

THE USE OF SCIENCE TEXTUAL MATERIALS
FOR TEACHING READING SKILLS NEEDED
IN SECONDARY SCHOOL SCIENCE

by ~~580~~ 936F N.C.

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B. A., Marion College, 1963

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

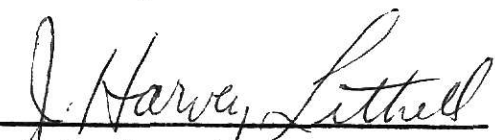
MASTER OF SCIENCE

College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

Approved by:


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ACKNOWLEDGMENTS

The writer wishes to express her sincere gratitude to Dr. J. Harvey Littrell of the College of Education for his advice, criticism and guidance in this report. I also appreciated the help given by Jan L. Holman, Science Consultant at the Kansas State Department of Public Instruction in selecting textbooks used in this report.

TABLE OF CONTENTS

	PAGE
I. INTRODUCTION.....	1
II. STATEMENT OF PROBLEM.....	3
III. REVIEW OF LITERATURE.....	4
Reading and Science Instruction.....	4
Critical Reading.....	8
Vocabulary Development.....	9
Reading Rates.....	10
Locational Skills in Textbooks.....	12
IV. PROCEDURES USED IN THE STUDY.....	14
V. SPECIFIC EXAMPLES OF THE USE OF SCIENCE	
TEXTUAL MATERIALS FOR TEACHING READING	
SKILLS.....	16
Critical Reading.....	16
Example 1. Translation.....	18
Example 2. Interpretation.....	19
Example 3. Application.....	20
Example 4. Analysis.....	21
Example 5. Synthesis.....	22
Example 6. Evaluation.....	23
Vocabulary Development Through Contextual	
Approach.....	24
Context clue 1.	24

	PAGE
Context clue 2.	25
Context clue 3.	26
Context clue 4.	26
Context clue 5.	27
Context clue 6.	28
Locational Skills In Textbooks.....	28
Example 1. Index.....	29
Example 2. Table of contents.....	30
Example 3. Title page.....	31
Example 4. Glossary.....	32
Reading Charts, Tables, Graphs, and Diagrammatic Material.....	32
Example 1. A technique for reading diagrams and charts.....	33
Example 2. A technique for reading tables...	34
Example 3. A technique for reading graphs...	36
Example 4. A technique for map reading and interpretation.....	38
Example 5. A technique for reading pictures.....	41
Reading Rates.....	43
Example 1. Scanning.....	44
Example 2. Skimming.....	45

	PAGE
Example 3. Speeded reading.....	45
Example 4. Study reading.....	46
Example 5. Careful and reflective reading.....	46
VI. SUMMARY AND CONCLUSIONS.....	47
VII. SELECTED BIBLIOGRAPHY.....	49

INTRODUCTION

There has been an increasing amount of literature concerned with the need for secondary school teachers to be able to help students read material used in subject fields. Michaels stated secondary school teachers must determine their subject's specific reading needs and difficulties and raise the level of their students' reading performance in those subjects.¹ There is increasing evidence that subject matter teachers can promote student's reading skills and consequently the learning of content by analyzing the reading skills needed in their subject areas.² These reading skills can be taught using textbook examples as the teacher proceeds in the subject material.

The writer has become aware of the current difficulty encountered by science teachers in aiding students to comprehend science material. Junior high and high school teaching experiences and a course taken at Kansas State University titled Reading

¹Melvin L. Michaels, "Subject Reading Improvement: A Neglected Teaching Responsibility," Journal of Reading, 9:19, October, 1965.

²Ned D. Marksheffel, Better Reading In The Secondary School (New York: The Ronald Press Company, 1966), p. 190.

Programs In The Secondary School have developed the writer's awareness for the need for teaching reading skills.

Mallinson stated that growing enrollments will lead to the inevitable increase in class size, hence it is likely that teachers may depend even more on textbooks than they do now.¹ Therefore, teachers and students must be able to use textbooks effectively.

¹G.G. Mallinson, "Textbook and Reading Difficulty In Science Teaching," The Science Teacher, 25:474, 1958.

STATEMENT OF PROBLEM

The purpose of this report was to develop examples of types of exercises which may be used by teachers in secondary school science classes to assist in teaching needed reading skills. The examples illustrate how the reading skills may be taught at the same time the subject matter is being taught. Materials used in the examples were taken from secondary school science textbooks.

Exercises were developed for teaching the skills:

1. Critical reading.
2. Vocabulary development through contextual approach.
3. Reading rates for different purposes.
4. Locational skills in textbooks.
5. Reading of charts, tables, graphs, and diagrammatic material.

REVIEW OF LITERATURE

Reading and Science Instruction

Schleich stated reading skills needed for high school cannot be mastered in the elementary grades.¹ Therefore, secondary school teachers must carry some responsibility for teaching reading. Secondary teachers should have no greater task than to guide their students in learning to read material of their subject area more effectively.² Braam stated that knowledge of reading skills necessary for successful reading of subject material on the part of the teacher was a prerequisite to teaching students to effectively read such material.³ Michaels stated two responsibilities of secondary school teachers: (1) Transmitting subject content. (2) Improving students' ability to acquire subject content independently.⁴ One way of achieving the latter would be to help students read better. Shores suggested that teachers

¹Miriam Schleich, "The Secondary Teacher's Responsibility for Literacy," Journal of Reading, 11:604, May, 1968.

²Ibid., p. 604.

³Leonard S. Braam and Marilyn A. Roehm, "Subject Area Teacher's Familiarity with Reading Skills," Journal of Developmental Reading, 7:190, Spring, 1964.

⁴Melvin L. Michaels, "Subject Reading Improvement: A Neglected Teaching Responsibility," Journal of Reading, 9:16, October, 1965.

teach more effectively about the nature of reading so the students will know when they are reading well for a given purpose.¹

Teachers must be familiar with the nature of reading to facilitate their instruction of reading. For a better understanding of the reading process Braam suggested there must be an improvement of communication between reading experts and the classroom teacher.² The literature indicated secondary school teachers should have at least one basic course in teaching of reading.³ Shores suggested teachers should devote much more attention to empirical and analytical studies of what is involved in ability to read for various purposes.⁴ McCracken conducted a year long demonstration with junior high school teachers aimed at improving instruction in reading. Before carrying out the demonstration these teachers attended a summer school session on reading. During the instructional period the instructor found the teachers wanted instruction on teaching reading, but needed assistance incorporating this into their

¹J. Harlan Shores, "Reading of Science for Two Separate Purposes as Perceived by Sixth Grade Students and Able Adult Readers," Elementary English, 37:468, November, 1960.

²Braam and Roehm, op. cit., p. 196.

³Schleich, op. cit., p. 603.

⁴Shores, op. cit., p. 468.

own teaching style. Materials should be readily available for the teachers use.¹

Davis suggested that systematic and carefully planned exercises, which are appropriate in level of difficulty for each pupil, should be provided throughout the secondary school grades.² Smith introduced instructional materials on reading for main ideas, sequence, comparison and others that could be adapted for science material.³ Practice exercises in reading were given to the student to improve skills for different purposes.⁴ Herber indicated suggestions for teaching reading skills while teaching subject material.⁵ In the literature study and reading skills were related. Stauffer stated study skills are essentially reading skills which enhance the quality of the learning experiences in

¹Robert A. McCracken, "Supervision of Reading Instruction in the Junior High School," Journal of Reading, 11:276-284, January, 1968.

²Frederick B. Davis, Identification and Measurement of Reading Skills of High School Students (Philadelphia: University of Pennsylvania, 1967), p. 73.

³Helen K. Smith, Instruction of High School Student's In Reading For Different Purposes (Chicago: The University of Chicago, 1966), pp. 271-414.

⁴Shores, 1960, op. cit., p. 468.

⁵Harold L. Herber, Developing Study Skills In Secondary Schools (Newark, Delaware: International Reading Association, 1967), p. 156.

study situations and assist young people in becoming more independent and effective learners.¹

Ekwall listed five steps to improve students reading comprehension in science:

1. Help the student recognize and state his own problem. Find and state his own reasons for improvement.
2. Help students develop an effective method of study.
3. Help students analyze and budget time properly.
4. Help the student keep an accurate up to date notebook.
5. Help the students to become familiar with the vocabulary of the science course.²

The Kansas Studies In Education listed the following reading skills needed in science:

1. Utilize sources to locate material.
2. Adjust reading speed to the type and difficulty of the material and the purpose for reading.
3. Comprehend written material.
4. Evaluate the material intelligently.
5. Use the content of written material in situations requiring scientific method.
6. Apply concepts gained from the reading material to confronting situations.
7. Develop the habit of extensive reading in the science field to stimulate and to satisfy intellectual curiosity and to participate more effectively in a physical world.

¹R.G. Stauffer and H.T. Hahn, "Reading, Studying, and Thinking," Instructor, 77:23, December, 1967.

²Eldon K. Ekwall, "A Science Teacher's Role In Reading," Science Teacher, 34:31-32, December, 1966.

8. Follow directions.
9. Make accurate self evaluations of progress in reading scientific material.¹

Further discussion of each of these reading skills were compiled by a committee.² Several of the skills listed above were investigated for further clarification.

Critical Reading

Critical reading must be used by students as they evaluate the material intelligently. Harvison suggested critical reading would help students in the following ways:

1. Detect conflicting views in written materials.
2. Detect contradictions in written material.
3. Detect bias on behalf of author or publishing company.
4. Determine if material is outdated.
5. Detect propaganda.
6. Examine content for validity and reliability.³

Harvison and Wardeberg felt that the ability to read critically can start in school as early as kindergarten and must continue even through graduate school.⁴ Eller stated critical

¹M. Jerry Weiss, Reading In The Secondary Schools (New York: The Odyssey Press, Inc., 1961), p. 250.

²Ibid., p. 250-260.

³Alan R. Harvison, "Critical Reading for Elementary Pupils," Reading Teacher, 21:244-247, December, 1967.

⁴Ibid., p. 244; Helen L. Wardeberg, "Critical Reading," Elementary English, 44:247-251, March, 1967.

reading skills must be taught specifically and these skills should be utilized by students in classes in content fields.¹

Vocabulary Development

The importance of contextual clues should be presented in such a manner that students could better understand textual material. In the article by Emans context clues were considered to be the most important single aid to word recognition. Contextual clues required more than incidental attention if children learn to make the most of this skill.² Ames provided a very good classification for contextual aids to identify context clues:

1. Clues derived from language experience or familiar expression.
2. Clues utilizing modifying phrases and clauses.
3. Clues utilizing definition or description.
4. Clues provided through words connected or in series.
5. Comparison or contrast clues.
6. Synonym clues.
7. Clues provided by tone, setting and mood of a selection.
8. Referral clues.
9. Association clues.

¹William Eller and Judith Goldman Wolf, "Developing Critical Reading Abilities," Journal of Reading, 10:196, December, 1966.

²Robert Emans and Gladys Mary Fisher, "Teaching The Use of Context Clues," Elementary English, 44:243-246, March, 1967.

10. Clues derived from the main ideas and supporting details pattern of paragraph organization.¹

Many textbooks of science contain non-technical words that could be replaced with easier synonyms.² Teachers should guide students with word study exercises usually available at the end of each section. It is too easy to assume that students have learned through previous experiences the necessary vocabulary for topics in science. Teachers should realize that each field of science has its own technical vocabulary and proficiency allows pupils to use the terms necessary to understand the basic concepts which the particular unit of science is designed to develop.³

Reading Rates

Reading rates were discussed extensively in the literature and a composite of the main ideas of these articles was that students must have a definite purpose in order to adjust reading rates. Stauffer stated students should learn to adapt rates of reading to purposes for reading

¹Wilbur S. Ames, "The Development of a Classification Scheme of Contextual Aids," Reading Research Quarterly, 2:57, Fall, 1966.

²Mallinson, op. cit., p. 475.

³Lawrence E. Hafner, Improving Reading In Secondary Schools (New York: The MacMillian Company, 1967), p. 149.

according to the nature and difficulties of the material.¹ Shores stated if purposes had been developed in advance then those purposes for reading influenced the speed with which the reading was done.²

Weinstraub stated elementary school pupils and high school students have not been instructed in the techniques of reading for different purposes. The researcher found those who were flexible readers had learned to adjust their rate and techniques on their own.³ Fleming stated there was a need to increase the understanding of the nature of skimming.⁴ Donald suggested skimming of assignments be used in the SQ3R (Survey, Question, Read, Recite, and Review) method of study. In her study where student skimming was used the students gained better powers in organization, association and critical thinking.⁵ Maxwell found by

¹R.G. Stauffer and M.A. Tinker, "Should Reading Stress Speed?," Instructor, 77:39, October, 1967.

²J. Harlan Shores, "Are Fast Readers the Best Readers? A Second Report," Elementary English, 38:245, April, 1961.

³Samuel Weinstraub, "Research: Reading Flexibility," Reading Teacher, 21:169, November, 1967.

⁴James T. Fleming, "Skimming: Neglected in Research and Teaching," Journal of Reading, 12:211, December, 1968.

⁵Sister Mary Donald, "The SQ3R Method in Grade Seven," Journal of Reading, 11:33-35, October, 1967.

suggesting to college students to practice simple techniques their reading rate improved without loss of comprehension.¹ Berkey had ninth graders take an eight week course on reading rates. At the beginning and end of the course the students were tested on Nelson Silent Reading Test. The study noted that the average gain to be 1.8 years.² This indicated that teachers should be more concerned with teaching of reading rates. Hanson stated the burden of adapting instruction to the individual in this area remains with the classroom teacher.³

Locational Skills in Textbooks

Smith stated in these days when teaching machines and self-instructional materials are being advertised widely, it is easy to overlook the fact that the modern textbook has been planned to help the student educate himself.⁴ Students

¹Martha J. Maxwell and Arthur C. Mueller, "Relative Effectiveness of Techniques and Placebo Conditions in Changing Reading Rates," Journal of Psychology, 11:184-191, December, 1967.

²Theodore L. Harris, Wayne Otto, and Thomas C. Barrett, "Summary and Review of Investigations Relating to Reading July 1, 1966 to June 30, 1967," The Journal of Educational Research, 61:260, February, 1968.

³Earl Hanson, "Factors Related to Reading Rates," Reading Teacher, 21:669, April, 1968.

⁴Harold L. Herber, Developing Study Skills In Secondary Schools (Newark, Delaware: International Reading Association, 1967), p. 32.

should be aware that their textbook is a tool to help them acquire knowledge and develop specific skills applicable to the text.¹ If the textbook is to be used efficiently for the purposes intended, its parts and their relationship to one another should be thoroughly understood by both teacher and student.² Jewett stated students should become acquainted with textbooks the day they are distributed.³ Parts used for locating material should be the index, title page, glossaries and footnotes. Subject teachers are responsible for offering instruction in how to read charts, graphs and diagrams common to their field.⁴ Teachers should begin early in secondary school with carefully planned experiences with diagrams.⁵

The reading materials of any subject area are designed to aid in the skill for communication of ideas and concepts for that area.⁶ All other factors being equal the textbook is probably the most satisfactory source of basic material for teaching science.⁷

¹Ibid., p. 6. ²Ibid., p. 41.

³Ibid., p. 33. ⁴Ibid., p. 102.

⁵Walter A. Thurber and Alfred T. Collette, Teaching Science In Today's Secondary Schools (Boston: Allyn and Bacon Inc., 1959), p. 473.

⁶Herber, op. cit., p. 97.

⁷Mallinson, op. cit., p. 474.

PROCEDURES USED IN THE STUDY

The procedures used in this report consisted of:

1. Obtaining a list of reading skills needed in science from the Kansas Studies in Education.¹

2. Selecting the following five skills from the list given in the Kansas study:

- a. Critical reading.
- b. Vocabulary development through the contextual approach.
- c. Reading rates for different purposes.
- d. Locational skills in textbooks.
- e. Reading of charts, tables, graphs, and diagrams.

3. Selecting two texts, which are used in Kansas secondary schools to find textual examples where each of the above skills is needed. The writer requested from Jan L. Holman, Science consultant at the Kansas State Department of Public Instruction, a list of science texts most widely used in Kansas schools. From the list which he supplied, the writer selected:

1. Otto, James H. and Albert Towle. Modern Biology, (New York: Holt, Rinehart and Winston, Inc., 1963), pp. 792.

¹Weiss, op. cit., pp. 250-259.

2. Thurber, Walter A. and Robert E. Kilburn.
Exploring Science Nine, (Boston: Allyn and Bacon, Inc., 1966),
pp. 575.

SPECIFIC EXAMPLES OF THE USE OF SCIENCE TEXTUAL MATERIALS FOR TEACHING READING SKILLS

Critical Reading

Critical reading has been given many names such as: "creative reading," "inferential reading," "reading between the lines," and "interpretive reading."¹ Marksheffel interpreted critical reading as purposeful reading in which the higher-level thinking processes were used in making sound judgements on the basis of all available evidence.² According to Sanders the inter-relationship involved in the translation of printed material into precise meaning requires the following: Memory which enables the student to recognize or recall data; translation as the intellectual process of changing ideas into parallel forms; interpretation as relating factual data, generalizations, definitions, values and skills; application which gives students practice in the transfer of learning. Additional factors demanding more reasoning abilities would be: analysis requiring solution to problems in the light of conscious knowledge of the parts and processes of reasoning; synthesis encouraging students to engage imaginative and original thinking; and evaluation containing

¹Ned D. Marksheffel, Better Reading in the Secondary School (New York: The Ronald Press Company, 1966), p. 250.

²Ibid., p. 250.

appropriate standards and how close the idea meets these standards.¹

Marksheffel stated the only difference between critical reading and critical thinking was that critical thinking becomes critical reading when it is applied to written symbols.² Sanders noted that critical thinking involves all categories above memory,³ therefore critical reading can involve all categories above memory or our higher level thinking processes as in Marksheffel's definition.

Marksheffel stated that a critical reader is an independent thinker and a reader that has developed numerous skills, concepts, attitudes and beliefs.⁴ A reader does not assume the material is correct because it has been printed in a newspaper, book or magazine article. An integral part of reading presupposed that a reader has been questioning and analyzing what is read.

The examples which follow show how materials from science books can be adapted to teach various aspects of critical reading. All of the following examples were taken

¹Norris M. Sanders, Classroom Questions What Kind? (New York: Harper and Row Publishers, 1966), P. 3.

²Marksheffel, op. cit., p. 251.

³Sanders, op. cit., p. 6.

⁴Marksheffel, op. cit., p. 251.

from the ninth grade general science book¹ and a tenth grade biology book.²

Example 1.

Translation: The student changes information into a different symbolic form or language.

General science:

Change each of the following elements into a symbol. Refer to page 210.

<u>ELEMENT</u>	<u>SYMBOL</u>	<u>ELEMENT</u>	<u>SYMBOL</u>
1. Oxygen		8. Sulphur	
2. Carbon		9. Chlorine	
3. Hydrogen		10. Magnesium	
4. Nitrogen		11. Iron	
5. Calcium		12. Copper	
6. Phosphorus		13. Iodine	
7. Potassium		14. Fluorine	

Biology:

Refer to page 228. After studying the equation try to explain the reaction in your own words.



¹Walter A. Thurber and Robert E. Kilburn, Exploring Science Nine (Boston: Allyn and Bacon, Inc., 1966).

²James H. Otto and Albert Towle, Modern Biology (New York: Holt, Rinehart and Winston, Inc., 1963).

Example 2.

Interpretation: The student discovers relationships among facts, generalizations, definitions, values, and skills.

General science:

Refer to page 227. Answer the following questions.

1. What are the functions of the liver?
2. Why are these functions important to the human body?

Biology:

Read the following paragraph on botulism and answer the following question.

Botulism is the most deadly of all food poisoning. Most cases result from home-canned foods, especially string beans, that are eaten before thorough cooking. The botulism organism, a close relative of the deadly tetanus bacterium, thrives in an airtight container. It gets into the food as a spore before canning and multiplies during the period of storage. Poisons are released from the bacteria into the food. Symptoms of botulism usually appear within 12 to 36 hours after the food is eaten. They include double vision, weakness and paralysis that creeps from the neck region to other parts of the body. Death may result from respiratory failure or heart failure. Mortality occurs in about 65 percent of the cases. Since the poison is destroyed by heat, botulism can be avoided by cooking home-canned vegetables before eating them.

Make a diagram of how botulism gets into food and becomes dangerous to the human if consumed.

Example 3.

Application: The student solves a lifelike problem that requires the identification of the issue and the selection and use of appropriate generalizations and skills.

General science:

Read the following paragraph. Carry out the simple experiment and answer the questions that follow the paragraph.

Carbon Compounds. Carbon compounds make up a large part of all organisms. Carbon compounds can be detected by (1) incomplete burning which produces soot, or leaves a black ash, or (2) testing the gases produced from burning for increased carbon dioxide.

1. What is a test for carbon dioxide?
2. Set fire to animal fat such as tallow. Hold a metal can in the flame. Test the gases given off for carbon dioxide. Test other animal tissues in the same way.

Biology:

Refer to page 238 in your text. Read the section on Robert Koch, the father of bacteriological technique and answer the following question.

Discuss the scientific contribution of Robert Koch in his investigation of anthrax.

Example 4.

Analysis: The student solves a problem in the light of conscious knowledge of the parts and forms of thinking.

General science:

Read the following paragraph. Carry out the simple experiment and answer the questions that follow the paragraph.

Fats. Fats contain only carbon, oxygen, and hydrogen, but there are many kinds which differ in the proportion and arrangement of the atoms in the molecules.

A test for fat: Rub the test material on a piece of brown paper. If the paper is translucent when held near a window, fat or oil is present.

To prepare a tissue for the test, grind it as fine as possible and mix it with carbon tetrachloride. (CAUTION: Do not inhale the vapor.) After a few hours, filter off the liquid and evaporate it. Test any remaining material for fat.

Weigh different animal tissue after grinding them. Then weigh the fat extracted by carbon tetrachloride.

1. Calculate the percentage of fat in each tissue.
2. What might affect the accuracy of your results?

Biology:

Refer to pages 247-248 and answer the following questions.

1. Why is this section titled "The Conquest of Diphtheria"?
2. Why would a mixture of toxin and antitoxin seem to be safe to the human body?

Example 5.

Synthesis: The student solves a problem that requires original, creative thinking.

General science:

After the student studied the section on "Supplying Our Cells" (pages 209-235) have them answer the following question.

How would life differ on a planet where no carbon atoms existed?

Biology:

Refer to pages 247-248 in your text. Then answer the following question.

Could you envision a method of treating a new disease caused by a bacterium that secretes a deadly toxin?

Example 6.

Evaluation: The student makes a judgment of good or bad, right or wrong, according to standards he designates.

General science:

After the students have studied the sections on bone parts (pages 211-212) have them answer the following questions.

1. Why are older people more apt to break bones than children?
2. Why do older bones heal more slowly when broken?

Biology:

Study each method of food preservation on page 234 of your text. Then answer the following question.

Would food industries be able to rely upon a single method of preservation for all types of food?

Vocabulary Development through Contextual Approach

Word study skills are an essential part of an educational program. Work on vocabulary development should be conducted at every grade level from the upper elementary to senior high.¹ Contextual clues are a means of determining the meaning for a word from the sentence or paragraph in which it is used. After each form of contextual clue will be examples which show how materials from science books can be adapted to teach various aspects of contextual approach. Context clues are presented in several forms:

Context clue 1: The grammatical use of the word in a sentence is indicative of established usage.

General science:

As a result, the embryo becomes surrounded by this membrane, as shown in D. The membrane, containing the embryo, fills with a liquid.

What do you know about the word "membrane"?

Biology:

After years of testing the effect of soil organisms on various pathogens, streptomycin, an antibiotic substance produced by Streptomyces griseus, was discovered.

What do you know about the word "streptomycin"?

¹Harold L. Herber, Developing Study Skills In Secondary Schools (Newark, Delaware: International Reading Association, 1965), p. 31.

Context clue 2: The context providing a clue by indicating that the unknown word is in comparison or contrast to some other words in the sentence.

General science:

- a. Set fire to animal fat such as tallow.

Define the word "tallow" from this sentence.

- b. In the past, there were both colonial corals and solitary corals.

Define the word "solitary" from this sentence.

Biology:

- a. The name filterable virus refers to the fact that they pass through the extremely small pores of unglazed porcelain filters used in separating bacteria from fluids.

Compare virus and bacteria according to size.

- b. Fission in paramecia involves the division of both the macronucleus and the micronucleus, after which two daughter cells form.

Define the word macronucleus from the sentence.

Context clue 3: A secondary word used in the context as a synonym to the unknown word.

General science:

Define "lipids" from the following sentence.

When fats (lipids) are digested, their molecules are broken into smaller units to which atoms of hydrogen and oxygen may join, as when maltose and proteins are digested.

Biology:

Define "virulence" from the following sentence.

The properties of many viruses are altered by the environment in which they are grown. This applies to the potency, or virulence, of many disease producing viruses.

Context clue 4: Definition of a word is purposely supplied by the author.

General science:

Define "chemical bonds" from the following passage.

Atoms making up molecules are held together by forces of attraction. These forces are called chemical bonds.

Biology:

Define "autotrophic" from the following passage.

A relatively small number of bacteria are autotrophic. These organisms synthesize their own organic compounds.

Context clue 5: The whole meaning of a paragraph will supply the definition of a word.

General science:

After you have read the following paragraph, define "glycogen."

The liver does not store glucose; instead, it converts glucose to a type of starch called glycogen. A molecule of glycogen may be made up of as many as 20,000 glucose units. This glycogen is stored in the liver and reconverted to glucose when the sugar level in the blood drops.

Biology:

After you have read the following paragraph define "flagella".

Various bacillus and spirillum forms of bacteria are equipped with threadlike ships or flagella which propel the cell through water and other fluids. Flagella may be found singly or in tufts at either or both ends of a bacterial cell. In some forms flagella are found all around the cell. Flagella are visible only when they are treated with special stains. Under the highest magnification of the light microscope, they appear as minute threads. The electron microscope shows them to be cytoplasmic extensions that project through openings in the cell wall. Flagella are strands of protein molecules resembling the microscopic fibers composing muscle. Thus, in the beating flagella of bacteria, we may have the basis for the muscle contractions of animal organisms.

Context clue 6: A person's own background of experience will help define a word.

General science:

What do you know about "cartilage" from the following sentence.

Bones begin as cartilage; the rubbery substances you can feel in your ears.

Biology:

Define the word "host".

We refer to the organism supporting the parasite as the host.

At higher levels contextual clues have little value when the material is heavy with unfamiliar words, and the student has lacked experience in the particular subject area.¹ If contextual clues fail to give meaning then students are advised to use the dictionary for further assistance.

Locational Skills In Textbooks

Locational skills are used to find specific information. The writer has considered the location of information only in textbooks, and therefore is concerned with the index, table of contents, title page, glossary, and footnotes. Following are some ideas and suggestions from textbooks:

¹Marksheffel, op. cit., p. 205.

Example 1.

Index. An index is a short-cut to details, facts, names, dates, and specific pieces of information. Entries in the index are arranged in alphabetical order.¹

General science:

The student may want to find out about shell fossils, they must first determine the key word. The key word is "fossils", then the student looks this up in the index. Second the student will skim the subtopics to find shell and following this word the pages will be given where the student can find this information.

Fossils, carbonization and, 184; as clues to the past, 178-181; coral reefs, 504; how formed, 182-185; inferences from, 178-181; interpreting, 186-195; petrification and, 185; restorations and, 196-205; shells and, 186-193; various explanations of, 177; volcanic activity and, 518.

Biology:

The biology student may want to find out about cellular division in bacteria. First he will look for the key word bacteria in the index. Second the student will skim the subtopics to find cellular division. The page numbers

¹Herber, op. cit., p. 34.

that follow this subtopic will be where the student will find out about cellular division of bacteria.

Bacteria, 3, 28, 222-235; anthrax 238-239, 245; cellular division, 107-108; chemosynthetic, 91-92; diphtheria, 248; in lymph, 594; and nitrogen cycle, 667, 668-669; as pioneers, 694; related organisms, 235-236; saprophytic, 681; as transformers, 678.

The following locational skill exercises can be used in both general science and biology.

Example 2.

Table of contents.

1. How many chapters are in this book?
2. Does this general science or biology book cover topics from biology, chemistry and physics?
3. What other sections are listed that you might use?

Example 3.

Title page.

1. Is the title given on the title page the same as the one on the cover?
2. What are the author(s) or editor(s) name(s)?
3. What qualifications to write this book does each author or editor have?
4. What is the copyright date?
5. Why would the copyright date be important to know in science?
6. Which of the textbooks you are using this year has the oldest copyright date?
7. Which one has the latest copyright date?
8. Why might they be different?
9. Who is the publisher?
10. Where is the publisher's central office located?¹

¹Herber, op. cit., p. 35.

Example 4.

Glossary. The glossary is a small dictionary section at the end of the book usually before the index. Science frequently presents definitions of key terminology in chapters where new concepts and principles are introduced. These definitions may also be found in the glossary. Students should be taught to look for these definitions, to study them thoroughly, and to analyze examples and illustrations preceding or following the definitions. Students should know that many publishers print important definitions in boldface type, italics, or in brightly colored type. One way to check if students use the glossary or learn the meanings of words would be to give a small vocabulary check once a week on new words covered that week or the most recent unit.¹

Reading Charts, Tables, Graphs, and Diagrammatic Material

A book uses many types of visual aids to get across abstract ideas. Students must learn how to read maps, charts, diagrams, tables, graphs, pictures and cartoons in order to learn effectively. Following will be specific examples for each type of visual aid.

¹Ibid., p. 36.

Example 1.

A technique for reading diagrams and charts.¹

General science:

Refer to page 285 of the ninth grade text.

1. What type of diagram is being presented?

The life cycle of ferns to show the sequence of development step by step.

2. What symbols or special devices are used?

Numbers in order to indicate which step is first and arrows indicating which direction to follow. The broken line divides the life cycle between sexual and asexual development. Each step is labeled to indicate the development of the plant at that stage.

3. What is the significance of the diagram?

The purpose of the diagram is to show alternation of generations. Refer to page 285.

Biology:

Refer to page 217.

1. What type of diagram is being presented?

Bacterial lysis by phage infection.

¹Ibid., p. 127.

2. What symbols or special devices are used?

Numbers in order to indicate which step is first, second, and third, and so on. There are three symbols for free phage, protein core, and DNA core.

3. What is the significance of the diagram?

The purpose of the diagram is to illustrate a phage virus destroying a bacterium.

Example 2.

A technique for reading tables.¹

General science:

Refer to page 454.

1. What is the title?

Star types and facts about each type listed.

2. What is the unit of measurement?

This table gives the temperature of the different types in fahrenheit degree. The color would indicate the heat being released, and the spectrum would measure the quantity of element.

3. What are the column (vertical) and row (horizontal) headings?

Column: Star type by symbols.

¹Ibid., p. 132.

Row: Type in symbols, typical stars,
temperature, color and spectrum.

4. What special explanation is provided?

Headnotes and footnotes are often used to explain peculiar properties of the data.

A headnote appears between the title and the body. There is no additional information given in this table.

5. Look at the table as a whole, what does it tell you?

Stars are very hot, vary in color and elements are combined into compounds.

Biology:

Refer to page 261.

1. What is the title?

Comparison Of Three Protozoans

2. What is the unit of measurement?

There are no numeral measurements. The ameba, paramecium and euglena are compared to each other by form, locomotion, speed, food-getting and so on.

3. What are the column (vertical) and row (horizontal) headings?

Column: Form, Locomotion, Speed, Food-getting, Food Taken In, Digestion, Respiration, Excretion, Sensitivity, and Reproduction.

Row: Ameba, Paramecium, and Euglena.

4. What special explanation is provided?

Refer to page 261. The table below comparing the ameba, euglena, and paramecium, may help you to review the degree of specialization of these three common protozoans.

5. Look at the table as a whole, what does it tell you?

One celled animals carry on many different body functions in one tiny cell. If we compared this to higher animals they need many, many different organ systems to carry on each different function.

Example 3.

A technique for reading graphs.¹

General science:

Refer to page 419 of the ninth grade text.

1. What type of graph is used and what data are presented?

Conversion graph used to change feet traveled in $\frac{1}{2}$ second by a projectile into speed which is in miles per hour.

¹Ibid., pp. 141-142.

2. What is the unit of measurement?

Miles per hour (mph) and feet in a $\frac{1}{2}$ second.

3. How are the data arranged?

Vertically and horizontally.

4. What symbols are used?

None

5. Is a key provided?

None

6. What numerical guides are given?

Miles per hour (mph) on the vertical guides.

Feet per $\frac{1}{2}$ second on the horizontal guides.

The horizontal is cut off between 10 and 20.

7. What is the significance of the information gained from reading the graph?

Refer to page 419.

Biology:

Refer to page 90.

1. What type of graph is used and what data are presented?

A curved line graph showing the effect of temperature on photosynthesis.

2. What is the unit of measurement?

Temperature in centigrade degrees and the relative rate of photosynthesis.

3. How are the data arranged?

Horizontally and vertically.

4. What symbols are used?

None

5. Is a key provided?

None

6. What numerical guides are given?

Temperature in centigrade degrees on the horizontal axis and relative rate of photosynthesis on the vertical axis.

7. What is the significance of the information gained from reading the graph?

Refer to pages 89-90 in the text.

Example 4.

A technique for map reading and interpretation.¹

In reading and understanding map facts students should be made aware of the following elements:

General science:

Refer to page 529.

1. Map title.

Holy Cross, Colorado

¹Ibid., p. 113.

2. Legend.

The legend shows symbols which represent different kinds of roads, railroads, power transmission line, telephone line, school churches, mines, streams, and contour lines which show elevation.

3. Direction.

North will be assumed at the top since most maps are made in this way.

4. Distance scale.

Every inch equals one mile.

5. Location grids.

None

6. Type.

Topographic maps are designed to show accurately the shapes of hills and valleys of a particular region.

7. Interpretation.

Refer to page 529.

Biology:

Refer to the map on page 724 in the text.

1. Map title.

No specific title is given.

2. Legend.

The legend shows the colors used to designate the difference between the following forest regions: Pacific Coastal forest, Rocky Mt. forest, Central Hardwood forest, Northern forest, Southern forest, and the Tropical forest.

3. Direction.

North will be assumed at the top since most maps are made in this way.

4. Distance scale.

None

5. Location grids.

None

6. Type.

Vegetation map which by color, lines and symbols indicate forests, deserts, jungles and grasslands.

7. Interpretation.

This vegetation map shows the many different forests in the United States and also where the forests are located. If we consider all the different forest regions together we can see that $1/3$ of United States is occupied by forests.

Example 5.

A technique for reading pictures.¹

General science:

Refer to page 20 of the ninth grade text.

1. Make a general survey of the picture.

- a. What is the over all message the picture is trying to convey?

What plants look like when infected with parasites.

- b. What objects are included in the picture?

Tree trunk and infected leaves demonstrating damage done by the parasites.

- c. Is a title included, what does it tell you about the purpose?

The destructive nature of parasites.

2. Look more closely at the picture.

- a. What are specifics portrayed?

The variation in the structures effected.

- b. Are there any relationships the pictures trying to impart?

The cause and effect of parasites on plants.

¹Ibid., p. 147.

3. In relation to text material and the problem at hand, what inferences and generalizations can be made from the picture?

Refer to page 20.

Biology:

Refer to page 239 of your biology text.

1. Make a general survey of the picture.

- a. What is the general concept the picture is trying to convey?

The picture is showing four disease producing bacteria.

- b. What objects are included in the picture?

Genus and species of bacteria such as:

Clostridium tetani, Diplococcus pneumoniae,
Streptococcus pyogenes, Mycobacterium
leprae.

- c. Is a title included and what does it tell you about the purpose?

No title given.

2. Look more closely at the picture.

- a. What are the morphological characteristics of the organisms?

The various shapes of bacteria that cause disease.

- b. Are there any relationships the pictures are trying to impart?

Pictures 1, 2, and 3 demonstrate growth on artificial media whereas 4 shows growth only in viable cells.

3. In relation to text material and the problem at hand, what inferences and generalizations can be made from the picture?

To determine if Koch's postulates are methods to determine pathogenicity.

Reading Rates

Students need to read material at different rates according to purpose. Good readers may naturally succeed in achieving this skill, but poor readers need help to accomplish this skill. The following chart adapted from Strang shows the different rates and their purposes.

CHART OF DIFFERENT READING RATES¹

Rate	Purpose
1. Scanning	To locate information.
2. Skimming	To skim for the main idea or to find out "what happened next."

¹Ruth Strang and Dorothy Bracken, Making Better Readers (Boston: Heath, 1957), p. 120.

- | | |
|-----------------------------------|---|
| | To "survey" or get an overview and raise questions the selection can answer. |
| 3. Speeded reading | To read rapidly for certain details or main ideas |
| 4. Study reading | To read with maximum understanding
Survey
Raise questions
Read
Review
Recite |
| 5. Careful and reflective reading | To follow directions as for example, how to make a cake or perform a chemistry experiment; to reflect on content; to evaluate; to enjoy; to read aloud to share an esthetic experience. |

Example 1.

Scanning.

General science:

Have students scan page 563 for the purpose of finding a simple definition.

What is the definition for "fault"?

Biology:

Scan through the pages in chapter 15 to find a page on which the classification of viruses is located.

On what page can you find the classification of viruses.

Example 2.

Skimming.

General science:

Have students skim page 214 to find a number.

How many types of tissue are there?

Biology:

Have the students skim through page 792 to find a specific page number.

On what page will you find information on rabies?

Example 3.

Speeded reading.

General science:

Have the students read rapidly page 212 to determine several items.

What material will you need to do the test on bone composition?

Biology:

Have students read rapidly page 239 for Koch's postulates.

How many of Koch's postulates are there and what are they?

Example 4.**Study reading.****General science:**

Have students read slowly page 216 on Organ Systems to answer questions presented in the reading material.

Biology:

Have students read slowly pages 240-241 for a list and some examples of each item in the list.

List the ways organisms are spread to cause diseases and after each give an example.

Example 5.**Careful and reflective reading.****General science:**

Have students read carefully page 212 on Composition of Bone to carry out an experiment in that section.

Follow directions to carry out an experiment of bone composition.

Biology:

Have students read carefully pages 249-252 for evaluation of the following problem.

After reading the section on antibiotics, what idea might you have to help the situation of resistant strains of bacteria in hospitals?

SUMMARY AND CONCLUSION

The literature concerned with reading in subject areas shows a need for secondary science teachers to be aware of reading skills involved in reading science texts. The purpose of this report was to develop examples in which secondary school science teachers may use textual material to teach reading at the same time they are teaching subject matter. A list of reading skills used in was obtained from the Kansas Studies in Education.¹ The following reading skills were illustrated:

1. Critical reading.
2. Vocabulary development through contextual approach.
3. Reading rates.
4. Locational skills in textbooks.
5. Reading charts, tables, graphs, and diagrammatic material.

Materials used for the examples were taken from secondary school science books.^{2,3}

¹M. Jerry Weiss, Reading In The Secondary Schools (New York: The Odyssey Press, Inc., 1961).

²Walter A. Thurber, Exploring Science Nine (Boston: Allyn and Bacon, Inc., 1966).

³James H. Otto and Albert Towle, Modern Biology (New York: Holt, Rinehart and Winston, Inc., 1963).

The writer found that the modern junior high science textbook, used in this study, used the discovery method in their discussions. Intermingled through the text were questions, experiments and directions on reading charts and diagrams. If the students study these questions as they read then they will be developing many reading skills. However, teachers have the responsibility of seeing that the skills are developed. The biology book used in this study was rather traditional in presenting factual information; therefore, original exercises would have to be made to develop the reading skills used in science. The writer felt that if teachers were to become aware of the reading skills and see textbook examples they would be able to introduce these skills when the reading skills are needed.

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THE USE OF SCIENCE TEXTUAL MATERIALS
FOR TEACHING READING SKILLS NEEDED
IN SECONDARY SCHOOL SCIENCE

by

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AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

ABSTRACT

The purpose of this report was to develop examples in which secondary school science teachers may use textual material to teach reading at the same time they are teaching the subject matter. The following reading skills were illustrated:

1. Critical reading.
2. Vocabulary development through contextual approach.
3. Reading rates.
4. Locational skills in textbooks.
5. Reading charts, tables, graphs and diagrammatic material.

Examples for each of the above reading skills were taken from a ninth grade general science text and a high school biology text. The modern junior high science text used in this report was written in such a way that properly instructed students could develop reading skills. The biology text used in this report did not develop reading skills, therefore more original examples using textual material needed to be developed.