary. Two of the members of this committee had recently completed graduate programs involving research projects and a thesis. Some slight modifications were recommended and the appropriate changes were made. Similarly the pictures used were viewed by this committee and were included only after all three members agreed that they appropriately represented the text.

Each treatment included a ten item multiple choice test instrument, developed by the investigator. The test instruments consisted of 60% recall questions and 40% application questions. The recall questions were designed to test information that was represented in both the text and the picture. Application questions were designed to require the students to apply information presented in both the text and the pictures to answer a related question that was not specifically represented in either the text or the pictures.

Both types of questions were randomly spread throughout the test instrument. Copies of the test instruments are given in appendix 2 with recall and application questions appropriately designated.

It had been difficult to find a time when most students were present at school and the school final examinations were beginning in a few days. It was therefore decided between the investigator and the school administration to keep the use of class time for this study to an absolute minimum. It was felt by the committee that the ten test items chosen would still adequately measure achievement, since the instructional treatments were very short.

To ensure the content validity of the test items the committee reviewed each treatment unit and corresponding test items simultaneously. The following criteria were used:

(1) reading level of the test items must be acceptable for grade nine students.

(2) the questions must be based upon and answerable from the information contained in the treatments.

(3) the recall questions were based on information represented by both the text and the pictures.

Procedure:

The treatments were administered to the two groups over a three day period. Each treatment consisted of two versions of the same instructional module. On day one, group A received Module 1C while group B received Module 1S. On day three, group A received Module 2S and group B received Module 2C. No treatments were administered on day two. The presentations of the treatments on both days were arranged so that the students did not have an opportunity to discuss information.

The amount of time to administer each treatment was approximately thirty minutes. This included time for the investigator to explain the instructions. In Modules 1C and 2C, the text and picture were combined on the same page. The students were allowed sixty seconds to view each page. After that time they were instructed to turn to the next text-picture combination page. In Modules 1S and 2S, the text was presented on one page and the corresponding picture was on the next page. The students were allowed to view each page for thirty seconds.

Once the administration of the treatments had begun, each page was viewed by all students for the specific amount

of time allowed. Viewing continued until all pages had been examined. No talking was allowed during this time. When the last page was viewed by the students, they were instructed to turn their booklets face down on their desks. Immediately the booklets were retrieved by the investigator.

The test instrument designed for the specific unit was then passed out, face down on the student desks. When all students had a test paper they were instructed to turn them over at the same time and answer each item by placing a circle around the best response for each. The students were given a maximum of ten minutes for this part. In each case, all students were finished before the ten minute time limit. When finished the papers were immediately turned face down on the desk as instructed. No talking or looking at other student papers was allowed during this time. The test papers were then retrieved by the investigator.

Analysis of Data:

Multiple linear regression analyses were used to determine possible relationships between:

(i) recall on test 1 and treatment 1

(ii) application on test 1 and treatment 1

(iii) recall on test 2 and treatment 2

(iv) application on test 2 and treatment 2

Regression analysis was also used to determine:

(v) any influences on the dependant variables by certain background variables of the participants; Gender, Vocabulary Ability, Reading Ability, Visual Materials Ability and Language Usage, as determined by a grade four CTBS instrument. The grade four measurement was the most recent indicator for this group because they had not participated in a grade seven test due to school closure.

For statistical purposes a 0.05 level of significance was considered appropriate. The background variables of the participants consisted of gender and results from the Canadian Test of Basic Skills administered to the participants in grade four. The following sections of the CTBS instrument were used; Vocabulary Ability, Reading Ability, Visual Materials Ability and Language Usage. These indicators were considered most relevant because the study involved students being required to read and understand text passages, and analyse associated pictures and diagrams. Therefore ability with reading, language, and visual materials were considered important.

CHAPTER IV

ANALYSIS OF DATA

Introduction:

The purpose of this study was to compare two different methods of presenting text and related pictures, namely, text and pictures combined and text and pictures separated, to determine if one or the other had a significantly greater effect upon achievement levels for recall and application type questions. To facilitate this determination, four research questions were constructed and the associated hypotheses stated in the null form.

A review of the literature revealed that in some related studies, the placement of pictures within text produced superior results on achievement than placing the pictures either before or after the text. It was not clear in these studies whether the student could switch from viewing pictures to viewing text during the presentation. For the purpose of this study, such switching between text and pictures was not permitted. Since the literature has already indicated that students generally place greater importance on text than pictures, it was decided that the

student would likely focus more on the picture while viewing it if the distracting text was not present.

Two instructional treatments were developed by the investigator, each with a "combined" and a "separate" version. One of the classes participating in the study received one combined module and one separate module. The other class received the alternate modules. Classes received each received one combined and one separate version of the treatments to offset random variations among the two groups.

Test scores on tests of recall and application were collected and a regression analysis was used to determine which if either of the modules produced superior results on the tests. Background variables were also analysed along with the two treatments to see if there were any influences. The background variables used included measurements from a CTBS test administered to the students earlier in the areas of language skills and visual materials skills.

This chapter reports the data collected during the investigation, the results of testing the hypotheses and other findings of the study. In presenting the results related to each question, the null hypotheses are stated and the results of the analysis given.

Question 1:

Are there any differences in achievement as measured by a test of recall between an instructional treatment using text and pictures combined and an instructional treatment using text and pictures separated?

Hypothesis 1:

The organization of material with text and pictures combined will produce the same results as text and pictures separate when measured on a test of recall.

Hypothesis 1.A:

Treatment 1 will produce no significant effect on achievement as measured by Recall 1.

Results:

Table 4.1A gives the Zero-order correlations between Recall 1 and Treatment 1. This value indicates the strength of the linear relationship between the two variables. A value of 0.028 indicates a very small positive association. The observed significance level of 0.421 indicates the probability of observing a correlation coefficient > 0.028 or < -0.028 in a sample of the unknown population when the value in the population is zero. Since this observed

significance level is > 0.05, the null hypothesis, that there is no linear association between the two variables, is not rejected.

Table 4.1B shows the regression analysis performed on Recall 1 with Treatment 1 as the independent variable. In this table, B represents the raw or unstandardized regression coefficients. SE B refers to the standard errors in B. This is an estimate of the standard deviations of the sampling distributions of B. The Beta column gives the partial regression coefficients in a standardized form by expressing all independent variables in Z-score form. When there is only one independent variable, as in this case, the beta value is equal to the correlation coefficient. T refers to the observed significance level and is calculated by dividing a sample value by its standard error. Sig. T refers to the two-tailed significance levels for the hypotheses that the slope and intercept are zero in the unknown population. This indicates the probability of finding a sample slope at least as large as the one observed if the true slope is zero. Multiple R is simply the absolute value of the correlation coefficient between the dependent and independent variables. It is also the correlation coefficient between the values predicted by the regression

model and the observed values. The value of 0.028 is close to zero, indicating that the regression model does not fit the data well. R-squared gives the percentage of the variability in the dependent variable that is explained by the independent variable. The F value is another test of the linear relationship. It is defined as the ratio of the mean square for regression to the mean square of the residual (difference between observed and predicted values of the dependent variable). Large values for F indicate that a linear relationship between the two variables exists. The significance of F in this case is very large, indicating that the regression model is not significant. The null hypothesis 1.A is accepted.

Table 4.1A: Zero-order correlations between Recall 1 and Treatment 1:

	Recall 1	Treatment 1
Recall 1	1.000	
Treatment 1	0.028 0.421	1.000

Table 4.1B: Regression analysis results for variables on Recall 1:

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	0.085	0.422	0.028	0.200	0.842

Multiple R = 0.028

R-squared = 0.0008

F value = 0.040

Significance of F = 0.842

Hypothesis 1.B:

Treatment 2 will produce no significant effect on achievement as measured by Recall 2.

Results:

Table 4.2B shows the regression analysis performed on Recall 2 with Treatment 2 as the independent variable. The

regression model was not significant. The null hypothesis 1.B is accepted.

Table 4.2A: Zero-order correlations between Recall 2 and Treatment 2.

	Recall 2	Treatment 2
Recall 2	1.000	
Treatment 2	-.049 .362	1.000

Table 4.2B Regression analysis results for variables on Recall 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.131	0.369	-0.049	-0.355	0.724

Multiple R = 0.049

R-squared = 0.002

F value = 0.126

Significance of F = 0.724

Question 2:

Are there any differences in achievement as measured by a test of application between an instructional treatment using text and pictures combined and an instructional

treatment using text and pictures separated?

Hypothesis 2:

The organization of material with text and pictures combined will produce the same results as text and pictures separate when measured on a test of application.

Hypothesis 2.A:

Treatment 1 will produce no significant effect on achievement as measured by Application 1.

Results:

Table 4.3B shows the regression analysis performed on Application 1 with Treatment 1 as the independent variable. The regression model was not significant. The null hypothesis 2.A is accepted.

Table 4.3A: Zero-order correlations between Application 1 scores and Treatment 1.

	Application 1	Treatment 1
Application 1	1.000	
Treatment 1	-.130 .171	1.000

Table 4.3B: Regression analysis results for variables on Application 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	-0.263	0.275	-0.130	-0.958	0.342

Multiple R = 0.131

R-squared = 0.017

F value = 0.918

Significance of F = 0.342

Hypothesis 2.B:

Treatment 2 will produce no significant effect on achievement as measured by Application 2.

Results:

Table 4.4B shows the regression analysis performed on Application 2 with Treatment 2 as the independent variable. The regression model was not significant. The null hypothesis 2.B is accepted.

Table 4.4A: Zero-order correlations between Application 2 and Treatment 2.

	Application 2	Treatment 2
Application 2	1.000	
Treatment 2	-.182 .091	1.000

Table 4.4B Regression analysis results for variables on Application 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.390	0.289	-0.182	-1.351	0.183

Multiple R = 0.182

R-squared = 0.033

F value = 1.824

Significance of F = 0.183

Question 3:

Are there any differences in achievement as measured by a test of recall between the interaction of background variables with text and pictures combined and with text and pictures separate?

Hypothesis 3:

The interaction of background variables and Treatment 1 will produce the same results as the interaction of background variables and Treatment 2 on a test of recall.

Hypothesis 3.A:

The interaction of Gender and Treatment 1 will produce no significant effect on Recall 1.

Results:

Table 4.5B shows the regression analysis performed on Recall 1 with Treatment 1 and Gender as the independent variables. The model was not significant. The null hypothesis was accepted.

Table 4.5A: Zero-order correlations between Recall 1, Treatment 1 and Gender.

	Recall 1	Treatment 1	Gender
Recall 1	1.000		
Treatment 1	.028 .421	1.000	
Gender	.255 .030	.013 .463	1.000

Table 4.5B: Regression analysis results for variables on Recall 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	0.075	0.412	0.024	0.101	0.857
Gender	0.833	0.439	0.254	1.897	0.063

Multiple R = 0.256

R-squared = 0.065

F value = 1.821

Significance of F = 0.172

Hypothesis 3.B:

The interaction of Gender, Vocabulary and Treatment 1 will produce no significant effect on Recall 1.

Results:

Table 4.6B shows the regression analysis performed on Recall 1 with Treatment 1 as the independent variable and Gender and Vocabulary as the background variables. The model was significant at the $p < 0.05$ level with R-squared explaining 19% of the variance. Vocabulary was significant indicating that students who scored higher on the Vocabulary section of the grade 4 CTBS instrument tended to score higher on the recall part of the test 1 instrument.

Treatment 1 and Gender were not significant. The null hypothesis was rejected.

Table 4.6A: Zero-order correlations between Recall 1, Treatment 1, Gender and Vocabulary.

	Recall 1	Treatment 1	Gender	Vocabulary
Recall 1	1.000			
Treatment 1	.086 .279	1.000		
Gender	.307 .016	.016 .458	1.000	
Vocabulary	.360 .005	.083 .286	.179 .209	1.000

Table 4.6B: Regression analysis results for variables on Recall 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	0.167	0.402	0.055	0.417	0.679
Gender	0.778	0.423	0.250	1.839	0.073
Vocabulary	0.078	0.034	0.311	2.279	0.028

Multiple R = 0.440

R-squared = 0.194

F value = 3.603

Significance of F = 0.020

Hypothesis 3.C:

The interaction of Gender, Vocabulary, Reading Ability and Treatment 1 will produce no significant effect on Recall 1.

Results:

Table 4.7B shows the regression analysis performed on Recall 1 with Treatment 1 as the independent variable and Gender and Reading Ability as the background variables. The model was significant at the $p < .05$ level. R-squared accounted for about 20% of the variance. Both Gender and Reading Ability were significant ($p < .05$), with Reading Ability being the more significant variable. The positive beta weight for Gender indicated that males were scoring higher than females in this model. Treatment 1 was not significant. The null hypothesis was rejected.

Table 4.7A: Zero-order correlations between Recall 1, Treatment 1, Gender and Reading Ability.

	Recall 1	Treatment 1	Gender	Reading Ability
Recall 1	1.000			
Treatment 1	.086 .279	1.000		
Gender	.307 .016	.016 .458	1.000	
Reading Ability	.352 .007	.152 .148	.072 .312	1.000

Table 4.7B: Regression analysis results for variables on Recall 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	0.094	0.403	0.031	0.233	0.817
Gender	0.879	0.414	0.283	2.122	0.039
Reading Ability	0.062	0.025	0.327	2.427	0.019

Multiple R = 0.452

R-squared = 0.205

F value = 3.862

Significance of F = 0.015

Hypothesis 3.D:

The interaction of Gender, Vocabulary, Visual Materials and Treatment 1 will produce no significant effect on Recall 1.

Results:

Table 4.8B shows the regression analysis performed on Recall 1 with Treatment 1 as the independent variable and Gender and Visual Materials as the background variables. The model was significant at the $p < 0.05$ level with R-squared accounting for about 19% of the variance. The Visual Materials variable was significant ($p < .05$) indicating that students who scored higher on the Visual Materials part of the grade 4 CTBS instrument tended to score higher on the recall part of the test 1 instrument. Gender approached significance but Treatment 1 was not significant. The null hypothesis was rejected.

Table 4.8A: Zero-order correlations between Recall 1, Treatment 1, Gender and Visual Materials.

	Recall 1	Treatment 1	Gender	Visual Materials
Recall 1	1.000			
Treatment 1	.086 .279	1.000		
Gender	.307 .016	.016 .458	1.000	
Visual Materials	.355 .006	.188 .098	.152 .148	1.000

Table 4.8B: Regression analysis results for variables on Recall 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	0.069	0.409	0.023	0.170	0.866
Gender	0.805	0.421	0.259	1.911	0.062
Visual materials	0.088	0.039	0.311	2.255	0.029

Multiple R = 0.438

R-squared = 0.192

F value = 3.563

Significance of F = 0.021

Hypothesis 3.E:

The interaction of Gender, Language Usage and Treatment

1 will produce no significant effect on Recall 1.

Results:

Table 4.9B shows the regression analysis performed on Recall 1 with Treatment 1 as the independent variable and Gender and Language Usage as the background variables. The model was significant at the $p < 0.01$ level with R-squared accounting for about 27% of the variance. The Language Usage variable was significant ($p < .01$) indicating that students who scored higher on the Language Usage part of the grade 4 CTBS instrument tended to score higher on the recall part of the test 1 instrument. Gender was significant ($p < .05$) and the positive beta weight indicated that males tended to score higher than females. The null hypothesis was rejected.

Table 4.9A: Zero-order correlations between Recall 1, Treatment 1, Gender and Language Usage.

	Recall 1	Treatment 1	Gender	Language Usage
Recall 1	1.000			
Treatment 1	.086 .279	1.000		
Gender	.307 .016	.016 .458	1.000	
Language Usage	.393 .003	.048 .371	-.071 .315	1.000

Table 4.9B: Regression analysis results for variables on Recall 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	0.181	0.382	0.061	0.474	0.638
Gender	1.041	0.397	0.335	2.623	0.012
Language Usage	0.096	0.030	0.413	3.233	0.002

Multiple R = 0.520

R-squared = 0.270

F value = 5.552

Significance of F = 0.0025

Hypothesis 3.F:

The interaction of Gender and Treatment 2 will produce no significant effect on Recall 2.

Results:

Table 4.10B shows the regression analysis performed on Recall 2 with Treatment 2 as the independent variable and Gender as the background variable. The model was not significant. The null hypothesis was accepted.

Table 4.10A: Zero-order correlations between Recall 2, Treatment 2, and Gender.

	Recall 2	Treatment 2	Gender
Recall 2	1.000		
Treatment 2	-.049 .362	1.000	
Gender	.121 .189	-.013 .463	1.000

Table 4.10B: Regression analysis results for variables on Recall 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.127	0.369	-0.047	-0.343	0.733
Gender	0.345	0.394	0.121	0.877	0.385

Multiple R = 0.130

R-squared = 0.017

F value = 0.447

Significance of F = 0.642

Hypothesis 3.G:

The interaction of Gender, Vocabulary and Treatment 2 will produce no significant effect on Recall 2.

Results:

Table 4.11B shows the regression analysis performed on Recall 2 with Treatment 2 as the independent variable and Gender and Vocabulary as the background variables. The model was significant at the $p < 0.05$ level. R-squared explained 21% of the variance. Vocabulary was significant indicating that students who scored higher on the Vocabulary section of the grade 4 CTBS instrument tended to score higher on the recall part of the test 2 instrument. Treatment 2 and Gender

were not significant variables in the regression equation. The null hypothesis was rejected.

Table 4.11A: Zero-order correlations between Recall 2, Treatment 2, Gender, and Vocabulary.

	Recall 2	Treatment 2	Gender	Vocabulary
Recall 2	1.000			
Treatment 2	-.119 .208	1.000		
Gender	.166 .127	-.016 .458	1.000	
Vocabulary	.447 .001	-.083 .286	.179 .109	1.000

Table 4.11B: Regression analysis results for variables on Recall 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.214	0.343	-0.083	-0.622	0.537
Gender	0.239	0.361	0.089	0.662	0.511
Vocabulary	0.091	0.029	0.424	3.145	0.003

Multiple R = 0.463

R-squared = 0.214

F value = 4.083

Significance of F = 0.012

Hypothesis 3.H:

The interaction of Gender, Reading Ability and Treatment 2 will produce no significant effect on Recall 2.

Results:

Table 4.12B shows the regression analysis performed on Recall 2 with Treatment 2 as the independent variable and Gender and Reading Ability as the background variables. The model was significant at the $p < .05$ level with R-squared accounting for about 20% of the variance. Reading Ability was significant ($p < .05$). Treatment 2 and Gender were not significant. The null hypothesis was rejected.

Table 4.12A: Zero-order correlations between Recall 2, Treatment 2, Gender, and Reading Ability.

	Recall 2	Treatment 2	Gender	Reading Ability
Recall 2	1.000			
Treatment 2	-.119 .208	1.000		
Gender	.166 .127	-.016 .458	1.000	
Reading Ability	.426 .001	-.152 .148	.072 .312	1.000

Table 4.12B Regression analysis results for variables on Recall 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.142	0.349	-0.055	-0.407	0.686
Gender	0.365	0.358	0.136	1.020	0.313
Reading Ability	0.067	0.022	0.408	3.021	0.004

Multiple R = 0.450

R-squared = 0.203

F value = 3.817

Significance of F = 0.016

Hypothesis 3.I:

The interaction of Gender, Visual Materials and Treatment 2 will produce no significant effect on Recall 2.

Results:

Table 4.13 shows the regression analysis performed on Recall 2 with Treatment 2 as the independent variable and Gender and Visual Materials as the background variables. The model was not significant at the $p < 0.05$ level. The null hypothesis was accepted.

Table 4.13A: Zero-order correlations between Recall 2, Treatment 2, Gender, and Visual Materials.

	Recall 2	Treatment 2	Gender	Visual Materials
Recall 2	1.000			
Treatment 2	-.119 .208	1.000		
Gender	.166 .127	-.016 .458	1.000	
Visual Materials	.372 .004	-.188 .098	.152 .148	1.000

Table 4.13B: Regression analysis results for variables on Recall 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.136	0.361	-0.053	-0.376	0.709
Gender	0.303	0.372	0.113	0.813	0.420
Visual Materials	0.084	0.035	0.345	2.441	0.019

Multiple R = 0.392

R-squared = 0.153

F value = 2.716

Significance of F = 0.055

Hypothesis 3.J:

The interaction of Gender, Language Usage and Treatment 2 will produce no significant effect on Recall 2.

Results:

Table 4.14B shows the regression analysis performed on Recall 2 with Treatment 2 as the independent variable and Gender and Language Usage as the background variables. The model was significant at the $p < 0.01$ level. Language Usage was significant ($p < .01$). Treatment 2 and Gender were not significant. R-squared accounted for about 23% of the variance. The null hypothesis was rejected.

Table 4.14A: Zero-order correlations between Recall 2, Treatment 2, Gender, and Language Usage.

	Recall 2	Treatment 2	Gender	Language Usage
Recall 2	1.000			
Treatment 2	-.119 .208	1.000		
Gender	.166 .127	-.016 .458	1.000	
Language Usage	.421 .001	-.048 .371	-.071 .315	1.000

Table 4.14B: Regression analysis results for variables on Recall 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.247	0.340	-0.095	-0.725	0.472
Gender	0.524	0.353	0.195	1.483	0.145
Language usage	0.086	0.026	0.431	3.270	0.002

Multiple R = 0.475

R-squared = 0.225

F value = 4.362

Significance of F = 0.0088

Question 4:

Are there any differences in achievement as measured by a test of application between the interaction of background variables with text and pictures combined with text and pictures separate?

Hypothesis 4:

The interaction of background variables and Treatment 1 will produce the same results as the interaction of background variables and Treatment 2 on a test of application.

Hypothesis 4.A:

The interaction of Gender and Treatment 1 will produce no significant effect on Application 1.

Results:

Table 4.15B shows the regression analysis performed on Application 1 with Treatment 1 as the independent variable and Gender as the background variable. The model was not significant. The null hypothesis was accepted.

Table 4.15A: Zero-order correlations between Application 1, Treatment 1, and Gender.

	Application 1	Treatment 1	Gender
Application 1	1.000		
Treatment 1	-.130 .171	1.000	
Gender	-.105 .222	.013 .463	1.000

Table 4.15B Regression analysis results for variables on Application 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	-0.261	0.276	-0.129	-0.945	0.349
Gender	-0.223	0.294	-0.104	-0.760	0.451

Multiple R = 0.167

R-squared = 0.028

F value = 0.744

Significance of F = 0.480

Hypothesis 4.B:

The interaction of Gender, Vocabulary and Treatment 1 will produce no significant effect on Application 1.

Results:

Table 4.16B shows the regression analysis performed on Application 2 with Treatment 1 as the independent variable and Gender and Vocabulary as the background variables. The model was not significant. The null hypothesis was accepted.

Table 4.16A: Zero-order correlations between Application 1, Treatment 1, Gender, and Vocabulary.

	Application 1	Treatment 1	Gender	Vocabulary
Application 1	1.000			
Treatment 1	-.068 .322	1.000		
Gender	-.129 .189	.016 .458	1.000	
Vocabulary	.209 .074	.083 .286	.179 .109	1.000

Table 4.16B Regression analysis results for variables on Application 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	-0.166	0.280	-0.085	-0.595	0.555
Gender	-0.347	0.294	-0.172	-1.108	0.244
Vocabulary	0.040	0.024	0.247	1.695	0.097

Multiple R = 0.282

R-squared = 0.080

F value = 1.297

Significance of F = 0.287

Hypothesis 4.C:

The interaction of Gender, Reading Ability and

Treatment 1 will produce no significant effect on Application 1.

Results:

Table 4.17B shows the regression analysis performed on Application 1 with Treatment 1 as the independent variable, and Gender and Reading Ability as the background variables. The model was significant at the $p < .05$ level. R-squared accounted for about 17% of the variance. Reading Ability was significant ($p < .05$) indicating that students who scored higher on the Reading Ability part of the grade 4 CTBS instrument tended to score higher on the application part of test 1. Treatment 1 and Gender were not significant in the regression equation. The null hypothesis was rejected.

Table 4.17A: Zero-order correlations between Application 1, Treatment 1, Gender, and Reading Ability.

	Application 1	Treatment 1	Gender	Reading Ability
Application 1	1.000			
Treatment 1	-.068 .322	1.000		
Gender	-.129 .189	.016 .458	1.000	
Reading Ability	.364 .005	.152 .148	.072 .312	1.000

Table 4.17B: Regression analysis results for variables on Application 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	-0.244	0.268	-0.125	-0.911	0.367
Gender	-0.313	0.275	-0.155	-1.138	0.261
Reading Ability	0.048	0.017	0.394	2.806	0.006

Multiple R = 0.414

R-squared = 0.171

F value = 3.104

Significance of F = 0.036

Hypothesis 4.D:

The interaction of Gender, Visual Materials and Treatment 1 will produce no significant effect on Application 1.

Results:

Table 4.18B shows the regression analysis performed on Application 1 with Treatment 1 as the independent variable, and Gender and Visual Materials as the background variables. The model was not significant. The null hypothesis was accepted.

Table 4.18A: Zero-order correlations between Application 1, Treatment 1, Gender, and Visual Materials.

	Application 1	Treatment 1	Gender	Visual Materials
Application 1	1.000			
Treatment 1	-.068 .322	1.000		
Gender	-.129 .189	.016 .458	1.000	
Visual Materials	.117 .212	.188 .098	.152 .148	1.000

Table 4.18B: Regression analysis results for variables on Application 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	-0.185	0.289	-0.948	-0.639	0.526
Gender	-0.305	0.298	-0.151	-1.024	0.311
Visual Materials	0.029	0.028	0.157	1.049	0.300

Multiple R = 0.210

R-squared = 0.044

F value = 0.693

Significance of F = 0.561

Hypothesis 4.E:

The interaction of Gender, Language Usage and Treatment 1 will produce no significant effect on Application 1.

Results:

Table 4.19B shows the regression analysis performed on Application 1 with Treatment 1 as the independent variable and Gender and Language Usage as the background variables. The model was not significant. The null hypothesis was accepted.

Table 4.19A: Zero-order correlations between Application 1, Treatment 1, Gender, and Language Usage.

	Application 1	Treatment 1	Gender	Language Usage
Application 1	1.000			
Treatment 1	-.068 .322	1.000		
Gender	-.129 .189	.016 .458	1.000	
Language Usage	.317 .013	.048 .371	-.071 .315	1.000

Table 4.19B: Regression analysis results for variables on Application 1.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 1	-0.158	0.273	0.081	0.578	0.566
Gender	-0.213	0.284	-0.105	-0.749	0.458
Language usage	0.047	0.021	0.314	2.233	0.031

Multiple R = 0.344

R-squared = 0.119

F value = 2.017

Significance of F = 0.1251

Hypothesis 4.F:

The interaction of Gender and Treatment 2 will produce no significant effect on Application 2.

Results:

Table 4.20B shows the regression analysis performed on Application 2 with Treatment 2 as the independent variable and Gender as the background variable. The model was significant at $p < .05$ with R-squared accounting for about 16% of the variance. Gender was significant and the positive beta weight indicated that males were scoring higher than females. Treatment 2 was not significant. The null hypothesis was rejected.

Table 4.20A: Zero-order correlations between application scores on test 2, Treatment 2, and Gender.

	Application 2	Treatment 2	Gender
Application 2	1.000		
Treatment 2	-.182 .091	1.000	
Gender	.359 .004	-.013 .463	1.000

Table 4.20B: Regression analysis results for variables on Application 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.381	0.272	-0.178	-1.400	0.168
Gender	0.813	0.290	0.357	2.808	0.007

Multiple R = 0.401

R-squared = 0.161

F value = 4.972

Significance of F = 0.011

Hypothesis 4.G:

The interaction of Gender, Vocabulary and Treatment 2 will produce no significant effect on Application 2.

Results:

Table 4.21B shows the regression analysis performed on Application 2 with Treatment 2 as the independent variable and Gender and Vocabulary as the background variables. The model was significant at the $p < 0.01$ level. Treatment 2, and Gender were significant in this model but Vocabulary was not significant. Gender showed the greatest significance ($p < .01$). The positive beta weight of Gender indicates that males tended to score higher than females. The negative beta

weight of Treatment 2 indicated that students tended to score higher when text and pictures were separated rather than when they were combined. R-squared explained 30% of the variance. The null hypothesis was rejected.

Table 4.21A: Zero-order correlations between Application 2, Treatment 2, Gender, and Vocabulary.

	Application 2	Treatment 2	Gender	Vocabulary
Application 2	1.000			
Treatment 2	-.321 .012	1.000		
Gender	.389 .003	-.016 .458	1.000	
Vocabulary	.322 .012	-.083 .286	.179 .109	1.000

Table 4.21B: Regression analysis results for variables on Application 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.630	0.266	-0.296	-2.371	0.022
Gender	0.755	0.279	0.342	2.703	0.010
Vocabulary	0.042	0.023	0.236	1.861	0.069

Multiple R = 0.551

R-squared = 0.304

F value = 6.544

Significance of F = 0.0009

Hypothesis 4.H:

The interaction of Gender, Reading Ability, and Treatment 2 will produce no significant effect on Application 2.

Results:

Table 4.22B shows the regression analysis performed on Application 2 with Treatment 2 as the independent variable and Gender and Reading Ability as the background variables. The model was significant at the $p < .01$ level. R-squared accounted for about 34% of the variance. All three variables were significant with Gender significant ($p < .01$), and Reading Ability and Treatment 2 following in order. The positive beta weight of Gender indicates that males tended to score higher than females. The negative beta weight of Treatment 2 indicated that students tended to score higher when text and pictures were separated rather than when they were combined. The null hypothesis was rejected.

Table 4.22A: Zero-order correlations between Application 2, Treatment 2, Gender, and Reading Ability.

	Application 2	Treatment 2	Gender	Reading Ability
Application 2	1.000			
Treatment 2	-.321 .012	1.000		
Gender	.389 .003	-.016 .458	1.000	
Reading Ability	.370 .004	-.152 .148	.072 .312	1.000

Table 4.22B: Regression analysis results for variables on Application 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.573	0.261	-0.269	-2.195	0.033
Gender	0.801	0.268	0.363	2.986	0.005
Reading Ability	0.041	0.017	0.303	2.462	0.018

Multiple R = 0.582

R-squared = 0.339

F value = 7.700

Significance of F = 0.0003

Hypothesis 4.I:

The interaction of Gender, Visual Materials and Treatment 2 will produce no significant effect on Application 2.

Results:

Table 4.23B shows the regression analysis performed on Application 2 with Treatment 2 as the independent variable and Gender and Visual Materials as the background variables. The model was significant at the $p < .01$ level. R-squared accounted for about 37% of the variance. Again all three variables were significant with Visual Materials and Gender significant at ($p < .01$) and Treatment 2 significant at ($p < .05$). The positive beta weight of Gender indicates that males tended to score higher than females. The negative beta weight of Treatment 2 indicated that students tended to score higher when text and pictures were separated rather than when they were combined. The null hypothesis was rejected.

Table 4.23A: Zero-order correlations between Application 2, Treatment 2, Gender, and Visual Materials.

	Application 2	Treatment 2	Gender	Visual Materials
Application 2	1.000			
Treatment 2	-.321 .012	1.000		
Gender	.389 .003	-.016 .458	1.000	
Visual Materials	.460 .000	-.188 .098	.152 .148	1.000

Table 4.23B: Regression analysis results for variables on Application 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.527	0.256	-0.248	-2.062	0.045
Gender	0.728	0.264	0.330	2.763	0.008
Visual Materials	0.073	0.024	0.363	2.988	0.005

Multiple R = 0.612

R-squared = 0.374

F value = 8.974

Significance of F = 0.0001

Hypothesis 4.J:

The interaction of Gender, Language Usage and Treatment 2 will produce no significant effect on Application 2.

Results:

Table 4.24B shows the regression analysis performed on Application 2 with Treatment 2 as the independent variable and Gender and Language Usage as the background variables. The model was significant at the $p < .001$ level. R-squared accounted for about 40% of the variance. Again all three variables were significant with Language Usage and Gender significant at ($p < .01$) and Treatment 2 significant at ($p < .05$). The positive beta weight of Gender indicated that males tended to score higher than females. The negative beta weight of Treatment 2 indicated that students tended to score higher when text and pictures were separated rather than when they were combined. The null hypothesis was rejected.

Table 4.24A: Zero-order correlations between Application 2, Treatment 2, Gender, and Language Usage.

	Application 2	Treatment 2	Gender	Language Usage
Application 2	1.000			
Treatment 2	-.321 .012	1.000		
Gender	.389 .003	-.016 .458	1.000	
Language Usage	.370 .004	-.048 .371	-.071 .315	1.000

Table 4.24B: Regression analysis results for variables on Application 2.

Independent variables	B	SE B	Beta	T	Sig. T
Treatment 2	-0.629	0.246	-0.295	-2.562	0.014
Gender	0.909	0.255	0.412	3.566	0.009
Language Usage	0.065	0.019	0.393	3.390	0.001

Multiple R = 0.635

R-squared = 0.403

F value = 10.136

Significance of F = 0.0000

Summary:

The results of regression analyses are as follows:

Question 1:

Are there any differences in achievement on recall between an instructional treatment using text and pictures combined and an instructional treatment using text and pictures separated?

There were no significant differences. The results of the regressions for the two treatments on tests of recall were not significant at the $p < 0.05$ level.

Question 2:

Are there any differences in achievement on application between an instructional treatment using text and pictures combined and an instructional treatment using text and pictures separated?

There were no significant differences. The results of the regressions for the two treatments on tests of recall were not significant at the $p < 0.05$ level.

Question 3:

Are there any differences in achievement on recall between the interaction of background variables with text and pictures combined and with text and pictures separate?

There were some significant differences between the two treatments when background variables were included. Treatment 1 produced four significant combinations or models with background variables. The following background variables were found to be significant; Vocabulary, Reading Ability, Visual Materials, Language Usage and Gender. Treatment 1 was not significant at the $p < 0.05$ level in either of the models. Treatment 2 produced three significant models when background variables were included in the analysis. Vocabulary, Reading Ability, and Language Usage were significant. Gender and Treatment 2 were not significant in either of the models.

There appears to be a slightly greater number of significant background variables in combination with Treatment 1 on measurements of recall as compared to Treatment 2. In particular Visual Materials and Gender have a significant influence on achievement of recall when in combination with Treatment 1 but not with Treatment 2. It appears that text and pictures combined produce slightly

greater achievement on measures of recall than text and pictures separate, when certain background variables are included in the analysis.

Question 4:

Are there any differences in achievement on measures of application between the interaction of background variables with text and pictures combined and with text and pictures separate?

There were significant differences between these two situations. Treatment 1 produced only one significant model and the single significant variable in this model was Reading Ability. Treatment 1 was not significant in any of the models at the $p < 0.05$ level. Treatment 2 produced five significant models with Gender, Reading Ability, Visual Materials and Language Usage all significant. Treatment 2 was significant in four of the five models. The negative Beta weight of Treatment 2 indicated that when in combination with certain background variables, text and pictures separated produced greater achievement on application type questions than text and pictures combined. This was particularly true for males in this part of the study since they tended to score higher than females on

application using Treatment 2.

Additional Findings:

Analysis of the regression results indicated that some of the background variables have greater influence on achievement for both recall and application than either of the treatments used in the study. In particular, Reading Ability was found to have a significant influence in all models in which it appeared. Language Usage was significant in three models out of four. Vocabulary was significant for measures of recall but not for measures of application. Visual Materials was significant for measures of recall under Treatment 1 and measures of application under Treatment 2.

These results indicate that student achievement on these sections of the CTBS test, even when measured many years earlier, may be important indicators of achievement on recall and application tests based on text and picture presentations.

CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

This chapter includes a summary of the study, the implications of the study and recommendations for further investigation.

Summary:

A review of related literature revealed that pictures generally facilitate learning from associated text. There were a number of different theories dealing with why pictures are effective in enhancing learning, and under what conditions they are effective. This study was restricted to an investigation of differences in achievement on measurements of recall and application caused by two different arrangements of text and pictures. Modules 1C and 2C presented text and pictures combined while Modules 1C and 2C presented text and pictures separately. The background variables; Vocabulary, Reading Ability, Visual Materials, Language Usage and Gender were also analyzed in combination with the two treatments to determine if there was any influence on achievement.

The population for the study consisted of two grade

nine classes from St. Michael's High School, Bell Island. There were twenty-eight students in each group. One group was administered Module 1C and Module 2S while the other group received Module 1S and Module 2C. The modules consisted of eight short descriptive text passages followed alternately by representative pictures. At the end of the presentation a ten item multiple-choice test instrument was administered.

Four research questions directed the data analysis and a series of hypotheses and sub-hypotheses stated in the null form were tested using multiple regression analysis. The level of significance was set at $p < 0.05$.

Conclusions:

Based upon the statistical analysis of the data obtained from the test instruments used in the investigation and from CTBS scores obtained for these students in grade four, the following conclusions were drawn:

1. Treatment 1 alone, had no significant effect on achievement on tests of recall or application.
2. Treatment 2 alone, had no significant effect on achievement on tests of recall or application.

3. Treatment 1 had no significant effect on measures of recall or application, when the background variables of Vocabulary, Reading Ability, Visual Materials, and Language Usage were controlled for.

4. Treatment 2 did not have a significant effect on achievement on measures of recall when these background variables were controlled for. Treatment 2 did however have a significant effect on achievement on measures of application when these background variables were controlled for. The negative Beta weight for treatment and gender in this part of the analysis indicated that male participants who had scored higher on Reading Ability, Visual Materials, and Language Usage tended to score higher when exposed to the separate form of Module 2 than the combined form.

5. An important finding of the study involved the influence of background variables. Reading Ability in particular was the most significant variable in the study, being highly significant in all regressions where it was included. Language Usage, was the next most significant variable followed by Visual Materials, Vocabulary and Gender.

This finding indicates that grade four CTBS scores can be used as powerful indicators of later achievement on text

and picture based material. The finding is not surprising when one considers that these scores are an indication of the students ability to understand both language and visual materials, both of which are used in this study.

Implications of the Study:

The results of this study relating to arrangement of text and pictures suggest that the arrangement, either combined or separate, generally does not have a significant effect on achievement. The exception is when application is being evaluated. In this situation, it appears that presenting the text followed by the representative picture produces greater achievement for males who have scored higher on the language and visual materials skills sections of a CTBS instrument than presenting the text and picture combined.

The background variables taken from the CTBS instrument were measured five years earlier when the students were in grade four. These students were engaged in much more sophisticated examples of language usage and visual materials by the time they had reached grade nine, when this study was conducted. It would have been interesting and perhaps more informative if recent CTBS scores had been

available.

Recommendations for further Research:

Since the results of this study indicate a connection between presenting text and pictures separately and improved achievement on a test of application, it is recommended that a larger study be conducted to investigate this apparent relationship in greater detail. It is further recommended that this study include a larger student sample, and a test instrument that more comprehensively measures application of information.

The significant effects of the background variables used in the present study require additional investigation. It is recommended that in the new study, population samples be selected that have recent CTBS measurements available for comparison with earlier CTBS scores and achievement on the recall and application test instruments.

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APPENDIX 1

Included are copies of the two modules used in the study. Module 1C and Module 2S are provided. Module 1S (not included) contains the same material as Module 1C but it is arranged in the seperated form, similar to Module 2S. Likewise Module 2C (not included) contains the same information as Module 2S but it is arranged in the combined form, similar to Module 1C.

Module 1C

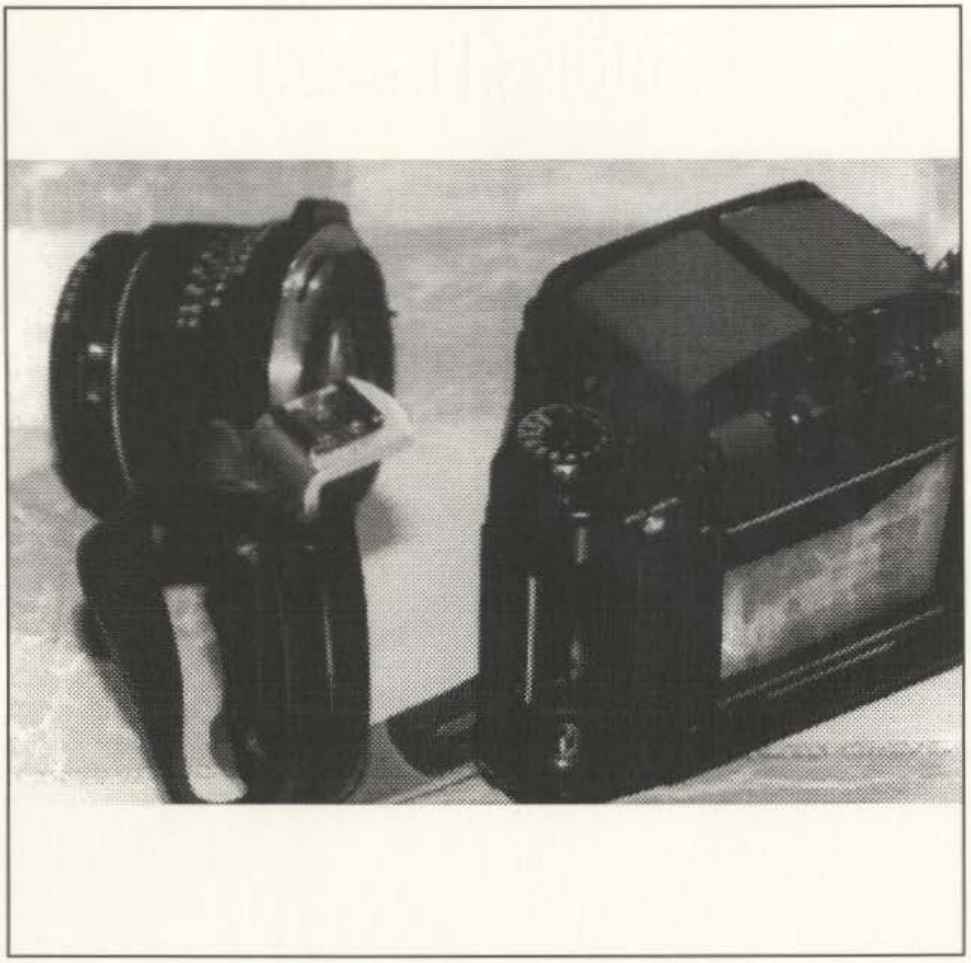
The Effect of F-Stop

on

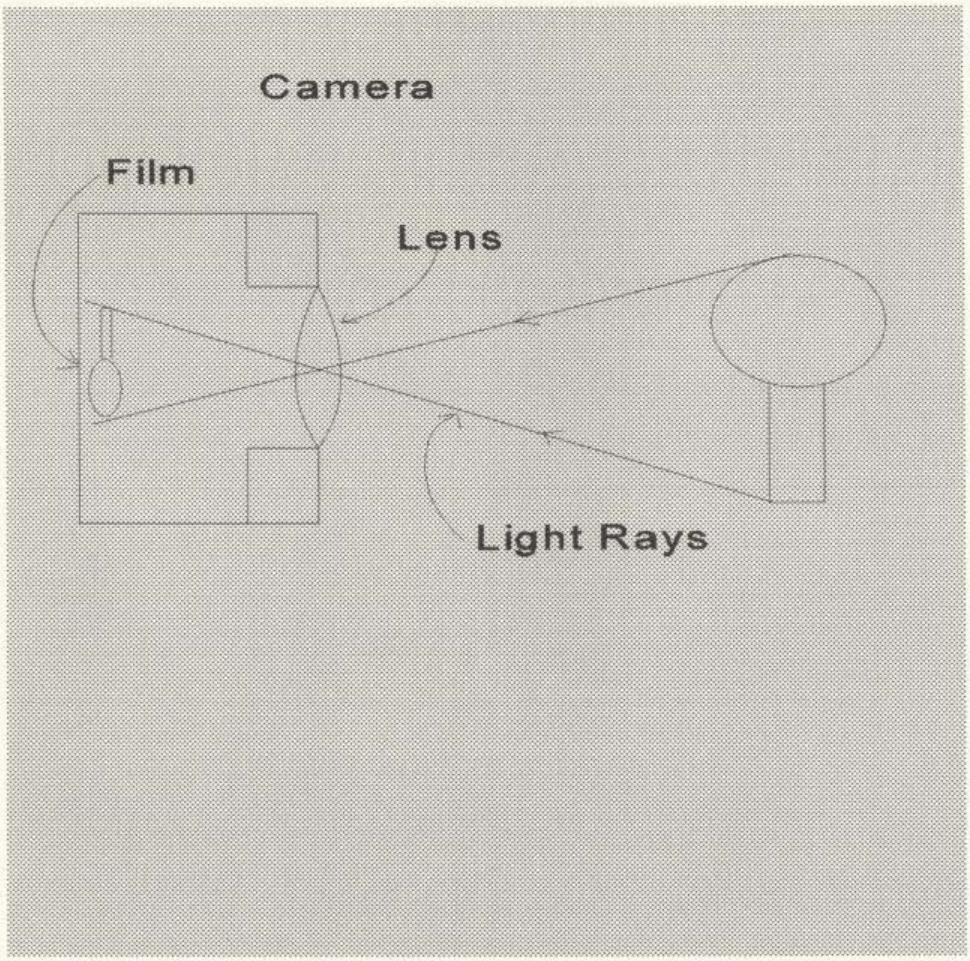
Depth of Field

Basic Camera Design

The camera is basically a light-tight box with a lens system at the front and film at the back.

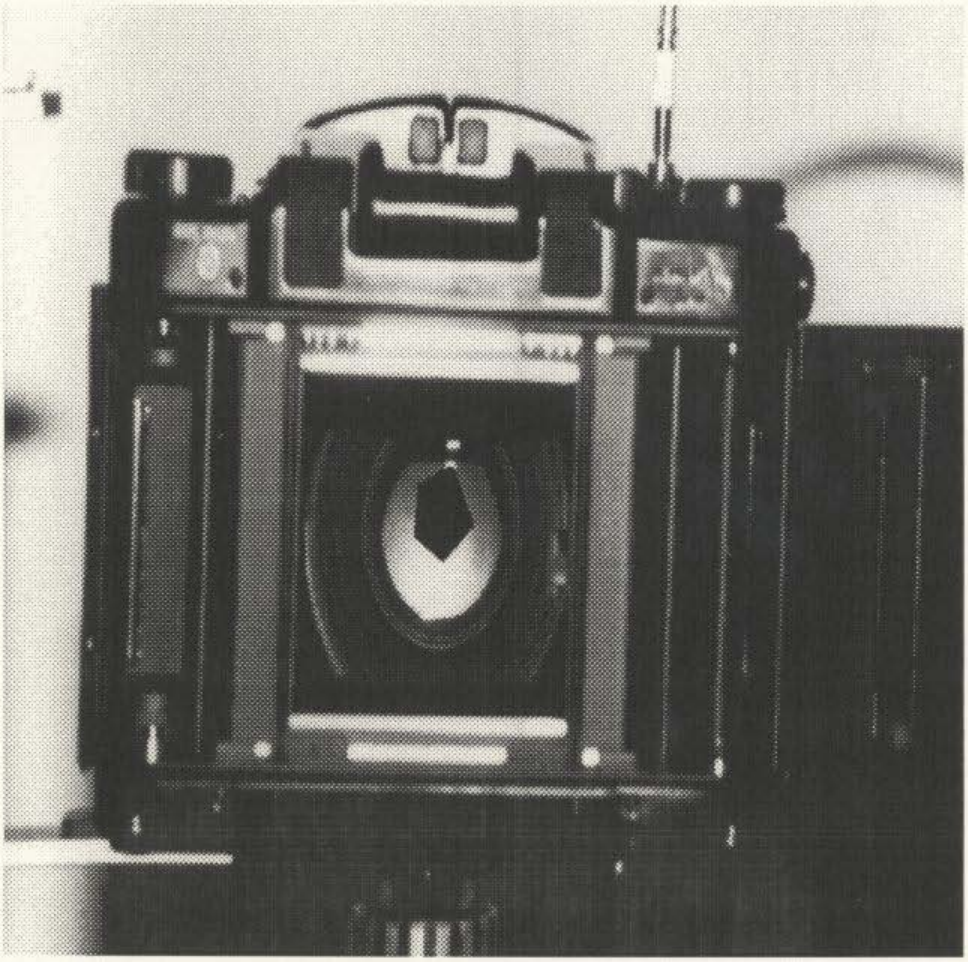


Light shines on a subject, reflects toward the camera, and enters the lens. The lens then focuses this light onto the film forming an image.



Aperture / F-Stop

The aperture is an opening located in the center of the lens. By turning a dial or ring (called the f-stop ring) on the lens, the size of the aperture is increased or decreased. This allows more or less light to enter the camera.



F-Stop numbers indicate the size of the aperture opening. The regular f-stop numbers are: 1, 2, 4, 8, 16, and 32. Between these are the half-stops: 1.4, 2.8, 5.6, 11 and 22. As the numbers increase, the aperture opening decreases.

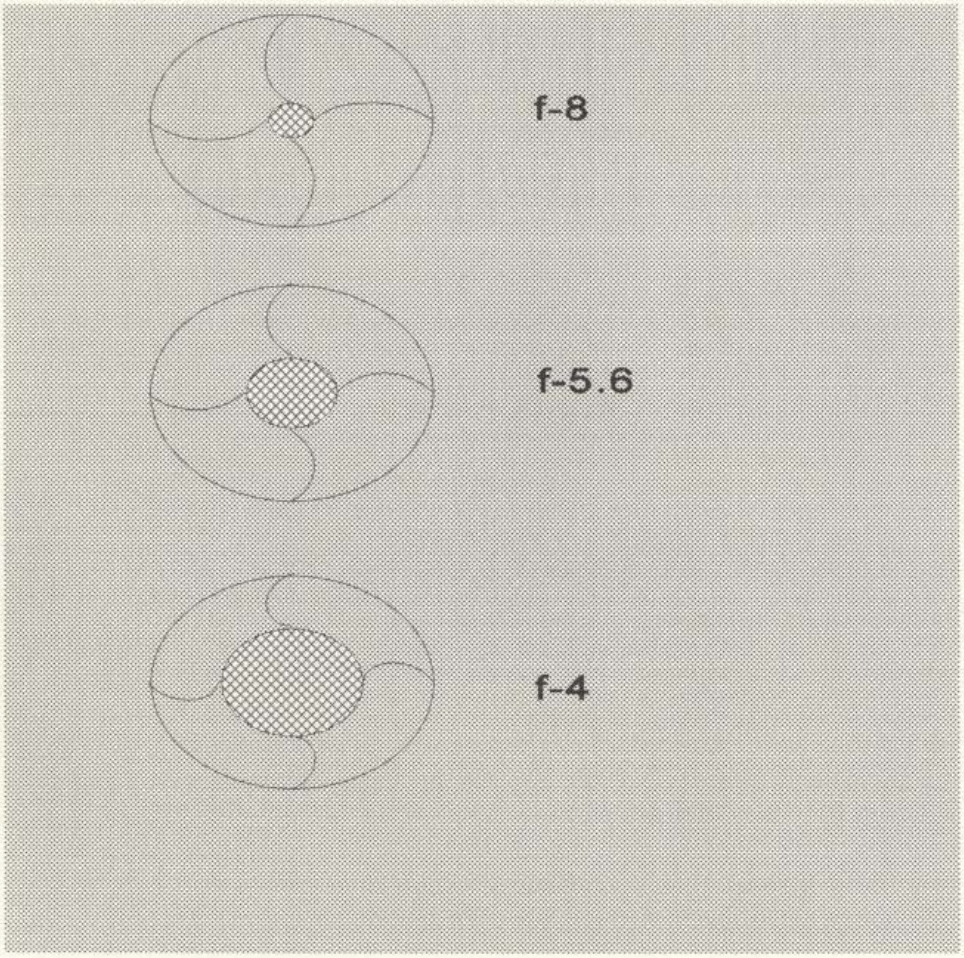
Note: all values are not given on a standard camera lens.

It is of interest to note that when each of these numbers are squared, the value is equal to approximately twice the value of the previous number squared!

$(1.4)^2$	=	2
$(2)^2$	=	4
$(2.8)^2$	=	8
$(4)^2$	=	16

Each time the f-stop value increases by one-half step, the aperture opening decreases by one-half in size. Therefore an

f-stop of 5.6 will only allow half as much light to enter the camera as an f-stop of 4. Similarly, f-stop 5.6 allows twice as much light to enter as f-8. Get the picture?



For any given photograph, only a certain region in front of the camera will be in sharp focus. This depth of field or D o F. region extends from a point somewhere in front of the subject (between the camera and the subject) to a point behind the subject.

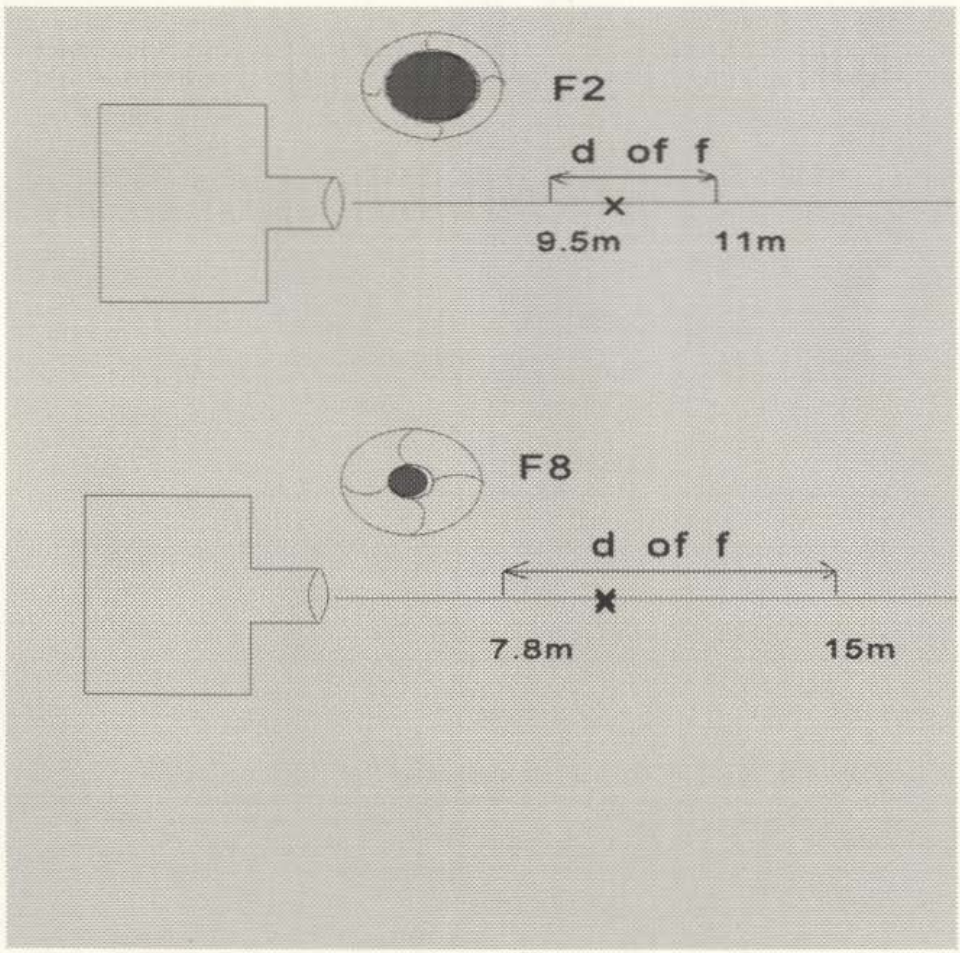
<Out of Focus

<Point of Focus

<Out of Focus

Note: From HOW TO TAKE GREAT PICTURES WITH YOUR SLR (p.34) by Lou Jacobs Jr., 1974, Tucson AZ.: HP Books. Copyright 1974 by Lou. Jacobs Jr. Reprinted by permission.

In general Depth of Field (D o F) increases when F-Stop decreases. Also, D o F is greater behind the point of focus than in front of it.



Module 2 S

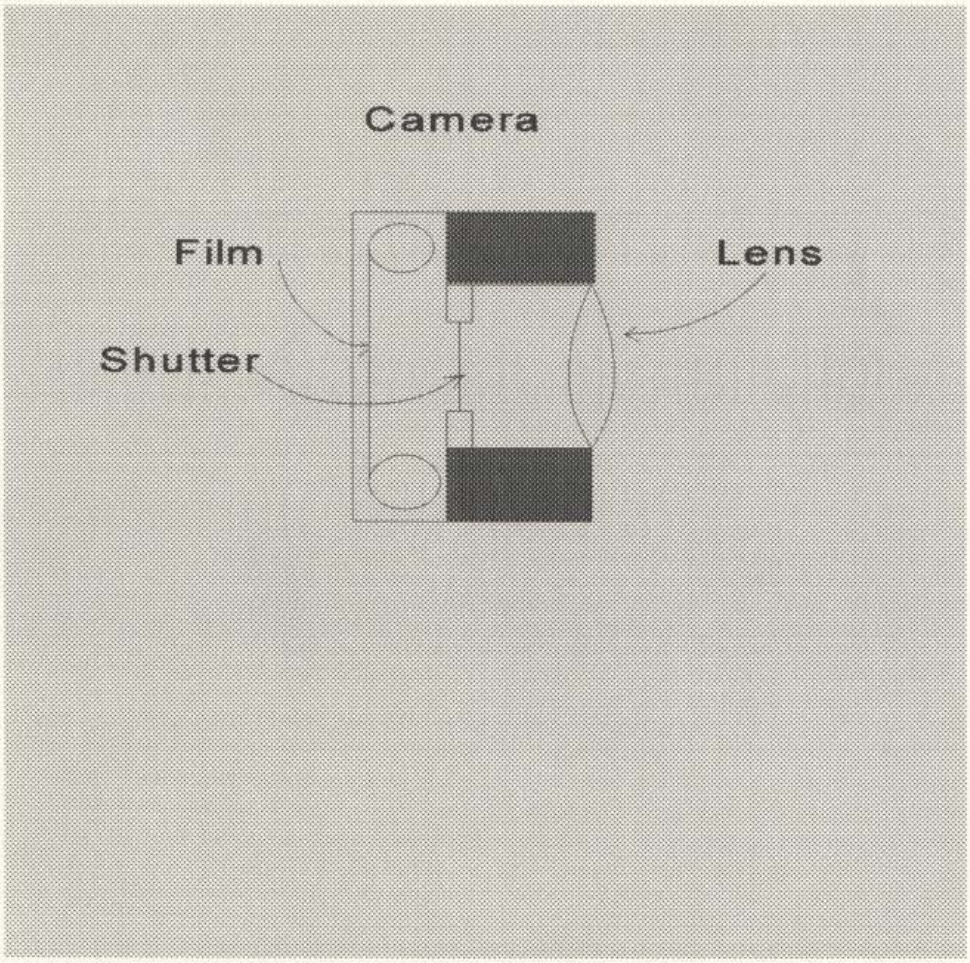
The Effect of Shutter Speed

and

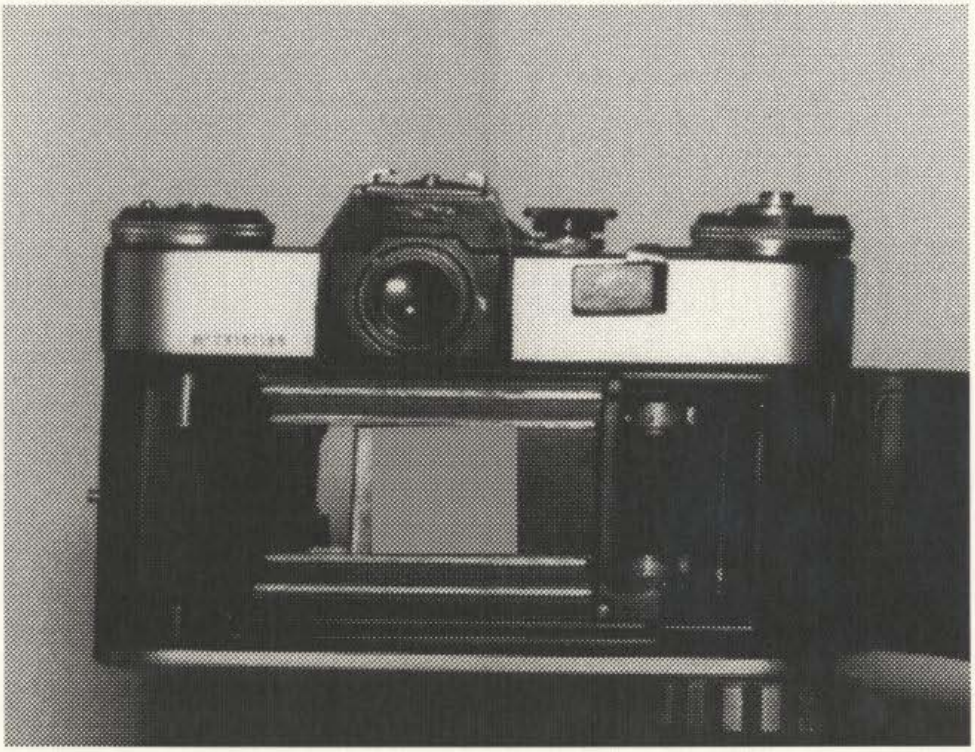
Movement

Shutter Speed

The second device is called the shutter.


Camera
Film
Lens
Shutter

This moveable shutter covers a rectangular opening immediately in front of the film and opens and closes quickly when the shutter button is pressed.



The shutter speed is usually set by turning a dial containing numbers on the outside of the camera or set automatically by an exposure meter device.


30
8
60
125
250
500

Shutter speeds range from around 1s to 1/2000s on modern 35mm cameras and like f-stops, each successive increment is 1/2 of the previous value, approximately. Common shutter speeds given in fractions of a second are: 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1,500, and 1/1000.

COMMON SHUTTER SPEEDS	FRACTION OF LIGHT REACHING FILM
1/30 s	2/1
1/60 s	1/1
1/125 s	1/2
1/500 s	1/4

The above table uses 1/60 s as a standard 1-unit of light.

Motion and Shutter Speed

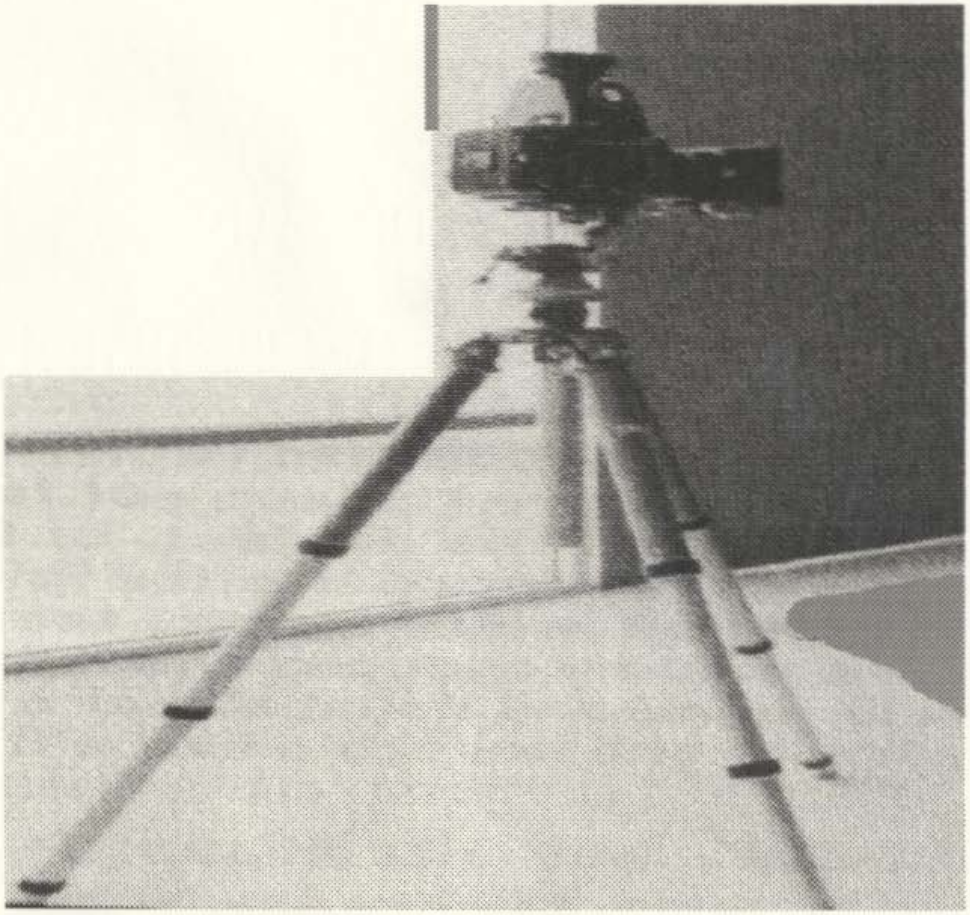
When the shutter speed is very slow (less than 1/60s) the image formed on the film remains there for a relatively long period of time, while the shutter remains open.

If the subject being photographed is moving during this time, the image on the film will also move slightly while exposure is occurring. The result is a photograph that is not "sharp" but rather fuzzy or blurred.

Note: From HOW TO TAKE GREAT PICTURES WITH YOUR SLR (p.127) by Lou Jacobs Jr., 1974, Tucson AZ: HP Books. Copyright 1974 by Lou. Jacobs Jr. Reprinted by permission.

Similarly, if the camera is moving, while the shutter is open, a blurred image will again result.

If however a sharp image is required and light conditions are dim, slow shutter speeds and large aperture openings are required. This is the time for a sturdy tripod.



APPENDIX 2

Test Instrument 1 (Recall 1 and Application 1:

Module 1

Multiple Choice Test Questions

1. The main function of the camera lens is to
   (a) focus light onto the film
   (b) reflect light toward the subject
   (c) change the color of the light entering the camera
   (d) limit the amount of light entering the camera

2. Which camera part has an adjustable opening?
   (a) focal length
   (b) f-stop ring
   (c) aperture diaphragm
   (d) film

3. F-stop settings may be used to control which one of the following?
   (a) shutter speed
   (b) lens focal length

(c) focusing distance to subject

(d) depth of field

4. Depth of field refers to

(a) distance between camera and subject

(b) distance from camera lens to film

(c) distance in sharp focus in the photograph

(d) distance from camera lens to shutter

5. An f-stop value of 4 will allow how much light to enter the camera?

(a) one quarter as much as f-stop 2

(b) one half as much as f-stop 2

(c) two times as much as f-stop 2

(d) four times as much as f-stop 2

6. Where would you find the greater depth of field?

(a) inside the camera

(b) in front of the subject

(c) behind the subject

(d) between the film and the aperture

7. If other factors are kept constant, depth of field increases as:

(a) f-stop increases and aperture opening increases

(b) f-stop increases and aperture opening decreases

(c) f-stop decreases and aperture opening increases

(d) f-stop decreases and aperture opening decreases

8. A possible depth of field at a given f-stop setting might be:

(a) from 3m in front of the subject to 3m behind the subject

(b) from 3m in front of the subject to 6m behind the subject

(c) from 6m in front of the subject to 3m behind the subject

(d) from 6m in front of the subject to 6m behind the subject

9. As the f-stop control ring is turned toward higher numbers:

(a) the aperture opening decreases in size

(b) the depth of field decreases

(c) the amount of light entering the camera increases

(d) the diameter of the aperture opening increases

10. Light entering a camera meets the parts of the camera

in the following order:

(a) aperture, lens, film

(b) lens, aperture, film

(c) lens, film, aperture

(d) film, aperture, lens

Test Instrument 2 (Recall 2 and Application 2:

Module 2

Multiple Choice Test Questions

1. The film in a camera is located:

(a) immediately behind the lens

(b) immediately behind the shutter

(c) immediately in front of the lens

(d) immediately in front of the shutter

2. The shutter is located:

(a) within the lens system

(b) between the lens and the aperture diaphragm

(c) between the lens and the film

(d) immediately behind the film

3. The shutter is designed to open and close quickly:

(a) limiting the size of the image on the film

(b) controlling the color of the image on the film

(c) limiting the time that light hits the film

(d) controlling the amount of light entering the camera

4. Shutter speed refers to:

(a) the speed with which the shutter release button is pressed

(b) the time taken for the shutter to open

(c) the speed of the light passing through the shutter

(d) the amount of time the shutter remains open

5. Shutter speed is set by means of:

(a) a dial on the outside of the camera

(b) adjustments on the camera lens system

(c) advancing the film

(d) pressing the shutter release button

6. Which of the following is the fastest shutter speed?

(a) ½ s

(b) 1/15 s

(c) 1/60 s

(d) 1/125 s

7. Fast shutter speeds are used to:

(a) increase the amount of time light is hitting the film

(b) reduce the possibility of fuzzy images

(c) give a feeling of motion to fast moving objects

(d) make a rushing stream look smooth

8. Slow shutter speeds:

(a) are usually used with dim light conditions

(b) are usually used with bright light conditions

(c) often produce the sharpest pictures

(d) often produce underexposed pictures

9. One advantage of using a tripod is:

(a) to help eliminate fuzzy images due to subject movement

(b) to help eliminate fuzzy images due to camera shake

(c) to allow for the use of fast shutter speeds in low light scenes

(d) to allow for the use of fast shutter speeds in fast action scenes

10. The two factors that contribute to blurred or fuzzy pictures:

(a) slow shutter speeds and tripods

(b) fast shutter speeds and race cars

(c) slow shutter speeds and camera shake

(d) fast shutter speeds and rushing rivers

APPENDIX 3

Letters of Permission:

Letters of permission were received from parents of all students participating in the study.

June 1996

TO: PARENTS OF GR. 9 SCIENCE STUDENTS

FROM: MR. RONALD BENNETT

Dear Parents:

I am presently completing a Masters of Education Degree at Memorial University of Newfoundland under the supervision of Dr. Glenn Clark.

Part of this program involves a study of the effects of the placement of pictures and diagrams within written text on student learning. It is hoped that the results of this study will be helpful in designing better textbooks and learning materials.

The study involves your child reading a number of very

short paragraphs relating to the operation of a camera and its parts, and viewing a number of pictures or diagrams related to the camera operation.

I therefore request your permission to allow your child to participate in this study and to use the results obtained in my research. No students' names will be mentioned in the report and any information about your child will remain completely anonymous and confidential.

Thanking you in advance for your cooperation.

Ron Bennett

Student name: _____

Parent(s) signature: _____

_____

Date: _____

Copy of letter of permission from Roman Catholic School Board to conduct research.

TELEPHONE (709) 753-8530 FAX (709) 7

Roman Catholic School Board for St. John's

BELVEDERE
67 BONAVENTURE AVENUE
ST. JOHN'S, NEWFOUNDLAND
A1C 3Z4

July 17, 1996

Mr. Ron Bennett
Box 62, RR#1
Bell Island
Newfoundland
AOA 4HO

Dear Ron:

I am pleased to approve your request to conduct research with Grade 9 Science students at St. Michael's High on the effects of the placement of pictures and diagrams within written text on student learning.

As you are aware, parental permission must be obtained before students may participate in the study. All gathered information on the identity of student, school and district must be kept confidential.

I wish you every success in your research.

Sincerely,

Maureen Dunne
Assistant Superintendent
Curriculum

/mstc

c. John Kent