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A Study of Selected Topics to be Taught in Sixth-grade Science in the Grant School, Ephrata, Washington

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A STUDY OF SELECTED TOPICS TO BE TAUGHT IN SIXTH-GRADE SCIENCE IN THE GRANT SCHOOL, EPHRATA, WASHINGTON

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TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

CHAPTER I

INTRODUCTION

The boys and girls of today live in a scientific world. From the time children awaken in the morning until they go to bed at night, and even during the night, their lives are under the influence of some aspect of science. While awake they are curious of many natural and man-made phenomena. During the school year much of this curiosity is brought into the classrooms. With the philosophy of helping children to grow in their ability to master their world, we need a sound science program in the elementary schools (24:15). Craig said:

> There has grown up a conviction thatthe free nations must remain strong if they are to remain free, and that no nation today can be strong unless it is strong in the power of science. Science is an essential element in maintaining and improving the democratic way of life. It will not be enough to have a small portion of the population educated as scientists; to be truly strong, an entire nation must be conversant with science. Achieving this goal is a task uniquely suited to the elementary school since this is the institution for <u>all</u> the children of all the people (16:3).

This is a challenge to be met by elementary school teachers.

THE PROBLEM

<u>Statement of the problem</u>. The purpose of this study will be (1) to set up a series of units from which a sixth grade science program can be built; (2) to determine what

materials can be used to teach this: and (3) to provide the nucleus around which an entire elementary science program can be developed.

LIMITATIONS OF THE STUDY

The study will be limited to the following aspects: (1) topics to be considered for sixth grade science; (2) textbooks from nine of fourteen publishers of elementary science textbooks; (3) proposal of a sixth grade science program.

DEFINITIONS OF TERMS USED

In this study the following meanings are used.

Materials. Materials mean films, filmstrips, slides, books, and/or pamphlets used for reference sources in the teaching of science.

Generalizations. Generalizations are the conclusions reached applicable to a class of data or a total situation on the basis of several specific instances (23:245).

Principle. A Principle is a comprehensive generalization describing some fundamental process or property relating to natural phenomena (23:412).

Concept. Good defines a concept as "any general or abstract intellectual representation of a situation, state of affairs, or object; a thought, an opinion, an idea, or a

mental image" (23:91). One author defines a science concept as being an individual's understanding of some aspect of his environment (27:2). The various elementary science textbooks authors used the terms concepts, learnings, generalizations, a and science meanings for children all to indicate those basic ideas to be learned from the study of a given topic. Since the meaning of the word concept is vague, the writer will use it to mean those statements of unifying ideas, major outcomes, or principles.

Unit. A resource unit* is "a collection of material, activities, and resources related to an area or topic and organized in a functional way which a teacher uses in planning and developing a unit of work with his class" (25:393). Since the material in the units in this study will not be complete, these will not be considered as resource units. They are subdivisions of the course of study--in this case sixth-grade science.

PROCEDURE

The procedure followed in this study were:

1. A review of selected literature pertaining to elementary science education.
2. An investigation of elementary science textbooks.
3. An inventory of present library materials available for the teaching of units to be selected.

*See also discussion of resource unit on page 23, Chapter IV.

4. A compilation of concepts pertaining to each unit.
5. A cataloging of reference materials, both available and desirable to have for each unit.

OVERVIEW

The remainder of the paper will pertain to the following aspects. In chapter two a review of the literature regarding elementary curriculum will be presented. Chapter three will explain the procedures to be used in surveying the materials used in the teaching of sixth-grade science. Chapter four deals with the units themselves. In the fifth chapter, the summary, the conclusions, and the recommendations are presented.

CHAPTER II

REVIEW OF THE LITERATURE

The teaching of science was put into a new perspective after the launching of the first man-made satellite. This momentous event has caused nearly every school child to expand his environmental curiosity to include outer space in a realistic rather than make-believe attitude. Children have always been curious about themselves, their pets, their immediate surroundings, and to some extent the heavens above.

Every elementary school teacher has had a pupil bring into the classroom an insect that had not been observed before with the question, "What is it?" Few individuals, either young or old, can resist the charm of watching beautiful snowflakes gently settle on the sleeve of a dark sweater or coat. Migrating geese in the fall bring about interest from both sportsman and nature lover. The satisfying of curiosity is one of the educators greatest assets in the teaching of science.

This curiosity can be developed by classroom teachers to help children understand their world by guiding their observations and investigations. By giving the children time to observe and think, to search and draw their own conclusions elementary teachers can prepare young minds for more extensive scientific work in later years (30:168; 24:15).

The teaching of science in the elementary grades offers more opportunities than just supplying the background information for the junior and senior high school courses in science. Science offers opportunities for real life learning situations and for desirable behavior growth (16:4). Hurley said through science young people may be helped "to a full and useful participation in the common wealth of humanity" (30:172). Science gives opportunity for children to work together, share, organize, classify, and communicate their findings. Science can do this because of the natural curiosity children have about their surroundings (12:99). Organizing and directing this curiosity into definite activities could be considered as science activities. Children make many investigations of their own volition so if these investigations can be guided, the youngster doing the work and his classmates will all profit (29:2). Zim said that first-hand experience was at the core of science; therefore, many of children's simple activities could be considered science if properly handled by teachers or parents (43:4).

In the spring of 1961, the American Association for the Advancement of Science conducted three regional conferences. The teachers, principals, superintendents, science educators, scientists, and psychologists who attended these conferences recommended:

> . . . instruction in science should be a regular part of the curriculum from kindergarten through grade 9. . . . Science should be a basic part of general education for all students at the elementary and junior high school levels. As a part of general education, science should constitute a regularly scheduled part of the curriculum in all grades (1:2020).

Science alone cannot make up the whole curriculum, yet it is not to be a thing apart from the rest of the interests and activities of children (6:6).

In planning the elementary science program, more than just isolated facts need to be considered. Numerous changes, including man's increasing scientific knowledge in recent years, have affected the elementary school's science curricula. Although many children seem to know many scientific facts, their understandings may be slight (30:168). Also, educators must be careful not to discard the durable basic content for the spectacular which might become obsolete before it is included in textbooks (30:172). Science in the elementary grades should involve investifating and rpoblem solving, not just reading about science, listening to the teacher, or answering questions which may cause them to give right answers yet not the answers the teacher wants (29:2; 33:157; 4:8).

In selecting content to be taught Craig said:

> Science instruction should be broad in scope to provide for growth in learning about all the major aspects of the environment--the sky, the atmosphere, the earth (including rocks, soils, and minerals)--conditions

> necessary to life, other living things, energy and forces (physical, chemical, and biological), and the inventions and discoveries of mankind. For the sake of convenience, a teacher might think of this environment of children as being all around them--the up, the down, and on the sides.(15:7).

The concepts should come from science content and not be drawn from some other area such as social studies. There should be a balance between the biological, physical, and earth sciences in any one year (36:21). These "concepts are the thinking principles" (27:2) or understandings of certain aspects of an individual's environment. They evolve over a period of time through interaction with his environment. In the classroom this interaction can be directed by the use of questions and the use of experimentation to discover ways the environmental phenomena can be understood and explained.

The content determines how scientific an elementary science program is. Podendorf recommended the content be presented in a broad spiral form so a given topic would be taught every three years (36:22). Fewer topics would be presented each year but those presented would be studied to a greater depth than most courses of studies now have it. This would give any child the opportunity to explore a desired topic to the extent of his interests and abilities.

In the teaching of elementary science one of the most important phases is the method (or methods) that the teacher

uses. A teacher might glibly tell a child that the jar he brought in contains frog eggs, place it on a shelf or table and promptly forget about it because the present topic in the text and, therefore, class discussion is "rocks". Allowing a textbook to dictate the "what" as well as the "how" of science would not bring out the scientific creativeness that is desirable in today's educational program. A worthwhile substitute for the above mentioned type program would be one in which there is active investigation on the child's part. It is not necessary for the teacher to know all the answers, in fact it is impossible, but he or she should be willing to help the student develop a plan for finding the answers. (32:14; 29:2).

Many individuals associate the idea of experiments, with science. Blough gives a series of guiding principles for conducting experiments in the elementary classroom. Briefly these principles are:

1. Conduct the experiment in a manner to make the pupils think.

2. Have the children be conscious of the purpose for doing the experiment. Write it out on the chalkboard if necessary.

3. Plan the experiment carefully. Have all materials available before starting and make sure they are the right ones.

4. If at all possible have the children do the experiment.

5. Whenever possible have the children originate the experiment, planning it from purpose to conclusion.

6. Perform the experiment carefully. Follow the plans exactly whether they be from a book or the children's.

7. Learn the value of a control and use it, whenever possible.

8. Keep the apparatus simple. The use of elaborate equipment frequently detracts from the experiment itself.

9. Use caution in drawing conclusions. Realize that one experiment does not necessarily prove a point and that many experiments need to be repeated several times before reaching a conclusion.

10. Apply the experiment to everyday situations (4:7-8).

Through students' reading research the results of experiments can be verified, thus building on information which they have previously acquired. They should learn to use a variety of sources and learn to evaluate the information from these sources. Through diversified reading, pupils can learn to differentiate fact from fantasy. Equally important, they should learn the distinction between fact and abstraction as well as fact and theory. Aside from general reading, it is very worthwhile for the pupil to read with a definite

purpose in mind. The purpose could be to check a conclusion, to find pertinent information, to find out how to do an experiment, or to find the answers to questions. Often notes should be taken so an individual's research efforts can be accurately shared with his classmates. The students learning to select appropriate material is another phase of reading research which is important to the overall educational objectives of the science program. On the other hand reading is a tool, not the science program (4:8).

The fundamental objective of the science program should be to help children develop an understanding of how to approach questions and problems scientifically. Appreciation of scientific attitudes, methods of investigation, encouragement in the use of scientific methods of inquiry in solving problems and finding answers should be outcomes of a good science program (34:40; 2:2). It should also help children acquire as broad a picture as possible of the world of science and its contributions to our democratic society. The student should develop a profound awareness of the importance of our natural resources, an awareness of the individual's responsibility in conservation and a positive view that something can be done in solving the ecological problems generated by man's influences when a sound science program is functioning within the school's overall curriculum.

CHAPTER III

PROCEDURE OF STUDY

A survey of topics presented in the sixth-grade science textbooks was made using student and teacher editions from various textbook publishers. Because there seemed to be considerable variation among authors as to the placement of topics, fifth grade texts were also briefly surveyed to ascertain topics for this study. The following tables of topic coverage, I and II, were prepared. Table I was taken from the table of contents in the students' editions. Table II was based upon the actual material presented in the various textbooks.

From Table II the writer selected nine units to be the nucleus for the course of study in sixth-grade science to be taught in the Grant Elementary School, Ephrata, Washington. Criteria used in selecting the unit topics were (1) Podendorf's suggestion of a balance among the various areas of science (36:21), (2) each topic was presented in at least three of the nine textbooks being surveyed, and (3) topics that are not now being taught in the present fifth grade science program. The nine topics were: (1) Energy: Sound, (2) Energy: Light, (3) Energy: Heat, (4) Chemistry, (5) Biology: Microscopic Life, (6) Health: The Nervous System, (7) Weather, (8) Geology; The Earth's Changing Surface, (9) Astronomy: Out in Space.

TABLE I

CONTENTS OF STUDENT EDITIONS

GRADE SIX SCIENCE TEXTBOOKS

Allyn and Bacon, Inc., 1958 — Exploring Science 6

Units		Pages
1.	Plants That Are Not Green	4-26
2.	Saving the Soil	27-52
3.	Time and Seasons	53-80
4.	Our Eyes	81-104
5.	Making Work Easier	105-130
6.	Musical Sounds	131-158
7.	Some Common Acids	150-180
8.	Electromagnets	181-200
9.	Bird Study	201-224
10.	How Airplanes Fly	225-250
11.	Warm Air In Motion	251-276
12.	Water in the Ground	277-298
13.	Fish Life	299-324
14.	Trees	325-347

American Book Company, 1961 — ABC Science Series 6

Units		Pages
1.	Insects and Flowering Plants	1-56
2.	Light: A Form of Energy	57-108
3.	Heat and Temperature	109-168
4.	Energy From the Sun	169-220
5.	Sensing the World Outside	221-270
6.	The Atom and Nuclear Energy	271-324

D. C. Heath and Company, 1961 — Science For Today and Tomorrow

Units		Pages
1.	The News Comes to Us	2-44
2.	Communication Across Time and Space	45-94
3.	The World of Chemistry	95-132
4.	A Visit to the Doctor	133-169
5.	Sunlight, The Maker of Food	170-200
6.	The Changing Earth	201-233
7.	The Universe	234-278
8.	Engineers At Work for You	279-303
9.	Power Today and Tomorrow	304-348

Ginn and Company, 1958 — Experimenting in Science 6

Units		Pages
1.	Energy Everywhere	4-27
2.	Why the Seasons Change	28-51
3.	Energy and Plant Growth	52-75
4.	Animals and Seasonal Change	76-97
5.	The Milky Way and Beyond	98-117
6.	Light Energy All Around Us	118-143
7.	Plants and Animals Live in Communities	144-163
8.	Using Water, Soil, and Forests Wisely	164-187
9.	Our Earth--A Huge Magnet?	188-211
10.	Machines to Direct Energy	212-233
11.	The Earth's Airways and Beyond	234-255
12.	Making the World a Healthful Place	256-276

Harper and Row, Publishers, 1963 — Today's Basic Science 6

Units		
1.	Science in the World Today	6-30
2.	The Earth's Atmosphere	31-74
3.	Looking Into Magnets	75-112
4.	Rockets and Space Travel	113-140
5.	Conservation, A Way of Life	141-176
6.	Animals--Their Growth and Development	177-210
7.	Your Living Body	211-240
8.	Senses and Signals	241-260
9.	Light, A Form of Energy	261-288
10.	Atomic Energy For Power and Peace	289-314
11.	Research and Discovery	315-335

Lyons and Carnahan, 1963 — Looking Ahead with Science 6

Units		
1.	Energy from the Atom	6-33
2.	Microscopic Plants and Animals	34-63
3.	Plants and Animals of Long Ago	64-93
4.	Out in Space	94-119
5.	Transmitting Light and Sound	120-153
6.	Energy Through Wires	154-181
7.	Man's Conquest of Air	182-207
8.	Riches from the Earth	208-239
9.	Resources for Tomorrow	240-269

The John C. Winston Company, 1956 The New Understanding Why 6

Units		Pages
1.	Understanding Our Community	1-38
2.	Our Health	39-76
3.	The Earth and the Seasons	77-120
4.	Means of Transportation	121-160
5.	Means of Communication	161-200
6.	Changes on the Earth	201-242
7.	Surviving Changes on the Earth	243-280
8.	Conservation	281-330
9.	Magic and Superstition	331-368

The L. W. Singer Company, 1962 Science Problems 6

Units		Pages
1.	Scientists Study the Earth	7-13
2.	The Atmosphere and Air Travel	14-29
3.	Weather and the Climate	30-57
4.	Plants and Animals You Cannot See	58-102
5.	Machines Help you Do Work	105-119
6.	Musical Instruments and Sounds	120-130
7.	This Is You	131-161
8.	Plant Improvement and Conservation	162-184
9.	The Surface of the Earth Changes	185-209
10.	Different Kinds of Animals	210-241
11.	Kinds of Energy	242-289
12.	The Universe	290-339

The Macmillan Company, 1960 Macmillan Science-Life Series 6

Units		Pages
1.	Testing Ideas	3-16
2.	Conditioning the Air	17-46
3.	Forecasting the Weather	47-80
4.	Controlling Sound	81-114
5.	Helping the Body Operate Properly	115-144
6.	Improving Our Relations with Others	145-174
7.	Growing Up Emotionally	175-202
8.	Travel to Other Planets	203-238
9.	Raising Animals and Plants for Food	239-266
10.	Resources of the Sea	267-286
11.	Using Power Machines	287-310
12.	Learning About Drinking and Smoking	311-318

TABLE II

TOPICS PRESENTED IN GRADE SIX SCIENCE TEXTBOOKS

TOPIC	PUBLISHER*								
	1	2	3	4	5	6	7	8	9
Astronomy		X	X	X		X		X	X
Biological Sciences									
Animals				X	X			X	X
Animal Changes							X		
Birds	X								
Ecology				X					
Flowering Plants		X	0	X				0	
Insects		X							
Microscopic Life						X		X	
Non-Flowering Plants	X								
Sea Life	X								X
Trees	X								
Chemistry	X	X	X		0	0			
Conservation	0			X	X	X	X	0	
Earth Sciences									
Geology	X		X			X	X	X	
Seasons	X			X			X		
Weather	0				0			X	X
Health									
Mental Health									X
Nutrition			X						
Senses	X	X	X		X		X		0
Physiology			X		X		X	X	X
Physical Sciences									
Aviation	X			X	X	X		X	
Electricity	X		0			X	0		
Magenitism				X	X				
Energy									
Atomic			0		X	X		0	
Heat	0	X	0		0				0
Light		X	0	X	X	0		0	
Sound	X		0			0		X	0
Machines	X		0	X			X	X	X

X-Topic extensively developed

0-Topic developed in conjunction with another topic

*1. Allyn and Bacon
2. American Book Company
3. D. C. Heath and Company
4. Ginn and Company
5. Harper and Row
6. Lyons and Carnahan
7. The John C. Winston Company
8. The L. W. Singer Company
9. The Macmillan Company

Each of these topics was developed in three or more sixth-grade textbooks, except the topic on microscopic life which was presented in only two textbooks.

Once the topics had been selected, the teachers' editions were carefully read and a list made of the concepts which could be developed through experimentation, research, and application of critical thinking by the students. The list of concepts were selected with the idea that they could be a basis for developing "resource" units. Since there was considerable duplication of concepts, the writer listed them from only one source even though several authors might have also developed the same concepts. Those texts which seemed to the writer to give the best presentation of a topic, as appropriate to the needs and environmental conditions of the students living in the Ephrata community, were listed as basic reference texts and those with similar but not as complete coverage were listed as supplementary references.

Using the nine topics, the library at the Grant School was surveyed for student and teacher reference material. After examining books in the Hebeler Elementary School Library and the Curriculum Laboratory of the Victor J. Bouillan Library, Ellensburg, Washington, additional titles of books were added to the list of those already available in the Grant School. These books, are indicated by an asterisk in the reference lists in the selected units in this paper.

Catalogs from the sudio-visual centers at Washington State University, and Central Washington State College were screened for appropriate films to use as aids in teaching the selected topics. The catalog of filmstrips from the Grant County Superintendent of Schools was also utilized.

CHAPTER IV

THE PROPOSED UNITS OF STUDY FOR GRADE SIX

Good defined a unit as a "major subdivision of a course of study." Units in this study contain "various activities, experiences, and types of learning around a central problem or purpose" (23:587). Each unit in this study builds upon basic science learnings elementary children should have and enables them to better understand their environment.

The content of the science program is important (36:21), but so are the methods used. To gain the most from educational content is to place it in the proper structure. If the fundamentals are understood the human mind will best remember what is placed in a proper structural pattern. Structuring aids in applying principles to new situations and provides for re-examining of content to select that which is fundamental (11:31-32).

There should be ample opportunity for individual student experimentation as well as some group work. Concepts should be derived from such experiments, observations, and discussions. No one student should be expected to master all the listed concepts for any one unit. Some pupils will

already have an understanding that will encompass many of the listed concepts. Other children might have to do more basic investigations in order to comprehend the simpler concepts.

Each child should be able to show evidence of growth in his understanding of his environment. He should also show growth in the different ways in which he approaches his problems and realize that much learning can come from an initial failure in performing an experiment (32:13, 67).

In preparing to teach these or any science units the suggestions of Blough, listed below, are significant, especially for a teacher who needs more self-confidence in the teaching of science.

1. Start with a unit with which you are familiar.

2. Read some basic texts on the elementary students' level as well as the junior and senior high school level.

3. Do some of experiments and activities suggested so as to provide you with the experience of working with the material.

4. Do some of the "things to do" before suggesting them to the children.

5. Make use of the teachers' manual.

6. Don't worry about materials because children can bring almost everything needed.

7. Let the pupils experiment.

8. Don't expect to know all the answers; be willing to learn with the children.

9. Watch current periodicals for appropriate articles.

10. Be open-minded in approach, methods like science change.

11. Keep records of material, reading notes, and suggestions for next time.

12. Talk with other grade-level teachers about their science experiences (8:10-12).

By using the manuals from several publishers and for various grade levels, a teacher can gain much background information before introducing the unit. Different manuals, as well as texts, use different experiments to help the children arrive at their concepts and build them into generalizations. Also, by using several texts the children can learn to be critical of printed material, learn to evaluate what they read, and take careful notes for reference (4:8).

There is included one list of references for teachers since so many of these books include sections or chapters on various phases of science. Most of these references include numerous experiments which, together with the respective textbooks and teachers' editions, will supply the teacher with many more experiments that could be performed or would be desirable to perform during the study of a given topic.

Experiments should have a value or not be done. As many experiments as possible should be done by the students. Many activities can be done individually at school or at home and results reported at school, other experiments can be done by small groups at school, possibly as demonstrations for the entire class.

In agreement with Hurley, there should be ample time for the students to think, therefore the exact extent of these units cannot be predicted, nor the depth to which each topic is pursued (30:168). This will depend upon the individual differences of the students making up the classroom. Lee indicates a few concepts had better be well learned than many presented and poorly learned (34:85).

In the preparation to enlarge these units into teaching units from which the daily lesson plans can be made, the suggestions developed in the Science Education class at Central Washington State College during the summer of 1964 are appropriate. Those suggestions are:

FIVE LEVELS IN AN "OVER-ALL" STRATEGY IN TEACHING SCIENCE IN THE ELEMENTARY SCHOOL

1. Continuous approach to getting materials--Being aware of the great variety of potential sources of materials. Utilize the students whenever possible in bringing materials. Be cognizant of materials and equipment that should be purchased; for example, binocular microscopes, micro-projectors, hand lens, dry cell batteries, aquarium equipment, flower pots etc., simple tools, etc. Be orderly, systematic in controlling storage problems.

2. Major projects, individual student projects, long range projects - Initiated and developed by students, related to various units of study that may be developed during the year . . . during the year most of the students will have beoome involved in an individual or team project.

3. Museum - Building up a classroom museum is a very valuable method of having specimens at ones side when optimum discussion contexts arise in various units of study. The collectors name, item, where found, date, etc., should be indicated on the specimen. The teacher should have a certain area in the classroom devoted to this purpose away from every day observation, avoiding stagnation of interest.

4. Resource unit-development - Developed initially from a labeled folder . . . objectives, questions, principles-concepts-structure, lists of related topics, pictures, experiments, demonstrations, lists of teaching ideas, references, audio-visual suggestions, evaluation . . . The unit is not a set of lesson plans but offers a basis for the preparation of lesson plans. The resource unit should be practical. (Adequate filing system for development of formal units.)

5. Lesson plans, weekly plans and yearly scope plans - Three developmental phases in the teaching of a unit:

    1. Initiating or Introductory Phase - In this phase the pupils become interested, motivated; their interest becomes "channeled" into the subject area. This may be accomplished by means of a film, presenting a problematic demonstration or experiment or through class discussion.

    2. Developmental or Main Sequence Phase - This is essentially a "work" phase. Answers to questions are developed through student research. By doing experiments, preparing charts and models, and class discussion.

    3. Culminating Phase - In this phase concepts should be emphasized. Unifying ideas developed through class discussion. The unit study can be enriched through the "results" of individual student research and experiments and demonstrations . . . results brought to the attention of all. Films may be utilized or some other

special culminating activity at this point. The interrelatedness of science can be developed extensively in this phase. Discussions can refer back to previous unit areas completed. Leads offering transition into the succeeding unit can be taken. This phase can invlove overall evaluation of work and learning accomplished (13:xv-xvi).

TEACHER REFERENCES

The books in the following list contain sections or chapters on nearly alllphases of elementary science. Most contain valuable background information as well as experiments for either the teacher or pupils to perform. Both the UNESCO book and the North Dakota Handbook have large numbers of experiments.

1. Blough, Glenn O., and Marjorie H. Campbell. Making and Using Classroom Science Materials. New York: Holt, Rinehard and Winston, Inc., 1954. 229pp.

2. Blough, Glenn O., and others. Elementary Science and How to Teach It. New York: Holt, Rinehart, and Winston, Inc., 1958. 608pp.

3. Burnett, R. Will. Teaching Science in the Elementary School. New York: Rinehart and Company, Inc., 1953. 541 pp.

4. Challad, Helen J., and Elizabeth R. Brandt. Science Activities From A to Z. Chicago: Childrens Press, Inc., 1963. 221 pp.

5. Craig, Gerald S. Science for the Elementary-School Teacher. Boston: Ginn and Company, 1958. 561 pp.

6. Department of Public Instruction. Elementary Science Handbook. Bismark, North Dakota: Department of Public Instruction, 1961, 485 pp.

7. Kambly, Paul E., and John E. Suttle. Teaching Elementary School Science. New York: The Ronald Press Company, 1963. 492 pp.

8. UNESCO. 700 Science Experiments for Everyone. New York: Doubleday and Company, Inc., 1958. 221 pp.

ENERGY: SOUND

By the time most pupils leave the elementary school they should know the basic concepts of sound, how it is produced and transmitted, and how man can control it. This unit should precede the one on the senses. There are many experiments listed in the various teachers' editions of textbooks to help children discover and verify the science learnings.

CONCEPTS

1. Things that make sounds vibrate and produce waves. These waves must travel through some material, such as air.

2. When a large sound wave is produced in the air, the sound is loud. When a small sound wave is produced in the air, the sound is soft.

3. The faster an object vibrates, the higher the sound you hear. The slower the object vibrates, the lower the sound you hear.

4. Some materials absorb sound waves. Other materials reflect sound waves. Materials can be used to control sound.

5. Pitch is affected by the length, thickness, and tension of the vibrating object. (3:49).

6. Pitch depends upon the speed of vibrations.

7. The pitch of bars of wood and metal depends in part upon the length of the bars.

8. The pitch of whistles and horns depends upon the length of the vibrating air column.

9. Sounds can be recorded by various machines.

10. Vocal sounds are produced by air blowing past cords that can be tightened or loosened at will.

11. Hearing results from vibrations being set up in our ears, the vibrations being caused usually by vibrating air. (40:75).

REFERENCES FOR CHILDREN

Basic Texts:

1. Barnard, Darrell J. and others. Science, Health, and Safety. New York: The Macmillan Company, 1959.

Learnings that may be developed from this unit have to do with an understanding of how sound waves are produced and how to control them.

2. Thurber, Walter A. Exploring Science, Book Six. New York: Allyn and Bacon Inc., 1958.

"Musical Sounds" is the name of the unit on sound.

Supplementary Texts:

1. Schneider, Herman, and Nina Schneider. Science For Today and Tomorrow. Boston: D.C. Heath and Company, 1961.

Concepts concerning sound are developed in Unit One, "The News Comes to Us."

2. Frasier, George Willard, and others. Science Problems. Chicago: The L. W. Singer Company, 1962.

The unit, "Musical Instruments and Sounds" is concerned with how sounds are different.

Library References:

1. Baer, Marian E. Sound. An Experiment Book. New York: Holiday House, 1952. 127 pp.

*2. Freeman, Ira M. All About Sound and Ultrasonics. New York: Random House, 1961. 139pp.

*Reference not in Grant School Library.

3. Geralton, James. The Story of Sound. New York: Harcourt Brace and Company, 1948. 74 pp.

4. Irving, Robert. Sound and Ultrasonics. New York: Alfred A. Knopf, 1961. 146pp.

*5. Kettelkamp, Larry. The Magic of Sound. New York: William Morrow and Company, 1956. 64 pp.

TEACHING AIDS

Filmstrips:

1. How Sound Travels. Color. Jam Handy Organization.

2. The Cause and Nature of Sound. Color. Jam Handy Organization.

Films:

1. Learning About Sound. Eight minutes. Black and white. Encyclopedia Britannica Films. 1954. Central Washington State College.

2. What is Sound? Eleven minutes. Black and white. Young America Films. 1949. Central Washington State College.

*Reference not in Grant School Library

ENERGY: LIGHT

A unit of study on light should provide opportunities for children to develop an awareness of the properties of light, its relation to seeing, uses of lenses and mirrors, and the phenomena of color. Through the use of many experiments, the children can build background for basic concepts.

CONCEPTS

1. A luminous body shines by its own light.
2. The sun is a luminous body.
3. An object heated to incandescence gives off light.
4. In some instances, the particle theory explains the movement of light; under different circumstances. the wave theory seems to explain how light travels.
5. Light can be looked upon as moving in little packets of energy called photons; photons spread out in waves.
6. Light passes through a transparent material.
7. A translucent material scatters light.
8. An opaque material blocks the passage of light.
9. Light moves in a straight line.
10. Shadows are formed because light moves in a straight line.
11. A shadow has two parts: the umbra and the penumbra.
12. An eclipse of the moon occurs when the earth passes between the moon and the sun; the shadow of the earth then falls upon the moon.
13. An eclipse of the sun occurs when the moon passes between the earth and the sun; the shadow of the moon then falls upon the earth.

14. Light travels at a velocity of 186,000 miles per second.

15. Nothing else moves as fast as light.

16. Light rays refract, or bend, when they move at a slant from one medium to another medium.

17. A change in speed causes light rays to refract.

18. White light consists of the six spectrum colors: red, orange, yellow, green, blue, violet.

19. A prism breaks up white light into the six spectrum colors.

20. The white light breaks up because each color bends at a different angle upon passing through the prism.

21. A mirror reflects light in a regular pattern; an image can be seen in the mirror (35:183).

22. We see things because they either give off light or reflect light given off by some other source.

23. How an object appears to us depends upon the color of the light shining on it and also upon the structure and condition of our eyes.

24. Light is a form of radiant energy, which travels in all directions from its source.

25. The sun is our most important source of light. Other sources include burning substances and electric-light bulbs.

26. Without light energy received from the sun, all plants and animals on the earth would soon die.

27. Some objects reflect light, others absorb it.

28. Reflection of light from surfaces between two layers can cause optical illusions. (mirages)

29. The principle of refraction is applied in the making of lenses, pieces of transparent materials which cause light to bend in various ways.

30. Convex lenses cause light rays to converge or come together.

31. Concave lenses cause light rays to diverge or spread apart.

32. Eye defects such as nearsightedness and farsightedness can be corrected by means of lenses.

33. The lenses in our eyes are convex lenses (41:36,54).

34. Electrons of the heated atoms in the sun give off light energy.

35. Electrons give off energy as light.

36. Light energy from the sun comes to us through space, but outer space is black.

37. Electrical energy heats wire as it moves through it. When a metal receives enough heat energy, some of the energy is changed into light (17:82).

38. When light strikes a surface at a slant, it is reflected at the same slant, but away from the source of light in the opposite direction.

39. Opaque objects reflect light of their own color and absorb light of other colors.

40. White materials reflect almost all the light which strikes them.

41. Colored materials reflect only some of the light. The rest of the light is absorbed and turned into heat.

42. Radiant energy is produced when hydrogen gas in the sun is changed to helium.

43. Heat waves are longer than light waves. Your eyes use light waves. Your body responds to the heat waves.

44. A rough surface reflects light in a great many directions. This is called diffusion.

45. Light is measured by a unit called a foot-candle. You may use a light meter to measure light (21:164).

REFERENCES FOR CHILDREN

Basic Texts:

1. Trexler, Clarence R., and others. ABC Science Series, Book Six. New York: American Book Company, 1961.

   The unit on light in this book is Unit II, "Light: A Form of Energy."

2. Navarra, John G. and Joseph Zafforoni. Today's Basic Science, Book Six. New York: Harper and Row, Publishers, 1963.

   In this book Unit Nine is, "Light, a Form of Energy."

Supplementary Texts:

1. Scheider, Herman, and Nina Schneider. Science for Today and Tomorrow, Book Six. Boston: D. C. Heath and Company, 1961.

   Light is discussed in Unit One, "The News Comes to Us."

2. Craig, Gerald S., Ruth Lippenberger Roche, and John Gabriel Navarra. Experimenting in Science, Book Six. Chicago: Ginn and Company, 1958.

   In this book Unit Four is "Light Energy Around Us."

Library References:

1. Beeler, Nelson F. and Franklyn M. Branley. Experiments With Light. New York: Thomas Y. Crowell Company, 1957. 144pp.

2. Feravolo, Rocco V. Junior Science Book of Light. Champaign Illinois: The Garrard Press, 1961. 62pp.

3. Harrison, George R. The First Book of Light. New York: Franklin Watts, Inc., 1962. 85pp.

*4. Irving, Robert. Electromagnetic Waves. New York: Alfred A. Knopf, 1960. 141 pp.

5. Parker, Bertha M. Light. Evanston, Illinois: Harper and Row, 1959. 36pp.

*6. Neal, Charles D. Exploring Light and Color. Chicago: Childrens Press, 1964. 156pp.

7. Ruchlis, Hy. The Wonder of Light. New York: Harper and Brothers, 1960. 154 pp.

TEACHING AIDS

Filmstrips:

1. Light and Color. Color. Jam Handy Organization.

2. Light and How It Travels. Color. Jam Handy Organization.

3. Light in Our Daily Lives. Color. Eyegate House Inc.

4. Putting Light to Work. Black and white. Popular Science Publishing Company.

5. Story of Lighting and Heating. Color. Curriculum Films.

Films:

1. Learning About Light. Eight minutes. Black and white. Encyclopaedia Britannica Films. 1955. Central Washington State College.

2. Light and Shadow. Eleven minutes. Black and white. Young America Films. 1949. Central Washington State College.

3. Light and Color. Thirteen minutes. Color. Encyclopaedia Britannica Films. 1961. Washington State University.

4. Science of Light. Eleven minutes. Color. Churchill-Wexler Films. 1960. Washington State University

*Reference not in Grant School Library.

ENERGY: HEAT

Many of the concepts that are developed in this unit on heat are closely related to those in the units on the other forms of energy. There are many phases of this involved in weather; therefore, if this unit precedes one on weather many of these learnings directly apply to that unit.

CONCEPTS

1. Burning is a chemical reaction in which a substance combines with oxygen after the substance has reached its kindling temperature.
2. Fuels are substances which produce heat when combined with oxygen.
3. Heat energy comes from sources such as; chemical energy, electricity, motion, nuclear energy, and the sun.
4. Heat increases the kinetic energy of the molecules in an object.
5. The temperature of a substance indicates how much kinetic energy the molecules of a substance have.
6. Heat indicates how much energy there is in a substance.
7. When heated, most substances expand because their molecules move faster and so spread apart.
8. When cooled, most substances contract because their molecules move slower and have less space between them.
9. Whether a substance exists as a solid, a liquid, or a gas depends primarily upon its temperature.
10. Heat energy is transferred in three ways: by conduction, by radiation, by convection.

11. All substances conduct heat, but some of them conduct heat better than others.

12. Heat energy comes to us from the sun in the form of radiation. We receive radiant energy in the form of waves which change into heat after they strike objects.

13. Dark objects are better absorbers of radiant energy than light objects.

14. Many modern vehicles are powered by internal combustion engines which operate by burning a fuel inside the engine.

15. Steam, gasoline, and Diesel oil engines are all heat engines which are designed to turn into mechanical energy the heat energy obtained when a fuel is burned (41:68, 84, 95).

16. Air expands when it is heated.

17. A given volume of cold air weighs more than the same volume of warm air.

18. Cold air tends to push up warm air and take its place.

19. The draft in stoves and fireplaces, and the circulation of air in a room, are usually due to the upward movement of warm air as it is pushed up by cool air.

20. Some surfaces become hotter in sunlight than do other surfaces.

21. Unequal heating of the earth's surface causes rising and falling air currents.

22. Many local winds are the result of unequal heating of the earth's surface (40:113).

23. We are more comfortable and work more efficiently when the air in a room has the proper temperature and contains the proper amount of water vapor.

24. We can control the temperature and the amount of water vapor in the air.

25. We transfer heat in our homes by conduction, convection, and radiation.

26. Some substances are better conductors of heat than others.

27. There are four common types of heating systems: Hot air, steam, hot water, and radiant heat.

28. Relative humidity is the amount of water vapor in the air compared with the amount it can contain at that temperature.

29. When the relative humidity of the air is too low, we may catch a cold more easily.

30. Relative humidity can be controlled by use of air conditioners.

31. Heating systems may make the air in our homes uncomfortable by lowering the relative humidity.

32. The air in our homes can be cooled in various ways: by shading, by reflecting the sun's rays, and by air conditioners.

33. Scientists are experimenting with different sources of power, such as atomic energy and the sun's energy, for heating and cooling (3:33).

REFERENCES FOR CHILDREN

Basic Text:

1. Trexler, Clarence R., and others. ABC Science Series, Book Six. New York: American Book Company, 1961.

Unit three is "Heat and Temperature".

Supplementary Texts:

1. Thurber, Walter A. Exploring Science, Book Six. New York: Allyn and Bacon Inc, 1958.

Possible learnings concerning heat are discussed in the unit "Warm Air in Motion".

2. Barnard, J. Darrell, and others. Science, Health, Safety, Book Six. New York: The Macmillan Company, 1959.

Some learnings to be developed concerning heat are in Unit Two, "Conditioning the Air".

Library References:

1. Adler, Irving. Fire in Your Life. New York: The John Day Company, 1955. 128 pp.

*2. Branley, Franklin M. Solar Energy. New York: Thomas Y. Crowell Company, 1957. 111 pp.

3. Parker, Bertha M. Heat. Evanston, Illinois: Harper and Row, 1959. 36 pp.

TEACHING AIDS

Filmstrips:

1. How Heat Causes Expansion. Color. Jam Handy Organization.
2. How Heat Travels. Color. Jam Handy Organization.
3. Story of Lighting and Heating. Color.
4. The Cause and Nature of Heat. Color. Jam Handy Organization.

Films:

1. Learning About Heat. Eight minutes. Black and white. Encyclopaedia Britannica Films. 1955. Central Washington State College and Washington State University.
2. Measuring Temperature. Eleven minutes. Black and white. Young America Films. 1950. Washington State University.
3. Things Expand When Heated. Eleven minutes. Black and white. Young America Films. 1949. Washington State University.

*Reference not in Grant School Library.

CHEMISTRY

Many of the children of sixth-grade age have chemistry sets at home. A study some of the simpler basic principles make these sets more than just toys. An understanding of the potentials in atomic energy is within the comprehension of these children. This unit should guide them to the answers of many of their questions pertaining to the world of chemistry.

CONCEPTS

1. Chemistry is involved in every act of our daily living.
2. A chemist's materials are everywhere and in everything.
3. Every single thing in the world is made up of tiny moving particles called molecules.
4. When the molecules in a material are tightly locked, that material is a solid.
5. A liquid is a material in which the molecules are close together but free to roll and slide around one another.
6. A material is in the gaseous form when its molecules are far apart and free to bounce and fly around.
7. Materials can be changed from one state to another by heating or cooling.
8. One of the most important scientific discoveries of modern times is that molecules are made of smaller particles called atoms.
9. Although there are millions of different kinds of molecules, there are only about one hundred different kinds of atoms.

10. Each different kind of atom is called an element.

11. Everything in the world is made up of one or more of these elements.

12. Most things are made of combinations of elements rather than single elements.

13. A substance that is made of combinations of elements combined chemically is called a compound.

14. A compound is usually quite different from the elements from which it is made.

15. A compound may be a solid, a liquid, or a gas.

16. Water, which is necessary to every form of life, is one of the most useful and important compounds in the world.

17. Water is made of two elements, hydrogen and oxygen.

18. Hydrogen and oxygen at ordinary temperatures are both gases, yet together they form a liquid--water.

19. Chemists' abbreviations for elements are called symbols.

20. Chemists' abbreviations for compounds are called formulas.

21. In forming a compound, two or more elements or other substances combine during a chemical change. A new substance is formed.

22. In forming a mixture, there is no change in the molecules. The main change is in the appearance of the materials. A physical change is a change only in the size, shape, or state of a substance.

23. Chemical changes occur when two or more elements are put together forming a compound.

24. Compounds can be taken apart as well as put together.

25. Heat is often needed to bring about these changes.

26. In some cases as element is attracted to another element.

27. Chemists analyze some materials by means of group tests.

28. The chemist's chief method of grouping an unknown substance is to find out how it acts when it is combined with certain known substances.

29. We can test for acids with blue litmus paper, which turns a red or pink color if acid is present.

30. Alkalies can be tested with red litmus paper. Alkalies will turn red litmus paper blue.

31. Substances which are neither acid nor alkaline are called neutral substances.

32. Both colors of litmus paper remain unchanged by these substances.

33. A farmer can test his soil for acids or alkalies with litmus paper.

34. Many substances other than litmus paper change color in acids or alkalies and can therefore be used for testing.

35. Clear limewater turns milky when carbon dioxide is present.

36. Starch will turn blue or violet when iodine is added.

37. Some contents of textiles may be tested for by burning a sample.

38. The smell of the burning cloth, the appearance of the ash and the rate of burning will help us identify the cloth.

39. The rate of burning is different because each textile catches fire at its own temperature.

40. The smell and ash are different because each textile is made of different compounds.

41. Some of the new man-made textiles are not easy to identify by the burning test.

42. Chemists have invented many new fibers.

43. A material may contain several compounds.

44. To analyze a mixture of compounds, the chemist usually separates the compounds from one another and then analyzes each compound.

45. Some mixtures will separate if they are allowed to stand.

46. Chromatography is another method of separating the different materials in a compound.

47. Chromatography is based on the fact that paper absorbs and carries some liquids more quickly than others. As the substances become separated on the paper, each section can be analyzed by itself.

48. Scientists have found that every element gives off its own special color when heated to a high temperature.

49. By means of an instrument called a spectroscope, the light of each element is separated into its own combination of colors.

50. A prism in the spectroscope is the means of separating the light.

51. Constant research by chemists has helped to make life better for all of us (37:72-74).

52. Atoms are composed of many particles including: neutrons which have no charge, electrons which have a negative charge, and protons which have a positive charge.

53. The nature of the atom was difficult to ascertain because of its small size.

54. The atomic number of an element is the same as the number of protons in the nucleus of an atom of the element.

55. Both the neutron and proton have weight or mass; each is about 1,836 times heavier than the electron.

56. The atomic weight of an atom, for all practical purposes, represents the total weight of its protons and neutrons.

57. Atoms which are chemically alike but different in atomic weight are called isotopes.

58. Some elements are radioactive. An example is radium which gives off three kinds of rays: alpha, beta, and gamma.

59. Some elements, such as radium and uranium, are naturally radioactive while most other elements can be made radioactive by bombarding them with atomic particles.

60. Atoms can be split by bombarding them with atomic particles.

61. When atoms of the isotope uranium 235 are bombarded with neutrons, they split producing a reaction called nuclear fission.

62. A controlled reaction of nuclear fission can produce usable energy and radioisotopes which are useful to research scientists.

63. When light atoms under extremely high temperatures combine to form larger atoms, a nuclear reaction called atomic fusion takes place (41:160, 170, 175).

CHILDREN'S REFERENCES

Basic Texts:

1. Schneider, Herman and Nina Schneider. Science for Today and Tomorrow. Boston: D. C. Heath and Company, 1961.

This text has a good introductory unit on chemistry and its uses in the modern world.

2. Trexler, Clarence R., and others. ABC Science Series, Book Six. New York: American Book Company, 1961.

Unit Six, "The Atom and Nuclear Energy" gives a very good basic understanding on the structure of the atom as well as nuclear energy.

3. Navarra, John G., and Joseph Zafforoni. Today's Basic Science, Book Six. New York: Harper and Row, Publishers. 1963.

The unit entitled "Atomic Energy for Power and Peace" gives a good understanding on atomic structure potential uses for atomic energy.

4. Bond, Austin D., and others. Looking Ahead With Science. Chicago: Lyons and Carnahan, 1963.

   This text also introduces the atom and then concludes the unit with atomic energy.

Supplementary Text:

1. Thurber, Walter A. Exploring Science, Book Six. New York: Allyn and Bacon Inc., 1958.

   The unit, "Some Common Acids" is limited for an introductory study of chemistry on this grade level. Material presented on this topic is good, however.

Library References:

1. Asimov, Isaac. Building Blocks of the Universe. New York: Abelard-Schuman, 1961. 280 pp.

2. _____. Inside the Atom. New York: Abelard-Schuman, 1961. 197 pp.

3. Barr, Donald. The How and Why Wonder Book of Atomic Energy. New York: Wonder Books, 1961. 48 pp.

*4. Beeler, Nelson F., and Franklyn M. Branley. Experiments With Atomics. New York: Thomas Y. Crowell Company, 1954. 160 pp.

5. Cooper, Elizabeth K. Discovering Chemistry. New York: Harcourt, Brace and World Inc., 1959. 190 pp.

6. de Camp, L. Sprague. Man and Power. New York: Golden Press, 1961. 189 pp.

7. Freeman, Mae and Ira. Fun With Chemistry. New York: Random House, 1962. 58 pp.

8. Gallant, Roy A. Exploring Chemistry. Garden City: Garden City Books, 1958. 120 pp.

9. Irvin, Keith Gordon, The Romance of Chemistry. New York: The Viking Press, 1959. 148 pp.

10. Irving, Robert. Energy and Power. New York: Alfred Knopf, 1961. 140 pp.

*Reference not in Grant School Library.

11. Keen, Martin L. The How and Why Wonder Book of Chemistry. New York: Wonder Books, 1961. 48 pp.

12. Lewellen, John. The Mighty Atom. New York: Alfred A. Knopf, 1955. 58 pp.

13. McCormick, Jack. Atoms, Energy and Machines. Mankato, Minnesota: Creative Educational Society Inc., 1957. 224 pp.

*14. Morgan, Alfred. First Book of Chemistry for Boys and Girls. New York: Charles Scribners Sons, 1950. 179 pp.

15. Morgan, Alfred. Simple Chemical Experiments. New York: D. Appleton-Century Company, 1941. 269 pp.

16. Pearl, Carleton. The Tenth Wonder Atomic Energy. Boston: Little, Brown and Company, 1956. 129 pp.

17. Watson, Jane Werner, and Bertha M. Parker. The Everyday Atom. Evanston, Illinois: Harper and Row Publishers, 1959. 36 pp.

18. Zim, Herbert S. Diamonds. New York: William Morrow and Company, 1959. 64 pp.

TEACHING AIDS

Filmstrips:

1. Man Discovers the Atom. Color. Encyclopaedia Britannica.

2. Our Friend the Atom. Color. Encyclopaedia Britannica.

3. Putting Atomic Energy to Work. Black and white. Popular Science Publishing Company.

Films:

1. Chemical Changes All About Us. Fourteen minutes. Color. Coronet Films. 1960. Central Washington State College.

2. Solids, Liquids and Gases. Ten Minutes. Black and white. Young America Films. 1949. Central Washington State College.

*Reference not in Grant School Library.

BIOLOGY: MICROSCOPIC LIFE

Pupils of the sixth grade are interested in and are mature enough to study microscopic plants and animals. This unit will give opportunity to do controlled scientific research, establish cultures and learn to properly use a microscope. An appreciation of the interdependence of plants and animals can be gained as well as some of the affects microscopic creatures have upon human beings.

CONCEPTS

1. There are many microscopic plants and animals in the world. These tiny plants and animals are found almost everywhere.
2. Many of the more common kinds of microscopic plants and animals are readily obtainable for study.
3. Algae produce their own food from carbon dioxide, water, and minerals by using the energy from sunlight.
4. Since many other plants and animals do not produce their own food, they feed upon algae.
5. Protozoa are microscopic animals which feed upon algae and bacteria.
6. Some protozoa eat other protozoa.
7. Microscopic plants and animals have many uses. They cause things to decay so that the substance of such things returns to the soil again and can be used by new living plants and animals.
8. Yeast is a microscopic organism much used in food preparation. Bakers use yeast in making bread and other bakery goods. These tiny plants also are used in making industrial alcohol.

9. Bacteria and molds help in the cheese-making industry.

10. Scientists are finding many uses for molds in making penicillin and other drugs for curing diseases.

11. Microscopic plants and animals also can be harmful and can cause disease.

12. Some microscopic animals, such as those which cause malaria and African sleeping sickness, release poisons which may be harmful to their hosts.

13. Scientists are learning how to prevent and how to cure disease caused by microscopic organisms (9:44-45).

14. Many plants and animals are too small to be seen with the naked eye.

15. Lenses make small things appear larger.

16. A microscope is an instrument which contains lenses and makes it possible to see objects that could not be seen otherwise.

17. Microscopic plants and animals live in ponds, streams, and other bodies of water.

18. The small, green plants you see in bodies of water are algae.

19. The smallest animals are protozoa.

20. Algae and protozoa are bits of living protoplasm.

21. Bits of protoplasm are living cells.

22. Algae and protozoa are one-celled plants and animals.

23. Most protozoa cannot make their own food.

24. One-celled plants and animals reproduce by dividing.

25. Many one-celled plants are colorless.

26. The plants feed upon sugar in the foods and release carbon dioxide.

27. Bacteria are colorless, one-celled plants that are smaller than yeast plants.

28. Yeasts and bacteria cause chemical changes to take place in the food upon which they live.

29. Some of these changes are helpful, and some are harmful.

30. Foods are kept from spoiling by canning and freezing.

31. Sterilizing food kills microorganisms.

32. Freezing food inhibits the growth of microorganisms.

33. Molds are plants that are larger than yeasts and bacteria.

34. The main part of a mold plant is the mycelium.

35. Molds reproduce by sincle cells, called spores. The spores are produced in spore cases that grow on stalks from the mycelium.

36. When mold spores fall on bread or other food, they may grow. They need food, moisture and warmth to make them grow. They grow better in the dark than in the light.

37. Sunshine and drying help to kill mold spores. Cold keeps them from growing.

38. Molds belong to a group of plants calles fungi. Fungi cannot make their own food.

39. Mushrooms are fungi. Some mushrooms are good to eat. others are poisonous. There is no way to tell the poisonous from nonpoisonous mushrooms but to know each kind just as you would a tomato or peach.

40. Many other fungi are common in woods and gardens. Some are harmless. Others harm plants upon which they grow (21:50, 58, 62).

CHILDREN'S REFERENCES

Basic Texts:

1. Bond, Austin D., and others. Looking Ahead With Science. Chicago: Lyons and Carnahan, 1963.

Unit Two, "Microscopic Plants and Animals," studies algae, protozoa, bacteria, molds, yeast, microorganisms which cause diseases, and man's ways of controlling them.

2. Frasier, George Willard, and others. Science Problems. Chicago: The L. W. Singer Company, 1962.

   The section of this text entitled, "Plants and Animals You Cannot See," includes work on algae, protozoa, molds, disease producing microorganisms and scientists cures for these diseases.

Supplementary Text:

1. Thurber, Walter A. Exploring Science, Book Six. New York: Allyn and Bacon Inc., 1968.

   The first unit in this book, "Plants That are not Green," is about mushrooms, mold, and yeast.

Library References:

1. Beeler, Nelson F. and Franklyn M. Branley. Experiments With a Microscope. New York: Thomas Y. Crowell, 1957. 154 pp.

2. Calder, Ritchie. The Wonderful World of Medicine. Garden City, New York: Doubleday and Company. 1959. 70 pp.

3. Corrington, Julian D. Exploring With Your Microscope. New York: McGraw-Hill Book Company, 1957. 229 pp.

4. DeKruif, Paul. Microbe Hunters. New York: Harcourt, Brace and Company, 1932. 368 pp.

5. Glemser, Bernard. All About the Human Body. New York: Random House, 1958. 136 pp.

6. Keen, Martin. The How and Why Wonder Book of the Microscope. New York: Wonder Books, 1961. 48 pp.

7. Schneider, Herman and Nina. How Your Body Works. New York: William R. Scott, 1954. 160 pp.

8. Schwartz, Julius. Through the Magnifying Glass. New York: McGraw-Hill Book Company Inc., 1954. 142 pp.

9. Shippen, Katherine B. Men of Medicine. New York: Viking Press, 1957. 220 pp.

10. Sutherland, Louis. Magic Bullets. Boston: Little, Brown and Company, 1956. 148 pp.

TEACHING AIDS

Filmstrips:

1. Beginning of Life. Black and white. Curriculum Films.

2. Bacteria, Good and Bad. Black and White. Young America.

3. Life in Ponds, Lake and Streams. Color. Jam Handy Organization.

4. Small Fresh-water Animals and Insects. Color. Jam Handy Organization.

Films:

1. Microscope and Its Use. Ten minutes. Black and white. Young America Films. 1949. Washington State University.

2. Microscopic Life; The World of the Invisible. Fourteen minutes. Black and white. Encyclopaedia Britannica. 1958. Washington State University.

3. Microscopic Wonders in Water. Eleven minutes. Color. Pat Dowling. 1953. Central Washington State College.

4. Tiny Water Animals. Eleven minutes. Black and white. Encyclopaedia Britannica. 1931. Central Washington State College.

5. World of Little Things. Fifteen minutes. Black and white. Moody Institute of Science. 1954. Central Washington State College.

HEALTH: THE NERVOUS SYSTEM

The study of the nervous system is equally interesting to girls as to boys. Children from different social, cultural, and economic backgrounds all seem to be fascinated by the study of the brain, spinal cord, and nerves. After a study of these and the sensory organs it is important to learn how to care for them. The conservation of human resources should not be overlooked in the study of science (41:131).

CONCEPTS

1. Your senses, which are controlled by the nervous system, help you to carry on your daily activities.
2. The nervous system may be thought of as a central control system. It controls the various activities of the body and is made up of three parts: brain, spinal cord, and nerves.
3. There are several kinds of neurons which act together to carry messages from one part of the body to another.
4. Most of our actions are voluntary actions which are actions we can control. Some of our activities are involuntary and are controlled by the autonomic nervous system.
5. Man has a more highly developed brain than any other living thing.
6. One of our most important senses is sight.
7. We see when light passing through the pupil and lens forms an image on the retina. Rods and cones in the retina are stimulated and pass nerve impulses to the optic nerve which carries the message to the brain.
8. We hear when sound vibrations are set up in the ear. Sensitive nerve endings in the cochlea produce nerve impulses which pass along the auditory nerve to the brain.

9. The main organ of taste is the tongue; the main organ of smell is the nose.

10. Most parts of the nervous system are protected by the body, but they can be damaged if they do not receive proper care.

11. The brain can be affected by certain chemicals and drugs.

12. Your sense organs should be protected from injury (41:132, 139, 152).

13. Every day we learn new things about the world we live in by means of our five senses.

14. The five senses are sight, hearing, smell, touch, and taste.

15. Two funnels guide air vibrations into the ear.

16. The end of the tube is closed by a strong skin, called the eardrum.

17. Vibrating air causes the eardrum to vibrate. The vibrations are passed along to three little bones.

18. The third bone presses against a tiny coiled tube full of liquid. When the liquid is made to vibrate, nerves within it send messages to the brain.

19. Ears must be treated carefully because they are made up of complicated and delicate parts.

20. Sight is perhaps the most important of the senses.

21. Babies have poor sight at first.

22. Six muscles attached to the outside of each eyeball move the eyes in the directions we wish.

23. The transparent covering of the eye is called the cornea.

24. Behind the cornea is a transparent convex lens made of living cells.

25. The dark center part of the eye is the pupil.

26. The back of the eyeball is called the retina. It is lined with hundreds of thousands of nerve cells which send messages to the brain when light shines on them.

27; The upside-down picture on the retina is "seen" right side up by the brain.

28. There are tiny muscles in each eye that change the shape of the lenses to help us see near and distant things.

29. The colored part of the eye is called the iris. It regulates the size of the opening which admits light.

30. In bright light the opening is small. In dim light the iris opens wide and allows as much light as possible to come in.

31. It is easier to judge distances accurately with two eyes than with one.

32. When the eyeball is a little to short from the lens to the retina, nearby things look fuzzy.

33. When the eyeball is too long from the lens to the retina, things far away look fuzzy.

34. Eyeglasses can help focus the lens so that the retina will get a clear sharp picture.

35. To keep the eyes in good condition we must give them proper care.

36. Nerve cells in every part of the skin send messages to the brain, which records them; then we recognize the things we have touched.

37. In some parts of the skin the nerve cells are very close together.

38. Nerve cells send warning signals.

39. We taste with both the mouth and the nose. Many flavors reach us through the sense of smell.

40. Almost every substance sends molecules into the air.

41. When we breathe in the molecules, they come in contact with nerve cells in the nose.

42. The nerve cells of taste in the tongue react to only four kinds of stimuli: sweet, salty, sour and bitter, or a combination of these.

43. The nerve cells for each kind of taste are concentrated in specific areas of the tongue.

44. The senses must send messages to the brain before we can know what is happening.

45. The brain is made up of billions of nerve cells, together with many blood vessels which bring oxygen and food to the nerve cells and take away waste materials.

46. The brain is made up of three parts--the cerebrum, the cerebellum, and the medulla.

47. The cerebrum receives messages from the senses, records them, and sends out orders to various parts of the body.

48. The cerebellum sends out orders to the muscles, helping them to work smoothly and evenly. The cerebellum also helps the body to keep its balance.

49. The medulla helps to control automatically the breathing, food digestion, blood circulation, and body temperature (37:25-27).

CHILDREN'S REFERENCES

Basic Texts:

1. Trexler, Clarence R., and others. ABC Science Series, Book Six. New York: American Book Company, 1961.

   Unit Five gives a good over-all picture of the brain and the sensory organs.

2. Schneider, Herman, and Nina Schneider. Science For Today and Tomorrow. Boston: D.C. Heath and Company, 1961.

   Material on the senses is in Unit One "The News Comes to Us" which also contains material on light and sound.

Supplementary Text:

1. Navarra, John G. and Joseph Zafforoni. Today's Basic Science, Book Six. New York: Harper and Row, Publishers, 1963.

   Unit Eight has a good section on the brain and the nerves. The senses of taste and small are neglected.

Library References:

1. Beeler, Nelson F., and Franklyn M. Branley. Experiments in Optical Illusion. New York: Thomas Y. Crowell. Company, 1951. 114 pp.

2. Calder, Ritchie. The Wonderful World of Medicine. Garden City, New York: Garden City Books, 1958. 68 pp.

3. Eberle, Irmengarde. Modern Medical Discoveries. New York: Thomas Y. Crowell Company, 1960. 184 pp.

4. Parker, Bertha M. How We Are Built. Evanston, Illinois: Harper and Row Publishers, 1959. 36 pp.

5. _____. Keeping Well. Evanston, Illinois: Harper and Row Publishers, 1959. 36 pp.

6. _____. You as a Machine. Evanston, Illinois: Harper

7. Schneider, Leo. Lifeline: The Story of Your Circulatory System. New York: Harcourt, Brace and World, Inc., 1958. 127 pp.

8. _____. You and Your Senses. New York: Harcourt Brace and World Inc., 1956. 137 pp.

9. Schneider, Herman. How Your Body Works. New York: William R. Scott. Inc., 1949. 160 pp.

10. Zim, Herbert S. Our Senses and How They Work. New York: William Morrow and Company, 1956. 64 pp.

11. _____. What's Inside of Me. New York: William Morrow and Company, 1952. 32 pp.

12. Perry, John. Our Wonderful Eyes. New York: McGraw-Hill Book Company, 1955. 158 pp.

Filmstrips:

1. Eyes and Their Care: Black and white. Encyclopaedia Britannica.

2. Health--How Your Ears Work. Color. Jam Handy Organization.

3. Health--Your Eyes at Work. Color. Jam Handy Organization.

4. Health--Your Nose and Throat. Color. Jam Handy Organization.

5. Your Eyes and Ears Are Good Helpers. Black and white. Society For Visual Education Inc.

Films:

1. Your Ears. Ten minutes. Black and white. Young America Films. 1947. Central Washington State College and Washington State University.

2. Your Eyes. Eight minutes. Black and white. Young America Films. 1947. Washington State University.

WEATHER

Newspaper headlines of floods, storms, or hurricanes help make sixth graders aware of the weather. Most will have had some study of it in lower grades but by now are ready to learn about the clouds, winds, work of the weatherman, and the instruments he uses. Many of the learnings from the unit on heat are applicable here so should be taught prior to or as a part of this unit.

CONCEPTS

1. Air is a mixture of gases.
2. Such debris as dust, pollen and smoke mixes with the atmosphere.
3. The sun radiates energy in the form of heat and light.
4. The earth reflects some of the heat from the sun back into the atmosphere.
5. The atmosphere is divided into four layers: the troposphere, stratosphere, ionosphere, and exosphere.
6. Hot, equatorial air rises and moves toward the poles.
7. Cold air at the poles hugs the ground and moves toward the equator.
8. The earth's rotation breaks up the general circulation of the air between the poles and the equator.
9. The circulation of air is broken up into wind belts.
10. Differences in the temperatures of land and water cause local movement of air.
11. Evaporation and condensation of water are constantly occurring within the atmosphere.

12. An object becomes cool as a liquid evaporates from it; evaporation has a cooling effect.

13. Humidity is the amount of moisture in the air.

14. An hygrometer is an instrument for measuring humidity.

15. Rising, expanding air gives up heat; the temperature of the rising air falls.

16. Water vapor in the air condenses when the air cools to a temperature known as the dew point.

17. Cold air is heavier than warm air.

18. Air tends to move across the earth in masses.

19. A front develops when one air mass moves against another air mass; there are warm fronts and cold fronts.

20. A cloud consists of tiny drops of water.

21. There are various types of clouds.

22. Precipitation falls from a cloud.

23. a low is a center of low atmospheric pressure.

24. A middle-latitude cyclone is an ordinary storm; it is a low.

25. An anticyclone is a high; a high is opposite of a low.

26. Tornadoes and hurricanes are violent storms; a hurricane is also known as a tropical cyclone.

27. A tornado is not the same as a cyclone (35:25-26).

28. Weather is what happens in our atmosphere.

29. Weather-observing stations measure and record many different things about the atmosphere. They measure air temperature, atmospheric pressure, wind direction and speed, precipitation, and visibility. They also gather information from the clouds.

30. Masses of warm air generally come from the south and move eastward. Masses of cold air generally move into the United States from the north and then move eastward.

31. Winds generally blow from west to east in the United States.

32. Weather information may be obtained during airplane, rocket, and jet flights.

33. Weather forecasts are not always correct because unexpected atmospheric conditions may develop that change the speed and direction of air masses (3:40).

34. All the weather conditions in a region over a long period of time make the climate of that region (21:43).

REFERENCES FOR CHILDREN

Basic Texts:

1. Navarra, John G. and Joseph Zafforoni. Today's Basic Science, Book Six. New York: Harper and Row, Publishers, 1963.

   Learnings to be developed concerning weather are found in Unit Two of this text.

2. Barnard, Darrell J. and others. Science, Health, and Safety. New York: The Macmillan Company, 1959.

   Teaching Unit Three is "Forecasting the Weather."

Supplementary Texts:

1. Frasier, George Willard, and others. Science Problems. Chicago: The L. W. Singer Company, 1962.

   "Weather and Climate" is the name of the unit developed in the text.

2. Thurber, Walter A. Exploring Science, Book Six. New York: Allyn and Bacon Inc., 1958.

   Possible learnings concerning weather are developed in the unit, "Warm Air In Motion" in Thurber's Book 6.

Library References:

*1. Bell, Thelma Harrington. Snow. New York: The Viking Press, 1954. 56 pp.

*Reference not in Grant School Library.

*2. _____. Thunderstorm. New York: The Viking Press, 1960. 128pp.

3. Bonsall, George. The How and Why Wonder Book of Weather. New York: Wonder Books, 1960. 48 pp.

4. Campbell, Ethel M. The Wind--Nature's Great Voice. Minneapolis: T. S. Denison and Company, Inc., 1959. 45 pp.

*5. Fenton, Carroll Lane, and Mildred Adams F. Our Changing Weather. Garden City: Junior Literary Guild, and Doubleday and Company, Inc., 1954. 110 pp.

6. Fisher, James. The Wonderful World of the Air. Garden City, New York: Garden City Books, 1958. 70 pp.

7. Gallant, Roy A. Exploring the Weather. Garden City, New York: Garden City Books, 1957. 64 pp.

*8. Irving, Robert. Hurricanes and Twisters. New York: Alfred A. Knopf, 1955. 144 pp.

9. Laird, Charles and Ruth. Weathercasting. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1955. 163 pp.

10. Parker, Bertha M. Ask the Weatherman. Evanston, Illinois: Harper and Row, 1958. 36 pp.

11. _____. Our Ocean of Air. Evanston, Illinois: Harper and Row, 1959. 36 pp.

12. _____. Ways of the Weather. Evanston, Illinois Harper and Row, 1957. 36 pp.

*13. Schneider, Herman. Everyday Weather and How It Works. New York: McGraw Hill Book Company, 1951. 189 pp.

*14. Lehr, Paul E., R. W. Burnett, and Herbert S. Zim. Weather. New York: Golden Press, 1957. 160 pp.

15. Spar, Jerome. The Way of the Weather. Mankato, Minnesota: Creative Educational Society, Inc., 1957. 224 pp.

*Reference not in Grant School Library.

16. Tannehill, Ivan Ray. All About the Weather. New York: Random House, 1953. 148 pp.

*17. Wolfe, Louis. Probing the Atmosphere. New York: G. P. Putnam's Sons, 1961. 160 pp.

18. Yates, Raymond F. The Weather for a Hobby. New York: Dodd, Mead, and Company, 1957. 181 pp.

19. Zim, Herbert S. Lightning and Thunder. New York: William Morrow and Company, 1952. 64 pp.

TEACHING AIDS

Filmstrips:

1. Climate. Color. Jam Handy Organization.

2. The Canopy of Air. Color. Life.

3. What Is Weather. Color. Jam Handy Organization.

4. What Makes the Weather? Color. Eyegate.

Films:

1. Clouds Above. Ten minutes. Black and white. Baily Films. 1951. Central Washington State College.

2. Operation Hurricane. Fourteen minutes. Black and white. U. S. Weather Bureau. 1955. Central Washington State College.

3. Our Weather. Eleven minutes. Black and white. Encyclopaedia Britannica Films. 1955. Central Washington State College.

4. Thunder and Lightning. Eight minutes. Black and white. Young America Films. 1950. Central Washington State College and Washington State University.

*Reference not in Grant School Library.

GEOLOGY: THE EARTH'S CHANGING SURFACE

Many sixth grade students have become aware of the beauty in many rocks and minerals, and made collections; therefore, a study of these and the earth's surface is of interest to them. This unit could include a study of fossils and prehistoric life if the area has not recently been studied. The importance of conserving soil and ground water should be emphasized.

CONCEPTS

1. By studying the rocks, soils, and rivers of a land area, a geologist can tell something about that land as it was millions of years ago.
2. Running water, glaciers, wind, and waves wear away rocks in the process called erosion.
3. Running water is the greatest of the earth changers.
4. In winter, the water in cracks freezes and expands. It cracks the rock and may break off pieces.
5. Chemicals in the water may help to dissolve a rock.
6. Rivers of ice and snow or huge sheets of ice are called glaciers. They carry rock fragments which scrape the rocks over which they slowly flow.
7. Wind wears away rocks by driving sand particles against them.
8. The battering of waves along the shores of oceans and lakes moves rocks and sand.
9. Expansion and contraction, due to the changes in temperature of day and night, cause rocks to crack.

10. Little plants, called lichens, give off acids which crumble the rock surfaces on which they grow.

11. The forces of erosion make high land into low land.

12. Imprints of sea creatures in rocks give geologists clues to how and when rocks were formed.

13. Sediments are materials that are carried by water and dropped to the bottom of the sea, where they pile up in layers.

14. Squeezed for millions of years by the weight of sea water and of other layers of sediment, the layers are pressed and hardened into layers of sedimentary rock.

15. As the sea bed gets heavier and the nearby land gets lighter, the pressure on the rock layers in the sea becomes greater. This difference in pressure gradually causes the land to rise.

16. The pressure of two land masses on either side of a sea trough may squeeze up layers of sedimentary rock into high land or into mountain ridges; this is called folding.

17. The land level may also be changed by the splitting apart of rocks in huge fractures, or cracks; this is called faulting.

18. Most geologists think that the earth is made up of several layers of materials.

19. The out layer of solid rock, or crust, is about twenty-two miles thick under the continents.

20. The materials beneath the crust are under great pressure. Geologists think that the rocks far below the surface are very hot, and that in some places they are hot enough to melt.

21. Molten rock, or magma, sometimes pours out of a volcano as a lava flow.

22. Fossils are the remains or imprints of dead plants or animals which have been preserved, usually in rocks.

23. In most cases of fossil-forming, chemicals in the water have dissolved the materials in the plant or animal itself and carried them away. Mineral matter has seeped in and hardened to the shape of the imprint.

24. Fossils help scientists to know what animals and plants of long ago were like.

25. Scientists who study fossils are called paleontologists.

26. From a few fragments of bone, a paleontologist can often reconstruct the appearance of an extinct animal.

27. Rich soil has been built up of grains of rock mixed with crumbling dead plants and animals.

28. In ancient times, people lived on whatever food they could find.

29. Farming began when someone discovered that a seed put in the soil could grow into a plant that would make hundreds of seeds. It was one of the most important discoveries ever made.

30. With some food supply that they could depend on, people had time to learn new ways of using the earth and the plants and animals on it.

31. All over the world erosion has been speeded up by furrowed fields left bare of crops, and by cutover forest land.

32. Where the topsoil has been washed away, there are deserts instead of fertile farm land. Ancient ruined cities lie buried under dust that was once good soil.

33. Today people know that the soil must be saved. A conservation bureau has been set up in each of our states.

34. In conservation bureaus, scientists work on the special Problems of each region. Experts advise farmers and lumbermen on good methods of conservation (37:134-136).

35. Many scientists believe that the earliest forms of life included algae, algaelike plants, and wormlike animals.

36. Most ancient plants and animals differ greatly from modern animals and plants.

37. The earth's story, as found in rocks, indicates that many kinds of plants and animals appeared, lived for a while, and then died.

38. The early Paleozoic Era was a time of abundant sea life.

39. During the middle of the Paleozoic Era, land plants and animals appeared. These land plants were much like mosses, ferns, and horsetails of today, although many were much larger.

40. Most of the great coal fields of North America were formed during the Paleozoic Era.

41. Four-legged animals, such as amphibious animals and reptiles, appeared in the rocks of the later Paleozoic Era.

42. Four-legged animals, such as amphibious animals and reptiles, appeared in the rocks of the later Paleozoic Era.

43. Many fossils of reptiles, such as the dinosaurs, are found in the rocks of the Mesozoic Era. For this reason, the Mesozoic Era is called the age of reptiles. It was during this time that the Brontosaurus, Tyrannosaurus, Stegosaurus, Triceratops, and the flying reptiles (pterodactyls) were prevalent.

44. Fossils of mammals and birds are found in the rocks of the later Mesozoic Era, although they were not numerous at that time.

45. The Cenozoic Era is called the age of mammals. The Cenozoic is the era in which we are living, but even in this era many kinds of strange animals have lived for a time and then died out. Many fossils of early camels, horses, and elephants have been found. These animals were much smaller than are their descendants that are seen today.

46. Fossils of man are found only in the topmost layers of rocks (9:67-68).

47. Vibrations in the earth's crust are called earthquakes.

48. Some parts of the earth's crust are continually moving.

49. When forces within the earth exert slow, constant pressure, the rock layers are crumpled, wrinkled, or folded. Mountains are formed.

50. Geologists have theories about the causes of movements in the earth's crust.

51. One theory of what causes unequal pressure is that soil is moved from one place to another.

52. Over thousands of years the unequal pressure may cause a rock layer to crack and slip.

53. The slipping or dropping of a block of rock hundreds of miles long, makes the earth vibrate. This trembling is called a tremor.

54. Geologists use an instrument called a seismograph to record earthquake shocks (21:129).

CHILDREN'S REFERENCES

Basic Texts:

1. Schneider, Herman and Nina Schneider. Science for Today and Tomorrow. Boston: D. C. Heath and Company, 1961.

This text has a good unit entitled "The Changing Earth."

2. Bond, Austin D., and others. Looking Ahead With Science. Chicago: Lyons and Carnahan, 1963.

The unit, "Plants and Animals of Long Ago" is obviously about fossils. The unit, "Riches from the Earth" is concerned with such minerals as gold, silver, copper and iron and how they are mined and processed. This unit could be used with either geology or chemistry.

Supplementary Texts:

1. Frasier, George Willard, and others. Science Problems. Chicago: The L. W. Singer Company, 1962.

"The Surface of the Earth Changes" tells the story of rivers, volcanoes, and earthquakes. The Chapter is good for these three topics.

2. Thurber, Walter A. Exploring Science, Book Six. New York: Allyn and Bacon Inc., 1958.

   The unit, "Water in the Ground" gives good supplementary information about ground water, caves, and water-holding properties of soils.

Library References:

1. Ames, Gerald, and Rose Wyler. The Earth's Story. Mankato, Minnesota: Creative Educational Society, Inc., 1957. 222 pp.

2. Andrews, Roy Chapman. All About Dinosaurs. Eau Claire, Wisconsin: E. M. Hale and Company, 1953. 146 pp.

3. _____. In the Days of the Dinosaurs. Eau Claire, Wisconsin: E. M. Hale and Company, 1959. 80 pp.

*4. Bauer, Helen. Water-Riches or Ruin. Garden City, New York: Doubleday and Company Inc., 1959. 121 pp.

*5. Block, Marie Halun. Mountains on the Move. New York: Coward-McCann, Inc., 1960. 96 pp.

6. Brindze, Ruth. The Gulf Stream. New York: The Vanguard Press, 1945. 63 pp.

7. Carson, Rachel. The Sea Around Us. New York: Golden Press, 1958. 165 pp.

8. Del Rey, Lester. Rocks and What They Tell Us. Racine, Wisconsin: Whitman Publishing Company, 1961. 60 pp.

9. Epstein, Sam and Beryl. All About the Desert. Eau Claire, Wisconsin: E. M. Hale and Company, 1957. 148 pp.

10. Fenton, Carroll Lane. Life Long Ago. New York: The John Day Company, 1937. 287 pp.

11. _____. Prehistoric World. New York: The John Day Company, 1954. 128 pp.

12. Fenton, Carroll Lane, and Mildred Adams F. Rocks and Their Stories. Garden City, New York: Doubleday and Company, Inc., 1951. 112 pp.

*Reference not in Grant School Library.

*13. Fenton, Carroll Lane, and Mildred Adams. The Rock Book. Garden City, New York: Doubleday and Company Inc., 1940. 357 pp.

14. Fisher, James. The Wonderful World. Garden City, New York: Hanover House, 1954. 66 pp.

15. Geis, Darlene. Dinosaurs. New York: Grosset and Dunlap Publishers, 1960. 48 pp.

16. _____. Dinosaurs and Other Prehistoric Animals. New York: Grosset and Dunlap, 1959. 105 pp.

17. Huntington, Harriet E. Let's Go To the Desert. Garden City, New York: Doubleday and Company, Inc., 1949. 90 pp.

18. Jensen, David E. My Hobby is Collecting Rocks and Minerals. Chicago: Childrens Press, 1958. 122 pp.

19. Keen, Martin L. Prehistoric Mammals. New York: Grosset and Dunlap Publishers, 1962. 48 pp.

*20. Malkus, Alida. The Sea and Its Rivers. New York: Doubleday and Company Inc., 1956. 221 pp.

21. Marcus, Rebecca B. The First Book of Glaciers. New York: Franklin Watts, Inc., 1962. 65 pp.

22. Parker, Bertha M. Soil. Evanston, Illinois: Harper and Row, 1959. 36 pp.

23. _____. Water. Evanston, Illinois: Harper and Row. 1959. 36 pp.

24. Pough, Frederick H. All About Volcanoes and Earthquakes. New York: Random House, 1953. 150 pp.

25. Reed, W. Maxwell. The Earth for Sam. New York: Harcourt Brace and World, Inc., 1960. 236 pp.

26. _____. The Sea for Sam. New York: Harcourt Brace and Company, Inc., 1960. 243 pp.

27. _____. The Sky is Blue. New York: Harcourt Brace and Company, 1940. 151 pp.

28. Scheele, William E. Prehistoric Animals. New York: The World Publishing Company, 1954. 125 pp.

*Reference not in Grant School Library.

29. _____. The First Mammals. New York: The World Publishing Company, 1955. 128 pp.

30. Schneider, Herman and Nina. Rocks, Rivers, and the Changing Earth. New York: William R. Scott Inc., 1952. 181 pp.

31. Selsam, Millicent E. Birth of an Island. New York: Harper and Brothers, 1959. 48 pp.

32. Shannon, Terry. About Caves. Chicago: Melmont Publishing, Inc., 1960. 46 pp.

33. Shuttlesworth, Dorothy E. The Age of Reptiles. Garden City, New York: Garden City Books, 1958. 56 pp.

34. _____. The Story of Rocks. Garden City, New York: Garden City Books, 1956. 56 pp.

35. Sterling, Dorothy. The Story of Caves. Garden City, New York: Doubleday and Company Inc., 1956. 121 pp.

36. White, Anne Terry. All About Great Rivers of the World. Eau Claire, Wisconsin: E. M. Hale and Company, 1957. 150 pp.

37. _____. Prehistoric America. New York: Random House, 1951. 182 pp.

38. _____. Rocks All Around Us. New York: Random House, 1959. 82 pp.

39. Wyler, Rose, and Gerald Ames. The Story of the Ice Age. New York: Harper and Row Publishers, 1956. 81 pp.

40. Zim, Herbert S. Rocks and Minerals. New York: Golden Press, 1957. 160 pp.

TEACHING AIDS

Filmstrips:

1. Hotsprings and Geysers. Color. Curriculum Films.

2. Our Changing Earth. Black and white. Curriculum Films.

3. Prehistoric Life. Series of six filmstrips:

   Age of Mammals.
   The Coming of Reptiles.
   Discovering Fossils
   The Rise of the Dinosaurs
   The Story Fossils Tell
   Triumph of the Dinosaurs
   Color. Encyclopaedia Britannica.

Films:

1. Earth: Changes in Its Surface. Eleven minutes. Color. Coronet Films. 1960. Washington State University.

2. Rocks for Beginners. Sixteen minutes. Color. Johnson Hunt. 1958. Central Washington State College.

3. Understanding Our Earth: Glaciers. Ten minutes. Black and white. Coronet. 1952. Central Washington State College.

ASTRONOMY: OUT IN SPACE

The sixth-graders of today are living in the space age. The need is present for an understanding which will help them differentiate between factual information and the "science-fiction" to which they are continually exposed. The extent to which it is necessary to study the solar system in detail will depend upon their understanding at the beginning of the study of the unit. The Lyons and Carnahan, Harper and Row, and Ginn fifth grade books all have good units on the solar system. The teachers' editions all have excellent back-ground for the teacher or better students.

CONCEPTS

1. The sun is a medium-sized star in a vast universe of stars.
2. The earth is one of the smaller planets.
3. Each planet moves around the sun in its own orbit and at different rate. Planets are held in place by gravity and centrifugal force.
4. Distances from the earth to other planets are very great, although small compared to distances between stars in the universe.
5. Moons, meteors, comets, and asteroids are parts of the solar system.
6. Living things, including human beings, are suited to the atmospheric conditions of the earth.
7. Planets differ with respect to temperature, amount of light from the sun, gravitational forces, atmospheric conditions, and presence of living things.

8. Space has no air. It is dark. Space has no heat, no sound waves, no gravity.

9. Powerful jet engines thrust jet planes through the air at very high speeds. Powerful rocket engines thrust rockets through the atmosphere into space.

10. There are many reasons why man is exploring the universe.

11. Because of the many problems to be solved before we can travel to other planets, there are differences of opinion as to its possibility or advisability (3:74).

12. People in the southern hemisphere see different stars from those we see in the northern hemisphere.

13. Our sun is a star because it shines by its own light.

14. The stars are so far away they look smaller than our sun.

15. Sirius is about eight light years away. A light year is the distance light travels in a year or 6,000,000 million miles.

16. Many stars are larger than our sun. Betelguese, the red star of Orion, is so large that the sun with the earth traveling around it could be inside it with room to spare.

17. Stars shine because they are hot. Their color shows how hot they are.

18. Red stars have a surface temperature of about 4,000 degrees. Betelguese is red. Yellow stars have a surface temperature of 11,000 degrees. The sun is a yellow star. White stars have a surface temperature of about 36,000 degrees. Sirius is a white star.

19. The stars move through space at tremendous speed. Astronomers think the sun moves at about twelve miles a second.

20. The Big Dipper and Little Dipper are visible in the U.S. all year.

21. Most constellations are visible only during some seasons.

22. Star maps help you to locate the constellations.

23. Millions of stars are grouped together to form a galaxy. Our sun is a star in the Milky Way galaxy.

24. Stars are hot. Planets are cold.

25. The moon is a satellite which revolves around the earth. It is less than one-third the diameter of the earth.

26. The moon's surface has craters and mountains.

27. It has no atmosphere nor water.

28. The moon shines by reflected light.

29. The moon seems to change its shape from night to night during the month it takes to travel around the earth. This is because we wee only part of the lighted side except when the moon is full.

30. Meteors are pieces of metal or stone that are moving in space.

31. When a meteor strikes the atmosphere, friction makes it hot enough to glow. When it strikes the earth it is called a meteorite.

32. Comets are heavenly bodies that look like stars with tails. They travel in oval orbits around the sun. The head is toward the sun, the tail is away from the sun.

33. Astronomers study the stars with telescopes. A telescope has lenses in it that make the heavenly bodies look closer.

34. The first telescopes were simple refracting telescopes.

35. The large telescopes, used by astronomers today, have very large lenses. They have reflecting mirrors to mirror the heavenly bodies. They are called reflecting telescopes.

36. Recently scientists have been using radio telescopes to gather information about space and the heavenly bodies (21:180, 188).

CHILDREN'S REFERENCES

Basic Texts:

1. Frasier, George Willard, and others. Science Problems. Chicago: The L. W. Singer Company, 1962.

The unit entitled, "The Universe," has three sections dealing with stars, other heavenly bodies, and man-made satellites.

2. Schneider, Herman, and Nina Schneider. Science For Today and Tomorrow. Boston: D. C. Heath and Company, 1961.

Unit Seven, "The Universe" explains the calendar, telescopes, eclipses and some material on the heavenly bodies.

Supplementary Texts:

1. Barnard, J. Darrell, and others. Science, Health, Safety, Book Six. New York: The Macmillan Company, 1959.

Unit Eight, "Travel to Other Planets," is concerned largely with the solar system and problems of space travel.

2. Bond, Austin D., and others. Looking Ahead With Science. Chicago: Lyons and Carnahan, 1963.

The unit, "Out in Space," has sections on meteors, asteroids, comets and stars.

3. Craig, Gerald S. Experimenting in Science. New York: Ginn and Company, 1958.

Library References:

1. Adler, Irving. Seeing the Earth from Space. New York: The John Day Company, 1961. 160 pp.

2. Branley, Franklyn M. Experiemnts in Sky Watching. New York: Thomas Y. Crowell Company, 1959. 111 pp.

3. _____. Experiments in the Principles of Space Travel. New York: Thomas Y. Crowell Company, 1955. 119 pp.

4. Chamberlain, Joseph Miles. Planets, Stars and Space. Mankato, Minnesota: Creative Educational Society, Inc., 1957. 223 pp.

*5. Crowther, J. G. Radioastronomy and Radar. New York: Criterion Books, 1961. 144pp.

6. Del Rey, Lester. Rockets Through Space. Philadelphia: John C. Winston Company, 1960. 118 pp.

7. Fenton, Carroll Lane, and Mildred Adam F. Worlds in the Sky. New York: The John Day Company, 1950. 96 pp.

8. Freeman, Mae and Ira. Fun With Astronomy. New York: Random House, 1953. 58. pp.

9. Gallant, Roy A. Exploring Mars. Garden City, New York: Garden City Books, 1956. 63 pp.

10. _____. Exploring the Moon. Garden City, New York: Garden City Books, 1955. 63 pp.

11. _____. Exploring the Planets. Garden City, New York: Garden City Books, 1958. 123 pp.

12. _____. Exploring the Sun. Garden City, New York: Garden City Books, 1958. 57 pp.

13. Gallant, Roy A. Exploring the Universe. Garden City, New York: Garden City Books, 1956. 62 pp.

14. Highland, Harold J. Planets and Interplanetary Travel. New York: Grosset and Dunlap Publishers, 1962. 38 pp.

*15. Hyde, Margaret O. Exploring Earth and Space. New York: McGraw-Hill Book Co. Inc., 1957. 160 pp.

*16. Johnson, Gaylord. The Story of Planets, Space and Stars. Irvington on Hudson, New York: Harvey House Publishers, 1959. 153 pp.

*17. LaPaz, Lincoln and Jean. Space Nomads. New York: Holiday House, 1961. 187 pp.

18. Lewellen, John. You and Space Neighbors. Chicago: Childrens Press, 1953. 58 pp.

*19. Maloney, Terry. The Sky is Our Window. New York: Sterling Publishing Company, 1960. 128 pp.

*Reference not in Grant School Library.

*20. Marshack, Alexander. The World in Space. New York: Thomas Nelson and Sons, 1958. 176 pp.

*21. Moore, Patrick. The Solar System. New York: Criterion Books, 1961. 127 pp.

22. Newell, Homer E. Guide to Rockets, Missiles, and Satellites. New York: McGraw-Hill Book Company, 1961. 96 pp.

23. Nicholson, Thomas D. The Adventure Book of Stars. New York: Capitol Publishing Company Inc., 1958. 111 pp.

24. Parker, Bertha M. Beyond the Solar System. Evanston, Illinois: Harper and Row, 1957. 36 pp.

25. _____. Rockets and Missles. Evanston, Illinois: Harper and Row, 1963. 36 pp.

26. _____. Satellite and Space Travel. Evanston, Illinois: Harper and Row Publishers, 1963. 36 pp.

27. Reed, W. Maxwell. Patterns in the Sky. New York: William Morrow and Company, 1951. 125 pp.

28. _____. The Stars for Sam. New York: Harcourt, Brace and World Inc., 1960. 179 pp.

29. Rey, H. A. Find the Constellations. Cambridge: Houghton Mifflin Company, 1962. 72 pp.

30. Rey, H. A. The Stars. Boston: Houghton Mifflin Company, 1952. 144 pp.

31. Schloat, G. Warren, Jr. Andy's Wonderful Telescope. New York: Charles Scribner's Sons, 1958. 48 pp.

32. Schneider, Herman, and Nina. You Among the Stars. Eau Claire, Wisconsin: E. M. Hale and Company Inc., 58 pp.

33. Tannenbaum, Beulah, and Myra Stillman. Understanding Time. New York: McGraw-Hill Book Company, 1958. 143 pp.

*Reference not in Grant School library.

34. VonBraun, Werhher. First Men to the Moon. New York: Holt Rinehart, and Winston, 1960. 96 pp.

35. White, Terry Anne. All About the Stars. Eau Claire, Wisconsin: E. M. Hale and Company, 1954. 144 pp.

36. Wyler, Rose and Gerald Ames. The Golden Book of Astronomy. New York: Simon and Schuster, 1955. 99 pp.

37. Zim, Herbert S., and Robert H. Baker. Stars. New York: Golden Press, 1956. 160 pp.

38. _____. The Sun. New York: William Morrow and Company, 1953. 63 pp.

TEACHING AIDS:

Filmstrips:

1. The Earth and Its Neighbors in Space (a series of six filmstrips):

   The Earth and Its Neighbors in Space
   Astronomy Through the Ages
   The Moon
   Our Earth
   The Solar System
   The Stars
   The Sun
   Color. Encyclopaedia Britannica.

2. The Sky (a series of seven filmstrips):

   Stories of the Constellations
   The Sun's Family
   Interesting Things About the Planets
   Our Neighbor, the Moon
   How We Learn About the Sky
   Black and white. Jam Handy Organization.

3. Space and the Atom (from Walt Disney, a series of ten filmstrips):

   Flight Around the Moon
   Flight Into Space
   Flight To Mars.
   Man and the Moon

Man Becomes an Astronomer
Man In Flight
Man In Space
Color. Encyclopaedia Britannica.

Films:

1. Exploring the Night Sky. Ten minutes. Black and white. Encyclopaedia Britannica Films. 1956. Central Washington State College.

2. Portrait of the Sun. Nineteen minutes. Color. Academy Films. 1960. Central Washington State College.

3. Trip to the Moon. Sixteen minutes. Black and white. Encyclopaedia Britannica. 1960. Central Washington State College.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

This study was undertaken with the purpose of organizing a series of science units to be taught in the sixth grade at the Grant Elementary School, Ephrata, Washington. These units consisted of various textbook references, library references, audio-visual aids and lists of concepts from which major learnings could be developed appropriate to the sixth-grade level. The units, entitled Sound, Light, Heat, Chemistry, Microscopic Life, The Nervous System, Weather, The Earth's Changing Surface and Out in Space, were developed after making a survey of topics presented in sixth-grade science textbooks from nine publishers. The units could become the nucleus for the development of the science program in Ephrata Elementary Schools.

CONCLUSIONS

After developing the nine units, the writer arrived at the following conclusions:

1. There is considerable variation as to the grade placement of many topics presented.
2. There is variation as to the extent a given topic is developed.

3. The greatest variations were in the areas of the biological sciences.
4. No single textbook seemed best as a reference for all nine selected unit topics.

RECOMMENDATIONS

Upon completing this study, the writer recommends that textbooks from more than one publisher be secured for classroom use. Using the nine topics developed in this study, sixth-grade textbooks from the following publishers would be recommended: American Book Company, The D. C. Heath Company, Harper and Row, Publishers, and Lyons and Carnahan. Two or three copies from other science textbook publishers, as well as a few copies of fifth-grade textbooks, would also be desirable to have in the classroom reference library.

The writer also recommends that each of these units be considered as only the beginning of resource units. Suggestions for introducing, carrying out, and culminating each unit should be kept, as previously suggested, in a file folder. Pictures, hints for teaching, teaching aids, directions for additional experiments, evaluation suggestions, and other material appropriate to the units should be added to these folders.

The writer recommends additional study be made to assure the development of a complete science program for the

Ephrata Elementary Schools. Such a science program would give students of the Ephrata Elementary Schools the oooprtunity to learn to develop an understanding of how to approach problems scientifically, develop scientific talent in all students and to acquire an enriched outlook of the world of science and its contributions to our democratic society.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. American Association for the Advancement of Science. "Science Teaching in Elementary and Junior High Schools," Science, 133:2019-2022, June 23, 1961.

2. "A Wider Outlook in the Teaching of Science." The ABC Bulletin 5:2 (undated).

3. Barnard, J. Darrell, and others. Teacher's Manual for Book Six, The Macmillan Science-Life Series. New York: The Macmillan Company, 1959. 104 pp.

4. Blough, Glenn O. Elementary Science Series. Federal Security Agency, United States Office of Education. Washington: Government Printing Office, 1947. 11 pp.

5. Blough, Glenn O. You and Your Child and Science. Washington: National Education Association, 1963. 28 pp.

6. Blough, Glenn O., and Albert J. Huggett. Elementary-School Science and How to Teach It. New York: The Dryden Press, 1951. 532 pp.

7. Blough, Glenn O., and others. "Developing Science Programs in the Elementary School," Rethinking Science Education, pp. 112-135. Fifty-ninth Yearbook of the National Society for the Study of Education, Part I. Chicago: University of Chicago Press, 1960.

8. Blough, Glenn O., and Paul E. Blackwood. Teaching Elementary Science. Federal Security Agency, United States Office of Education. Washington: Government Printing Office, 1948. 40 pp.

9. Bond, Austin D., and others. Teacher's Guide for Looking Ahead With Science. Chicago: Lyons and Carnahan, Inc., 1963. 276 pp.

10. Brownell, W. A., and G. Hendrickson. "How Children Learn Information, Concepts, and Generalizations," Learning and Instruction, pp. 92-128. Forty-ninth Yearbook of the National Society f or the Study of Education, Part I. Chicago: University of Chicago Press, 1949.

11. Brumer, Jerome S. The Process of Education. Cambridge: Harvard University Press, 1960. 97 pp.

12. Burnett, R. Will. Teaching Science in the Elementary School. New York: Rinehart and Company, Inc., 1953. 541 pp.

13. Burns, Robert B., "Materials for Elementary School Science." Unpublished report, Curriculum Laboratory, Central Washington State College, Ellensburg, 1964.

14. Craig, Gerald S. Science for the Elementary-School Teacher. Boston: Ginn and Company, 1947. 561 pp.

15. Craig, Gerald S. Science in the Elementary Schools. Washington: National Education Association, 1957. 33 pp.

16. Craig, Gerald S., and Beatrice D. Hurley. Learning Science With Children. Boston: Ginn and Company, 1959. 22 pp.

17. Craig, Gerald S., and others. Teachers Manual for Experimenting in Science-Science Today and Tomorrow. Boston: Ginn and Company, 1958. 185 pp.

18. Decker, Donald G. "Science K-12," NEA Journal, 48: 10-12, April, 1959.

19. Dunfee, Maxine and Julian Greenlee. Elementary School Science: Research, Theory and Practice. Washington Association for Supervision and Curriculum Development, 1957. 67 pp.

20. Dutton, Wilbur H., and Lois Stephens. "Measuring Attitudes Toward Science," School Science and Mathematics, 63: 43-49, January, 1963.

21. Frasier, George Willard, and others. Teacher's Guide Science Problems, Grade Six. Syracuse: The L. W. Singer Company, 1962. 206 pp.

22. Freeman, Kenneth, and others. Helping Children Understand Science. Philadelphia: The John C. Winston Company, 1954. 314 pp.

23. Good, Carter V., Dictionary of Education. New York: McGraw-Hill Book Co., 1959. 676 pp.

24. Greenlee, Julian. "Effective Learning Through Science Investigations," The Science Teacher, 23:15-16, February, 1956.

25. Hanna, Lavone A., Gladys L. Potter, and Neva Hagaman. Unit Teaching in the Elementary School. New York: Rinehart and Co., Inc., 1955. 592 pp.

26. Hopman, Anne B. "Effecting Changes in the Elementary Science Curriculum of a School System," Science Education. 48:101-109, March, 1964.

27. Hill, Katherine E. "Children's Evolving Science Concepts," Elementary School Science Bulletin, Washington: National Science Teachers Association, 44:1-2, February, 1959.

28. Hill, Katherine E. "Issues and Problems in Elementary Science in a Changing World," Science Education, 47:109-113, March, 1963.

29. Hubler, Clark. Working With Children in Science. Boston: Houghton Mifflin Company, 1957. 425 pp.

30. Hurley, Beatrice J. "Effects of Rapid Changes in Science Upon Children," Science Education, 47:168-172, March 1963.

31. Kambly, Paul E. and John E. Suttle. Teaching Elementary School Science. New York: The Ronald Press Company, 1963. 492 pp.

32. Keeslar, Oreon. "The Science Teacher and Problem Solving," The Science Teacher, 23:13-14, 67, February, 1956.

33. Lahti, Arnold M. "Scientific Methodology--The Education for a Changing World," Science Education, 47:157-162, March, 1963.

34. Lee, J. Murry, and Doris May Lee. The Child and His Curriculum. New York: Appleton-Century-Crofts, Inc., 1960. 596 pp.

35. Navarra, John Gabriel, and Joseph Zaffaroni. Teacher's Edition, Today's Basic Science Six. Evanston, Illinois: Harper and Row, Publishers, 1963. 251 pp.

36. Podendorf, Illa. "Is Our Science Scientific?" School Science and Mathematics, 63:21-24, January, 1963.

37. Schneider, Herman, and Nina Schneider. Teacher's Guide Science for Today and Tomorrow. Boston: D. C. Heath and Company, 1961. 209 pp.

38. Smith, Eugene H. "An Analysis of Some Prominent Viewpoints on Teaching Elementary School Science," Science Education, 47:188-193, March, 1963.

39. Tewes, Helen McCall. "Accent on Thinking Through Curriculum Revision," Science Education, 47:175-178, March, 1963.

40. Thurber, Walter A. Teachers' Manual for Exploring Science Six. Boston: Allyn and Bacon, Inc., 1958. 143 pp.

41. Trexler, Clarence R., and others. Teacher's Edition for ABC Science Series Six. New York: American Book Company, 1961. 200 pp.

42. Zafforoni, Joe. "A Study of Pupil-Teacher Interaction in Planning Science Experiences," Science Education, 47:132-137, March, 1963.

43. Zim, Herbert S. Science for Children and Teachers. Washington: Association for Childhood Education International, 1953. 55 pp.