University of Manitoba

TEXT BOOK ILLUSTRATIONS AND DESIGN: THEIR RELATION TO THE PSYCHOLOGY OF LEARNING.

Being a thesis submitted to the Committee on Post-Graduate Studies in partial fulfilment of the requirements of the Degree of Master of Education.

by

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V I T A

The writer, in undertaking this study, drew upon a background of experience gained both in the publication industry and in the teaching of young people. Contacts with engravers, printers and book binders in the actual production of books, and commissions in the design and illustration of three Manitoba science textbooks and a Canadian History text have materialized as valuable assets in the completion of this study.

Undergraduate work, projected in the field of Curriculum and Audio-Visual Education, and concentrated activity in the promotion of audio-visual education in the schools, organization of Junior and Adult Film Councils, and a possession of skills for the production of a wide variety of instructional materials, have made this study both interesting and valuable.

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Chapter 1

INTRODUCTION

Those who are engaged in writing and publishing textbooks have recognized a mutual basis with those engaged in the promotion of audio-visual education and the manufacture of equipment to make possible such education. This mutual basis is the responsibility of making the greatest possible contribution to the learning of the child.

This study has, as its general purpose, the relating of a brief background of the comparatively recent rapid development of audio-visual education and its relation to textbook development. Such is necessary to form a basis of thought which might stimulate action toward a broader cooperation between the educator and the book publisher.

Historically, first came the teacher and the pupils. Then came the textbook, which added to the knowledge imparted by the teacher. Following this came the school building and equipment and the pupils learned and retained more because of better environment. Later came the "pictured" textbook and the pupils' motivation to learn became greater. Through all of these periods, each a history in itself, there developed curricular improvements, teaching, techniques, environmental factors and an increasing use of models, maps, charts, and pictures. In other words, visual education developed with the other factors which create a learning situation.

However, audio and visual education could not develop as rapidly in parallel with these other educational factors. Printing and photography made possible the rapid advance of the textbook from its elementary form to its present content of interesting, well illustrated subject material. Similar progress in audio and visual education was forced to wait for the rapid development of electronic science of the past two decades to demonstrate its full force as a motivating educational factor. Since this scientific development, educators have become keenly interested in audio-visual aids to instruction. The educational motion picture has received particular attention. So have the potentialities of radio and television. Teachers have increased the use of other instructional materials familiar to them, such as filmstrips, slides, models, flat pictures, and recordings.

Enthusiasm for audio-visual instructional material was heightened during the recent world war. Service training programs successfully used these aids to obtain speed in instruction without sacrificing quality. Techniques were developed which were both efficient and effective. Civilian educators observed the results and were stimulated to increase the use of instructional materials of this type in the schools.

Now the flurry of excitement is passing. Educators are still enthusiastic about audio-visual aids, but in addition are taking more constructive steps in the field. A recent yearbook of the National Society for the Study of

Secondary Education has been devoted exclusively to "audio-visual aids to instruction". At several colleges and universities, research students are investigating various aspects of the problem. Producers of equipment and materials are expanding their operations. Contributions to the trade magazines and other periodicals include studies made by teachers in real teacher-learner situations. There seems to be an enlarging concept of the field and a movement to apply scientific analysis to its problems.

This trend is a good one. But there is a tendency to obscure some aspects of the problem in the light of the more glamorous motion-picture, radio, and television phases. The scope of audio-visual aids includes a wide range of materials and techniques, each of which has important contributions for the teaching process. The important factor is that the audio-visual aids are supplementary and do not supplant either the teacher or the textbook. The closer and better integrated these factors are to each other, the more effective will be the teaching and the more effective will be the teaching situation. The illustrations that vitalize today's textbooks have become increasingly important. These, together with the design of a book, have been chosen as the basis of this study. In addition, since principles derived from the psychology of learning are an integral part of the utilization of audio visual materials, this study would afford an opportunity to observe relationship between them.

Therefore, it was the purpose of this survey:

1. To obtain a general background of information concerning textbook illustrations;
2. To determine the main aspects of the textbook illustration problem as derived from both research and opinion;
3. To examine specific research studies in this area as to purposes and results;
4. To note investigation techniques employed in the research;
5. To relate the findings of the survey to principles in the psychology of learning.
6. To compile factors which make for good book design with respect to type, layout, size, paper, jackets, press work, binding and other aspects of book planning.
7. To classify art-techniques of book illustration based on the historical development of the reproductive process, noting efforts to develop the newer teaching pictures.
8. To examine current processes used in the graphic arts with a view to classifying the economics of book production.
9. To arrive at some generalizations related to the problem.

The survey was limited to the more recent literature concerning textbook illustrations and related topics deposited in the University Chicago's Department of Education Library. The Education Index was used as a guide to articles in periodicals published since 1930 through 1948. Other material was found in books related to the audio-visual field. In addition, a brief survey was made of textbooks on

file in the curriculum library of the Manitoba Department of Education.

The body of this paper is divided into nine sections. Each section summarizes the findings concerning one of the purposes listed above, and in that order. A brief summary of the whole problem is included at the end of the paper.

Instead of footnotes, a system of numbers is used to make references. For example, (10:235) indicates the tenth (10) references listed in the accompanying bibliography, and specifically to page two-hundred-thirty-five (:235) of that reference.

Frequent reference is made, in Chapter VIII, to illustrations and the format of the newly published textbook "Science Indoors and Out Book III" for which the writer had prepared the greater portion of its illustrations and page design. Some original photographs and some photostatic reproductions of line drawings from the book have been imposed on the pages of this paper; additionally, a copy of the actual textbook has been provided so that illustrations can be studied in relation to the text and page layout, which together form the frame of reference.

Chapter 11

THE NATURE AND PURPOSE OF ILLUSTRATIONS.

What is the history and purpose of textbook illustrations?

According to an article by Good, the first illustrated schoolbooks appeared about 1460 shortly after printing came into general use (13:338). Many kinds of books were printed at that time, including geography, travel and nature books. These needed explanatory pictures to make the text clear and vivid. Pictures had a functional purpose.

Early illustrations were copied from old manuscripts. These pictures were transfered to woodcuts which could be used in the simple processes of that era. But down through the tradition of hand-copying these manuscripts, the pictures had become less and less representative of the original meaning. So by the year 1500, artists were drawing directly from nature for the woodcuts used (13:339).

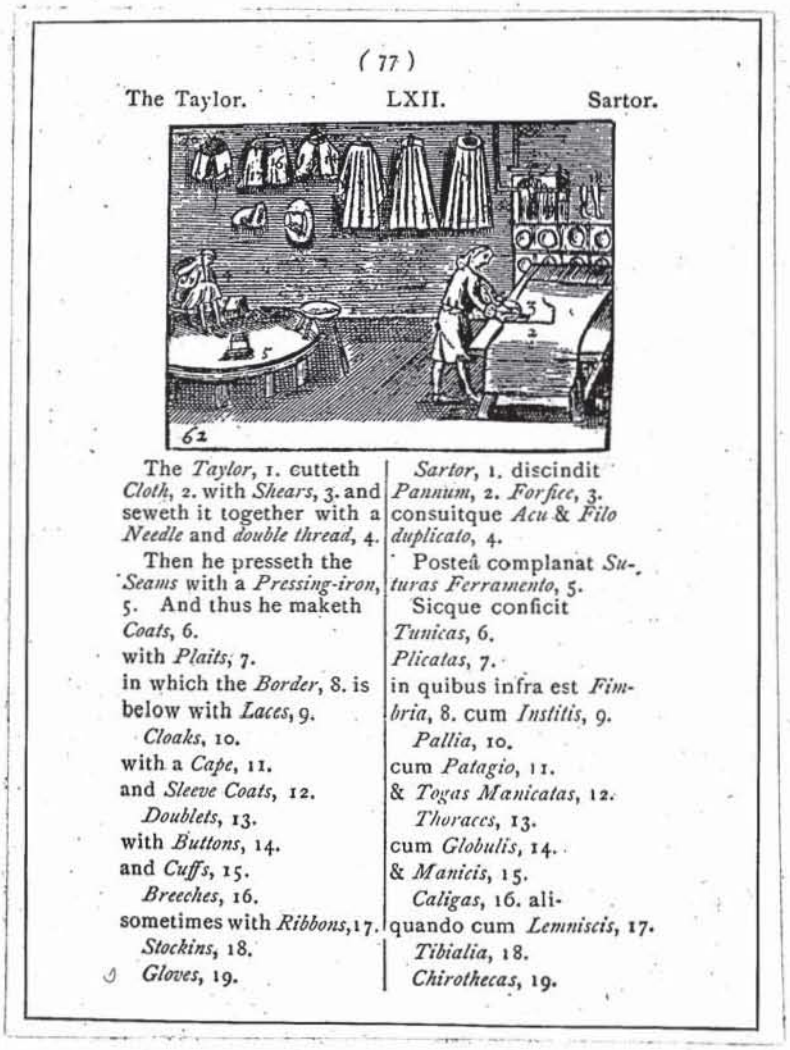
Early popular books included many illustrations, and many kinds of illustrations. DER EDELSTEIN, 1461, was a collection of fables with 101 woodcuts. A few years later AESOP appeared with 200 pictures. In 1478 Ptolemy's COSMOGRAPHIA had maps. The same year Braybenback's PILGRIMAGE, a famous travelbook, included many pictures to illustrate foreign lands. In 1488, John Widman, a German, printed the ALGORITHMUS LINEALIS, showing illustrations of commercial customs and exchange, geometric diagrams, various tables and

examples of arithmetic operations. Three years later PICTOGORIS ARITHMETRICE INTRODUCTOR was published in Florence, Italy, which included thirty-nine illustrated problems. About the same time SUMMA was printed as the first work to illustrate finger symbolism of numbers, with thirty-six positions of the fingers and hands shown. The first printed EUCLID had 420 diagrams in the margins. Music books of the time included both music scores and pictures. Even Latin grammars were illustrated and in 1545 Henry Vlll authorized the Primer with religious pictures. Hence, comenius' ORBIS PICTUS which appeared later was not the first illustrated school book as is sometimes supposed (13:343).

Comenius' ORBIS PICTUS (Fig. 1) appeared in 1638. It was notable because of the innovation of the use of pictures in a direct method of teaching Latin. The Puritan movement also produced the famous NEW ENGLAND PRIMER, an important influence. The PRIMER included twenty-four pictures to illustrate the alphabet (26:7).

During the 18th century, in Britain, there were evidences of the importance of book illustration. John Newberry was famous for his little flowery and gilt books for children. Famous, too were Thomas Bewick's TOMMY TRIPS' HISTORY of BIRDS and BEASTS for CHILDREN, and William Blakes' SONGS of INNOCENCE (26:8).

Since the middle of the 1800's new artistic trends appeared in book illustrations. In 1860, Walter Crane originated a series of 'toy books' for children and Howard Pyle,



(77)

The Taylor. LXII. Sartor.

The *Taylor*, 1. cutteth *Cloth*, 2. with *Shears*, 3. and seweth it together with a *Needle* and *double thread*, 4.
Then he presseth the *Seams* with a *Pressing-iron*, 5. And thus he maketh *Coats*, 6.
with *Plaits*, 7.
in which the *Border*, 8. is below with *Laces*, 9.
Cloaks, 10.
with a *Cape*, 11.
and *Sleeve Coats*, 12.
Doublets, 13.
with *Buttons*, 14.
and *Cuffs*, 15.
Breeches, 16.
sometimes with *Ribbons*, 17.
Stockins, 18.
Gloves, 19.

Sartor, 1. discindit *Pannum*, 2. *Forfice*, 3. consuitque *Acu* & *Filo duplicato*, 4.
Posteâ complanat *Suturas Ferramento*, 5.
Sicque conficit *Tunicas*, 6.
Plicatas, 7.
in quibus infra est *Fimbria*, 8. cum *Inſtitis*, 9.
Pallia, 10.
cum *Patagio*, 11.
& *Togas Manicatas*, 12.
Thoraces, 13.
cum *Globulis*, 14.
& *Manicis*, 15.
Caligas, 16. aliquando cum *Lemniſcis*, 17.
Tibialia, 18.
Chirothecas, 19.

FIG. 1 -- This page, from Comenius' ORBIS PICTUS, shows the earliest known use of illustrations as a teaching instrument.

artist of the late 1890's, inspired in his students a development of book illustrations for children. During the twenties, illustrators began to use a 'modern' treatment, savoring the more decorative rather than the realistic (26:8).

The combination of art trends and technological improvements greatly influenced book illustrations. Up to the 19th century the sole method of reproducing illustrations was engraving. This was supplanted in the early Victorian period by line drawings some of which were hand colored.

In the 1860's a wood-block process for color printing evolved. Then in 1852 the half-tone process was invented for black and white, and twenty years later for color. The invention of the halftone process was one of great importance in the development of printing and bookmaking. Fox Talbot conceived, in 1852, the idea of a screen, using at first an open-weave fabric to break up the picture. In 1879 Joseph Swan, in England, patented a screen ruled in one direction which was moved during the exposure to obtain a cross-ruled effect. The perfection of the half tone process waited, however, on the development of a cross-ruled screen. Max Levy, of Philadelphia, made a ruling machine accurate enough for the ruling of satisfactory screens. In 1886, Ives used two such screens at different angles, sealed face to face, thus producing the cross-ruled screen which is in general use today. It is pleasant to report that almost all halftone screens are still made by Levy. Lithography was im-

ported from Germany, improving quantity production. Finally electrotyping was introduced, which reproduced practically every medium an artist wanted (26:9).

Thus illustrative techniques have been vastly improved. Even the texts of three decades ago are dull compared to those of today. Changes in format, typography, and illustration have made the textbook more attractive and interesting. Wood cuts are sometimes still used, but modern lithography and photography provide a medium which would amaze the old manuscript artist. Color process in photography and printing make it possible to reproduce exact and lifelike pictures which vividly portray their purpose. The artistic possibilities are well exploited.

Since these early beginnings, illustrations have apparently always been an integral part of most schoolbooks. Today, an examination of textbooks reveals a profusion of pictures and other illustrations. Charts, graphs, diagrams, tables, line drawings, photographs, decorative paintings, and sketches abound.

The original intent of illustrations in schoolbooks seems to have been the functional purpose of clarifying and supplementing the text. That the pictures were also works of art was incidental to the main purpose. However, in the evolution of books and printing techniques, emphasis on artistic aspect of illustration increased.

Eventually both art and function became the criteria for choosing illustrations for textbooks. With the advent of color processes and other improvements art took the fore, and

pictures became less related to the text material. Osbervations by teachers that children were paying little or no attention to the illustrations during study periods led to a growing conviction that they were of little value in texts. In 1939, two good publishers admitted they had no criteria for selecting illustrations other than the intuitive judgment of the authors and editors (21:17). But more recently there has developed a trend the other way. In 1945 King said: "It is interesting to note the discrimination with which modern textbook-makers select pictures. They are definitely a part of the text itself and are used as teaching devices. There possibly will be a wider and even more discriminating use of photographs and other illustrative material" (22:9).

It is reasonable to assume that both art and aid to clarification are important criteria for textbook illustration. Learning ought to be pleasant to be effective, and concrete where possible. Text illustrations can serve to do both. The two major attributes of any textbook are its content and its appearance. The successful textbook must have high quality content and an attractive format. Today books are to be studied and appreciated (41:298).

Two purposes of textbook illustrations should be to give (1) visual satisfaction and (2) visual aid to understanding. Zisman says illustrations should be functional in content and functional in visual arrangement (44:219). He goes on to say: "Illustrations should be the means of making more

concrete whatever may be difficult or elusive in comprehension because of abstraction or vagueness". Orth points out that texts have led to an emphasis on memory, and that in order to get more observation and comparision books need illustrations (37:444). Modley states that most American people are literate, but that the ability to read and the ability to understand are two things. Pictures help the reader to understand books (35:152). Grossnickle suggests that the function of the picture in textbooks is principally to enable the pupils to form concepts and acquire information through visual aids, rather than the printed page (15:50). Today educators are generally agreed that illustrations can contribute to textbooks. That illustrations should contribute both to the attractiveness of the book and to aiding understanding of the reading material is also generally agreed upon. There seems to be no question about the main purposes of textbook illustrations.

Chapter III

POINTS OF CONCERN ABOUT ILLUSTRATIONS

What are the main points of concern about textbook illustrations? It is often true in education that theory and practice do not coincide. The literature bears this out in the case of textbook illustrations. Both the "armchair" articles and reports of research suggest that there is much to be desired, particularly concerning the functional relationships of illustrations and text content.

During the past decade, designers of books have greatly improved the appearance of books. Principles of good art, design and layout are evident. But there is a need for similar application of a set of principles to illustrations as visual aids.

Several points of concern are raised about book illustrations. Some have been investigated in research studies. Others remain to be examined. A closer analysis might bring to light more issues which have not been discussed in literature sampled but the literature implies the major aspects of the problem are as follows:

What are the objectives of illustrations in textbooks?

What are some ways to classify illustrations?

What are adequate means of evaluating illustrations?

What are some principles for layout of illustrations?

What should be the criteria for selecting illustrations?

How effective are illustrations?

Do students use illustrations? Do teachers?

What are children's preferences in illustrations?

How can the teacher best use illustrations to make the textbook a most effective teaching tool?

How can educators and publishers get together on the problem?

CONTRIBUTIONS OF RESEARCH

What research has been done which contributes to the textbook illustration problem?

In the literature sampled, but few research studies were found which could make useful contributions to the illustration problem. However, these have shed some light on particular aspects, and point the way to further experimentation.

A study by Good has already been mentioned (13:--). He unearthed some interesting facts concerning the historical background of schoolbook illustrations. That this study was limited to the very first examples is apparent. Martin gave only a brief background sketch (26:--). Perhaps it would be useful to conduct a study which would trace more adequately the background of illustration from its beginnings. Past experience is a useful source of data.

CLASSIFICATION OF ILLUSTRATIONS

A means for classifying illustrations has been worked out by Grossnickle (15:84). He divided them into

three groups:

(1) decorative
(2) associative
(3) functional

He defines the first groups as those which attract the eye for a cursory look, but make no other contribution. The second type associated with the text in some way, but only indirectly. A functional picture is one which is directly connected with the text, either by supplying the same data as the text, in which case it is static or by bridging the gap with questions, in which case it is dynamic. His study of arithmetic books shows that only a small percent. of the pictures are of the functional type. The majority of illustrations are associative or decorative. In a study of biology texts, Neal classified illustrations on the basis of type and quality (36:267). "Representative" illustrations were those which were as "accurate as possible". "Analytical" types emphasised parts, such as cutaways and symbols. The rest were included in two groups: charts and tables; maps and graphs.

SPACE ALLOTED TO ILLUSTRATIONS

Some studies include an analysis of how much space is alloted illustrations in textbooks. Kambly, in an examination of science textbooks, found that about one-quarter of the total space was used (12:17). Melbo and Waterman found about one-third of space was given to illustrations in their study of geography texts. (28:365).

Neals investigation of biology texts revealed that twenty-three percent of the total space was used for illustrative materials of all types (36:268).

EFFECT OF ILLUSTRATIONS ON COMPREHENSION

The effect of illustrations on comprehension has also been investigated. Halbert found that pictures do contribute to comprehension (16:44). She tested three groups, using a story alone, illustrations alone, and a combination of illustration and story. She concluded from the results that children get more relevant ideas by using the illustrated story than by the other method. Pictures alone aroused a greater variety of ideas, but pictures directed by reading material increased relevant ideas -- a possible point in the selection of illustrations.

DO ILLUSTRATIONS AID ACHIEVEMENT?

Kambly's study includes an investigation of whether illustrations properly used by pupils and teachers aid achievement. He concluded that they do, provided the teacher helps the students learn how to study the illustrations in their textbooks (21:19). On the other hand, in a text with primary readers, Miller found that children did as well in reading with or without pictures. However, he pointed out that though illustrations may be necessary to get comprehension, this is not an argument against using them (33:682).

HOW PEOPLE LOOK AT PICTURES

Two significant research studies contribute objective data on how people look at illustrations. Buswell made photographic records of eye-movements to determine the fixations people make in viewing pictures. He found that an individual makes a general survey of sweeping moves if he just "looks" at the picture. But if he studies the picture, then the general survey is followed by detailed movements. Buswell also found the same perceptual pattern for children and adults. He draws two inferences:

(i) if teachers require a general survey of the picture as a whole, this may be so satisfying that the student will not study the picture.

(ii) if attention can be centered, the teacher can induce the child to study the picture until he can call it his own.

"The problem of teaching is partly that of transforming the simple survey types of perceptual experiences into the analytical types which give satisfaction and enjoyment." (7:426). Brandt made a similar study using ocular photography, which includes a treatise on evaluating advertising layouts. He points out the relative importance of size, color, isolation of elements, implied motion, and arrangement of layout for the attention given by ads by the reader (4:55-111).

Nearly all the research studies state a conclusion that if pictures are to aid the understanding of printed materials, the attention of children must be directed to important items in the picture, and to interpretation of these items. Cropper found that with instruction children see relationships, but without it they see the picture in terms of facts only (5:--).

CHILDREN'S PREFERENCES

Children's preferences concerning illustrative material have been the focus for several studies. Miller made a study of the picture choices of primary grade children (32:273). He found that pictures in full color ranked in choice. Photographs were chosen above wash drawings, line drawings, and other mediums, and this tendency increased with age. Hall found that a group of high school science students preferred cartoons, diagrams, and photographs in that order. He noted that inexperienced students made up the majority of those who chose cartoons and photographs, whereas older students with several courses in science preferred diagrams (17:--). Children definitely preferred color to black-and-white, and a realistic treatment to conventionalized style, according to an investigation by Mellinger (29:--). Hildreth also found a strong preference for colored pictures over monotone, outline, or silhouette (18:435). Martin, too, discovered color to be an important factor, younger children

choosing bright and older children softer tints. She found other factors influencing choices. Pictorial content presented realistically was most important. Decorative types were not popular, nor were silhouettes. Humor was enjoyed by all grade levels. Children with art experience showed no marked difference in choices. Intelligence made little difference in first choices (26:--).

It is apparent that many points of concern about textbook illustrations are unanswered by research and investigation. The few studies reviewed above are a start. Table I on the following page, indicates aspects which were considered by each author. Certainly much more could and should be done.

TABLE I

ASPECTS OF TEXTBOOK ILLUSTRATION CONSIDERED BY AUTHORS REPORTING ON RESEARCH

	Reference No.	Layout	Perception	Historical	Classification	Comprehension	Children's Preference	Selection	Evaluation	Teacher Direction	Student Use
BRANDT	4	X	X								
BUSWELL	8		X								
CROPPER	9									X	
GOOD	13			X							
GOODYKOONTZ	14					X					X
GROSSNICKLE	15	X			X						
HALBERT	16					X					
HALL	17						X				
HILDRETH	18						X				
KAMBLY	21	X				X					X
MARTIN	26			X			X				
MEADOR	27					X					
MELBO	28	X			X						
MELLINGER	29						X				
MILLER	32						X				
MILLER	33					X					
MILLER	34						X				
NEAL	36	X			X						
TROLINGER	40							X	X		
WAYMACK	43						X			X	

Chapter IV

RESEARCH TECHNIQUES RELATING TO TEXTBOOK ILLUSTRATIONS

What techniques of investigation were employed in the research related to textbook illustration?

A variety of techniques were used in the research studies summarized here. It might be useful to mention these in the event further studies along similar lines are contemplated.

A questionnaire survey of "ninety-five percent" of the publishers in the textbook field was made by Buck. He "sought comments on selected influences aiding and retarding textbook recovery" (5:25). He claimed a seventy percent return, which is unusual for a questionnaire type of investigation, though he did have a highly selected group.

In four of the studies a "quantitative" technique was used. Neal examined eight high school biology texts according to criteria of kinds of illustrations. He counted and classified the kinds, and tabulated the data in percentages, determined by dividing the total number of square inches in the book (36:--). Kambly analyzed several science books in a similar fashion, by measuring the amount of space given to illustrations and expressing the results in percentages (21:--). Grossnickle made a more detailed analysis of eight series of arithmetic texts. He set up

some criteria for kinds, for sizes, and for color in illustrations. He made a count and tabulated the data by number and percent (15:--). Melbo and Waterman used the same technique with geography texts, counting the number of illustrations classifying as to types of scenes, classes of pictures, legibility and attractiveness, and up-to-dateness (28:--). This sort of technique is relatively simple and could be applied in various other subject areas to determine the status quo in textbooks. Some aspects of illustrations can be measured quantitatively in this way, but it is doubtful whether an extensive use of this kind of study is merited in terms of the usefulness of the results.

Kambly devised a method of determining whether students really used pictures in texts. He devised a test on items in the pictures containing in five pages of biology textbooks. A group of students was asked (without emphasis on the pictures) to study the pages. They were given a surprise test, being told it did not count on their grades. He then determined the percentage of current responses (21:--). In another investigation, Kambly tested two groups of students of three classes each. The first group used an illustrated text, and the second mimeographed material identical to the text, except for necessary re-writing where the text referred to illustrations. A pre-test was given on the text copy. Then the groups studied the materials over a period of three weeks, during which the same teaching procedures were used with both groups.

The pre-test was given again as an achievement test, and the two groups were compared (21:--). If the latter technique were carefully controlled, and the groups closely matched, possibly more significant data could be obtained.

Trolinger devised a score card for evaluating flat pictures. She secured the cooperation of a battery of experts in the audio-visual field in making the card. These judges were later asked to grade a set of pictures, ranging from 'good' to 'bad'. These pictures were given to a group of teachers to be graded with and without the use of the score card. Medians for the three groups of data were compared (40:--). The great weakness of this technique is the extreme subjectiveness involved. Trolinger suggested that the wide individual variation found shows a need for standards that are based on more objective analysis.

Miller selected a group of twenty-five pictures covering the various media of photography, line drawings, wash drawings, and color. Three hundred primary grade children were asked individually to indicate their preferences. The number of choices in each category was tabulated, and conclusions drawn from these data (32:--).

In another study Miller used the multiple group technique to find if pictures aid comprehension in reading. Six hundred children were equated according to reading ability, as determined by standardized reading tests. "picture" and "non-picture" groups were formed. A set of

widely used primary readers were divided, one group using books as they were, and the other using books with paper pasted over the pictures. Comparisons of the groups by individual stories and on the total book were based on tests on words, ideas and concepts. Matched groups were compared as to means, standard error, and standard deviation (33:--). Though the study seems to have been conducted with a fair degree of expertness, there is a question of its worth on the basis of the fact that fifteen different teachers involved could not teach in precisely the same manner.

Miller used another technique in testing one hundred third grade children to determine what children see in pictures. He selected six pictures from books and analyzed them for their content. A check list of these items were used by the examiner in questioning individual children. The children were classified as to sex, C.A., and I.Q. A comparison was made of the total number of items and number of generalized items identified (34:--). There did not seem to be any allowance for possible variation in the backgrounds of children as related to the content of the pictures used.

Waymack and Hendrickson used a similar technique in testing the effect of teaching "appreciation" on children's preferences in pictures. Four pictures were selected from composite lists for grades four, five and six. They were judged as to artistic quality by a jury

of teachers in each grade. The experimenters presented the pictures to groups in natural activity situations. The children chose one of the four pictures and wrote why. Responses in both cases were tabulated and compared with the jury's choices as well as each other (43:--). A rather 'loose' technique. How valid were the standards set by jury? Choice was among only four pictures - a definite limitation. There was probably a "familiarity" effect operating on the second choice aside from "learned "appreciation".

Good's study possibly could be classified as historical research. Actually it seemed to be a summary of literature. There was no indication of a true historical investigation, in the sense that primary sources were used (13:--).

Goodykoontz examined old texts to find out if children look at illustrations when reading textbooks. She tested 294 children in grades six to eight. Children were asked to read illustrated material, without mention of the pictures. Then they answered questions on both pictures and the copy. The tests were analyzed in light of the hypothesis that most children do not make use of the illustrations. About half did not. This was obviously a rather informal kind of technique, from which only limited conclusions could be expected (14:--).

Halbert used a multiple-group technique. She equated three groups of rural children on the basis of reading age. Each group was divided on three reading levels. The groups were given a series of stories with

illustrations, stories without illustrations, and illustrations alone. Verbatim responses of the children were recorded and classified by subjective judgment according to a previously determined set of criteria. These data were then compared (16:--). Conclusions drawn from such data would certainly be limited due to the strong subjective factors operating.

Meador used the multiple-group technique in a manner much the same as Halbert's. Ten filmstrip units of about twenty-five views each were assembled with informational leaflets on each unit. Over a period of eleven weeks the ten lessons were given successively to intermediate level groups in three schools. The procedure was to give the test immediately following the lesson, and test again one week later for retention. School A was given an exclusively verbal lesson; school B, the verbal lesson followed by the filmstrip without discussion; and school C, a combined verbal-visual lesson with discussion. The number of correct test responses was tabulated for the score. Medians of the groups were compared (27:--). The practice of using the same test for gain and retention is a weak feature of the study. Another form of the test should have been used to avoid a practice effect. Subjective equating of groups is also a weak aspect, tending to invalidate the comparison of medians.

Martin used individual case studies as a preliminary to defining the aspects of pictorial content,

familiarity, pictorial treatment, and process of reproduction. Some sixty books were selected which covered these aspects of illustrations. Three groups slicing through seventeen schools were asked to fill out a score card in making choices of pictures presented by the investigator. The data were worked up in percentages to compare the groups (226:--). Apparently a well-planned study, but the technique has many subjective factors, both from the viewpoint of the several investigators differing in testing skills and the ability of young children to fill in a score card accurately.

Hildreth devised a battery of color and picture choice tests to use with children aged three to six. The children were shown colored papers, asked to name the color, and to choose the one color they liked best. Verbatim responses were recorded and analyzed. In the picture preference test the child was asked to choose the best subject and the best color among several renditions of the same subject. Verbatim responses were analyzed as a basis for conclusions (18:--). Hildreth points out the weakness of the study -- the sixteen pictures selected by the teachers to be representative made possible only a narrow choice by the children.

Buswell's study was the rigorous experimental type. Special ocular photographic equipment was designed to record eye-movements of individuals as they looked at various kinds of pictures. A trace of movements

was recorded on motion picture film. This was then analyzed as to fixations on elements in each picture. Charts were constructed to show the movements of the eyes from one element to another in each picture. Both adults and children were tested. Comparisons of individuals and groups were made (8:--). More studies of this kind might be applied to particular aspects of the illustration problem.

The above examples of investigative techniques indicate a variety of approaches to the textbook illustration problem. Questionnaire, quantitative analysis, single group, multiple group, and individual interview methods were employed.

Whatever techniques are used, they should fit the purpose of the study. Where broad implications are desired, an informal study is probably warranted, provided the limitations are clearly recognized. A more rigorous method must be used when specific information is wanted. A complicated study should not be conducted for simple purposes, nor vice-versa. The kind of data sought will largely determine the kind of technique to be used. A method ought not to be used just because it is "scientific" perse.

Chapter V

IMPLICATIONS FROM THE PSYCHOLOGY OF LEARNING FOR ILLUSTRATIONS

What are some implications of the psychology of learning for the textbook illustrations?

Learning results when there is a change in behaviour due to experience. This change in the learner's behaviour is greatly influenced by the type of obstruction he encounters in his drive toward a goal. Teaching involves suggestion of experiences to the learner which will help him achieve his goal. These learning experiences are best when the sequence advances from the simple concrete to the complex abstract, for meanings are ultimately derived from concrete, perceptual experiences.

Most of our learning depends upon reception, or sensory experience. Meanings depend largely on the kind of sensory patterns the learner has developed. These patterns are modified with learning, so that the individual develops sensory 'cues' which he associates with certain meanings. The sensory perceptions are crude in children, but can be improved with training. A child's attention to perceptual stimuli favors intense, changing, novel and moving things. He is easily distracted, but with sufficient interest and variety his attention can be sustained.

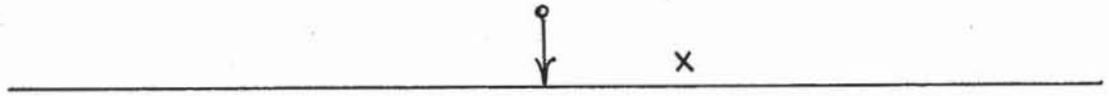
These generalizations about learning have implications for all instructional materials, including

textbook illustrations.

Illustrations are a means to an end. In the larger sense, the end is a particular type of pupil behaviour. If the illustrations are good, they will bring about the desired change more quickly and more effectively.

The design and selection of illustrations should be determined by the specific types of behaviour that are to be brought about by them. In other words, the objectives, once established, will determine criteria for design and selection of illustrations.

A visual continuum might show how illustrations are related to a scale of concreteness and abstractness. At the left end of a line concrete experiences are placed; abstract experiences are placed at the right end.



A real experience involving seeing, hearing, touching and smelling an object would be placed near the left on the continuum. Reading or hearing about an object would be located near the right. An illustrated story about an object would be placed between the center of the continuum and the right extreme at about point "x". By adding illustrations to reading material in textbooks, the learning experience is made more concrete.

The meaning of words read or spoken is ultimately derived from perceptual experiences with objects or operations represented by words. Illustrations provide a greater degree of perceptual experience, which facilitate comprehension of meaning in the textbooks.

Principles of learning have been operating in the background right along in the use of illustrations. Pictures provide a more varied activity in problem situations, -- such activity is a means for a larger part of learning. Pictures provide repetition of meaning, which is important to progressive modification of meaning. Pictures help motivate learning by making books more interesting and pleasant. And pictures help develop meaningful relationship -- the real essence of the learning process. An awareness of these operating principles on the part of educators and publishers would contribute to the improvement of textbook illustrations.

Decisions regarding illustrations to be used will depend on many factors inherent in learning. The following factors are important.

1. What particular behaviour changes does the teacher want to bring about?
2. What possible types of illustrations are available?
3. What is the unique contribution of each kind of illustration?
4. Will the illustration provoke an active response on the part of the learner?

5. Are teachers familiar with the types of illustrations and their use?
6. Are teachers willing to use them in teaching?
7. What is the relative cost and difficulty of production when illustrations of equal learning and teaching value?

These factors suggest others when applied to practice in designing and selecting illustrations for textbooks.

Recently, in connection with a course in audio-visual aids given at the University of Chicago, a group was concerned with developing criteria for selecting teaching pictures. Notes of the discussion revealed several considerations which should have implications for text illustrations. These are as follows:

1. Reproductions should be clear and accurate.
2. The person who is choosing the pictures must be clear about his objectives; i.e., what he is trying to teach, and choose the picture accurately.
3. Captions under the picture or questions under the picture, or at the end of the chapter should be included to draw attention to the significant points in the picture.
4. The picture should contain many details or only a few significant and related items, depending on what the picture is trying to show, and whether

it precedes or follows the verbal material which it illustrates.

5. Whether or not illustrative pictures are to be used depends on whether the teaching objective is to communicate certain ideas and information, or whether the objective is to teach reading skills so that students can learn from writings that are not illustrated.
6. There are varying points of view on whether pictures should be located:
   (a) near the verbal material and serve to illustrate it;
   (b) before the verbal material so that the picture can serve as an attention getting and motivating device to make the student want to read the material and find out more about the picture; or,
   (c) after the verbal presentation to serve as a summary where the student can identify or trace the things he has learned.
7. The idea should be presented clearly, so that it can be verbalized by the student.

Certainly, if illustrated textbooks are to be really effective teaching tools, value judgments about them should be made in terms of the principles of learning.

Selection and utilization of illustrations are definitely related to them.

Chapter VI

GENERALIZATIONS FOR FURTHER STUDY OF PRINCIPLES FOR TEXTBOOK ILLUSTRATION

What are some generalizations related to the textbook illustration problem?

This survey indicates a need for much more work in this particular phase of instructional materials. Presumably there will be work done. It might be useful to consider some broad ideas which have come out of this study in a further investigation of the topic. At this writing the following generalizations seem evident:

1. Illustrations in textbooks are visual aids, and can be treated as such.
2. The principles of learning that apply to all visual aids apply to illustrations.
3. Certain important principles of learning can be directly applied to illustrations.
4. Principles developed in regard to selection and utilization should be in terms of the particular objectives for illustrations.
5. A continuous re-evaluation of data acquired is a necessary and useful procedure in developing principles that can be practiced.
6. Emphasis should be placed on obtaining objective rather than subjective data in studying the problem.
7. One aim of further investigation should be to

gather information which will contribute to greater cooperation between educators and publishers.

8. The real responsibility for improving textbook illustrations lies with the educator.

THEORETICAL CONSIDERATIONS

Preceding sections of this paper deal with a summary of material that applies to the textbook illustration problem. Some broad generalizations seem to be implied. But generalizations are useful only if they provide some sort of structure within which to operate. Reflection on the preceding evidence, or lack of it, suggests theoretical considerations which might be useful in a future investigation.

Quite obviously, the problem is closely tied up to the question of how we learn. A structure must be based on some concept of the learning process. A brief statement is pertinent here, first, as a broad orientation. This concept can then be applied to the specific text illustration problem.

THE LEARNING PROCESS

Learning involves two essential factors: the individual and the individual's environment. There can be no learning without these.

The environment is a total thing, composed of a number of elements. These elements are differentiated in

various ways, but regardless of how they are defined, certain ones can be resolved into organized patterns. This occurs through the interaction of the individual with his environment. The patterns are specifically different for each individual, but two or more individuals can have generally similar patterns.

Actually, the environment exists only if the individual perceived it.

The individual, by nature, has two fundamental attributes. He has "senses" by which he makes contact with elements of his environment. He has "reasoning powers" by which these perceived elements are integrated and formed into ideas and concepts. These attributes are not mutually exclusive -- rather they are integral parts of the learning within the individual.

Learning is also characterized by factors of place and time. The place where an interaction occurs between the individual and his environment is a learning situation. Learning is continuous in time, but at any moment a situation is always in present time.

Further, there is purpose in learning. The individual interacts with certain elements of his environment with some purpose or goal in mind. The purpose is relative to the needs of the individual, physiological and intellectual, but is always there to some degree.

The continuous interacting of these factors is a process called experience. This experience is the learning

process.

Experience involves the past, the present, and the future. Actually, the individual exists only in the present. But all of this learning is based on what he has learned in the past. That is, in each new situation the sum total of his past experience is brought to bear on his present experiences. Yet the aspect of purpose in his experiences involves the future. Purposeful learning is a continuous process of building present experiences on past experiences in view of desired future experiences.

The complex learning process is based on concrete perceptual experiences. From the moment he begins life the individual "senses" or perceives concrete elements in his environment. On these he builds concepts and ideas which are meaningful and useful in his further experience. There is a constant modification of ideas as new concrete experiences occur. It is difficult to indicate a sequence in process involving concretes and ideas for the process is very complex. But in general, it can be said that learning is based on concrete perceptual experiences.

The learning process, then, is an experience involving purposeful, continuous interaction of the individual with concrete elements of his environment.

THE TEACHING PROCESS

Learning results in a change in the behaviour of the individual. Teaching involves the suggestion of exper-

iences to the individual which will change his behaviour for a purpose.

There are two important ways by which a teacher can influence the learning process.

First, certain elements in the situation can be emphasized, and second, an emphasis can be placed on how the individual shall perceive these elements. By doing this, the teacher helps select the kind of concrete perceptual experience which will lead to the development of purposeful ideas.

The elements can be selected so that through interaction with them the individual builds on his past experience. The only way the teacher can help select the proper elements is through observation and evaluation of the individual's past and present behaviour. If the elements are properly selected, continuity is introduced to the situation. This increases the possibility of the individual achieving his goal or purpose. By guiding the individual to perceive the selected elements in a particular way, the interaction of the individual and elements is made even more selective. In this way the activity can be directed to specific immediate goals leading to the overall purpose.

A TEACHING-LEARNING SITUATION

Every experience can be, and probably is, a learning situation. If the individual consciously directs his

activity toward a particular goal, the learning becomes less random and more effective. The learning becomes even more effective when another person also applies effort toward that individual's goal. A teacher is an important factor in the learning process.

A PARTICULARIZED SITUATION

Let us look at a situation involving the use of textbook illustrations to see how the structure developed in the foregoing sections applies.

A learner has a purpose in mind that requires a modification of his behaviour. He discusses the problem with his teacher. Immediately, the situation becomes selective, for the teacher is a particular "element" in the learner's environment.

The teacher gives the learner a textbook to read. The situation becomes more selective, because of the particular content of the book. Out of the possible environmental elements with which the individual might interact, the book differentiates certain ones. The book was chosen because the teacher believed these certain elements would have instructional value. The book suggests for the learner particular ideas that will modify his behaviour in terms of his purpose.

The combination of these selective factors has directed the learner's interaction with those particular

environmental elements which are related to his purpose. The possibility of the learner achieving his goal is increased. The use of an illustrated textbook becomes a particularized learning situation.

SPECIFIC IDEAS

In a particularlized situation involving an illustrated textbook the ideas to be suggested assume a major role. The specific ideas contained in the book form the base upon which the learner will build and develop concepts.

Of the many discrete ideas that might be used, those which will be most effective should be chosen. Here is a great responsibility for those who have the task of evaluating the selecting the ideas. How should this be done? What ideas should be included? Which ones should be omitted?

The answers will be derived from an investigation of the purpose of the particular textbook, or parts of the book.

ORGANIZED SPECIFIC IDEAS

How these ideas are organized is an important factor. Discrete ideas in themselves are of little value unless they fall into some conceptual pattern. Ultimately the learner must do this for himself, but he will do it more efficiently when there is some organized pattern of ideas

within the book to give him a start.

In writing the book, the author combines and organized his ideas into conceptual pattern which he hopes will be closely approximated by the reader. He words the text in such a way that the desired ideas are suggested. A skillful writer can do this rather well. A similar skill is needed in connection with illustrations in the book. They are intended to serve the same purpose as words -- to suggest ideas to the learner. How can illustrations be composed or organized to suggest the right ideas?

Illustrations and words have the same fundamental purpose. Actually, they are different degrees of the same thing. That is they are both means to an end. The relation of ideas within the word framework and within the illustration is important, and so is the relationship between words and illustrations. The real essence of the problem is the total organization of the ideas. How can this best be done?

To be effective the content of the book must be designed to fit into the continuity of the individual's learning. The ideas suggested must build on the learner's past experience up to the moment he sees the book. Then one idea must build on another towards the purpose in mind. This poses the question as to how much previous experience must be included for the learner to integrate the book with his past experience.

In addition to providing a continuity of experience, the content should provide a breadth of experience. A large

amount of random interaction takes place in the learning process. A variety of concrete experiences increases the possibility of his developing desired concepts. The textbook could suggest similar ideas in a variety of ways through the combined use of words and illustrations.

Ideas in a textbook should be organized to provide both continuity and breadth of experience. How can this be accomplished within the content of the book?

Chapter VII

DESIGN AND ILLUSTRATIONS HELP TO CONVEY IDEAS.

It has been pointed out that the particular ideas included in the textbook are important to the learning situation. How these ideas are conveyed to the learner is another factor.

Of course, the organization of the ideas into a pattern is a fundamental step in communicating them to the individual. But this organization must be translated into a concrete, perceptual experience for him before the communication is possible.

This means the selection of certain media to provide this experience. These media include the total substance of the textbook. The cover, the pages, the printed words, the illustrations -- all act as a means to convey ideas. They provide the concrete elements for the perceptual experience.

Though the whole book is important, probably the printed word-text and the illustrations deserve the greatest emphasis in the investigation of the problem. These are the language that convey the ideas. Words represent what is called written language. Illustrations are graphic language.

A great deal of effort has been applied to the teaching of reading the written word. Apparently relatively little has been done to teach the learner how to

read illustrations. An investigation of how to set up a program for this would be well worth while. How can the learner be taught to read illustrations?

The language abilities of the learner must be taken into account. A book on calculus could not be expected to give much help to a fifth grader learning fractions. The language must be appropriate to the learner's ability. This means that the words should be within the understanding of the reader if they are to suggest ideas. There must be elements in the illustration with which the learner has already had experience. Tests have been devised to determine how and what words are appropriate at various ability levels. Similar devices would be useful for illustrations. How can the ability level of understanding illustrations be determined?

Most textbooks rely more on written language than graphic language to convey ideas to the reader. Illustrations assume a secondary role to text material. This is probably due to factors of time, effort, and expense in producing textbooks, rather than sound learning principles. This status points out implications for illustrated textbooks.

If textbooks are to rely mainly upon words, and use illustrations only when necessary, the important question arises as to when illustrations are necessary. The general answer is that they are necessary when words alone

might not convey the intended idea. But how can it be determined when illustrations are needed to supplement the text?

It is possible to think of illustrations as having an equal or even dominant function in textbooks. However, the function is defined, it should be in terms of the purpose of conveying ideas to the learner. Illustrations must always be considered in relation to the text material, regardless of where the emphasis is placed.

It is also possible that the desired ideas may not be effectively conveyed even with the best organized and planned textbooks. A text is not necessarily self-sufficient. Perhaps some direct teaching with the textbook will be needed. A teacher might have to aid the learner. How self-sufficient should an illustrated textbook be?

VISUAL PERCEPTION

Underlying the ability of the learner to understand the language of the book is his ability to perceive it. Unless he can perform the mechanics of reading the book, the ideas will not be conveyed to him. A fundamental factor in the learning situation involving the illustrated book is the perceptual ability of the learner.

In reading the book the learner concentrates on the use of his visual sense. This is a particular perceptual experience. As he looks at the book, he also feels it, hears the pages turning, and even smells the glue or ink.

But in terms of purposeful learning, he emphasizes the use of his visual sense over the others. This should be taken into account in considering the illustration problem. How does the learner use his eyes when reading a textbook?

Studies of eye-movements have been made in connection with the teaching of reading. Buswell (8:--) and Brandt (4:--) have made similar studies with pictures and advertising layout respectively. Perhaps more investigation of this kind would reveal how the learner reads a textbook that contains both words and illustrations. How does the learner look at a page or pages having text illustrations?

If there are particular habits existing, or if useful habits could be developed, principles might evolve which would facilitate visual perception. This would lead to better organization of textbooks so as to expedite the conveying ideas.

The extent to which meaning is conveyed to the learner by the textbook depends on many factors. The reasoning ability of the learner is probably a major factor, but his visual perception ability is also important.

In order to convey desired meaning, the ideas are organized by the author into the best conceptual framework he can devise. This is then translated into a visual perception experience for the learner in the form of the book. Too often a well-prepared framework of ideas is not conveyed to the learner because the translation into written

and graphic language is inadequate. The physical nature of the book can greatly influence the degree of the learning situation.

By means of a well-organized framework of ideas within the book the learner is helped a great deal in the reasoning process that develops his concepts. A well-organized physical layout of the book should aid in his perception of the language intended to suggest those concepts.

The design of the textbook would include the printed words, the illustrations, the cover, paper, end sheets -- whatever make up the physical substance of the book. It is the organization of these into a pattern of communication that is book design. Book design is especially concerned with the kinds of type used to print words, the way the type is arranged on the page, the reproduction of illustrations, and the space relationships of the illustrations and type.

Obviously, if the learner did not see the book at all, he could not benefit from the ideas suggested by it. Further, if in reading the book he did not see the visual cues designed to carry the language that conveys ideas, his chances of developing the desired concepts would be impaired. If the book were laid out so as to provide the best possible visual cues, the learner should be aided in his visual perception.

Chapter VIII

"SCIENCE INDOORS and OUT": a Problem in Design and Illustration.

The total task confronting the textbook designer is always a composite of various factors. The chief problem may be primarily a technical one -- as with a book on general science, in which hundreds of halftones, line cuts, visiograms, charts, diagrams and subordinate matter must all be managed into an organic pattern. It may be an imaginative pattern -- an anthology of writings encompassing twenty centuries of changed thought and feeling. Or the problem may be narrowed down to one of translating into typography a radically new method of teaching a foreign language: a manuscript which the author insists must be set up in his own special way. The problems are innumerable and always unique: for basically each textbook manuscript is a problem in itself.

The illustration and design of Manitoba's Science Indoors and Out, Books I, II and III has provided for the writer a practical medium in which factors making for good design can be isolated and studied in relation to the psychology of learning. Over 700 drawings and photographs were especially prepared for this series of texts. Body format and the cover design were a part of the total effort to produce a more comprehensible, better visualized and more efficient vehicle for junior scientific reading.

For purposes of discussion, Book III will comprise the frame of reference, since this book is typical of the revised writing and format of Manitoba's authorized junior high school text. Additionally, 324 of its 442 illustrations were prepared by the writer and these include a variety of types which can serve to illustrate the principles and classification element of the concluding chapters. References to proof pages or photostatic reproductions forming part of this paper shall be designated as (Fig. 000). References to the actual textbook shall be noted as Fig. S.000) or (Page S.000). A textbook is, therefore, included and forms part of this thesis.

The art of book design during the past generation was almost wholly dependent upon tradition. Bookmakers were content to follow quite slavishly the models of one or another of the masters of bygone days -- type faces were revivals of those designed by master punch cutters of the past. Individual features of bookmaking such as title pages, chapter heads, cutlines, body type, and the like, all followed along traditional channels. Title pages, for example, were cast in standard molds, balanced carefully on a central axis.

The twentieth century concept of design is based on the principles of the engineer, who learned early in his work the apparently simple axiom that form should follow function. This realization brought about a new respect for legibility, for large enough type to read with comfort. Display type were simplified in design and reduced to the most elementary form. Simplicity in layout led to arrange-

ments of illustrations and type areas in geometric forms.

CONCERNING TYPE DESIGN

As a result of tests conducted in the General Electric Research Laboratory, Frank Moss (46:--) termed reading a difficult task, especially since the brain demands clear and effective reading even though the ocular mechanism may be fatigued. Blinking is an involuntary expression of weariness on the part of the eyes, and it is the blink-rate, the test of ocular fatigue, that Luckiesh and Moss have found to be the most satisfactory criterion of readability.

For reading under standard conditions, they believe that:

-- paper should be as "white" as practicable.
-- non-glossy papers and inks should be used.
-- glossy inks should never be used for reading materials.
-- the prevailing deficiency of modern type faces is the lack of adequate boldness.
-- in the interest of readability the limitations of esthetics in type design must be recognized.
-- paper, ink and printing must be properly coordinated to produce clear-cut delineation of characters in all copies of a book.
-- type size should be at least 12 pt.
-- with measures of 21 picas, at least 2 pt leading is satisfactory for 10 pt. type, and 3 pt. leading is about best for 12 pt. type. ("Science Indoors and Out" conforms to this latter specification).
-- line length in books should be shorter than measures now commonly used. (Some newer Social Studies textbooks are appearing in this format).
-- margins which provide a pleasing page are probably adequate.

The demand for ease and comfort of reading calls first for a well-designed typeface, free of affectation or labored drawing, which we can read for hours on end without undue fitigue. The best typefaces are those having a design of which we are not sensible. As Beatrice Warde has so aptly put it, type for extended text composition should be "invisible." These requirements narrow down our choice to the simplest type faces, most of which have successfully stood the test of time.

The legibility of letters as individual symbols is determined by construction; the readability of a page is controlled by the arrangement of well-designed letters. Both operate under the laws of design and utilize the same elements; line, mass, proportion, area, relative weights, and contrast with the background.

Letters are simple lines, related to each other and to the paper on which they are printed by curves and angles; words and lines of type are complex masses in angular forms; both are measured by interior illumination. The same principle that calls for daylight inside a letter demands similar 'lebensraum' between lines. Readability depends upon the ratio between white paper and black lines in the letter forms.

Type designers for many years have been studying and manipulating the construction of letter forms, changing weights and counters and fitting all directed towards maximum legibility and comfortable readability.

There is much talk, also, about 'beauty' but that element may be disregarded here, except to recognize that graceful contours and rhythmical horizontal movement contribute to smooth progression from letter to letter and from word to word.

A survey of the characteristics of outstanding textbooks selected during the past decade for annual exhibit as the "50 Textbooks of the Year" (under auspices of the Textbook Clinic, American Institute of Graphic Arts) shows type faces which helped to produce prize winning textbooks.

TABLE 11

SHOWING TYPEFACES USED MOST FREQUENTLY IN OUTSTANDING TEXTBOOKS of the PAST DECADE.

	'41	'42	'43	'44	'45	'46	'47	'48	'49	'50	Total
Baskerville .	3	5	7	5	6	13	2	11	3	5	60
Janson	1	8	3	8	5	3	9	4	3	7	51
Granjon	11	1	7	0	5	3	6	5	3	3	44
Estienne	2	2	2	1	2	1	5	2	1	5	23
Electrar	-	-	-	6	2	2	2	3	3	4	22
Caslon Old Face	0	2	2	3	1	3	3	0	1	0	15
Caledonia ...	-	-	-	-	-	--	0	2	4	4	10
Scotch	1	1	0	0	2	2	1	0	1	2	10
Bodoni Book .	3	0	1	1	0	2	1	0	0	1	9
Garamond	1	0	2	1	0	1	1	2	0	0	8

The Baskerville's crisp and vigorous "modern roman"

design lends itself naturally to the production of school textbooks. The letters are wide and open, the script long and bracketed with round curves. In mass, they compose into a smooth, even interesting graytone. Twelve point Baskerville was used as the body type of "Science Indoors and Out". (Fig. 1).

The width of the type page was limited to 24 picas (4 1/4 inches) so that the eye may take a span without undue difficulty. Enough white space or "leading" was placed between lines to direct the eye back from the end of one line to the beginning of the next without possibility of confusion.

Textbooks and reference books should be as liberally provided with "signposts" in the way of bold face subheads, paragraph heads, and soforth, as the well marked highway. It is easy for the editor to put in these aids to the student, who will not fail to appreciate them as a study outline -- a glance through "Science Indoors and Out" will indicate the strength of this learning aid.

Perhaps, one important quality is lacking in the page design of "Science Indoors and Out" -- cutlines may have served a better purpose if they too were set in bold face of 8 point to aid in the outlining function that each page should provide. The sameness of tonal value of the cutlines as they appear in the textbook confuse the students reading the page, in that cutlines are often absorbed into the text material. (Page S116).

CHAPTER 30

DIGESTION AND HEALTH

Introduction. Our bodies are made up of billions of tiny cells, each too small to be seen by the unaided eye. In living bodies as you know, there are many different kinds of cells. In our body this is also true. Some cells form bones; others form muscles, nerves, skin, and all of the other tissues that make up the body. Every one of these countless individual cells must be fed in order that it may remain alive and grow. How is this done?

What is digestion? Because each cell is completely surrounded by its membrane wall, no solid food can enter it. The only form of food that cells can absorb, is *liquid* food that can soak in through the cell walls. To be useful in the body, therefore, all of our foods must be changed to liquids. *The changing of food into liquids that can be absorbed by the cells is called digestion.*

The digestive system. The cells in our bodies work together in groups. We call these groups of cells, *tissues, e.g.* skin tissue, muscle tissue. A group of tissues in the body working together is called an *organ, e.g.* heart, hand, stomach. A group of organs working together forms a *system.* One such group of organs in our body forms the *digestive system.* It has, as its function, the digestion of the foods that we eat, making them ready for absorption through the cell walls.

Examine Figure 386 and find the parts of the digestive system through which the food actually passes—the mouth,

FIG. 2 -- Proof-page showing boldface 'sign posts' used to guide reading.

Modern book designers have experimented with the proportion and area of margins. The accepted relationship is for the margin towards the binding edge or gutter to be the narrowest, with margins to the top, outer edge, and bottom of the page increasing progressively.

"Science Indoors and Out" has made a new use of outer marginal areas. Illustrations, extending beyond the boundaries of the type page in a variety of patterns, have helped to do away with the stereoptic monotony of page lay-outs of older textbooks. Pages S7, S24, S48, S66 and S116 are representative of the variety in page treatment. The advantages of this departure from confinement to traditional marginal framework are:

1. Allows for larger, clearer illustrations.
2. Gives the page a feeling of "reaching out" into the student's spirit of learning.
3. Does away with monotony of pattern.
4. Increases the "teaching area" of a text-book by about 5%.

Thus, the layout of type on a page with respect to margins and illustrations can contribute to the students understanding of the text. As far as possible the arrange-ment of the material should make the page self-outlining. The function of good book design should be to synchronize the 'visual design' of the layout and the 'thought design' of the author.

SOME PROBLEMS OF BOOK ILLUSTRATION

Since the time of "Orbis Pictus" there has been much encouraging activity in the field of book illustration. After the processes of photo-engraving had apparently smothered the old-fashioned wood engraver, who was content to render technically the artistic creations of others, the air was cleared for a renaisance of creative engraving, with the artist cutting his own blocks. Other artists, equally competent, have chosen to work with pen or brush on paper, entrasting to mechanical means the reproduction of compositions so rendered. The recent developments of photo-mechanical methods, particularly in color printing, have enormously increased the range of techniques available to the artist-illustrator.

A well designed book, used as a teaching-learning vehicle, is a purposeful and unified medium of expression. When pictures are needed to extend or clarify the conception of the author, the illustrations must hold to the writer's images, so that visual understanding can be entered into by the reader. Illustration has point only when the illustrator speaks in phrases opposite to those of the writer.

By its very nature, illustration is interpretation of a text, and not a scene of self-expression for the artist. The writer has command of ideas, and of his own medium, words; the illustrator must likewise have command over his representation of those words and images. Such authority exists only

when the illustrator can fasten on the printed page a realized picture. Materialization of such an objective can exist only when the artist weighs the intrinsic value of his medium, which is not the finished drawing, but the lines and tones which emerge upon the pages of a book. The book is his medium, not the sheet of paper on which he sketches, and that medium has to be gauged through the processes of the plate maker and the operations of the press -- that work has to be established finally on a particular layout of a sheet of paper to be used in a given book. Beyond these details, the illustrator has to judge precisely the effect of reduction of his originals in weight of line, or tonal values.

Book pages are of course made up of type, which is line, and obviously pictures which are to be placed beside type must bear some relationship to the form of the test. The working rule that pictures and type should balance each other, if not in line, at least in color, or weight has been satisfactorily applied to the design of "Science Indoors and Out". A bolder, crisp and definite stroke of the pen has been used throughout the illustrations for the new edition of "Science Indoors and Out". The line illustration of a human heart (Fig. 3) is an example of this technique, and is contrasted herein with an illustration used in the older edition (Fig. 3b) where lines are fine and indefinite and follow the spirit of an "expressive" artist of a school of fine art.

Addressing "The Boston Bookbuilders" with respect

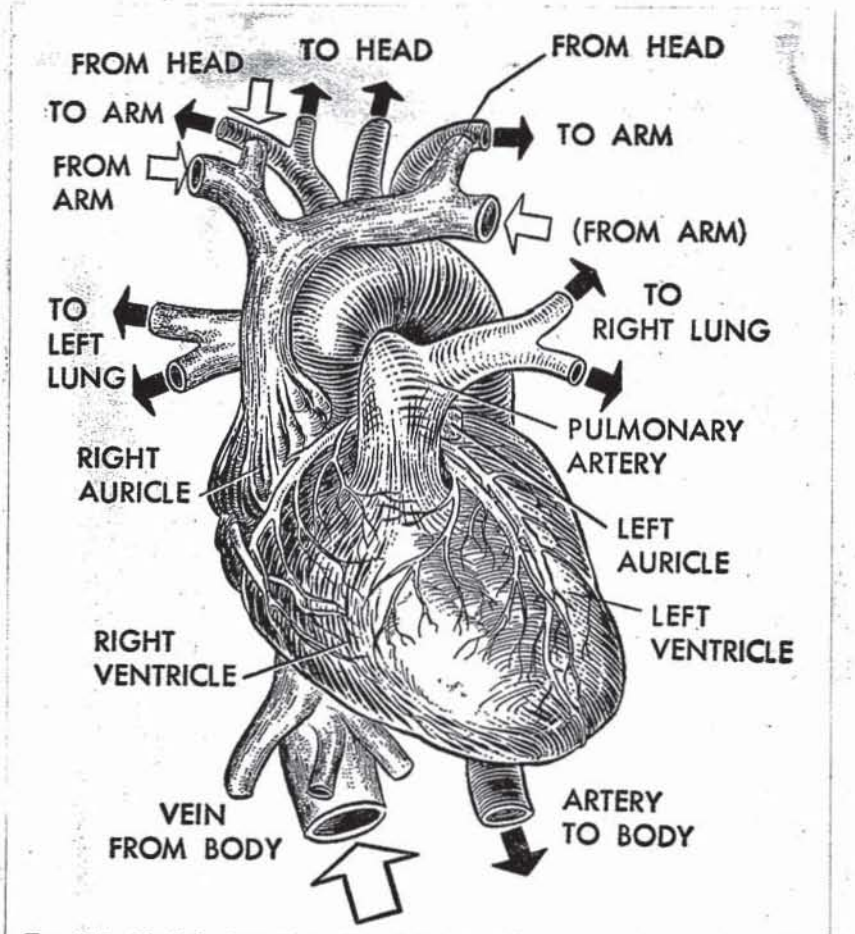


FIG. 420. Find the large branches of the coronary artery lying just beneath the surface of the heart. These bring an abundance of blood to this double muscular pump. Large veins in the same area carry away this blood, after it has given its load of food and oxygen to the heart muscles. Trace the flow of blood through this double pump. The arteries bringing the purified blood back from the lungs are not shown, but find in the diagram a small corner of the auricle into which these arteries lead the blood.

FIG. 3a -- A good line illustration should bear clear, definite strokes.

Fig. 52. The gumweed has sticky, turned-down bracts or scales around its flower. Can this crawling insect secure the nectar?

FIG. 3b -- A 'sketchy' illustration cannot clearly teach.

to a want of textbook illustrators, Margaret Evans, designer for D. C. Heath & Co., Boston, pointed out that

> "we have very few artists working today who fasten an image properly upon the printed page. In our art schools art is taught as expression; and beyond that we have the lesser angle, commercial art. From too much freedom students pass to too much restriction. Illustrators are studio artists fussing with a new form, or advertising artists trying to express themselves in the book medium. Illustrators do not pull together those intangible elements in their work because they do not know how, and because they imagine that it doesn't matter too much, after all." (Reported in Bookbinding and Book Production, Sept. 1946.)

This statement may be true of the overall situation in textbook illustration, but science books, generally, have occupied a favored niche in the quality of illustrations appearing in textbooks. It is in the field of science textbook illustration that most outstanding progress in the development of teaching pictures has been made. Scientific writers have invented or improved scientific aids to learning in the form of 'visiograms' as in Masson's "Science Made Easy" (New Ed.) and Kahn's world-famous medical teaching-pictures, one of which was redrawn from "Man in Structure and Function" and appears as Fig. S410 in "Science Indoors and Out".

Some studies, Hall (17:21) Kambey (21:--) investigated childrens preferences for size of illustration. Results show that a size 4 1/2 inches by 4 inches seems to be the favorite size for a standard book. This finding will support the decision to make illustrations for the new

Science text larger than has been the practice in the older edition. For this reason, then, illustrations were projected out from the type pages utilizing marginal space and in many cases "bleeding" off the pages. Illustration always seems to impress better when it is composed beyond the type page, when the picture grows out of the text itself, like leaves from a tree.

Typographical compositors were at first reluctant to develop "Bleed" layouts since this technique created new problems of form lock-up, and critical trimming. However the demand for newer page design, inspired these traditional stalwarts into renewed creative effort giving birth to less monotonous, more interesting and dynamic page layouts.

Additionally the value of textbook illustrations has become recognized as a very important part of the book budget, and editors are more willing to expend more on pictures, cuts and integrated layouts. Science Indoors and Out has devoted 31% of its printed area to illustrations of the text as shownin Table 111.

TABLE 111

SHOWING TOTAL AREA OF LINE and HALFTONE ILLUSTRATIONS IN "SCIENCE INDOORS and OUT - BOOK 111"

	Number of Separate Cuts	Total Area
HALFTONES, PHOTOGRAPHS	175	2220 sq. in.
HALFTONES, WASH	16	234 sq. in.
LINE and BENDAY	183	2256 sq. in.
TOTAL Number and Area	374	4710 sq. in.
TOTAL Type Page Area		15120 sq. in.
PERCENTAGE		31%

Science Indoors and Out also indicates a willingness of publishers to illustrate texts with photographs and drawings specifically prepared for the text. Although many photographs and drawings were available in stock cuts and prints, 73% of the illustrations for the Science textbook were specially prepared. The remaining 27% were stock photographs of out-of-season or remote objects and situations. However, all drawings in the book were developed for a particular requirement -- each was chosen specifically for its teaching value and is closely related to the text.

Where labels appear as part of a diagram, these were first set in type, proofed, and then "stripped-in" the original drawing. The result is a diagram of high quality which cannot be matched by hand lettered labels (Fig. 3). Each label was identified with the part it named by a clear cut line trimmed with a fine white line to carry it to its definite destination, thus reducing the possibility of error on the part of the reader (Fig. S-375).

Benday screens, hand stippling, and a crisp brushlike stroke were used to give body to most drawings, and emphasize significant parts.

All photographs were highlighted for the sharpening of detail, and where necessary, the background of the general picture was subdued by judicious retouching. Figures S-252 and S 253 are examples of retouched photographs from

which people in the immediate background were airbrushed out of the picture. In all cases photographs were "cropped" to eliminate unnecessary portions, or change the proportion of the picture to conform to the layout of the page.

Direction of movement was indicated on some pictures (Fig. S-354) by means of lines painted on the original photograph, thus giving the illustration a higher teaching value.

Illustrations of microscopic views were enclosed in a circle to simulate a microscopic field (Figs. S-38, S-39, S-42, S-44, etc.) The circle also suggests partiality of a view,-that more of the same exists beyond the circle.

In the light of Hall's (17:--) research in "High School Students Preference of Illustrative Materials" wherein she found that cartoons received top preference, the cartoon technique of illustration was included in Science Inoors and Out. Figures S-314, S-316, S-462, S-327, S-328 and S-331 may show how the cartoon technique can be used as an educative instrument for purposes of presenting, in a dynamic way, the facts against smoking and drinking. A Study could be made of this section of the textbook to determine how well the cartoons have helped to put across the message of the text. The cartoon technique is an innovation in Canadian textbooks which have always carried on high level of dignity, therefore, both author and publishers were a little uncertain of the advisability of including this technique. Perhaps this technique is a step nearer the

FIG. 4 -- The Frontispiece of "Science Indoors and Out", designed to motivate readers into a love of nature.

visual language of the student.

Many other problems of illustration present themselves during the course of development of each unit, each chapter and each page. Individual problems were resolved around principles of illustration identified in this study. Some decisions were supported by results of research, some were based on tentative hypothesis which remain to be tested by further investigation. It may be interesting to enumerate a few of the most challenging problems, and the psychology underlying their dissolution.

Page S-3 -- Frontispiece - To inspire children into an appreciation of nature and outdoor living, the frontispiece was designed around a human interest element with a feeling that may lead readers to enter a similar situation.

Fig. S-3 -- Directs a student in the method of laying out a page of drawings for a note book. A screened silhouette is used to show location of the individual sketches.

Fig. S-7-- Shows an analytical or "exploded" drawing of a mustard flower. This illustration is designed to tell the story of a mustard flower from bud to seed.

Fig. S-21 - Shows how a human figure is used as a guide to the reader's comprehension of the size of the plant.

Figs. S-29 and 28 -- Shows plants of the sunflower family

grouped into useful and obnoxious classes. These illustrations are accurate reproductions and are designed to be used as plant identification guides. In each case the leaves and flowers are shown in their proper relationship. Note how a large drawing can be had by extending the type page into the marginal areas.

Fig. S-42 - Microscopic views appear in circles simulating the field of the microscope.

Fig. S-72 - A "with and without" type of illustration. The problem here was to show enlarged tonsils but these must be contrasted with normal tonsils if learning is to take place.

Fig. S-75 - A wash drawing which portrays 'realistically' what can happen if wire screens and general tidiness are omitted.

Fig. S-77 - Is a "process diagram" which is designed to show the path taken by bacteria from source to a victim.

Fig. S-82 - This illustration is designed to "show how" a certain operation is performed. Note the black arrow directing attention to a barely visible but most significant object.

Fig. S-83 - Shows how retouching can make invisible germs 'visible'. A child can see clearly what is taking place in this picture.

Fig. S-95 - The Plant "tree" illustrates graphically the evolution and relationships of the various

families of plants. This diagram is a good illustration of the Chinese proverb - "One picture is worth a thousand words". Note how the Ben Day screen was used to tie the story together.

Fig. S-107 -- Illustrates the inside structure of the Tiger Lily -- a floral diagram shows effectively the relation of its components.

Page S-155 -- Tells the story of the relationship of members of the Buttercup family. Lines lead the eye to relatives.

Fig. S-124 -- Could a love for wild animals be stimulated by drawings such as that of the 'smiling' pocket gopher?

Fig. S-132 -- Children can find amusement in a store of knowledge in their effort to solve the 'mystery of the missing footprints in the margin'.

Fig. S-146 -- A 'skin on - skin off' type of illustration is shown here, and was designed to enable a student to visualize the underlying bone structure of a live animal, after a certain amount of practice in relating the two drawings with each other. Other examples can be found in Figs. S-122 and S-123.

Fig. S-151 -- Shows how a small boy was used in the photograph of a goat as a guide for the reader's

comprehension of the size of the animal.

Fig. S-169 -- Shows how a silhouette type of drawing could be used effectively to illuminate a chart. It may be noted here that Martin's and Freeman and Freeman's studies on 'Children's Preferences for Illustrative Material' show that silhouettes are highly unpopular with children.

Fig. S-187 -- Is an example of an "how it's done" illustration. The drawings do the job of directing a student.

Fig. S-190 -- Is a photograph of huge glass models of vorticella, a magnificent teaching tool and produced by The Bausch and Lomb Optical Co. Page S-239 bears another photograph of a model.

Fig. S-193 -- Illustrates how a drawing of a "magnifying glass" can direct attention to the concept of an enlarged view.

Fig. S-208 and S-209 -- Show the development of cells to plants and animals. The diagrams are followed as the text is read. Note the formation of the sphere in Fig. S-409.

Fig. S-220 -- The 'pages of history' and what they reveal.

Fig. S-230 -- A 'realistic' wash drawing showing sea life as it was.

Fig. S-235 -- This chart is designed to carry a reader deep down through the strata into history. Note the modern developments on the surface of the earth and the depths (and ages) to which the oil and coal shafts have been dropped. All lettering was typeset and stripped in the drawing.

Fig. S-246 -- The 'cycle' concept is represented by the 'moving' wheel -- divided into four sections representing the life stages of the insect.

Fig. S-251 -- The reader is 'carried into' ancient history by means of ancient drawing technique simulating a woodcut.

Fig. S-287 -- Illustrates the lengthening of life span -- the Ben Day background suggests the increase and aids in the comprehension of the figures. Note that the lettering was typeset and 'stripped-in' the drawing.

Fig. S-316 -- A cartooned gremlin is added to an otherwise formal illustration.

Fig. S-317 -- The comic-strip technique used to teach a lesson. A concluding frame was censored -- it showed a coffin draped with the bouquet and cane and read "OVER 5 --- DROPS DEAD".

Fig. S-319 -- Shows the damage that alcohol can do to a home. A wash drawing was used here because of its realistic representation.

Fig. S-324 -- Has a great power of suggestion based on human sympathy. This photograph was a difficult assignment since the child was too well trained not to venture on the road. The car was therefore posed stationary and later retouched to simulate motion.

Fig. S-326 -- Illustrated the theme of the whole section on tobacco -- the power of resistance. Note that the boys have been carefully selected for this typical scene.

Fig. S-327 -- Implies "a fool and his gold are soon parted". A slave to nicotine makes fat men richer.

Fig. S-331 -- A cartoon and limerick may be combined into a powerful teaching-learning tool, both have high appeal for children.

Fig. S-342 -- Shows how a black line can emphasize the point of the illustration -- the curved spine.

Fig. S-371 -- Illustrates good sitting posture. Note that the furniture used is most modern to reduce the possible "datedness" of the book in later years.

Fig. S-373 -- Picture especially posed to show physical differences in people -- What could be more interesting than a good old "he-was-safe" argument.

Fig. S-377 -- Shows different kinds of nerve endings with

peculiar sensitivity of each suggested by the hands on the surface of the skin.

Fig. S-382 -- The 'boy-girl' psychology used here to motivate boys and girls of the same age level into good grooming.

Fig. S-384 -- This picture provided instead of requested photograph of a "boy washing face at a sink" -- Note the high human interest element of this type of picture and its power to draw the eye, which would be lacking in the ordinary scene.

Fig. S-387 -- Ben Day screen used to identify the portions to be noted.

Fig. S-412 -- Students are asked to color this 'course-of-flow' diagram.

Fig. S-415 -- Artery is indicated by a black line drawn on the photo. This helps to clarify the definite position of the fingers.

Fig. S-420 -- Heavy arrows are used here to show direction -- a type of 'process-diagram', yet not a diagram.

Page S-616 -- A chart designed to aid students identify terminology for the description of leaves. Note the two-page spread and clear definite captions.

Fig. S-429 -- Shows how a black line can indicate on a 'high key' figure the path and direction of

a nerve impulse that causes reflex action. Note that the subject is a girl of the age level of students using the text.

The production cadre formed to cope with the problems in designing "Science Indoors and Out" has revealed ideal cooperative pattern for the production of school textbooks. The artist was brought in to work as closely as possible together with the authors and the publisher in the planning and production of the textbook. Students were also invited to participate in the scheme as successive units of the book were developed. Opportunity was given students to suggest where the text needed "visualization"; their queries and suggestions were carefully weighed to establish locations and types of illustrations that may be adequate to meet the specific needs. In all cases illustrations were designed to form, as far as possible, an actual part of the text, not a part from it. Photographs were carefully considered before their use, as often times a drawing could do a better job, being more adaptable to actual illustration of what is contained in the text matter.

Chapter IX

A CLASSIFICATION OF ART TECHNIQUES USED IN THE ILLUSTRATION OF TEXTBOOKS.

It would follow from the foregoing discussions of the problems of illustration as related to the psychology of learning, that a form of classification for illustrative media may be useful in arriving at some definite principles for the illustration of textbooks. A re-examination of printed pictures in the light of the subject matter and objectives of education, brings to the fore the question of the degree to which the factors of learning should be incorporated into the materials themselves; motivation, intrinsic interest, identification, dramatic emphasis, a sense and touch of humor, suspense, repetition, continued motivation, pacing, etc. These are psychological factors which facilitate learning. Lack of them impedes learning. It would appear, therefore, that these factors should be considered in arriving at a classification of illustrations.

All illustrations may be systematized into two main groups: (a) Realistic, and (b) Symbolic.

(a) <u>R E A L I S T I C P I C T U R E S :</u>

A picture provides a recognizable counterpart of the thing itself. Black and white photographs or illustrations are unmistakable substitutes of the original. When they are colored they are even closer to the direct

reality.

Realistic pictures are recorded through the medium of photography and represent three types of concepts:

(1) Those reader has seen in concrete form.

(2) Those from which reader has been separated by time, space, or environment.

(3) Those reader could not have perceived in reality.

Each of these general groups can be reduced further into types based on the reader reaction which they were designed to stimulate.

(1) THOSE PORTRAYING CONCRETE EXPERIENCES

(i) Common-descriptive: include those photographs which represent ordinary every day scenes or objects, and are reproduced to reduce verbalism of the text, motivate reader interest, and pictorially 'pace' the book.

Fig. 5 Common-Descriptive: Reduces verbalism of text motivates reader interest (Fig. S-32).

(ii) Technical-descriptive: include detailed photographs of plants, animals, apparatus, etc., which are displayed for purposes of detailed observation and comparison, though the object may be common.

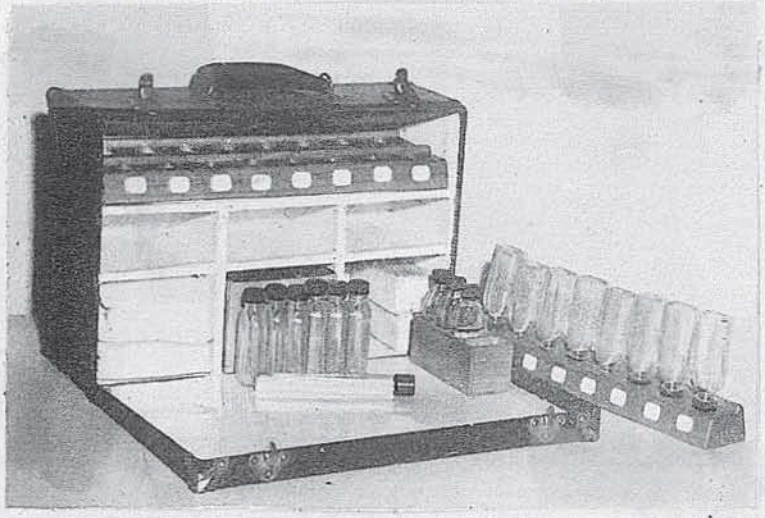


Fig. 6 Technical-descriptive: Stimulates comparative observation making concrete what might otherwise remain verbal abstraction. (Fig. S-80).

(iii) Directive: photographs which show "how to perform an operation" or "how an object operates."

Fig. 7 Directive: Shows how the culture is swabbed -- where the cork is held. (Fig. S-82).

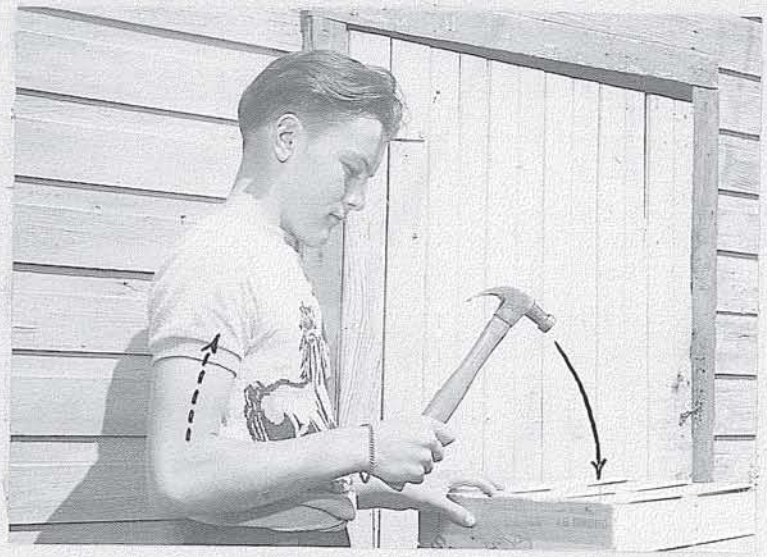


Fig. 8 Directive: Shows direction muscles move when hammer is brought down. (Fig. S-354).

(iv) Reader Motivating: This Classification includes photographs which have been individually designed to bring about a change in behavior or establish definite attitudes and habits.

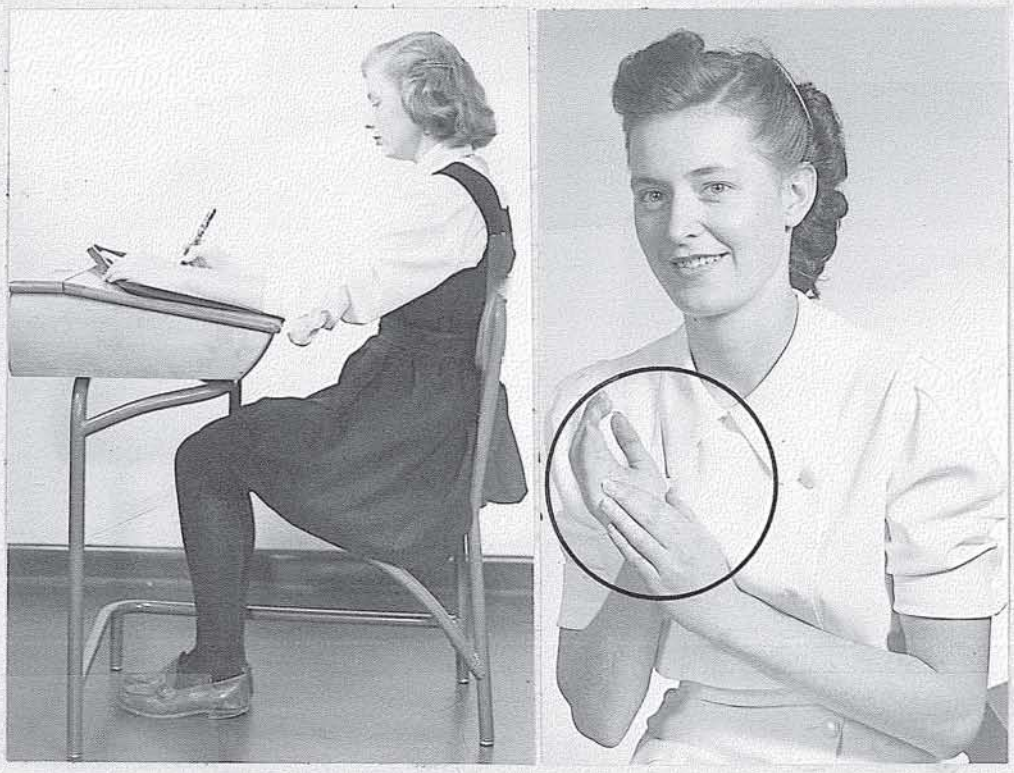


Fig. 9 Readers are motivated into acceptance of good habits because these are related to their

interests. Note how both models help to motivate good posture and cleanliness. The black circle draws attention to the clean hands referred to in the text. (Fig. S-383 and S-371).

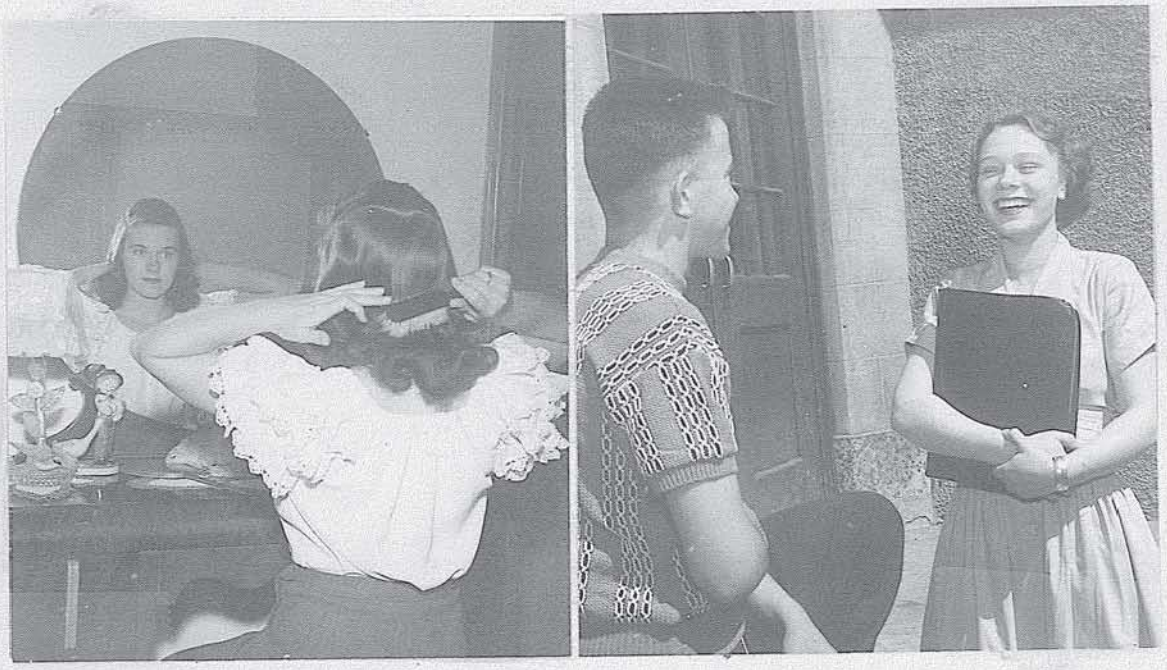


Fig. 10 Attempts to bring about formation of a good habit by the power of suggestion. Both model and props have been carefully selected to achieve aim. (Fig-S-385).

Fig. 11 Good teeth, happy smile and the familiar boy-girl situation which no high school student will overlook. (Fig. S-382).

(v) Dramatic emphasis: Often there is need to emphasize certain situations and particularly their results. Two predicaments are illustrated here:

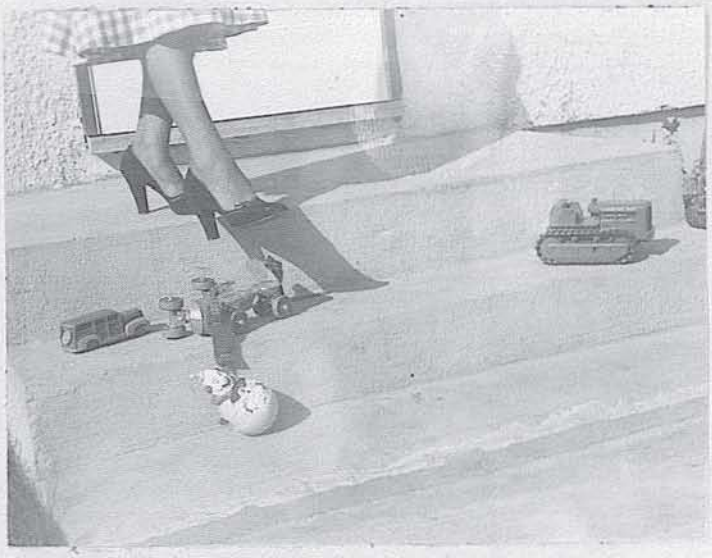


Fig. 12 Body-less legs descending onto a hazard gives it that "blind venture" effect and dramatically focus attention on the feet.

Fig. 13 Antisocial behavior is here emphasized in a lifelike situation. This photograph may create a desirable emotion in the reader.

(vi) Humorous interest: Its emotional impact is probably the source of the peculiar satisfaction that many readers take in a well planned photograph with a humorous tone. Certainly most are aesthetically pleasurable.

Fig. 14 Humorous interest: These boys could have been lined up shoulder to shoulder to illustrate the point of the text. However readers can find pleasurable interest in 'listening-in' the argument and at the same time observing more accurately the subjects in the picture. (Fig. S-373).

(2) THOSE PORTRAYING REMOTE SITUATIONS

(i) UNFAMILIAR OBJECTS: include photographs which may be remotely familiar apart from verbalistic perception.

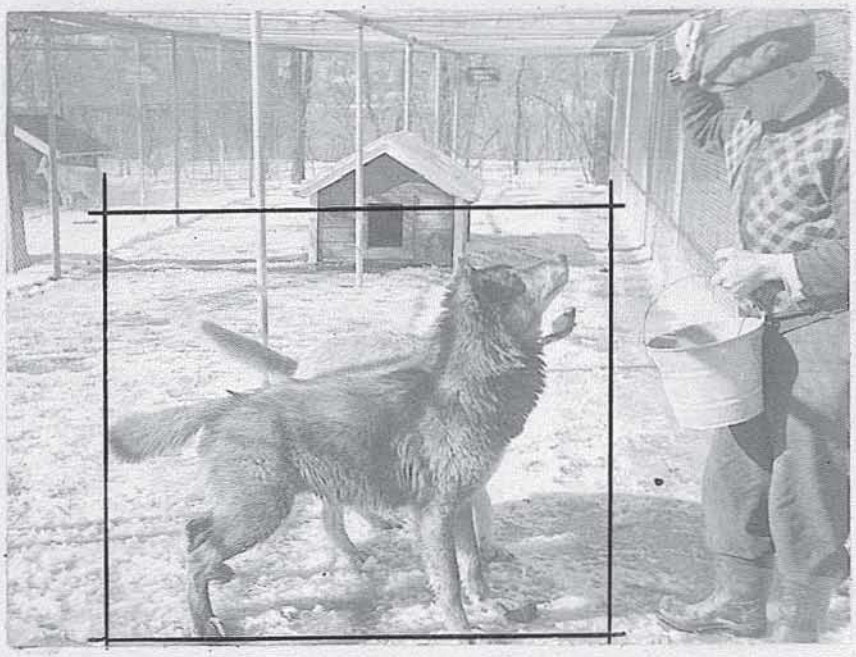


Fig. 15 Unfamiliar Objects: Most children have not seen a wolf. These have been photographed in the cage at the zoo. The man was cropped out of the picture and the hut was air brushed. (Fig. S-133).

(ii) REMOTE SITUATION; include rare photographs of situations that seldom are witnessed -- atomic expolsion, travelling meteor, flooding, etc.

Fig. 16 A Remote Situation: A photograph of a real situation like this would be rare indeed. This

photograph was therefore posed and was used for emotional effect.

(3) THOSE MOTIVATING NON-PRECEIVABLE SITUATIONS

Photographs which reader could not have perceived in reality are prepared by a conbination of photograph and retouching. In some instance it may be necessary to 'fake' a part of, or the complete photograph to produce a desirable concept.

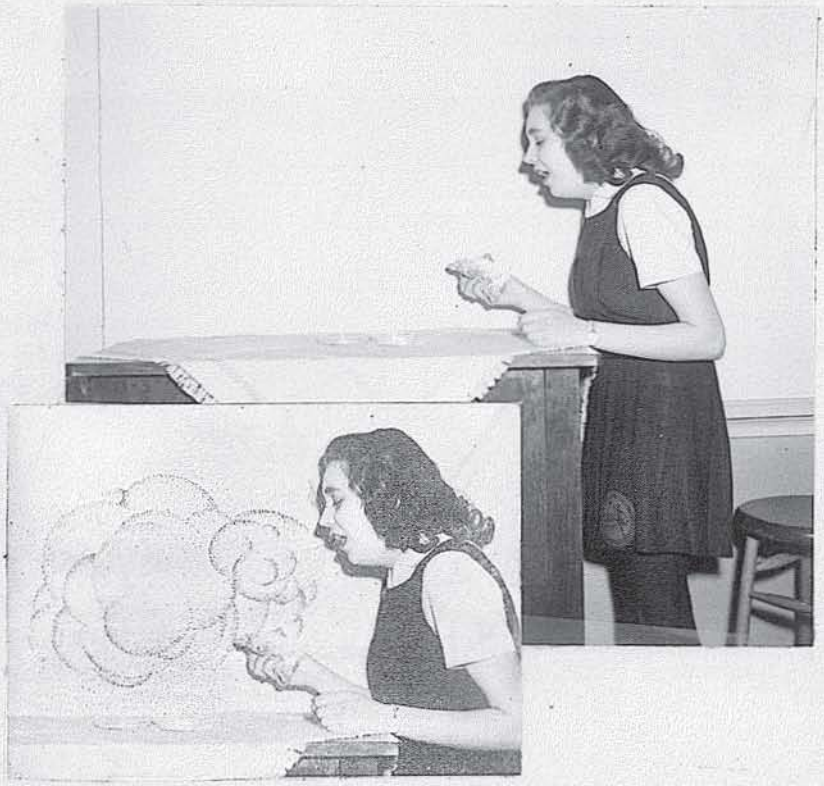


Fig. 17 Non-Preceivable Situations: Is partially the motive of this illustration. Germs are invisible; to make the cough 'visible' clouds were stippled onto the photograph to represent germs. In such an instance the cutline should advise the student of its unreality. (Fig. S-83).

B. V I S U A L S Y M B O L S

Are not intended to reproduce the direct reality but merely represent it. A map is not supposed to reproduce a view of the earth -- it is a visual symbol -- but a photograph looks much like the subject as possible.

There are eight kinds of visual symbols used in learning: (1) Drawings (2) Diagrams (3) Cartoons (4) Charts (5) Graphs (6) Posters (7) Flat Maps (8) Comic Strips. Each of these types can be identified in "Science Indoors and Out".

(1) DRAWINGS: In drawings the sweep and context are more important than detailed exactness. A camera will reproduce with precision, -- a drawing usually need not be precise in its minute detail. By means of a drawing, irrelevant detail may be eliminated and only pertinent outlines or portions included.

Drawings are used when (a) an event happens when no one has a camera handy, (b) editors desire a photograph of a concept but can't obtain one, (c) a photograph won't reproduce clearly, (d) photography is hazardous, (e) a prehistoric scene is to be represented in a near realistic medium.

(i) Common-descriptive drawings which were provided because a photograph was unobtainable, or because a drawing can be clearer and more specific. (Fig. 18).

(ii) Technical-descriptive - the greater number of drawings in the science textbook belong to this category. They serve the purpose of establishing habits comparative observation of scientific detail. (Fig. 19), and (Fig. 20).

FIG. 212. The squirrel is adapted to its tree life by its ability to turn its hind feet backward to grip the bark as it runs down head foremost.

Fig. 18 A Common-descriptive drawing of a squirrel. Attention is directed by the cutline to the squirrel's hind feet. Fig. S-212.

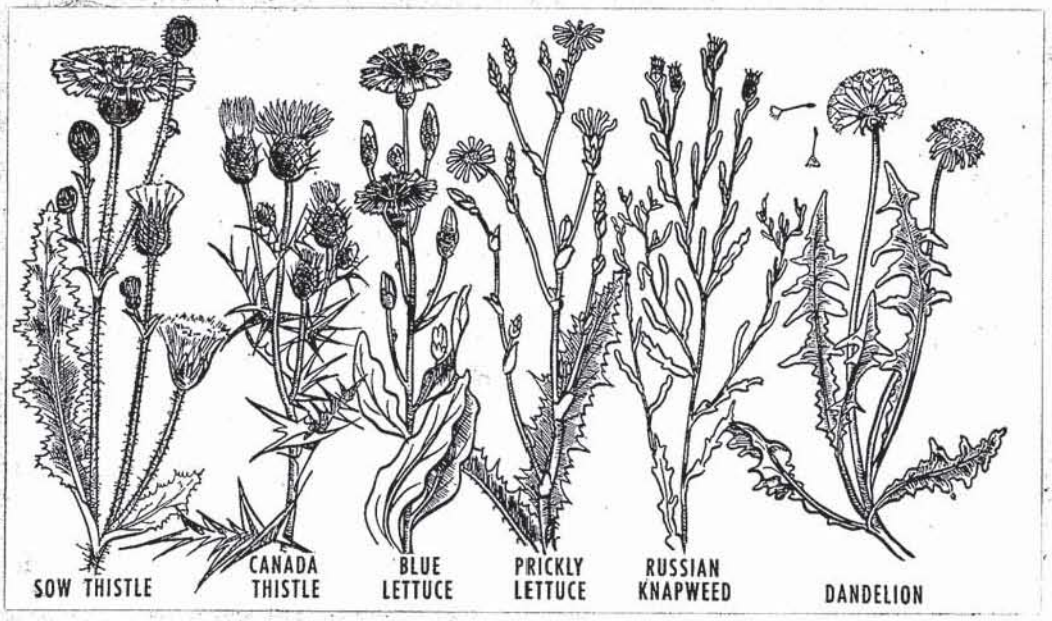


Fig. 19 Relative characteristics of each plant of this family is reproduced in technically accurate outline. These serve as identification guides for plant study.

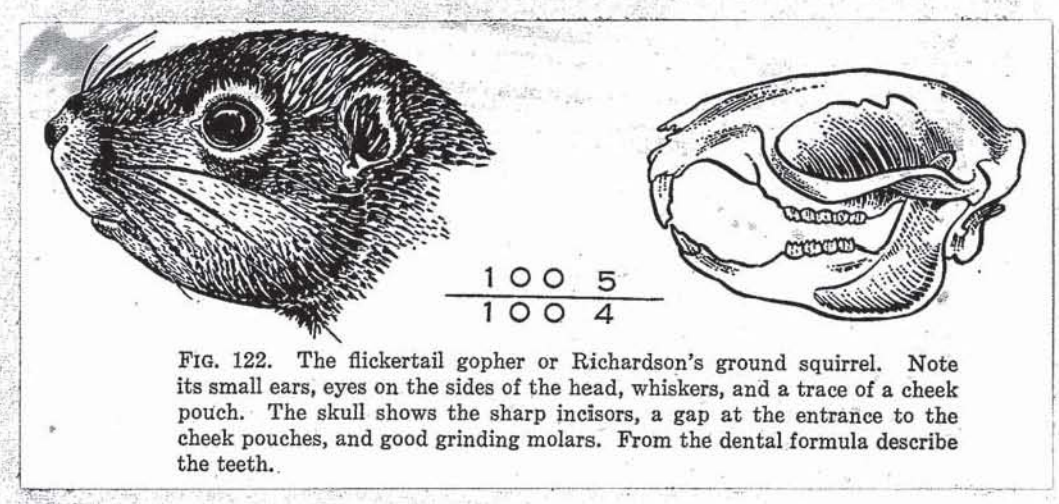


FIG. 122. The flickertail gopher or Richardson's ground squirrel. Note its small ears, eyes on the sides of the head, whiskers, and a trace of a cheek pouch. The skull shows the sharp incisors, a gap at the entrance to the cheek pouches, and good grinding molars. From the dental formula describe the teeth.

Fig. 20 The skull of an animal is reproduced in accurate relation to the head as the pupil knows it.

(iii) Directive: Drawing of this type are especially designed to lead the reader through a thought process to a specific conclusion.

FIG. 77. The typhoid carrier at the summer camp. Trace the path of the germs from the carrier to the drinking water. Show three places at which the path of these germs could be blocked to make the water quite safe.

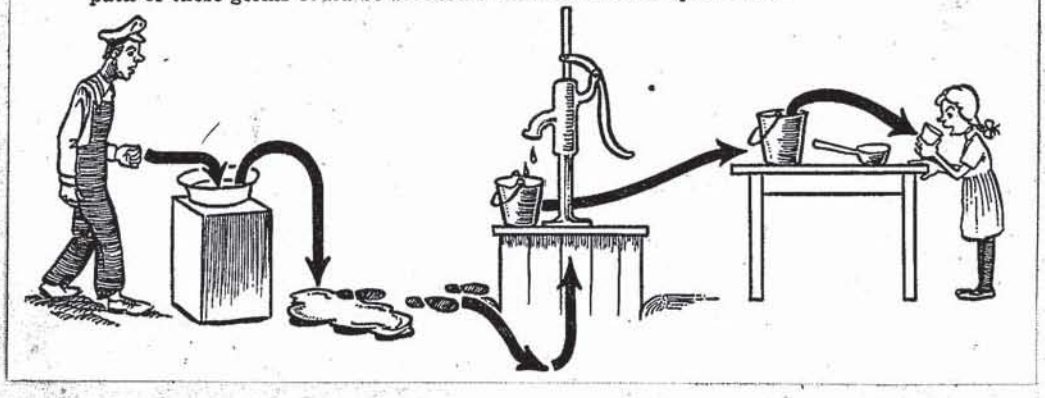


Fig. 21 The direction function of this illustration is obvious from the emphasis on the path of bacteria. The primary purpose is to direct the reader through a definite thought pattern. (Fig. S-77)

(iv) Dramatic Empahsis: Often a contrived drawing can portray a situation more vividly than can a photograph.

Fig. 22 A 'Dramatic-emphasis' type of wash drawing is reproduced here to show the supercharged power of this contrived medium for altering the attitudes of the observer. (Fig. S-319).

(v) Remote Situations and Objects: May be quickly and easily illustrated through the medium of pen and ink drawings with a high degree of selective arrangement of elements. (Fig. 23).

(vi) Non-Perceivable Situations: Illustrations of non-perceivable situations help to make concepts more accurate and more generally useful, enabling generalization, and extending and carrying over understanding from one thing to another. It is important, then, that abstractions be brought as close to concrete experiences as possible, if learning is to take place. (Fig. 24).

FIG. 132. The mink kills many rodents. What animal made the wavy track at the bottom of the page? Why are there tracks of only one animal along the side of the page?

Animals that feed upon the flesh of other animals are called *carnivorous animals* or *carnivores*.[1] Without the protection of these carnivorous animals, we should be literally "eaten out of house and home" by rodents.

The balance between rabbits and coyotes. Rabbits living in a district where food is very plentiful, increase rapidly in numbers. This increase provides more food for the coyotes of the district, so they, too, multiply rapidly (Fig. 123). As the coyotes become more numerous, they kill more and more rabbits, until the number of rabbits begins to decrease. Food then becomes more scarce for the coyotes, with the result that they increase less rapidly or not at all. Now, because of scarcity of food, many of them must leave the district or die of starvation. In this way, the numbers of rabbits and of coyotes in a district are kept balanced. This balance between the numbers of different kinds of living things is called the "balance of nature."

[1]Carnivore comes from the Latin, *carnis*, flesh, and *voro*, devour.

Fig. 23 Remote situations can be brought to the observation of a student and can contribute to his understanding.

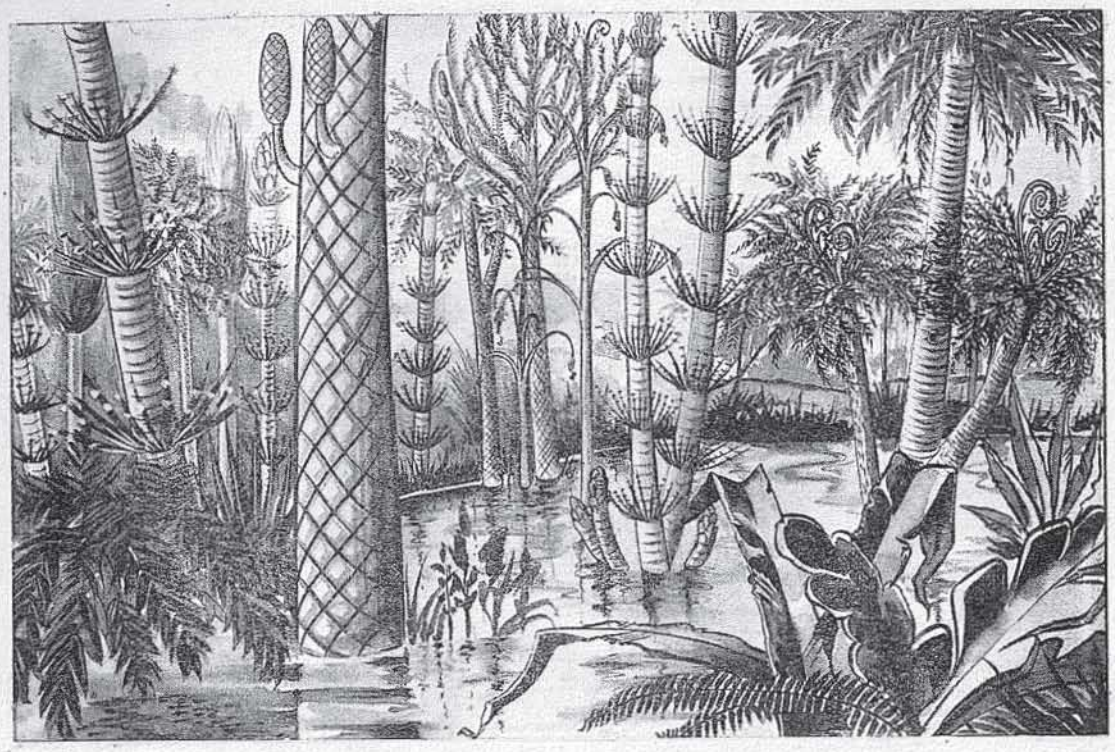


Fig. 24 Delineation of a non-perceivable situation can motivate learning if its purpose and value is made clear.

(2) DIAGRAMS: A diagram is a figure or a drawing made to illustrate a statement or to facilitate a demonstration. They are "skeleton forms" of the original, and are used in most cases to expedite learning.

Diagrams consist of:

i. Representations of objects entering into central relationship.

ii. Verbal symbols used to name the parts, etc.

iii. Symbols such as dash-lines to indicate motion, paths, etc.

Results from some research studies indicate that a need for certain directives for the use of diagrams is apparent:

1. Diagrams should not be used as a starting place in the development of a concept. (General science students will have difficulty translating outlines into three dimensional impressions). Diagrams should be used as a follow-up.

11. Students should be taught the concept behind the contruction of cross-sections in general.

111. The meanings of Symbols such as arrows and dash lines should be taught.

1V. A diagram should not be expected to communicate concept of motion.

Diagrams can be identified into three types:

(a) Those which communicate organizational relationships such as a floral diagram:

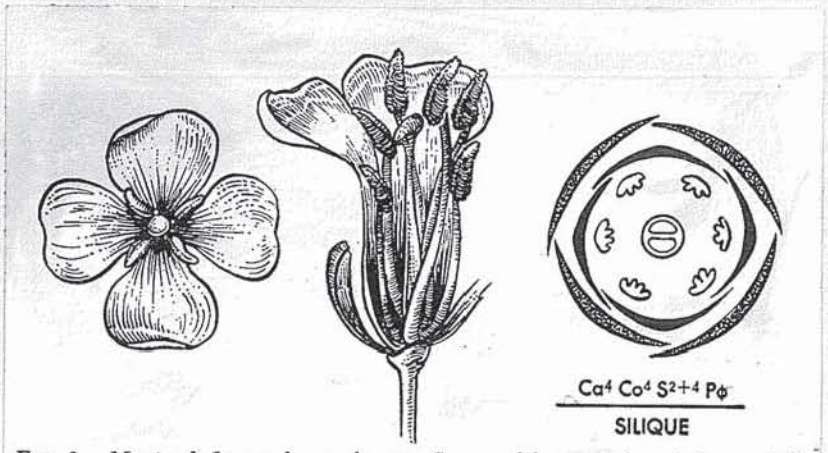


FIG. 6. Mustard flower from above. Same with a sepal and two petals removed. Can you find the stamens and pistil like these on your specimen? The "floral diagram" tells a botanist about the flower. The formula tells the same story in "shorthand."

Fig. 25 A diagram showing organizational relationship.

(b) Those which communicate operational relationships, such as a diagram of a carbon dioxide generator:

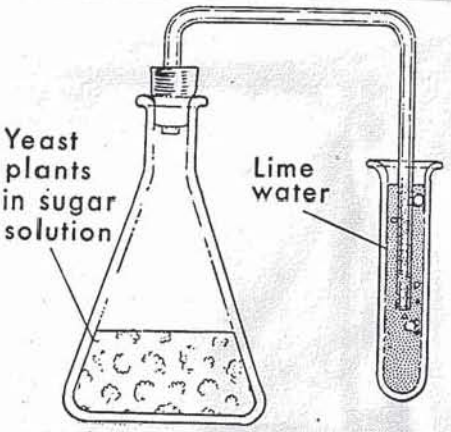


FIG. 65. Yeast plants growing in a sugar solution produce alcohol and carbon dioxide. How is this gas used in breadmaking?

Fig. 26 A diagram showing operational relationship.

(c) Those which communicate functional organization as a diagram of function of the different kinds of nerve endings.

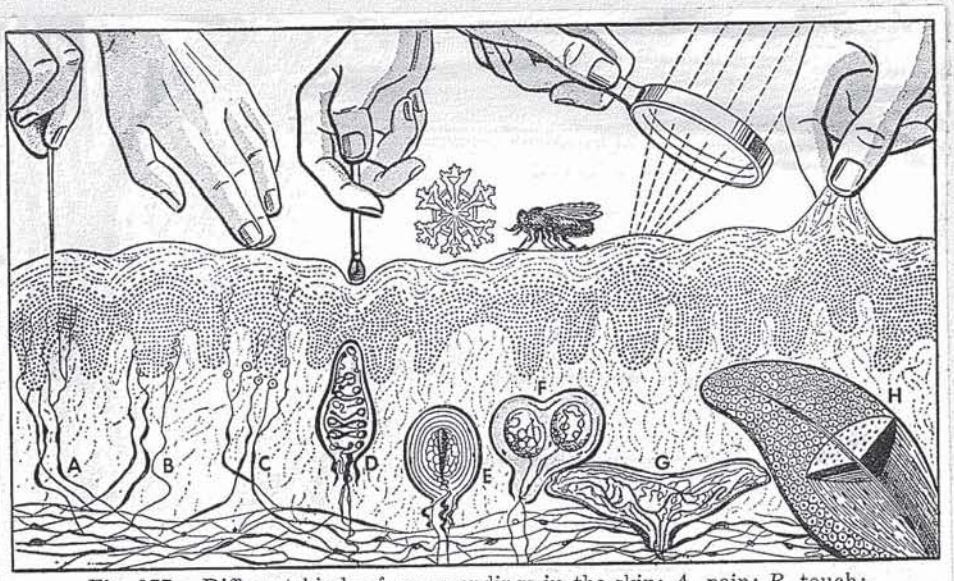


Fig. 377. Different kinds of nerve endings in the skin: *A*, pain; *B*, touch; *C*, stroking; *D*, pressure; *E*, cold; *F*, tickling; *G*, heat; *H*, traction.

Fig. 27. A diagram showing functional relationship.

(3) CARTOONS: A first rate cartoon tells its story metaphorically through pictures and a metaphor can be more powerful than a direct statement. It is in this sense that cartoons were included in the design of "Science Indoors and Out". The best cartoons make their point instantaneously -- its symbolism tells the message. On controversial subjects, such as alcohol and tobacco education, cartoons used are frankly one-sided, using every means to make its point, exaggerating some elements, reducing others. Like all emotionally charged media, cartoons must be used with care and intelligence.

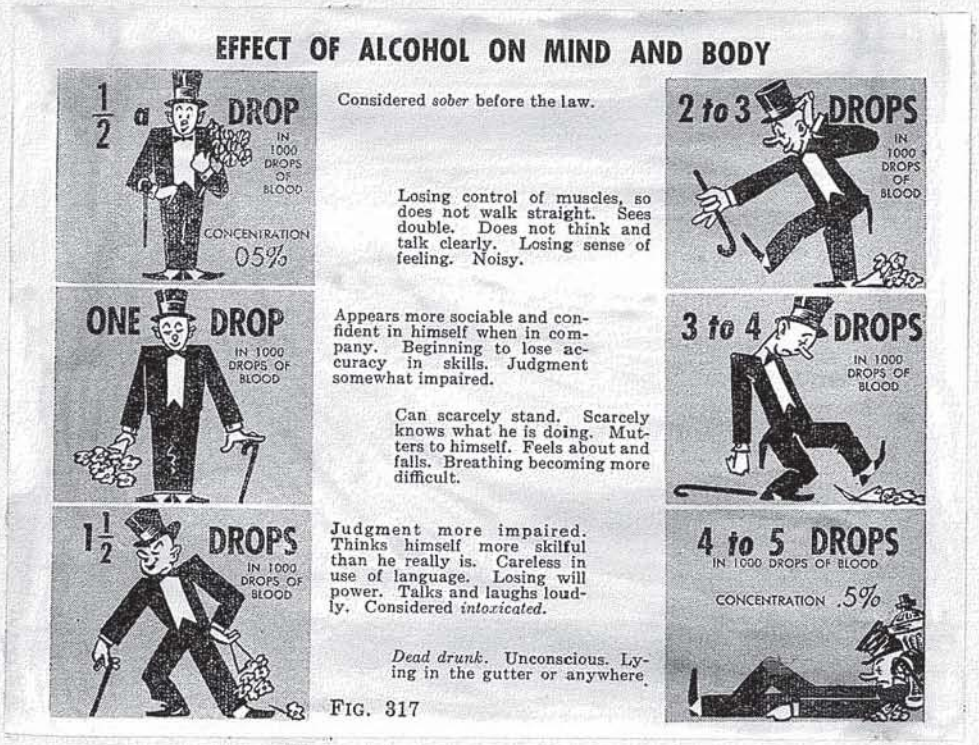


Fig. 28 The emotional impact of cartoons makes them valuable media for propaganda.

(4) CHARTS: In this frame of reference the chart is to be considered as a visual symbol for summarizing, comparing, contrasting, and providing other helpful means for dealing with subject matter. We can distinguish four general kinds of charts, each representing a visual pattern.

(a) Stream or Tree charts depict development, growth, change, by beginning with a single source (trunk) which then spreads into many branches.

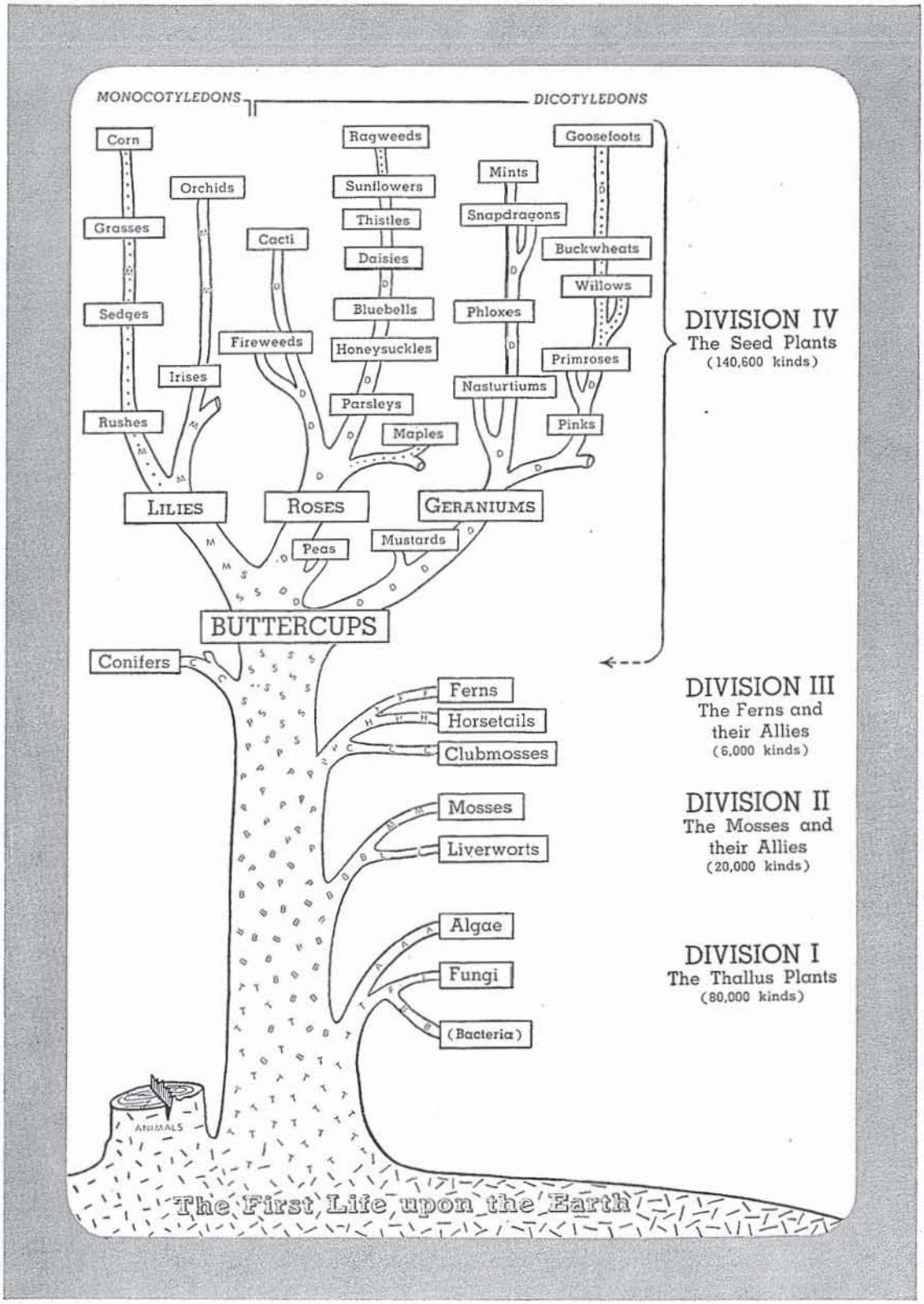


Fig. 29 The family tree of the plants, charts the origin of our modern plant families.

(b) Comparison and Contrast chart -- tells a summarized story by a simple device.

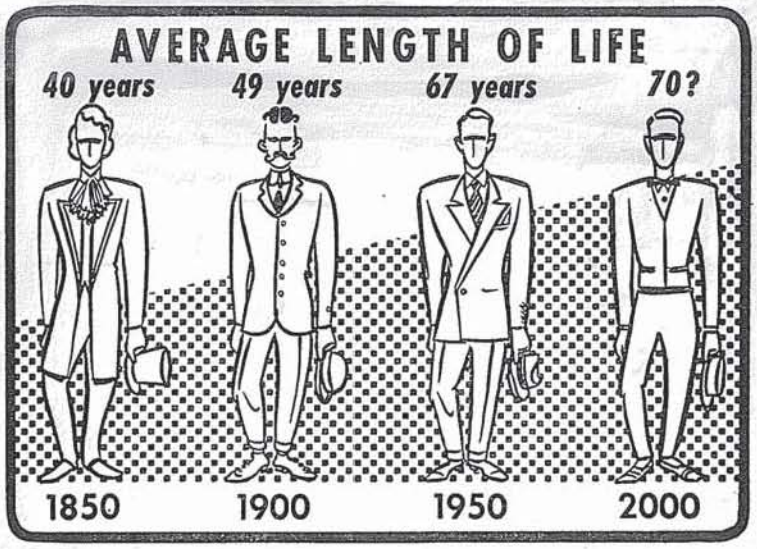


FIG. 287. Until recent times it was a very rugged person who lived much beyond forty years. To-day a greater number of people are living to old age. Suggest four important reasons why you may expect to live longer than did your ancestors in former generations.

Fig. 30 Compares the span of life by a screened background and auxiliary numbers.

(c) Direction or Guidance charts present, in simple statement or outline form, certain data for pupils to understand and follow. The following is a chart designed for this purpose.

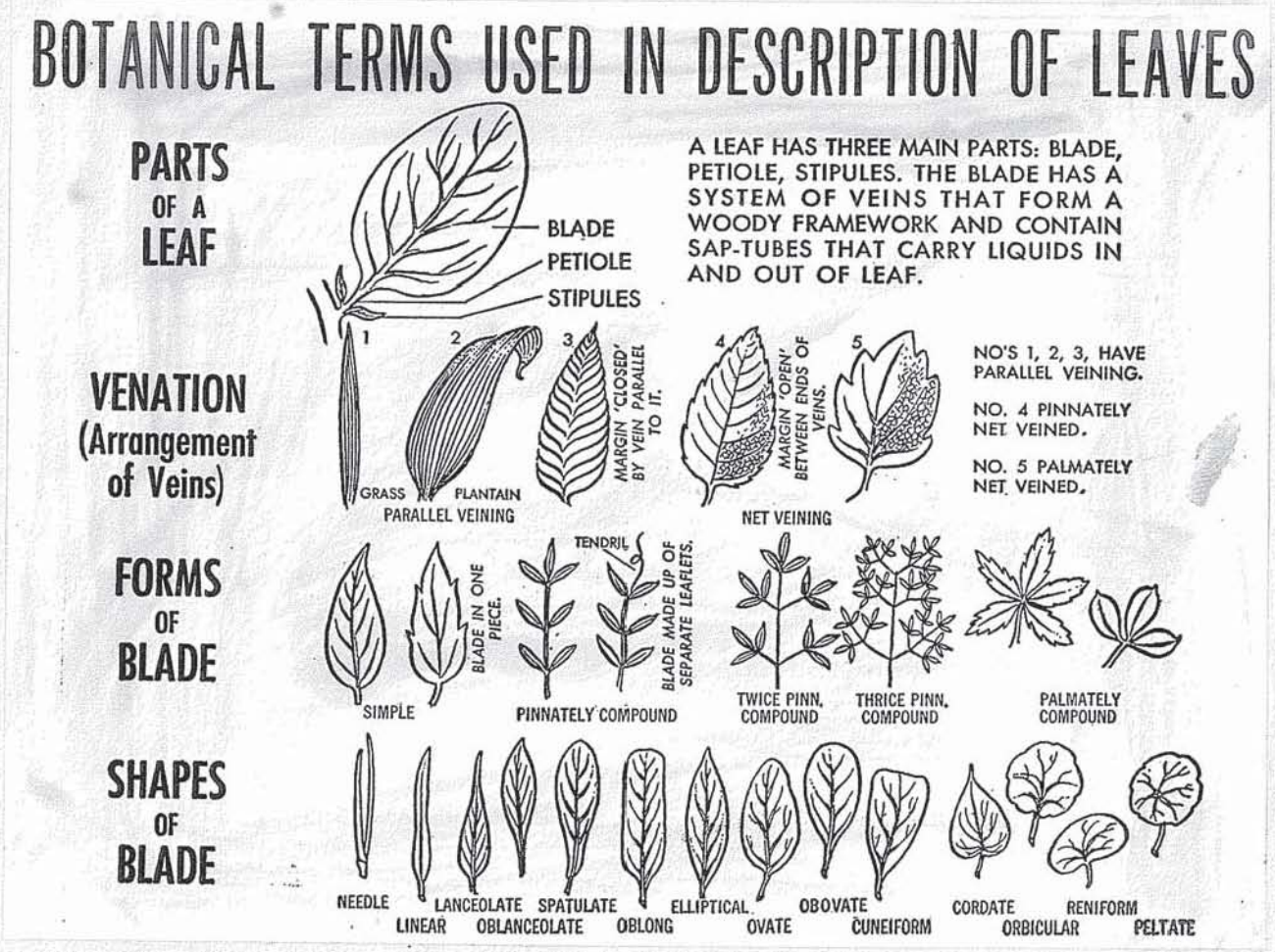


Fig. 31 A portion of a chart designed to guide students.

(d) Flow or Organization charts represent by lines and rectangles the functional relationships with an organization. The organization of the Department of Health and Welfare for Manitoba is pictured by a chart. (Fig. S-298).

IDENTIFICATION OF DRAWING TECHNIQUES

Technically, drawings comprising "Science Indoors and Out" can be grouped according to six techniques of rendering used in the production of illustrations:

(a) Pen and ink line with stipple shading.

(b) Pen and ink line with brush-point shading.

(c) Pen and ink line with "Zip-a-tone" shading.

(d) Pen and ink line with Ben Day shading.

(e) Ink wash with outline.

(f) Ink wash with deep tone values.

Each drawing was rendered according to the nature of the subject. Soft jelly-like cells were stippled for three dimensional illusion, plants and animals were brush-shaded for crispness of line. Experimental apparatus was illustrated by steel-engraved-like lines with "zip-a-tone" delineation of its contents. Wash drawings were produced where it was thought realism can influence the development of a concept.

Chapter X

SOME PRINCIPLES FOR THE ILLUSTRATION OF TEXTBOOKS

Textbook illustrations are a means to an end; the end is to help teachers do better the job of communicating information and ideas, of stimulating desirable attitudes and appreciations, of expanding interests, and of developing potentialities into skills and competencies.

The following claims for illustrations used adequately in the teaching situation are supported by research evidence:

1. They supply a concrete basis of conceptual thinking and hence reduce verbalistic response of students.
2. Illustrations have a high degree of interest for students.
3. Illustrations supply the necessary basis for developmental learning and hence make learning more permanent.
4. They offer a reality of experience which stimulate self activity on the part of the pupils.
5. Illustrations contribute to growth of meaning and hence to vocabulary development.
6. Illustrations provide experiences not easily secured in other materials, and hence they contribute to the depth and variety of learning.

In addition to the basis supplied by research, discussion advanced in the foregoing chapters related to the psychology of learning develop into some tentative hypothesis; these may be of significance in determining principles for the illustration of textbooks.

HYPOTHESES.

1. Illustrations can be designed to emphasize selected ideas the teacher intends the learner to develop.
2. Illustrations can present specific discrete ideas to the learner.
3. Illustrations can be selected to fit the continuity of the learner's experience.
4. The layout of a page of text and illustrations influences the effectiveness of visual perception and thereby comprehension.
5. Illustrations and text can be designed so that the learner perceives the intended interrelationship.
6. The effectiveness of the text book is increased by presenting the same idea by means of both the text and illustrations.
7. Principles can be developed whereby teachers can predict where an illustration is needed to supplement the text.
8. A learner can be taught specific techniques of reading illustrations which will improve his

ability to grasp the ideas suggested.

9. Tests can be devised which will determine the learner's ability to read and understand illustrations.

10. A learner develops certain habits of eye-movement in reading an illustrated textbook.

Educational purposes are the real basis for the selection of illustrative material. The materials that are utilized enable the teacher to give direction to the learing experiences the students will have. On this premise, selection becomes precise and analytical. Teachers will evaluate illustrative material by applying certain criteria. These should determine the significant principles of the illustration of textbooks.

Criterion 1. Will the illustration help achieve a teaching purpose?

> Some pictures in textbooks are wasteful because they serve no real purpose, such as portraits of famous mathematicians in mathematic books.

PRINCIPLE 1. -- Each illustration must hit a specific target.

Criterion 11. Is this a good illustration technically and artistically?

> Because we want to show pupils what things look like....

PRINCIPLE 2. -- For teaching purposes fidelity and richness of detail are important.

> Drawings must be clear and definite in outline and tone. "Fuzzy" 'sketches' have no place in a science textbook. 'Stipple' or 'scratch' toning of line drawings should accentuate detail not obscure it.
>
> Photographs must be in sharp focus, pleasingly lighted and composed. There should be good contrast in its tones.

Criterion lll. Does the illustration give a generally true impression?

If a picture does not leave a truthful impression, it will lead to wrong inferences.

PRINCIPLE 3. -- The total impression formed by an illustration must be valid.

Criterion lV. Will the Picture stimulate the imagination?

A good picture will start imaginative currents in the mind of the beholder. The child should see the picture itself and beyond.

PRINCIPLE 4. -- A good illustration should have inherent qualities of opening up new vistas of imagination.

CRITERION V. Will the picture add to the pupils' fund of knowledge?

There is no point to using a picture to show what children already know.

PRINCIPLE 5. -- Illustrations should be used only when they will create a new concept or attitude.

CRITERION VI. Does the picture give an accurate impression of relative size of the object?

G. Stanley Hall, found that some city children thought a cow to be the same size as a mouse -- the two animals were the same size in the reader used by these children.

PRINCIPLE 6. -- Familiar objects should be included with strange objects to give an accurate impression of the relative size. (Figs. S-20 and S-21).

Criterion Vll. Does the picture have the proper amount of detail?

A picture can have so many details that the central idea is obscured, and conversely it can have so little detail that it shows too little to be worth using.

PRINCIPLE 7. -- The size of illustration should be large enough to make clear every detail it is designed to present.

PRINCIPLE 8. -- The quality of paper and the kind of reproduction process must be selected to provide good reproduction of every detail.

PRINCIPLE 9. -- Halftone screens should be of the finest the paper can 'take' to achieve clearer detail and pleasanter total effect.
a more pleasant total effect.

PRINCIPLE 10. -- Drawings should be drawn and rendered 'around' the detail significant to the development of the proper concepts.

Criterion VIII Does the picture focus attention upon one main idea?

Some illustrations lack a central idea in terms of focus -- the "eye doesn't know where to go".

PRINCIPLE 11. -- The illustration must reveal the main idea clearly and immediately.

SUMMARY

There has been an enlarging concept of the audio-visual field. The recent war heightened enthusiasm for the use of instructional materials of this kind. Now educators are looking at the field more objectively. Constructive contributions are being made.

Emphasis on the motion picture has overshadowed less glamorous aspects of the field of visual aids. Textbook illustration and design can be classified among these.

It was the purpose of this survey to investigate the literature concerning various aspects of the textbook illustration problem. To get background material, to examine research, to discover main points of concern, to relate findings to the psychology of learning, to formulate generalizations, and to develop a structure for further study were purposes for this survey.

The survey reveals that little specific information is in the literature. There are several "armchair articles" stating personal opinion. Research studies have utilized historical survey, and experimental techniques. Studies are few, but do contribute useful data.

The main issues revolve around the selection and utilization of illustrations. It is concluded that principles of learning directly apply to illustrations as they do to other instructional materials.

Generalizations include: (1) the need for more study and research, (2) closer cooperation between educators and publishers on the problem, (3) the application of the principles of learning and scientific method to criteria for the selection and use of text illustration, and (4) the placing of the responsibility mainly on the educators.

Theoretical considerations based on the evidence gathered in the survey develop into a structure which should be useful in a further investigation of the problem. Several hypothesis are advanced which circumscribe areas to be tested experimentally and which may establish certain principles to the illustration of textbooks.

With respect to the general design of the textbook the following items were presented important:

1. Legibility and attractiveness of the type page. This involves selection of the right type face, the matter of leading, space between the lines, line length, relationship between the main text and reduced matter, amount of white space, running heads, etc.
2. The "layout" of the page. This should be designed to aid the student to understand the text. As far as possible the arrangement of the material should make the book self-outlining. A crowded, unbroken page presents a needless barrier to student's learning effort. The function of the designer should be to synchronize the visual design of his layout and the thought design of the author.

3. The texture of the paper should be smooth but light absorbent. "Slick" papers should not be used. The various off-white shades are usually preferable to clear white, but care should be taken to avoid noticeable color.

4. Illustrations should receive very careful attention. They should be chosen specifically for their teaching value and should be closely related to the text. Illustrations may be grouped into two main categories (a) Realistic (Photographs) (b) Visual symbols (drawings, diagrams, charts, cartoons, etc.) Types in each category are classified as:

   (1) Common-descriptive (2) Technical-descriptive (3) Directive (4) Motivating (5) Dramatic emphasis (6) Humorous interest (7) Remote (8) Unfamiliar (9) Non-existant.

5. The cover and size of the book is responsible for the first impression made by the book and is therefore of primary importance.

Problems in the designing and illustration of "Science Indoors and Out" were discussed, and criteria for the selection of textbook illustrations presented. Finally ten principles for the illustration of textbooks were formulated.

Probably no other single commercially produced instructional material reaches so many pupils today as does the textbook. It is evident that here is an important influence on the learning of the child. If teachers can recognize that

pictures are on a par with words as instruments of communicating subject-matter, they will not hesitate to use them interchangeably. A picture is not a luxury, a frill, something to sugar-coat learning. It is an integral part of the learning process. The textbook design and illustration problem is important.

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