A Survey of the Field of Primary Science

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A SURVEY OF THE FIELD OF

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CHAPTER I

INTRODUCTION

We are living in a generation of science. The advances of the last one hundred years in the area of science and technology have done more to shape our lives and ways of living than any other development. Teachers are concerned that the children they teach develop an awareness of the scientific, technological environment in which we live so that they can begin to understand and deal with the problems they face in such a world. Thus an important dimension of science is to make the events of the environment explicable to our young people.

The teaching of science, as such, in the elementary grades is a relatively new development. The methods of research have only recently been applied to this area of science teaching.[1] The development of this area of the curriculum is being accepted more and more as a responsibility by those who are planning the education of children. This instruction in science is necessary because of the values inherent in the subject matter.

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[1]Helen Heffernan, "Science in California's Elementary School Program," Science Education, October, 1953.

There seems to be general agreement among writers in the field of primary science concerning the major aims of the program. These aims are: to cultivate scientific attitudes and methods of procedure, to lead to broader concepts, to open new avenues of interest and satisfaction, to enable the individual to meet the problems of existence, and to develop social attitudes and appreciations.

Since this is a relatively new field there are many areas that need to be investigated. It would appear that a curriculum study should be made to determine the extent of science experiences which should be provided for the children in the six to nine age group and the type of program in which these activities could be developed. Teaching helps and materials need to be provided with which to carry out this program. Some way should be developed to evaluate and measure the learnings and functional outcomes of this science teaching.

The selection and organization of content material differs with various schools and is best done by the individual with firsthand knowledge of the needs, aptitudes, abilities and interests of the pupil group. They need to know where to obtain materials and how to use them most effectively. Some traditional content material could perhaps still be used. Teachers have no wish to discard what is of value in the traditional curriculum which has vitality and meaning for the child. They should not desire to retain what does not so function.

A sequence in primary science should be presented in an orderly manner. Incidental experiences cannot be depended upon for the full development of all the concepts in such a sequence. Textbooks may be used as an outline but at the six to nine year level the textbook is the least important resource for the child. Reading about science can never be substituted for firsthand experiences in which the child has an opportunity to learn by doing.

The purpose of this paper will be to develop the specific objectives of science teaching as it applies to the children of the six to nine age group, commonly known as the primary school. Some problem areas will be suggested for investigation. A review of the major concepts which are developed in the field of primary science will be made. Some representative lists of materials for both teacher and pupil will be included. In conclusion an attempt has been made to devise methods of evaluating some of the science learnings with a view to suggesting further work on this problem of the evaluation of primary science concepts.

CHAPTER II

PHILOSOPHY AND OBJECTIVES OF PRIMARY SCIENCE TEACHING

What is science? It has sometimes been called organized common sense. How to present the facts of science in such a way that it makes sense to the young child is the task of the primary teacher.

The goals or objectives of science teaching may be divided into two general parts: (1) abilities and attitudes to be developed, and (2) the scientific concepts to be understood. In this chapter we shall consider the first group.

Craig states that "American children must be encouraged to have high ideals for service to humanity and must know how to put their ideals into operation on a democratic basis. They must realize their responsibilities and opportunities. They must discover while they are young the importance of science and must learn how it can be used to promote world welfare."[1]

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[1]Gerald S. Craig, You Can Teach Elementary Science (New York: Ginn and Company, 1951).

The task of the teacher is clear. She must help to develop a generation of children that will be wiser than those of the past. Failure to open up the avenues of science to the natural drives of children may result in citizens of tomorrow who are poorly prepared for the Atomic Age. A realization of the importance of science must be made to function in the thinking of all children.

From the time a child starts to talk he asks questions. If his questions are answered with truth and with as full an answer as the child can understand both emotionally and intellectually, he comes to possess an amazing amount of knowledge. His curiosity is satisfied, his horizon enlarges, and he has a good start on problem solving.

What better starting point do we need than when the child enters school? He is still curious. He is eager to enlarge his understandings. He has problems to solve. By answering a child's immediate needs in living and by satisfying his curiosities, the content of science emerges.

Children from the ages of six to nine have a great deal of natural curiosity. Small hands in the first grade bring numerous rocks, shells, leaves, flowers, insects, and other materials to school. Boys and girls ask the why's and what's and how's of many things. The wise teacher will not glibly answer the questions but will help the child find the answers to his own questions. She asks, "How can we find out?" The problem becomes a group concern. The teacher has an excellent opportunity to assist children to develop critical attitudes in reference to methods of securing information, methods of problem solving and ways of drawing reliable conclusions.

In teaching science we are concerned primarily with how to find the truth. An informal working situation brings the best results. This does not mean a loose and undisciplined procedure. Science in itself has its discipline which grows out of scientific attitudes and methods. The teacher should be aware of the relation of method and attitude to desirable social behavior in children. Teacher and children should feel relaxed. The very nature of science calls for discovery and open-mindedness. The true scientist is learning when he makes discoveries.

The modern program of science seeks to eradicate superstitions, prejudices, and unfounded opinions and to substitute respect for truth. Children must be helped to recognize that the scientific method is one of man's greatest discoveries and to help them appreciate the importance of basing their actions upon truth in so far as truth is obtainable. Heffernan believes "Our great interest in providing appropriate science experiences through the entire school period is not primarily because of a desire to develop the intellectual foundations which will produce a new drug, a new type of engine, or a new process. Rather, we see in well selected science experiences the opportunity to instill devotion to truth and straight thinking."[2]

We live in a world of accelerated change and tremendous complexity. The application of science to technology has resulted in spectacular changes in all aspects of modern life. A curriculum is really obsolete which does not recognize the impact of science on contemporary life and has not made provisions to include this study for all ages of children.

By the time they enter first grade some children will have had many rich science experiences. They will be accustomed to answer their own questions by testing out varied hypotheses. They will be ready to learn new skills, new methods of observation and new ways of testing. Others will have had experiences but because their emotional concerns were too great they are confused. Others have had relatively little experience.

Science in the primary grades must be appropriate to

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[2]Heffernan, op. cit., p. 223.

children of that age: their ideas of themselves and their world, their interest in discovering facts for their own purposes, their natural applications of critical thinking, and their development and growth in resourceful and intelligent behavior. Such science is the exploration of events in the environment and the development of explanations for them. As such it utilizes the natural drives of children.

With each child, learning begins where he is in his understanding of a given area of content. He finds his springboard where he now is. He puts down roots into new subject content which further helps him to understand himself in terms of his environment. He sends sturdy stems out in all directions to gain further pertinent information. Thereafter this knowledge is a part of him forever.

The progress of science activities in the primary grades is decidedly a developmental process. Understandings and attitudes are built upon previous experiences and solved problems. The six year old observes the world near at hand. He lives in a world where tools and machines are both puzzling and fascinating. As he grows older his understandings gradually increase and his questions become broader in keeping with his developmental growth. So it is important that teachers see the significance of a continuous program of science beginning when the child enters school and continuing throughout his school life. There must be a development toward definite science objectives beginning at each level where the children are in their thinking. We must relate the known to the unknown and build upon that.

Elsa Meder gives four factors that help children in scientific problem solving: curiosity that moves the child to discover the world in which he lives; observation that enables children to see things that other people miss; imagination so much a part of children; and discovery that brings joy to children and scientists alike.[3]

So we can see that the process of the interpretation of our environment which we call science is an extension and refinement of the activity that is observable in all children. It is not difficult to use this function of science and this behavior of children in an advantageous manner. The child whose teachers have been alert to their opportunities never ceases to be deeply interested in the natural phenomena which occur about him, and in the effects of scientific discoveries on hom and on the civilization of which he is a part.

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[3]Elsa Marie Meder, "Problem Solving For Today's Children," Science Education, April, 1952.

Navarra believes that one of the prime functions of elementary science is to nurture and encourage the skillful use of creative imagination.[4] We must encourage, stimulate, and maintain the inquisitiveness of children and facilitate in every way possible the ability of the child to cope with his concerns as they arise in the course of his development. In the words of Almy, "If one believes that the very nature of the child's growth and development is such that he begins to operate as a scientist from the age of three on, then it seems evident that the school needs to provide science experiences throughout the school life of the child."[5]

To summarize, then, we can say that the primary teacher must be alert to the interests of children, be enthusiastic about the subject of science, make science learnings a shared experience, be scientific in her own attitudes, and remember individual differences and backgrounds. She must strive to develop an intelligent appreciation of the natural and physical world, develop scientific attitudes of cause and effect, instill a respect for another's point of view,

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[4]John G. Navarra, "Elementary Science As It Relates to the Developmental Aspects of Children," Science Education, October, 1953.

[5]Millie C. Almy, "Science Through the Eyes of Children and Youth," Science Education, Vol. 37, October, 1953, p. 237.

help the child acquire the scientific method of problem solving and help the child acquire useful knowledge of scientific principles within the limits of his understanding.

CHAPTER III

SCIENTIFIC CONCEPTS TO BE DEVELOPED

Science in the elementary school is not just so much content to be learned. It is the constant emergence in the child's life of large outcomes as a result of his interaction with his environment in an age of science. So the tendency is to consider elementary science in terms of its social significance.

Content is valuable in so far as it meets the needs of the child and society. Zim states that the nature of science implies the role of content in the study of it. Content or facts are tools to be used in scientific work. They are only tools and never an end. Hence the content in the primary grades of the elementary school should depend upon the facts that the pupils want to discover or upon the problems they want to solve. Learning about science is not a substitute for learning science. The primary school science program should be free and flexible with emphasis on problem solving.[1]

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[1]Herbert S. Zim, Science for Children and Teachers, Association for Childhood Education Pamphlet, Washington, D. C.

According to Craig the task of the curriculum maker is to render available to the teacher the kind of materials, based on research, that will assist her in creating her own values.[2] Children should be allowed to live through experiences which will help them to gain increasing control and understanding of the basic scientific conceptions of modern life. The organization of the primary school as well as the age group which it includes make it the ideal place to give the child experience in asking questions, raising problems and attempting to find solutions through observation and experiments.

During the school year of 1954-1955 a Science Curriculum Committee was formed in the Wenatchee school system for the purpose of determining what learning experiences were being provided for pupils in the elementary schools and to find out what changes or additions were needed to make the program more effective. The objective was to formulate a curriculum guide for the schools of the city. The science committee included one representative teacher with a known interest in science from each of the grade levels. One science teacher from the Junior High School, one from the High School and one from the Junior College completed the group.

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[2]Gerald S. Craig, Science for the Elementary School Teacher (Boston: Ginn and Company, 1949).

The Assistant Superintendent of Schools and Director of Curriculum for the city, Mr. John Rutherford, was chairman of the committee and directed the study.

Since the Junior High and High Schools had quite definite courses of study the emphasis was placed on the elementary grades. A survey was made to determine what general concepts were already being taught at each level. A subcommittee made a tentative list of concepts using such sources as the Spokane Science Outline for Elementary Schools and Gerald Craig's "Scope and Sequence of Science in the Elementary Grades."[3] This list was approved by the committee and the survey sheets were sent to each teacher to be marked.

A compilation of the totals was made on the same form that was used in the survey. The basic concepts and the findings on frequency of use are shown on the following pages.* The numbers in the squares show the number of classrooms that had explored that particular concept during that school year or who usually included it in the curriculum for that grade. The findings for all six grades are included to demonstrate that learnings are not confined to one grade level but overlap freely.

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[3]Craig, op. cit., pp. 528-30.

*Used by permission.

Please place a check in the column for your grade the topics that you teach.

11	11	11	10	10	10	← Number of rooms per grade
Grade Level						Science Topics
1	2	3	4	5	6	I. Animals
9	6	8	6	4	3	1. Distinguishing characteristics of animals.
8	7	11	6	2	6	2. Food of animals.
8	7	11	4	5	2	3. Homes of animals
9	6	9	6	2	5	4. Animals are helpful to man.
7	6	10	6	7	4	5. Animals adapt themselves to seasonal changes.
4	5	9	7	7	6	6. Animal adaptation to environment.
1	1	3	5	3	3	7. Classification into groups.
2	2	0	1	2	1	8. Pattern of growth
5	6	8	4	4	4	9. Care and protection.
2	1	2	4	3	2	10. Life cycles of animals.
0	0	6	5	3	5	11. Animals of the past.
1	0	0	1	2	4	12. How man improves animals.
1	0	0	2	1	1	13. Insect study.
0	0	0	1	0	0	14. Simple anatomy and physiology.
						II. Plants
7	6	6	8	9	1	1. Kinds of plants.
7	5	2	7	7	1	2. Distinguishing features.

1	2	3	4	5	6	Science Topics (Continued)
						II. Plants (continued)
6	3	10	6	6	2	3. Parts of a plant.
5	7	11	4	8	3	4. Growth of plants.
7	8	11	8	6	2	5. Seeds.
7	8	10	8	8	2	6. Need for water.
1	3	4	2	8	3	7. How plants are protected.
0	0	1	2	2	2	8. Classification of plants.
1	0	0	2	3	3	9. How man improves plants.
4	2	8	5	4	3	10. Uses of plants.
						III. Plants and Animals
						A. Interdependence of Living Things
2	4	7	4	2	2	1. How some animals help other animals.
3	4	7	7	5	4	2. How plants help animals.
1	1	5	3	5	3	3. How animals help plants.
1	1	4	3	1	1	4. How plants help other plants.
1	2	4	1	2	1	5. How some plants harm other plants.
2	6	5	2	3	1	6. How some animals harm other living things.
6	7	10	8	7	3	7. Value of plants to man.
6	6	7	8	5	4	8. Value of animals to man.
0	0	3	3	4	5	9. Balance of life.

1	2	3	4	5	6	Science Topics (Continued)
						II. Plants and Animals (continued)
1	0	0	2	1	1	10. Social animals.
0	0	3	1	7	3	11, Bacteria, molds.
						B. Plant and Animal Adaptation
5	6	8	5	6	2	1. Plants and animals are found everywhere.
3	4	8	7	5	3	2. Each is fitted by nature to live in its own surroundings.
6	6	10	7	5	3	3. How animals are fitted to live in water.
5	6	11	7	5	3	4. How animals are fitted to live on land.
2	3	7	4	7	2	5. How plants are fitted to live on land.
2	2	6	4	4	2	6. How plants are fitted to live in water.
4	6	10	2	7	8	7. How living things are fitted to meet seasonal change.
1	2	10	5	3	2	8. Structural characteristics of animals for protection from enemies.
2	2	6	2	2	3	9. How man can do more than other living things to cope with his environment.
						C. How Living Things Reproduce
2	2	2	4	3	3	1. Every living thing comes from other living things.
5	5	5	6	5	3	2. Seed production.
0	0	1	0	7	4	3. Cells.
0	2	2	5	7	3	4. Pollenization.
0	0	1	1	3	2	5. Spores.

1	2	3	4	5	6	Science Topics (Continued)
						III. Plants and Animals (continued)
						C. How Living Things Reproduce
1	2	1	1	4	3	6. Buds.
0	0	1	0	3	5	7. One cell division.
1	0	2	0	4	2	8. Plant reproduction by parts.
6	1	2	2	3	1	9. Animals come from other living animals.
8	6	8	3	6	1	10. Hatching from eggs.
7	4	8	4	5	2	11. Some animals born alive.
0	1	0	1	5	2	12. All living things start from a single cell.
7	4	5	0	3	1	13. Parental care of newborn animals.
5	4	6	1	2	1	14. Some animals care for themselves at birth.
						D. How Living Things Get Food
3	3	7	6	4	3	1. Food-getting a major activity of all living things.
1	2	4	2	3	4	2. Specialized structures used by animals to get food.
1	1	8	4	7	3	3. Green plants manufacture food.
1	3	9	3	6	3	4. Function of sap in plants.
1	2	5	3	6	3	5. Plant use and storage of food.
0	0	1	0	6	3	6. Plants that do not manufacture food.
1	1	5	0	3	5	7. Why and how man grows food.

1	2	3	4	5	6	Science Topics (Continued)
						IV. Physical Environment
8	6	9	3	7	5	1. Weather--thermometer
8	6	9	4	4	3	2. Sunlight and shadow
5	5	9	8	7	6	3. The sun
3	5	9	8	7	6	4. The moon
3	5	9	6	7	8	5. The stars
1	4	3	6	8	6	6. The air--air pressure
6	6	7	9	7	6	7. The wind
6	6	7	6	6	5	8. The water
7	6	7	3	5	6	9. Clouds
1	3	6	4	5	5	10. The ground--soil--how formed
0	2	5	5	5	4	11. The earth
0	0	6	5	5	5	12. Fossils
1	2	7	10	7	6	13. Movements of the earth
0	1	5	6	7	7	14. The planets
0	0	0	0	5	3	15. Molecules
5	6	6	6	6	4	16. Time
10	8	6	6	2	2	17. Seasons
						V. Machines, Tools and Power
3	3	4	3	2	0	1. Machines--types and kinds

1	2	3	4	5	6	Science Topics (Continued)
						V. Machines, Tools and Power (continued)
1	3	3	1	2	1	2. Machines--uses and purposes
1	2	6	8	4	7	3. Electricity
1	2	9	8	3	6	4. Magnetism
1	1	2	4	1	4	5. Friction
1	3	3	5	3	4	6. Heat
1	4	4	3	3	5	7. Light
0	3	3	4	3	7	8. Sound
1	2	5	0	2	1	9. Tools--three basic
4	4	5	0	2	2	10. Fire--uses--control
0	2	0	5	4	5	11. Gravity
						VI. Miscellaneous Other Topics
0	0	5	3	3	4	1. Great scientists and their contributions
0	2	3	5	5	5	2. Vitamins
0	2	5	1	4	2	3. Recreation
0	1	3	3	7	6	4. Conservation
0	1	4	2	5	2	5. Minerals
1	3	7	5	4	2	6. Rocks--how formed--uses
0	1	2	2	3	6	7. Earthquakes--volcanoes

TEXTBOOK SOURCE SURVEY

Recognizing the fact that this body of content is commonly used in the science curriculum and should be available for the use of children and teachers for the solution of problems and answers to questions, several publishers of elementary textbooks have produced science texts for the primary age group within the last few years. They are within the six to nine year range of vocabulary and interest. The American Educational Catalog[4] which lists the textbooks which are in print shows that eleven publishers now have primary science books on the market. These range in reading difficulty from pre-primer or readiness level to book three. A list of these publishers and authors follows:

Row, Peterson and Co., Basic Education Series, 1956.

By Parker and Blough--A series of twenty unitexts, each one on a different topic usually taught in the primary science curriculum. Graded in difficulty according to placement of subject.

Scott Foresman Co., By Beauchamp and Crampton, 1947 to 1951.

Book I--Look and Learn

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[4]American Educational Catalog -- Textbooks in Print Vroman's School Book Depository, San Francisco, California.

Book II--<u>All Around Us</u>

Book III--<u>How Do We Know</u>

Ginn and Co., <u>Our World of Science Series</u>, 1950.

By Craig and Others

Book I--<u>Science Near You</u>

Book II--<u>Science Around You</u>

Book III--<u>Science Everywhere</u>

Suggest activities and experiments at intervals.

J. B. Lippincott Co., <u>Science For Modern Living Series</u>, 1956.

By Smith and Clark

Book I--<u>Along the Way</u>

Book II--<u>Science Under the Sun</u>

Book III--<u>Science Around the Clock</u>

The authors suggest some activities and frequently include questions for self-testing or class discussion.

Rand McNally & Company, <u>Junior Scientist Series</u>, 1955.

By Baker, Maddux, and Warrin

Book I--<u>Down Your Street</u>

Book II--<u>Around the Corner</u>

Book III--<u>In Your Neighborhood</u>

Allyn and Bacon, <u>Exploring Science Series</u>, 1957.

By Carpenter, Bailey, and Others.

Book I--_Adventures With Judy and Joe_

Book II--_Adventures With Bob and Don_

Book III--_Adventures With Jane and Paul_

Suggests many simple experiments and activities.

John C. Winston Co., _Understanding Science Series_, 1957.

By Dowling, Freeman, Lacy and Tippett

Book I--_I Wonder Why_

Book II--_Seeing Why_

Book III--_Learning Why_

Suggested experiments and activities throughout.

Charles Scribner's Sons, _Wonderworld of Science_, 1950.

By Knox, Stone, Meister and Noble

Wonderworld Readiness, Books I, II, and III. (No names)

Questions for testing and discussion for each chapter.

The Steck Co., _Series of Worktexts_, 1955 to 1957.

By Hudspeth, Steele, Whitney and Ware

Worktext I--_Do You Know_

Worktext II--_Things Around You_

Worktext III--_Here and There_ (Not available for examination)

D. C. Heath and Co., _Elementary Science Series_, 1955.

By Herman and Nina Schneider

Book I--*Science for Work and Play*

Book II--*Science for Here and Now*

Book III--*Science Far and Near*

Suggests many simple experiments and activities for teacher and children.

L. W. Singer, Inc., *Elementary Science*, 1955.

By McCracken, Armstrong and Others.

Readiness--We See

Book I--*Sunshine and Rain*

Book II--*Through the Year*

Book III--*Winter Comes and Goes*

Beckley-Cardy Co., By Thorn and Harbeck, 1951.

Pre-Primer--*Let's Try*

Book I--*Let's Find Out*

Book II--*Let's Look Around*

Book III--*Let's See Why*

An examination of the titles of these books will indicate that they all use the standard primary approach to learning: begin with the child's own familiar surroundings and gradually expand his understandings and relationships to include those that are farther afield. These books were all examined by the writer except those designated otherwise. They all have manuals to aid the teacher in developing the activities. Reading consultants have worked with the authors in the writing of the later texts so that the vocabulary is carefully controlled for age and maturity level of comprehension.

To summarize the textbook survey, Hurley's statement concerning the use of textbooks seems fitting:

> Unquestionably teachers in the elementary schools wish to meet the growing demand for science. Many of them are hesitant about teaching science because they recognize a weakness in their own backgrounds. Good basal science books and their accompanying manuals, written to meet the needs of the classroom teachers, whether they have had previous training in science or not, permit a program of science in which teachers can learn with their pupils. Science books should not be read as other books. The teacher must relate the content to the experiences of the group.[5]

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[5]Beatrice D. Hurley, You Can Teach Elementary Science (Chicago: Ginn and Company, 1950).

CHAPTER IV

PROBLEM AREAS IN PRIMARY SCIENCE

That science has not been incorporated more quickly into the curriculum at the primary level is partly because many teachers feel inadequately prepared to give children proper guidance in science activities. This problem is in the process of being met. Programs of teacher education include courses in the teaching of elementary science where emphasis is placed on content and method appropriate to the maturity level of the children. Many school systems provide opportunities for teachers to attend practical science workshops. Local districts are developing a twelve-year science curriculum. Committees on science are developing lists of library source materials and standard lists of equipment.

Joseph states that the teaching of science is considered by many primary teachers to be one of their most difficult problems. He agrees that the most important thing is to provide firsthand experiences; that science teaching achieves greatest efficiency only when real experiences are provided.[1] The teacher must take her cue

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[1]Dr. Alexander Joseph, "What to Teach in Science" Elementary Science (Darien, Connecticut: Educational Publishing Corporation, 1950).

from the children's interests and their surroundings for her teaching material. Every primary classroom should have a science corner where children can place their carefully labeled contributions, including living things which are under proper care.

Branley gave substance to the same idea when he said,

> Frequently one hears teachers express doubts as to their own abilities. No one person could answer all the questions of a room full of children, but every teacher should sincerely desire to know the answer. She must search out the materials and experiment until an answer is obtained. This is the approach to science--a driving desire to find the answers. It is also a basic habit that every teacher should strive to instill in each and every child.[2]

More significant than the feeling of inadequacy on the part of the teacher, however, has been the overcrowded curriculum of the school. The importance of science and the natural interests of children in scientific phenomena has led to many proposals of ways and means to incorporate science into the primary program. In the words of Jacobson,

> Some educators think science should be handled incidentally when a particular interest arises. That when children have such experiences and spontaneous interests, the alert teacher naturally takes advantage

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[2]Franklyn M. Branley, Associate Astronomer, American Museum-Hayden Planetarium, New York. "Science in Childhood Education," Grade Teacher, April, 1957.

of the situation to expand the children's understanding.[3] He feels, however, that science teaching is too important to leave entirely to chance.

Chase recognizes the sense of pressure that is common in all of today's schools. He comments,

> Courses of study have so much content to "cover" that teachers and children have little time for thinking, experimenting, contemplation or enjoyment in the process of learning. Every teacher recoils from any proposal to add another "subject" to an already staggering list of requirements. Schools need to prune out the deadwood in content. What remains should constitute what is considered essential to intelligent thinking and action in the modern world.[4]

So we conclude that the development of interests, appreciation, scientific concepts, scientific attitudes and methods are attainable for children with the guidance of a teacher who has a spirit of adventure even if his own knowledge has serious gaps. Since the trend in the modern primary curriculum is to organize learning around large areas of human experience rather than in terms of subject matter, it is easy to help children see relationships. A

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[3]Willard Jacobson, "A Generation of Science and a Young Generation," Science Education, Vol. 37, p. 219, October, 1953.

[4]John B. Chase, Jr., "Stimulating Scientific Thinking," Grade Teacher -- Special Science Section, April, 1957.

unit of study becomes an area of human experience which encompasses all the fields of subject matter and draws appropriate content from each. Therefore, in promoting more attention to science, we are not adding another subject. Rather we are deepening and broadening the experiences with content which will provide a sound basis for thinking and action. The science program is not rigid. It depends not so much on the use of a science period but on cumulative results for the year. The new type of program which provides for continual growth for the child offers a new role for science in the primary school: it enriches life in the classroom.

CHAPTER V

EQUIPMENT AND MATERIALS FOR TEACHING PRIMARY SCIENCE

Without materials of some kind a satisfactory science program is almost impossible. The word "materials" will include anything which is used to make a concept of science clear to the child's understanding. They will include books for the child and books for the teacher, visual aids, equipment and materials with which to perform simple experiments, materials brought into the schoolroom for observation and those brought in for construction activities. Craig maintains that all the resources of a community are legitimate and stimulating materials. No matter what the type of community or its climate, it can provide firsthand contacts which will furnish evidence with which children can explain the world in which they live. A walk through the neighborhood may reveal to an enterprising teacher sufficient material for science teaching for weeks ahead.[1]

Many scientific principles may be observed and demonstrated with little or no equipment. A jar full of water with a tight

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[1]Gerald S. Craig, Science for the Elementary School Teacher (New York: Ginn and Company, 1947).

lid may be placed outside to freeze in the winter. The broken jar will prove that water expands when it freezes. A sailboat in a puddle will prove that wind can push. Even though many science experiences in the primary grades can be carried on with little equipment, some is necessary. In the report of the National Council for Elementary Science this statement is made,

> Experimental materials are even more important than books for a science program for young children. The board of education should furnish science materials just as it furnishes chalk and other supplies.[2]

It also suggests that a school might prepare a pamphlet listing the sources of material at hand along with references for both pupils and teachers.

I. EQUIPMENT

In primary science the emphasis has been on simple, low cost homemade equipment. However, we might ask, "Are social studies, arithmetic, or music taught with that kind of equipment?" The best science teaching will not be accomplished until this question is viewed in the light of the value placed upon children's

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[2]Report of the National Council for Elementary Science, Cleveland Meeting, Science Education, October, 1953, pp. 254-55.

activities and the most effective use of the teacher's time.

Many of the items in the following list of supplies compiled by Zim[3] come under the head of regular school supplies. Some of the materials will be brought in by the children. Some may be purchased locally and a few items must be obtained from science supply houses. It is the obligation of the school administration to see that teachers have the instructional materials that they need. Many schools have "science closets" where a supply of these more expensive materials are kept so that they may be available to any teacher in the school. The materials would be more specialized than those which the teacher would keep in his room.

Glassware

Pint and quart bottles
Shallow dishes
Miscellaneous jars
Bottles--heat resistant
Aquaria
Glass sheets--assorted
Bells jars or large bottles

Tools

Hammers
Small saws
Screw drivers
Pliers
Knife
Can opener
Brace and bits
Tin snips
Putty knife
Ice pick
File

Hardware Supplies

Assorted nails
Assorted screws
Copper wire
Picture wire
Stove bolts

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[3]Herbert S. Zim, This is Science, Bulletin of the Association for Childhood Education, Washington, D. C.

Hardware Supplies (continued)

Quick-drying enamel
Paint brushes
Turpentine
Denatured alcohol
Kerosene
Dowel sticks, several sizes
Glue
Wire screening
Staples
Alcohol lamp
Lamp chimney
Steel wool

Dime store supplies

String
Rope
Candles
Dyes
Magnifying glass
Marbles
Magnets
Flower pots
Fertilizer
Clothespins
Cellophane
Pins and needles
Corks
Curtain springs
Cheap scales
Rubber gloves
Rubber balloons
Strainers
Pots
Sheet oilcloth
Thermometer
Sponge
Drinking glasses
Potholder
Mirror

Electrical Supplies

Push buttons
Bell wire
Dry cell batteries, No. 6
Flashlight bulbs and sockets
Electrical bell
Light bulbs--several sizes
Electric heating unit
Train transformer
Bell transformer
Electric hot plate
Small electric motor
Lamp cord
Assorted plugs and sockets
Flashlight
Electric fan--rubber blades

Household Chemicals

Household ammonia (use with care)
White vinegar
Baking soda
Washing soda
Sugar
Iodine solution (use with care)
Chloride of lime (use with care)
Peroxide
Salt

Scientific Supplies

Small microscope
Small telescope
Electromagnet
Glass prism
Barometer
Good scale
Telegraph key
Model glass pump
Glass tubing

School Supplies	Miscellaneous
Gummed labels	Wooden spools
India ink	Storage boxes, assorted sizes
Filing cards--3x5	Kerosene lamp
Ruler and yardstick	Tin foil
Chalk, white and colored	Old clocks
Paper clips	Old phonograph--for motor
Assorted colored paper	Tin cans--several sizes
Thumb tacks	Scrap wood
Blotters	Sand
Rubber bands	Pebbles
Stapler	Sawdust
Envelopes	Germinating box--glass front
	Animal cages

II. VISUAL AIDS

Visual aids offer valuable materials to the primary teacher. These include motion pictures, filmstrips, maps, charts, models, exhibit cases, living materials such as plants and animals, flannel boards, and pictures. Etten has the following to say about visual aids:

> A great deal has been said about the feasibility of using visual aids in the teaching of elementary school science. Scientific instruction that lacks the use of such aids is incomplete. Audio-visual aids provide concrete experiences in situations where the problem studied may be remote as to time and place, as well as beyond the ability of the child to visualize.
>
> The selection of an aid should depend upon what is to be accomplished. An aid should promote understanding, interest, appreciation, and help develop certain techniques or concepts. It should not exist for

> the mere sake of having something going on in the classroom. Materials are valuable only if they contribute to the achievement of educational purpose. Perhaps the greatest service rendered by the use of visual aids is to be found in the lower elementary grades where textbook comprehension is not developed enough to analyze science concepts via the printed page.[4]

A picture file is always a useful aid in primary work. Pictures of commonly known animals, commonly known plants including trees, natural phenomena such as lightning, floods or volcanic eruptions, and any others that demonstrate something that occurs in our environment are invaluable.

Films are useful only when they can supplement a direct experience or when the direct experience is impossible. The following lists of films, filmstrips and slides are suggestive of those that are available for the use of primary teachers. Others may be found listed in film catalogs which are provided in most schools. The code letters for film companies are found at the end of this section.

Films

The Seasons

Spring is Here--(Library Film) Early signs of spring such as flowers,

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[4]John F. Etten, "Audio-Visual Aids to Science," Grade Teacher, Special Science Section, April, 1957.

frog eggs, woodchucks coming out of hibernation, birds feeding their babies, chicks hatching, elk shedding antlers, new arrivals at the zoo, bear cubs, and a young fawn.

Spring on the Farm--(EBF) 11 minutes, colored. Shows typical spring activities on the farm, discoveries the children make in field and orchard, baby animals, etc.

Summer on the Farm--(EBF) 11 minutes, b&w. Shows how the changing seasons affect plants, animals, farm life and activities.

Autumn on the Farm--(EBF) 11 minutes, b&w. Shows farm activities on the farm in the fall.

Winter on the Farm--(EBF) 11 minutes, colored. Shows farm life in the winter.

When Winter Comes--(Library Film) A quick review of the three preceding seasons, mare's-tail clouds, snowfall, snowflakes greatly magnified, buffaloes, bears, elk, otters, turkeys, hares, and woodchucks.

Play in the Snow--(EBF) Shows the activities of children in the snow, building a snowman, playing games, sliding and skiing. Appropriate clothing, good health habits, and safe play in the snow are depicted.

Weather

Air--(Gateway, 1950) 10 minutes, b&w. The uses, properties, and importance of air to animal life, plant life, industries and commerce.

Air All Around Us--(YAF, 1948) 10 minutes, b&w. Classroom demonstrations of air pressure, contraction and expansion of air, and compression of air.

Blow, Wind, Blow--(Coronet, 1952) 10 minutes, b&w. The story of wind seen through the eyes of Johnny. How wind can turn windmills, knock down trees, help kites to fly.

Clouds Above--(Bailey, 1952) 11 minutes, b&w. Four main types of clouds, absorption of water by air, condensation into rain.

Our Weather--(EBF) Wher weather begins, why it changes, how it is observed and forecast. (Good for third grade, can be used for first and second with proper background of discussion. Should be previewed.)

What Makes Rain--(YAF) To introduce the young child to the concepts of evaporation and condensation as they apply to the water cycle.

Machines

Airplane Trip--(EBF) 11 minutes, b&w. A trip on an airplane from Los Angeles to Salt Lake City. Plane instruments and operation are simply explained.

Boats--(EBF) 11 minutes, b&w. Nancy and Roger on a Hudson River boat. Shows different types of boats and shows how the machines make the boats go.

Bus Driver--(EBF) The story of a cross-country bus trip by a small boy.

Energy--(Gateway, 1950) 10 minutes, b&w. A boy's muscle, a spring, gasoline engines, air, steam, electricity, and water sources of energy.

Electricity--(Gateway, 1952) 10 minutes, b&w. Operation of an electric train, how power is generated, transmitted and used.

Machines Do Work--(YAF) Introduces the four basic types of machines and points out how their everyday application helps us do our work.

Machines--(Gateway) 8 minutes, b&w. Examples of simple machines.

Passenger Train--(EBF) A trip on a diesel powered passenger train.

Pirro and the Alarm Clock--(Official Films) 10 minutes, b&w. A Puppet shows how to tell time.

Pirro and the Lamp--(Official) 10 minutes, b&w. He learns about light for reading, the switch, bulb and the purpose of the cord in between.

Pirro and the Scale--(Official) 10 minutes, b&w. Demonstrates the principle of weight and balance with a see-saw.

Pirro and the Telephone--(Official) 10 minutes, b&w. He learns how to dial a telephone and make a call.

Sailing a Toy Boat--(EBF, 1953) 5 minutes, colored. Frank learns to set a rudder on a toy boat so it will return from out on a pond.

Simple Machines--Levers--(Coronet) 6 minutes, b&w or colored. How levers work and different forms of levers.

Simple Machines--Pulleys--(Coronet) 6 minutes, b&w or colored. Explains the principle of operating a pulley.

Plants

Gardening--(EBF) 10 minutes, b&w. A child's garden raising project from selection of seeds to the raising of crops.

Growth of Flowers--(Coronet) A recording of the growth and life history of flowers.

Plant Growth--(EBF) Presents the life history of the pea plant from sprouting seed to ripened seed dispersal.

What is Soil?--(Films) Show that while soil is essential to all living things, they, in turn, after their life is done contribute to the formation of the soil.

Water Animals

Beach and Sea Animals--(EBF) 10 minutes, b&w. Starfish, sea urchins, crabs, cuttlefish, octopus, crayfish, snail, lobster, shrimp, scallop and sea cucumber.

Frog--(EBF) 10 minutes, b&w. The entire life cycle of frog.

No Vacancy--(Kenneth Holst) 3 minutes, b&w. A humorous account of hermit crabs, their nature, and how they survive.

Pond Life--(EBF, 1950) 11 minutes, b&w. Representative animals at various water levels. Dependence of animals upon one another. Principle of survival that helps keep pond life in balance.

We Visit the Seashore--(YAF) 10 minutes, b&w. The beach, fishing, coast guard, making sand castles, gathering sea shells.

Birds

Birds of North America--I, II, and III (EBF) 15 minutes each, colored.

Friends of the Air--(Bell and Howell) colored, 10 minutes. Our bird visitors, common birds we might see.

Robin Redbreast--(EBF) 10 minutes, b&w. The story of a robin family from the time the mother and father build the nest until the young are able to care for themselves.

Animals

Adventures of Bunny Rabbit--(EBF) Shows the habits and characteristics of rabbits in their natural environment.

Animal Babies--(Am. Film Registry) Baby birds and baby animals that would be of interest to young children.

Animals of the Zoo--(EBF) Shows many zoo animals and the kind of food they eat.

Baby Animals--(YAF) Introduces and explains such concepts as the degree and nature of parental care among animals; relationships between the number of young and the amount of parental care and chances of survival.

Baby Bear--(Bray) A baby bear is found starving in the Oregon woods. It is taken home and brought up as a pet by the children whose other pet is a fox terrier.

Bear and Its Relatives--(Coronet) Shots of the raccoon, panda, kodiak bear, grizzly, polar, and American black bear.

Black Bear Twins--(EBF) Shows the experiences of a family of campers while watching the antics of a couple of hungry and mischievous twin bears.

Care of Pets--(EBF) Natural scenes of pets and instructions concerning proper care of them.

Circus Animals--(Bailey, 1947) 11 minutes, b&w. Activities of circus animals and how they travel.

Common Animals of the Woods--(EBF) 10 minutes, b&w. Shows several common animals in their natural habitat.

Day at the Zoo--(N. Y. Zool.) John Kiernan narrates this film trip through the Bronx Zoo in New York City.

Elephants--(EBF) Shows the habits of Mumbo, the circus performer. Taken at a farm where circus animals are trained.

Farm Animals--(EBF) The care and activities of farm animals. Natural sounds are included.

Farmyard Babies--(Coronet, 1952) 10 minutes, b&w. Self-explanatory.

Goats--(EBF) The life of goats and kids on a goat farm. Shows milking and care of goats.

Gray Squirrel--(EBF) Shows the animals from the age of one week until they are full grown.

Grey Owl's Little Brothers--(NFB) 10 minutes, b&w. Canadian woodsman and a beaver construct a winter home.

Grey Owl's Neighbors--(NFB) Available from Univ. of Wash. Similar to previous--more animals.

Grey Owl's Strange Guests--(NFB) Univ. of Wash. More of the life of the owl and forest creatures.

How Nature Protects Animals--(EBF) 10 minutes, b&w. Ways various animals are provided with devices to conceal themselves.

Insect Zoo--(EBF, 1950) 10 minutes, colored. Ted's and Susan's zoo consisted of insects. Characteristics of insects in general.

Kangaroos--(EBF, 1953) 10 minutes, b&w. Habits and behavior of the animals in Australia.

Kitty Cleans Up--(YAF) 10 minutes, b&w. Getting the kitten ready for a pet show. Emphasizes cleanliness.

Let's Look at Animals--(YAF) This film uses the device of animation. Shows how animals vary in size, move in different ways and have different kinds of covering.

Life in the Aquarium--(YAF) Shows how to set up and stock a classroom aquarium and explains how fish, tadpoles and snails live in water.

Live Teddy Bears--(EBF, 1947) 11 minutes, b&w. The life of the koala in its natural habitat.

Mother Duck's Surprise--(YAF, 1950) 11 minutes, b&w. Mother Duck disappears from the farmyard. Father Duck looks for her, finds her on a nest hatching ducklings.

Nature's Engineers--(Wild Life Films, 1951) 10 minutes, color. Life of the beaver, building homes and dams, care of young and protection from enemies.

Our Animal Neighbors--(Coronet) Shows ten common small animals, bat, rabbit, squirrel, chipmunk, gopher, deer and meadow mice, shrew, mole and fox squirrel.

Poultry on the Farm--(EBF) Adult and young chickens, ducks, geese and turkeys. Sounds and activities.

Raccoon--(EBF) 5 minutes, b&w. Life and habitat.

San Diego Zoo--(Santa Fe) One of the world's greatest collections of birds, animals and reptiles.

Shep, the Farm Dog--(EBF) Shows the duties of a Collie dog on the farm.

Snakes Can Be Interesting--(YAF) 10 minutes, b&w. Snakes of various types, life cycle, habits, economic importance to man.

Snapping Turtle--(EBF, 1940) 11 minutes, b&w. Life, habitat, eggs, hatching, hibernation.

Spotty, The Story of a Fawn--(Coronet, 1950) 10 minutes, b&w. Adventures of a fawn in the north woods.

Squeak the Squirrel--(Churchill-Wexler) How the animal can find food that is hidden. Value of scientific method for investigating animal behavior.

Three Little Bruins in the Woods--(Castle) Unusual shots of baby bears and other wild animals of the woods.

Three Little Kittens--(EBF) The farmer's wife found them in the barn with their mother. Shows characteristics of cats.

Zoo--(EBF) 10 minutes, colored. Wild animals living in a zoo which is unique because of the natural habitat of the cages.

Zoo Babies--(Coronet) 10 minutes, colored. Physical characteristics and habits of monkeys, kudus, gnus, lions, peacocks, alligators and bears. Relationship of the babies to their parents.

Miscellaneous

Big Little Things--(Foster) Things are shown as they are and then shown through a magnifying glass: toothbrush, soap bubbles, comb, pencil, sand, soap.

Fire--(Gateway, 1952) 10 minutes, b&w. At a family barbecue children learn what is needed to make a fire, what fire does for man, how controlled.

Magnetism--(Coronet) Shows what magnetism is, types of magnets, uses of magnets and electro-magnets.

Magnets--(YAF) Shows the nature and behavior of magnets.

Water--(Gateway, 1950) 10 minutes, b&w. Explanation of three forms of water: solid, liquid, and gas.

Slides and Filmstrips

Row-Peterson Textfilms in Science: Color filmstrips.

These are designed to be used with the Unitexts on the same subject. For primary use there must be some preliminary discussion and readiness for the films. Film topics: You and the Universe, The Sun and Its Family, Earth's Nearest Neighbor, Pictures in the Sky, Simple Machines, Air About Us, Telling Trees Apart, Clouds, Rain and Snow, Insects, Flowers, Fruits, Seeds, Living Things, Seeds and Seed Travelers.

Simple Machines--(YAF) Color filmstrip. Description and use of simple machines.

Fundamentals of Machines--(Keyview) 42 slides.

Animals of the Woodland Park Zoo--50 color slides. Order through the University of Washington Visual Aids Department, Seattle, Washington.

Singer Filmstrips--Color. Weather, Plants, and Animals.

Primary Science--(EBF) Series of six in color.

Key to Film Code

EBF -- Encyclopedia Britannica Films, Wilmette, Illinois

YAF -- Young America Films, New York 17, New York

Coronet -- Coronet Films, Chicago, Illinois

Keyview -- Keystone View Company, Meadville, Pennsylvania

Bailey -- Bailey Films, Hollywood 8, California

Gateway -- Gateway Productions, San Francisco, California

Churchill-Wexler Film Productions, Los Angeles, California

Castle -- Castle Films, Park Avenue, New York

Bray -- Bray Studios, Seventh Avenue, New York

Library -- Library Films, West Forty-fifth Street, New York

Bell and Howell -- Bell and Howell Company, Chicago, Illinois

Row Peterson Publishing Company, Evanston, Illinois

The L. W. Singer Company, Syracuse, New York

III. PRINTED MATERIALS

Firsthand observation and experiences are the most appropriate sources of information for primary science teaching. However, printed materials are necessary for reference when trying to find the answers to the questions of children. Books and magazines with science content are most fascinating to young children. Branley asserts,

> There are numerous good science books of substance geared to the middle and upper grades but there is a paucity of science literature for the primary grades. Fortunately, such material is now appearing.[7]

It is unwise for a teacher to choose books from a list without first having an opportunity to examine them. A careful perusal before purchase would enable her to choose materials that would better fit her needs. Schneider gives some suggestions to follow when selecting science books for children. He asks, "Does the book make sense to you; is the book accurate in the light of the child's maturity and experience; is it attractive; and is it right for the age level of the reader?"[8] Using these principles as a guide

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[7]Franklyn M. Branley, "Science in Childhood Education" *The Grade Teacher*, Special Science Section, April, 1957.

[8]Herman Schneider, "Science Books and You," *The Grade Teacher*, Special Science Section, April, 1957.

the following books were selected as a sample list which would be suitable for children in the primary age group. Some books for the teacher's reference and background are also listed as well as other printed materials.

Books For Children

Allen, Gertrude E. Everyday Birds. Boston: Houghton Mifflin Company, 1943.

Bertail, Inez. Summer and Winter. New York: Veritas, 1946.

Blough, Glenn O., and Bertha M. Parker. Doing Work. Evanston, Illinois, Row Peterson Company, 1943.

__________. Wait for the Sunshine. New York: McGraw Hill Book Company, 1954.

__________. After the Sun Goes Down. New York: Whittlesey, 1956.

Branley, Franklyn M., and Eleanor K. Vaughan. Mickey's Magnet. New York: The Crowell Company, 1956.

Buff, Mary and Conrad. Dash and Dart. New York: The Viking Press, 1942.

Colmont, Marie. Along the Coast. New York: Harper Brothers, 1949.

D'Aulaire, Ingri M. and Edgar P. Animals Everywhere. Garden City, New York: Doubleday, Doran and Company, 1954.

Downer, Mary Louise. The Flower. New York: W. R. Scott, 1955.

Eberle, Irmengarde. Hop, Skip, and Fly. New York: Holiday House, 1937.

Erickson, Phoebe. The True Book of Small Animals of the Pond. Chicago: Children's Press, 1953.

Flack, Marjorie. Topsy. New York: Doubleday, Doran, 1940.

Garelick, May. What's Inside? New York: W. R. Scott, 1955.

Green, Mary McBurney. Everybody Has a House. New York: W. R. Scott, 1944.

Harris, Norma and Louise. Hummer and Buzz. Boston: Little, Brown and Company, 1956.

Hoke, John. The First Book of Snakes. New York: Watts, 1953.

Hogner, Dorothy Childs. Frogs and Polliwogs. New York: The Crowell Company, 1956.

Humphries, Dona. Zoo Book. New York: The Holt Company, 1947.

Janice. It's Spring, It's Spring. New York: Lothrop, Lee and Shepherd Company, 1956.

Kane, Henry B. The Alphabet of Birds, Bugs and Beasts. Boston: Houghton Mifflin Company, 1938.

__________. The Tale of the Bullfrog. New York: Alfred A. Knopf, 1941.

King, Eleanor and Wellmer Pessels. Garden Creatures. New York: Harper Brothers, 1939.

Lathrop, Dorothy P. Who Goes There? New York: The Macmillan Company, 1935.

Lenski, Lois. The Little Train. New York: Oxford University Press, 1940.

Lewellen, John. Tommy Learns to Fly. New York: The Crowell Company, 1956.

__________. Toys At Work. Chicago: The Children's Press, 1956.

__________. <u>Honeybees</u>. Chicago: Children's Press, 1956.

__________. <u>Moon, Sun, and Stars</u>. Chicago: Children's Press, 1955.

Parker, Bertha M. <u>Seeds and Seed Travelers</u>. New York: Harper Brothers, 1941.

Petersham, Maud and Miska. <u>The Story Book of Transportation</u>. Philadelphia: John C. Winston Company, 1933.

Phillips, Mary G. <u>Things That Go</u>. Chicago: Rand McNally, 1941.

Podendorf, Illa. <u>The True Book of Seasons</u>. Chicago: The Children's Press, 1955.

__________. <u>Insects; Trees; Pebbles and Shells; Animals of the Seashore; Animal Babies; Weeds and Wildflowers</u>. Chicago: Children's Press.

__________. <u>Science Experiments</u>. Chicago: Children's Press, 1954.

Pease, Josephine. <u>It Seems Like Magic</u>. New York: Rand McNally, 1946.

Rey, Hans A. <u>Anybody At Home?</u> Boston: Houghton Mifflin, 1942.

Schlein, Miriam. <u>It's About Time</u>. New York: Young Scott Books, 1955.

Schloat, G. Warren Jr. <u>The Magic of Water</u>. New York: Chas. Scribner's Sons, 1955.

Schneider, Herman and Nina. <u>How Big is Big? From Stars to Atoms</u>. New York: W. R. Scott, 1950.

Selsam, Millicent. <u>Egg to Chick</u>. New York: International, 1946.

Simon, Norma. <u>A Tree for Me</u>. New York: Lippincott, 1956.

Sears, Paul M. <u>Firefly</u>. New York: Holiday House, 1956.

Webber, Irma E. Up Above and Down Below. New York: W. R. Scott, 1943.

____________. Anywhere in the World. New York: W. R. Scott, 1947.

Webb, Addison. Birds In Their Homes. Garden City: Garden City Publishing Company, 1947.

Wygant, Elsie A. Wheel, Sail, and Wing. Chicago: Follett Publishing Company, 1937.

Ylla. Big and Little. New York: Chas. Scribner's Sons, 1938.

Zim, Herbert S. What's Inside of Me? New York: Wm. Morrow and Company, 1946.

____________. Lightning and Thunder. New York: Morrow, 1946.

____________. The Great Whales. New York: Morrow, 1951.

Books for Teachers

Baer, Marian E. Without Fire. New York: Rinehart, 1946. A book of experiments. 39 pages.

Blackwood, Paul E. Science Experiment Books for Children. U. S. Office of Education, Washington, D. C.

Blough, Glenn O., and Paul S. Blackwood, Teaching Elementary Science. Washington, D. C.: U. S. Office of Education. A bulletin.

Blough, Glenn O. Elementary Science Series. Washington, D. C.: U. S. Printing Office, 1947.

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

Craig, Gerald S. Science for the Elementary School Teacher. Chicago: Ginn and Company, 1949.

Garrison, Charlotte G. Science Experiences for Little Children. New York: Chas. Scribner's Sons, 1939.

Podendorf, Illa. The True Book of Science Experiments. Chicago: Children's Press, 1954.

Schneider, Herman and Nina. Science Fun with Milk Cartons. New York: McGraw Hill, 1953.

____________. Let's Find Out. New York: W. R. Scott, 1946.

Vessel and Wong. How to Stimulate Your Science Program. San Francisco: Fearon Publishers, 1955.

Bulletin. This is Science. Washington, D. C.: Association for Childhood Education, 1945.

Forty-sixth Yearbook. Part I. National Society for the Study of Education. Chicago: University of Chicago Press, 1947.

Education Brief Number 12, Experimenting in Elementary Science. Washington, D. C.: U. S. Office of Education, Elementary Division.

Miscellaneous

American Museum of Natural History, New York. Post Card Pictures of Animals. Free.

National Geographic Society, Washington, D. C. Reprints in color of animals, insects, and plants.

National Audubon Society, Fifth Avenue, New York. Audubon Magazine; Nature study materials.

United States Department of Agriculture, Washington, D. C. Publications on many topics which may be of interest.

Office of Education, Elementary Division, Washington, D. C. Education Briefs. Bibliography of selected references.

Golden Nature Guides to Trees, Birds, Flowers, Stars, Weather, Fishes, Insects, Reptiles, Seashores, Mammals. New York: Simon and Schuster.

Nature Magazine. New York 71, New York.

Life Magazine, New York. Frequent science articles with excellent pictures.

CHAPTER VI

SUGGESTED ACTIVITIES

The term experiment may have a very special and restricted meaning among scientists. But among children it is used to describe any activity in which they manipulate materials and watch to see what happens. An experiment is setting up a procedure to find out something about some materials or forces and following through to see what results. It enables children to obtain by direct observation some desired information about things in their natural environment.

In order for experiments to yield valid and meaningful results they need to be carefully planned. In the Education Brief Number twelve, we find these suggestions given: Help children state what they are trying to find out; encourage them to form a hypothesis as to the outcome; plan the procedures to be followed, materials needed, observations to be made and the records that should be kept; keep the experiment as simple as possible; urge children to discuss their observations; caution them against making conclusions about cause and effect; and discuss the relationship of the results to other things which are important to the children.[1]

It would be impossible in the scope of this paper to give an exhaustive list of experiments for primary age children. A few will be cited as examples of the type of activities that are suitable. A third grade experimented to see the effect of heat on the growth of seeds. By placing jars of planted seeds on the radiator, on the floor, and in the refrigerator, they set up a controlled experiment whereby they might find the answer to their question. A tumbler put over a burning candle proved that fire cannot burn without air. So they decided that a blanket was more effective to put out a small home fire than water. A simple fire extinguisher was demonstrated by putting some vinegar on soda in a glass. When effervescing ceased the glass was tipped and a lighted candle inserted. When it went out the children could see that something other than air was present.

There are many questions the children ask that do not allow for experimentation but can be answered by observation and demonstration. The following activities are samples of those

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[1]Education Briefs, Number 12, Experimenting in Elementary Science, U. S. Department of Health, Education and Welfare, U. S. Office of Education, Washington 25, D. C., 1954.

carried on in primary rooms in one building during one year:

Wind can push--observe a sailboat in a puddle on a windy day, or blow a boat across a sink filled with water, watch a pinwheel or a windmill in the wind, or clothes blowing on a line.

Air contains water--put water into two metal cans. Place ice cubes in one of them and watch the water collect on the colder one.

Air takes up space--Invert a glass in a pan of water. The water will rise only a short distance.

Air exerts pressure--Fill a tumbler with water. Place a cardboard over the top. Turn it over quickly and the water will not come out. Use a medicine dropper--the air in the bulb forces the liquid out. Empty the fish bowl with a rubber tube. The air pushing on the water in the tank forces the water out of the tube.

Air expands when heated--Place a small balloon on the neck of a small bottle. Set the bottle in a pan of water. Heat the water and the balloon will inflate.

There is air in soil--Pour water on soil and watch the bubbles come up. Observe angleworms coming to the surface for air when rain soaks the soil.

Evaporation--Watch water boil from a pan on a hot plate. Watch sidewalks dry after a rain. Water must be added to the aquarium. Paintings and clay objects dry.

When water freezes it expands--Seal a lid on a jar level full of water. Place outside in freezing temperature. The jar will break and prove the point.

What does snow consist of? Carefully fill a jar with snow, do not pack it down. Allow it to melt. Snow consists of water, air, and dirt. They ate no more snow.

Thermometer readings--Outside temperatures were recorded carefully during the year. A comparison of the high and low for each month was made as well as comparing the months. A wooden model of a thermometer with a red tape "mercury" was used so the children could set it each day to correspond with the one outdoors.

Tools make work easier--Rolling books on pencils to show the principle of the wheel; pushing objects up a ramp; opening a can of paint with a screw driver or other lever to demonstrate that principle.

Caterpillars were caught in the fall and put in jars with a branch. They formed cocoons and emerged as butterflies or moths in the spring.

Keeping an aquarium with various kinds of fish, snails, and water plants, and a terrarium with woodland plants and insects.

Growing bulbs in the winter. Rooting slips of plants for gifts to take home. Watching pussywillow branches flower and form roots for planting.

Wasp's nest brought in from the mountains. Led to a study of papermaking in the third grade group.

Blue-tailed skink brought in and kept for three months in a jar of sand. Discovered why it could not live in captivity in the winter. It must have live insects.

Some natural phenomena can be observed most effectually by the means of field trips. The resources of the community which can be used for science activities depends upon local factors. The teacher should be aware of the possibilities in her own community. Suggested areas for plant and animal life include the woods, meadows, swamps, streams, sky mountains or seashore. Within the city or limited environment are parks, greenhouses, empty lots, backyards, pet shops, museums, and roadsides. Farms and dairies are usually close enough for field trips also.

For other areas of science, various industries such as fuels and heating, communication, transportation and manufacturing may be utilized. The facilities in the school building may be used to great advantage. The circulation of steam in the pipes, the water system, and the electric lights are convenient object lessons for many scientific principles.

The resource of people can be very important. Professional and amateur scientists are often willing to come to school to share their knowledge. Collectors of rocks, minerals, shells or plants are usually glad to explain the objects they have collected. Hobbyists who raise fish, birds or plants are also effective resource people. The fireman, the telephone repair man and the fruit warehouse foreman are typical of specialists who can liven the science program. An orchardist who had been to Hawaii brought films of the Islands, including an actual eruption of Mauna Loa in color, and gave a travel talk. The explanation of the volcanic eruption was of great scientific interest even to first graders. People are too important as resources to be overlooked.

A science corner in the school room, even if it is just a shelf or a small table, helps to keep interest high. Collections made by the children are more valuable than any other at this age because of the firsthand interest involved. The science corner gives them a place to display the objects they bring in and a place to set up their experiments for observation. Children bring plants, animals and insects to share and observe. Worms and caterpillars arrive in jars. Rocks and minerals are added to the collection as well as shells and seeds of all kinds. A science corner is almost indispensable.

The activities that have been mentioned are suggestive of the possibilities in the area of scientific exploration even on the most elementary level. If primary children are given materials, encouragement, and a teacher who shares their enthusiasm for "finding out," science will emerge from the realm of the magic and unreal into real discovery and learning. In the words of Burnett:

> The world needs to be learned. The child wants to learn it. If we recognize the child for what he is and the world for its deeper meanings to the mature mind we will remove the artificial barriers so common in many classrooms and allow learning to proceed.[2]

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[2]Will R. Burnett, Teaching Science in the Elementary School (New York: Rinehart and Company, 1953), p. 21.

CHAPTER VII

EVALUATION IN THE PRIMARY SCIENCE PROGRAM

Evaluation in a program of science in the primary grades is a continuous process. Blough says,

> There is still much to learn about how to evaluate the contribution of science, as well as of other subjects, to the general growth and development of children. It is desirable for children to help evaluate their own work. As we work more with children in carrying on evaluation, our knowledge of evaluation procedures will increase.[1]

Ruth Strickland seemed to be in agreement when she wrote,

> Evaluating is not the final step of a process but a part of the process from beginning to end. Through guidance in evaluation children learn to take note of strengths as well as weaknesses.[2]

The measurable outcomes of science as listed by Greene include knowledges, skills, concepts and understandings, applications, attitudes and interests. He explains that most tests tend to over-emphasize information and knowledge as the goal of study. Skill tests should be of performance rather than paper and pencil tests and should, as far as possible, measure the relational aspects of

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[1]Glenn O. Blough and Paul E. Blackwood, Science Teaching in Small Town and Rural Schools. (Washington, D. C.: U. S. Office of Education, 1955).

[2]Ruth Strickland, The Language Arts in the Elementary School (Boston: D. C. Heath and Company, 1951).

science. He also maintains that attitudes and intents have not as yet been defined clearly so cannot be adequately evaluated.[3] Blough further states that little of significance has been accomplished in measuring growth in ability to use the scientific method of problem solving, in development of scientific attitudes, or in appreciation of and interest in the natural environment.[4]

Observation of pupils as they participate in class experiences and activities, and as they react in problem situations seems to be the best way of evaluating growth in some of the more intangible qualities which can be developed through the teaching of science. The knowledge a child has acquired may be measured a little more concretely. Little has been done in this area for the primary grades. Greene states that no standardized primary tests are known and but few have been developed for the upper elementary grades.[5]

With these facts in mind, the writer has devised six tests which were given to approximately three hundred forty children in the

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[3]Greene, Gerberich and Jorgensen, Measurement and Evaluation in the Elementary School (New York: Longmans Green and Company, 1953).

[4]Glenn O. Blough and Paul E. Blackwood, Teaching Elementary Science (Washington, D. C.: U. S. Office of Education, 1948).

[5]Greene, op. cit., p. 511.

primary grade group in an attempt to discover the possibility of measuring some of the knowledges and understandings possessed by children of this age group. The tests are exploratory in nature. They are designed to check the extent of the information the child has in three areas of science which are commonly developed in the primary grades. These areas include Seasons, Air and Water, and Tools and Machines.

As a preface to the preparation of these tests science textbooks for the primary grades published by several publishing companies were examined. These three areas were included in every text for every grade in a more or less comprehensive way. The Science Curriculum Outline prepared by the Wenatchee Science Curriculum Committee included these areas as important ones for this age group. With this assurance that the topics chosen were suitable for primary use, the tests were prepared. They are designed to be as nearly as possible non-reading tests so that science learnings are tested rather than reading skills.

The cooperation of twelve teachers, four for each of grades one, two, and three, was secured for the administering of the tests. They were instructed to follow the directions which accompanied the tests and to fill out the questionnaire which was included for each area.

Each teacher checked her own tests for her own information. The writer then rechecked all tests to be certain that they were all scored in the same way.

The tests were administered during the last quarter of the school year, so that children in the first grade had learned the words "yes" and "no" and had become familiar with testing techniques. The sample tests shown on the following pages are self-explanatory. Figure 3 shows the instruction sheet for the second test for each topic tested. Figure 5 shows the child's work sheet for the second test for each topic. The questionnaire as illustrated by Figure 12 was completed by the teacher for each of the areas tested.

The results of the tests are shown in table form in Figure 13. Figure 14 shows the results of the first part of the questionnaire for teachers and the remainder of it is discussed in the paragraphs following the figure.

SEASONS TEST I

Provide each child with a picture test sheet and a pencil. Instruct them to draw a line under the one you tell about. Draw a line under:

In row 1 -- the number that tells how many seasons there are.

In row 2 -- the trees we could see in winter.

In row 3 -- the two children that are dressed for summer.

In row 4 -- each animal that sleeps all winter.

In row 5 -- the ones you can see in the fall.

In row 6 -- the ones we can see in the spring.

Key

Row 1 -- 4

Row 2 -- first and third ones.

Row 3 -- first and last ones.

Row 4 -- bear and turtle.

Row 5 -- birds flying; leaves falling.

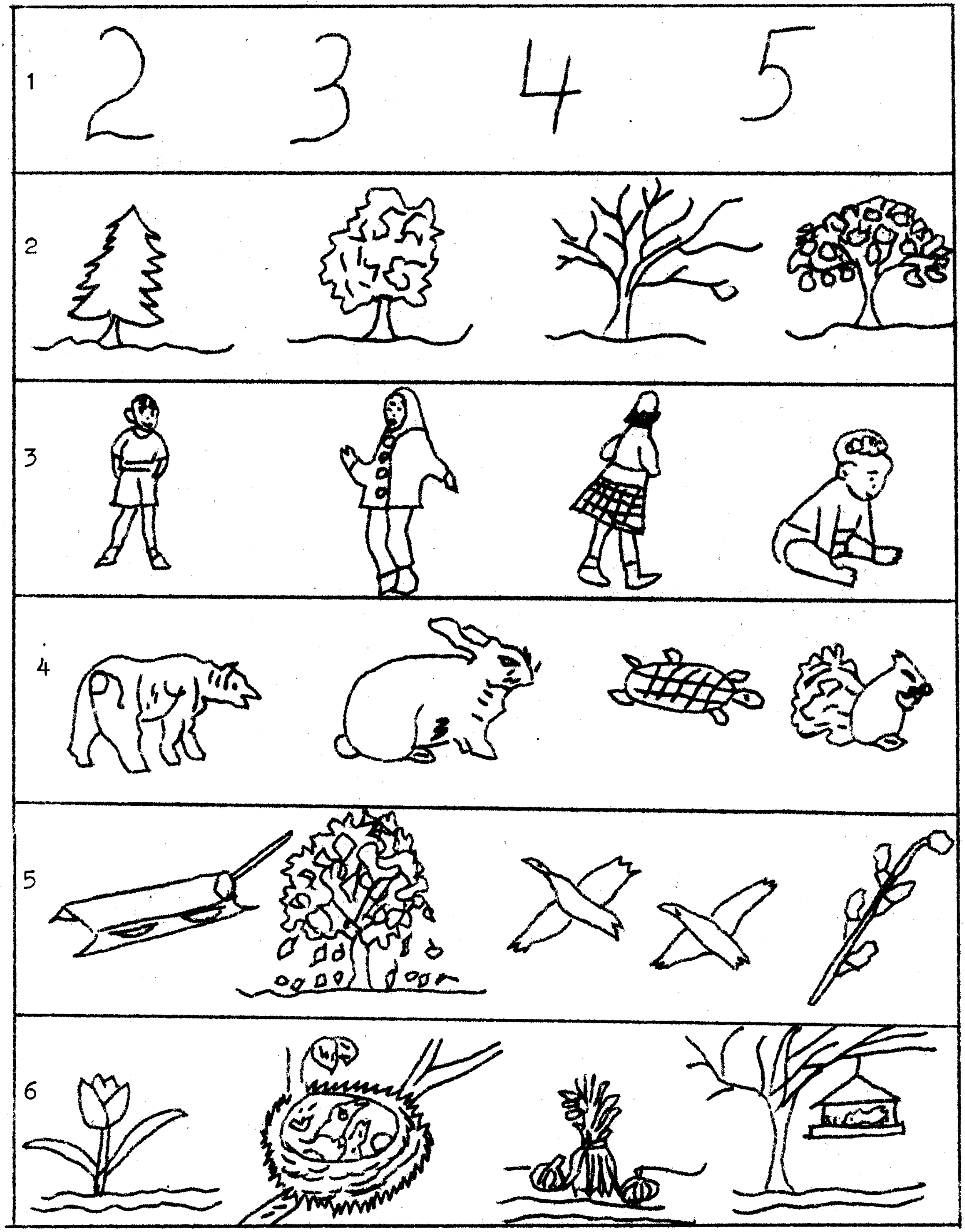
Row 6 -- tulips; bird's nest.

The highest possible score is eleven. Count the number right.

Grade level ____________ Number of children tested ___________

Range of scores __________________ Median score _______________

Figure 1



Name ____________________ Number right __________

Figure 2

TEST II

Directions: Provide each child with a 'yes or no' test sheet, a marker to help him keep his place (especially important for grade one) and a pencil. Direct the children to write their names in the place provided. They are then ready to begin the test. Say to them, "If the sentence or question I read to you is true draw a line under the yes. If it is not true draw a line under the no. When you have finished, move the marker down to the next number."

Read the sentences slowly enough so that all may have time to think about them. No time limit has been set since understandings and not speed are being tested. The highest possible score is twenty. Count the number that are right.

Grade level ____________. Number of children tested____________.

Range of scores__________________. Median score________________.

Figure 3

SEASONS TEST II

Questions to be read by the teacher:	Key
1. Does the sun warm things?	Yes
2. Do we wear warmer clothing in summer than we do in winter?	No
3. Are summer days longer than winter days?	Yes
4. Do some animals have to find food in the snow?	Yes
5. Do all plants die in the winter?	No
6. Do all birds go to a warm place in the winter?	No
7. Does water freeze when it gets very cold?	Yes
8. Do we plant seeds in the Spring?	Yes
9. Do all trees lose their leaves in winter?	No
10. Do some animals hibernate in winter?	Yes
11. Is it dark when you go to bed in winter?	Yes
12. Does the sun come up before you wake up in summer?	Yes
13. Do plants grow outdoors in the winter?	No
14. Is it warmer in summer because the sun shines longer?	Yes
15. Do people and animals have to get ready for winter?	Yes
16. Is winter a good time for baby animals?	No
17. Are most baby animals born in the Spring?	Yes
18. Is air warmer in summer and colder in the winter?	Yes
19. Do we wear less clothing in the summer because the air is warmer?	Yes
20. Does the farmer raise food for people and animals in the spring and summer?	Yes

Figure 4

Test II

1.	Yes	No	11.	Yes	No
2.	Yes	No	12.	Yes	No
3.	Yes	No	13.	Yes	No
4.	Yes	No	14.	Yes	No
5.	Yes	No	15.	Yes	No
6.	Yes	No	16.	Yes	No
7.	Yes	No	17.	Yes	No
8.	Yes	No	18.	Yes	No
9.	Yes	No	19.	Yes	No
10.	Yes	No	20.	Yes	No

Name ______________________________

Number right ____________________

Figure 5

AIR AND WATER TEST I

Instruct the children to look at the square with the one in it. Put a line under the thing that answers the question. Read the question and allow plenty of time for thought. Move to the square with the two in it. Continue in the same way.

Questions:

1. Which one tells how hot it is?
2. Which one needs air to live?
3. Which one does moving air push?
4. Which one shows water in the air?
5. Which tree shows moving air?
6. Which one would we see when the air is very cold?
7. Which thermometer shows a cold day?
8. In which one is air pushing water?
9. In which one do we see wind making a machine work?
10. Which one shows water going into the air?

Key

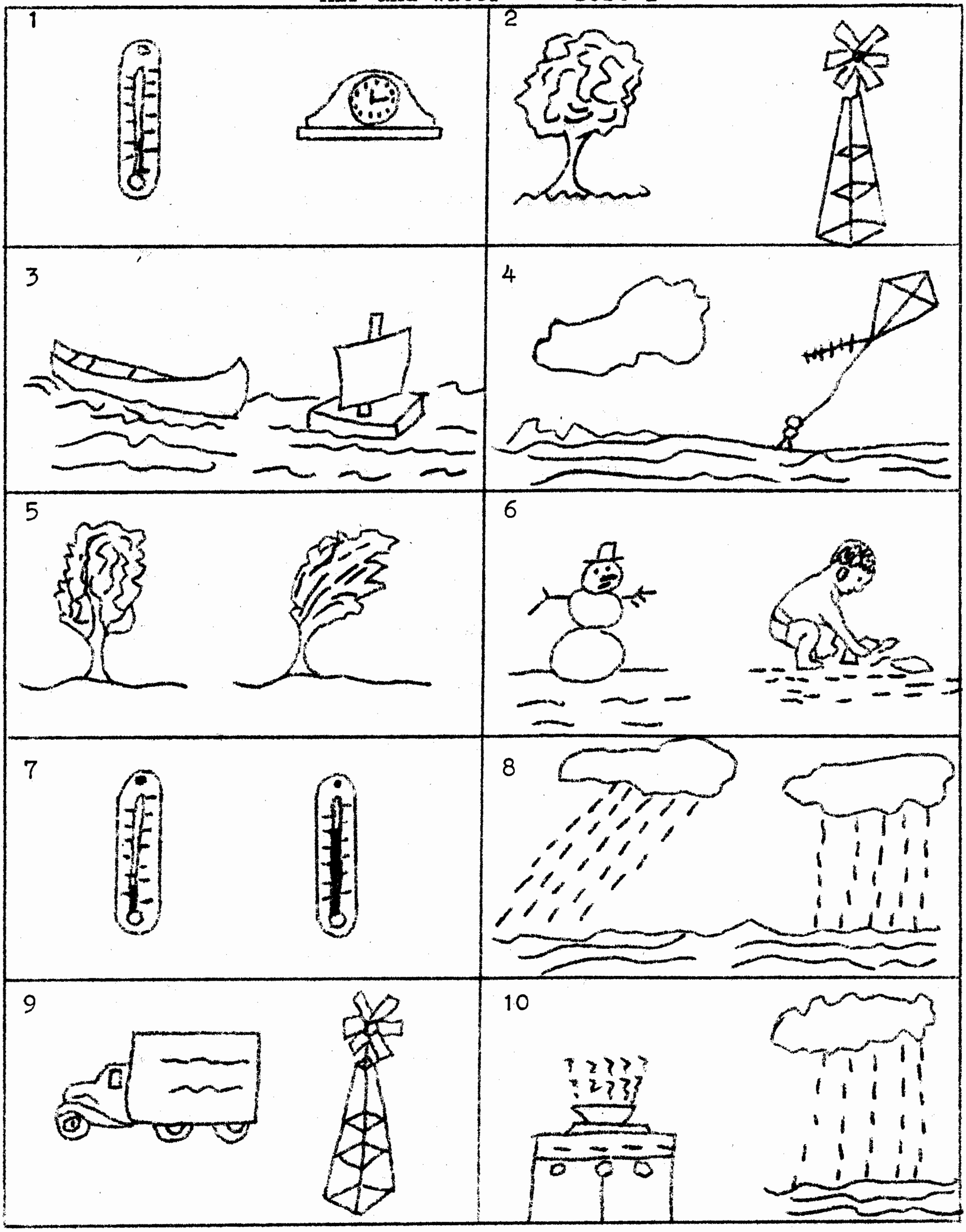
1. thermometer
2. tree
3. sailboat
4. cloud
5. leaning tree
6. snowman
7. the one at twenty degrees
8. slanting rain
9. windmill
10. pan of water

Highest possible score is ten. Count the number right.

Grade level____________. Number of children tested____________.

Range of scores____________. Median score____________..

Figure 6



Name ______________________ Number right ____________

Figure 7

AIR AND WATER TEST II

1.	Air may change from warm to cold	Yes
2.	A thermometer tells how warm or how cold the air is.	Yes
3.	Wind is moving air.	Yes
4.	There is nothing in the air.	No
5.	Air does not weigh anything.	No
6.	When water evaporates it goes into the air.	Yes
7.	Water in warm air will collect on cold objects.	Yes
8.	You can never see water in the air.	No
9.	We can see clouds, rain and snow in the air.	Yes
10.	There is air in a pile of snow.	Yes
11.	Water evaporates faster when it is cold.	No
12.	Fog is a cloud on the ground.	Yes
13.	Air is always clean.	No
14.	Air is all around us everywhere.	Yes
15.	Moving air pushes things.	Yes
16.	Moving air makes some machines work.	Yes
17.	All living things need air and water.	Yes
18.	When the wind blows hard it always rains.	No
19.	Ice is frozen water.	Yes
20.	Snow changes the temperature of the air.	No

Figure 8

TOOLS TEST I

Directions: Tell the children that they are to find the pictures in each row that you tell them about. Beginning with the first:

Row 1 -- Draw a line under the tools father might use.

Row 2 -- Draw a line under the tools mother might use.

Row 3 -- Draw a line under the two tools a farmer would use on the farm.

Row 4 -- Draw a line under the tools we might use in the schoolroom.

Row 5 -- Draw a line under the tools mother would use when making a dress.

Row 6 -- Draw a line under the tools we would use when making a garden.

Key

Row 1 -- hammer, saw

Row 2 -- iron, broom

Row 3 -- tractor, truck

Row 4 -- pencil sharpener, pencil

Row 5 -- scissors, needle

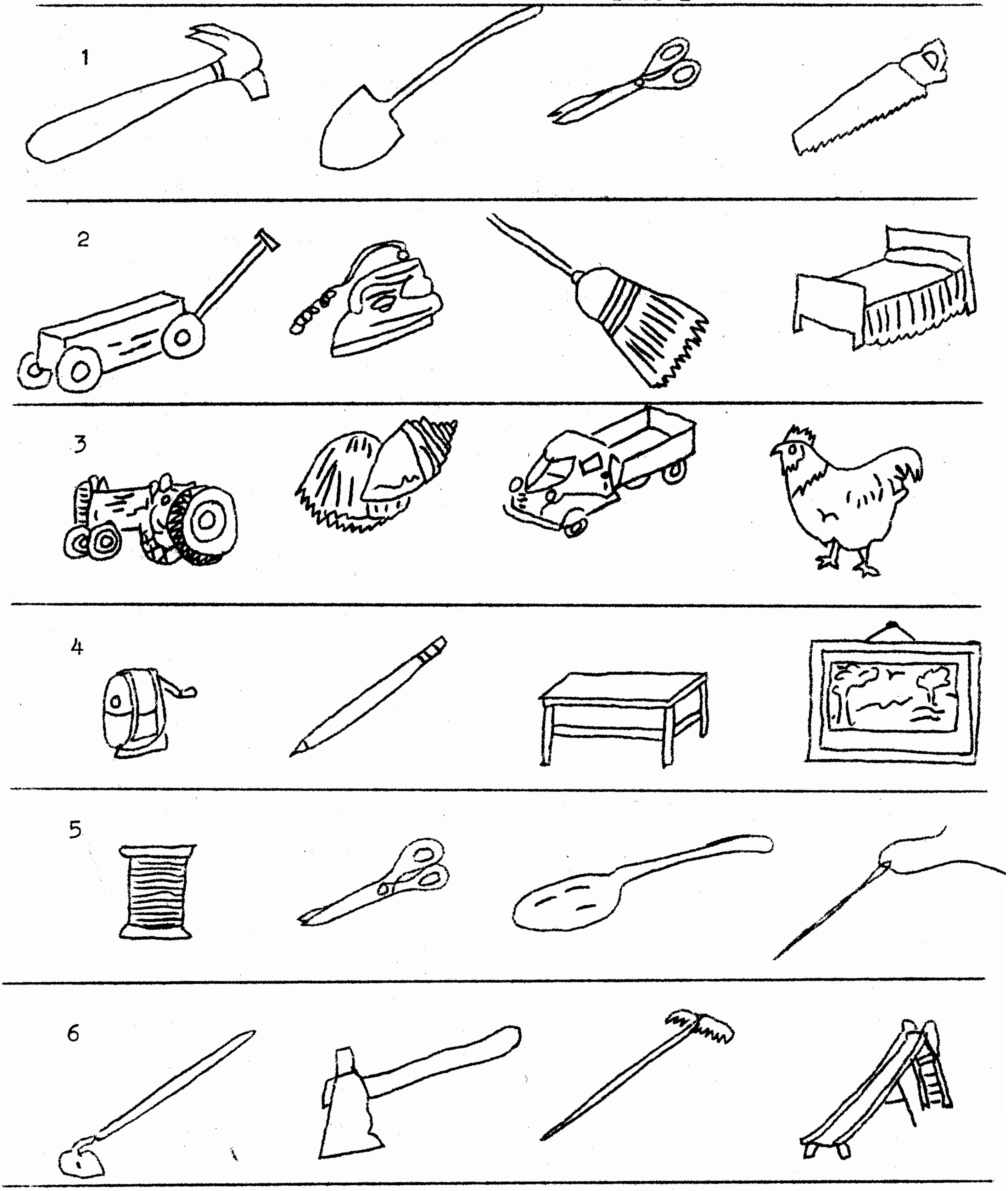
Row 6 -- hoe, rake

Count the number that are right. Highest possible score is 12.

Grade level__________ Number of children tested__________

Range of scores__________ Median score__________

Figure 9



Name ________________ Number right ________

Figure 10

TOOLS AND MACHINES TEST II

Statements to be read by the teacher:

1.	A tool is something we use to make our work easier.	Yes
2.	A machine is a tool.	Yes
3.	It is easier to carry a heavy box than to roll it.	No
4.	Some tools have wheels on them.	Yes
5.	Wheels are used in work and play.	Yes
6.	Some machines have wheels to make them run.	Yes
7.	A sled can be moved easier than a wagon.	No
8.	We use tools to eat with.	Yes
9.	Springs make some things work.	Yes
10.	Electricity makes all kitchen tools work.	No
11.	A can opener is a lever.	Yes
12.	Electricity makes all machines run.	No
13.	Rolling is an easy way to move something.	Yes
14.	To make a bird house, you would use several tools.	Yes
15.	Farmers and doctors use the same kinds of tools.	No
16.	Some wheeled machines are moved by people.	Yes
17.	Engines move some wheeled machines	Yes
18.	We do use tools in the schoolroom.	Yes
19.	All people use the same kind of tools.	No
20.	It is easier to go on wheels than it is to walk.	Yes

Figure 11

To the Teacher: Please complete this sheet by putting an x in the proper blank or blanks.

1. Has this unit been taught this year? Yes_______ No_________

2. If so, has the material been presented formally_________ or incidentally?__________

3. Did you use: one text book_______, several supplementary textbooks__________, library books_________, all three_________?

4. Was the study introduced by the teacher________or a child_______?

5. What films, if any, were used?

6. What experiments or demonstrations were used? Describe briefly.

7. Were any field trips included in the study? Yes______ No________

   If the answer is "yes," describe briefly.

8. What other aids were used? List briefly.

9. In your opinion, are the instructions for the tests stated clearly enough? Yes________ No________

Figure 12

Figure 13

	Grade 1				Grade 2				Grade 3			
<u>Air and Water</u>												
Test I												
Perfect score 10												
Range of scores	5-10	8-10	7-10	8-10	7-10	6-10	8-10	8-10	7-10	7-10	7-10	9-10
Median score	9	10	9	9	9	10	10	10	9	10	10	10
Test II												
Perfect score 20												
Range of scores	9-19	12-17	11-17	9-18	11-18	12-19	12-20	13-18	11-19	11-18	9-20	13-19
Median score	14	15	15	15	16	16	16	16	16	16	16	17
<u>Seasons</u>												
Test I												
Perfect score 11												
Range of scores	4-10	5-9	6-11	3-11	6-11	8-11	5-11	6-11	0-11	7-11	6-11	6-11
Median score	8	8	9	9	10	10	10	9	10	10	9	9
Test II												
Perfect score 20												
Range of scores	10-20	15-20	14-19	14-20	15-20	14-20	14-20	15-20	9-20	14-20	13-20	16-20
Median score	15	17	17	18	17	19	18	19	18	19	19	19
<u>Tools and Machines</u>												
Test I												
Perfect score 12												
Range of scores	7-12	10-12	10-12	10-12	10-12	11-12	10-12	10-12	11-12	10-12	10-12	11-12
Median score	10	11	11	11	12	12	11	11	12	12	12	12
Test II												
Perfect score 20												
Range of scores	10-19	13-19	11-17	9-19	10-20	11-19	14-20	13-19	10-19	13-20	9-20	14-20
Median score	15	17	14	15	16	15	17	16	16	16	16	18
No. children tested	30	27	26	31	28	28	28	24	32	28	34	27

	Air and Water	Seasons	Tools and Machines
Number reporting	12	9	12
Number that had taught unit	7	9	6
Number that had not taught unit	2	3	6
Formal presentation	3	3	3
Incidental approach	7	6	4
One text used	4	2	3
Several texts used	2	4	2
Library books used	2	4	2
All three kinds used	4	4	1
Introduced by teacher	7	8	5
Introduced by child	3	0	0

Figure 14

One film was used in the study of air and water. None reported using films for presenting tools and machines. Those used for seasons included Birds in Winter, Animals in Winter, Spring on the Farm, Summer on the Farm, Fall on the Farm, and How Nature Protects Animals.

Experiments, demonstrations, and activities seem to be used quite freely. Weather charts and calendars were reported.

Studies of snow and ice, storing cocoons for the winter and thermometer reading were the other activities reported for the work on seasons. For tools and machines, the activities reported included the use of toys to demonstrate levers and rolling, a bulletin board display of tools and the making of scrapbooks of various tools and machines.

More activities were reported in the study of air and water. These include: watch steam rise from boiling water, hold something cold in the steam to watch condensation; watching the rate of evaporation from a covered and an uncovered glass of water; making pinwheels to demonstrate moving air; use of thermometers to demonstrate changes in air; a balloon filled with air and placed over heat to show that warm air rises; watering soil to watch for bubbles to show that there is air in soil; burned a candle in a jar to show that fire needs air to burn; and making a parachute to show that air pushes against things.

One teacher took her class to observe the clouds, fog and mist on the hills. One teacher took a class to watch a construction crew working nearby with large machines. The seasonal trips included a walk in the winter to observe the dormant plants, and a walk to the greenhouse in the spring.

Other aids listed were weather maps, radio weather news, charts of common tools, magazine pictures, thermometer, leaves, fruit, seeds, calendar and pictures of seasonal activities. One reported that seasons had been taught with a social studies unit and not as a science.

CHAPTER VIII

SUMMARY AND CONCLUSION

This, then, is the goal of science teaching in the primary grades: to so recognize and stimulate the natural desire of young children to explore, to question, to try out or experiment, and to so channel eager curiosity into worthwhile learning activities that they will be challenged to a further investigation of their environment. Experiences must be provided that will give children opportunities to define, analyze and solve problems. This will necessitate scientific thinking which involves both a method of work and attitudes reflecting the ability to think clearly and logically.

In following through the experiences which involve the scientific attitude children will practice accuracy of observation and reporting, open-mindedness, the habit of looking for natural causes, the habit of suspended judgment and the habit of criticism. Children will be stimulated to think scientifically, however, to the extent that teachers provide for experiences by "doing science" rather than just reading about science. The classroom should become a laboratory for solving problems where pupils may examine causes and conditions, share ideas, discuss and evaluate differences of opinion and look for facts and evidences.

The teacher should provide the motivation and guidance in the learning process in order to stimulate thinking and problem solving. She should avoid serving as a reservoir of information but should direct children in finding their own answers.

A good science program goes forward as it broadens the understanding of the children concerning their environment by supplying the content that is suitable and appropriate to their interest and developmental level. This content should be incorporated in such a way that a reservoir of meaningful knowledge is built up through the activities experienced. This can be done best in a relaxed and permissive atmosphere in a classroom where there is an ample supply of materials with which to work.

Evaluation should be a continuous process with more emphasis being placed on the "intangibles" of science teaching than on the mere acquisition of facts. Much more study needs to be done in the field of evaluation on the primary level. A check list should be devised whereby the observations of the teacher may be recorded. Adequate science teaching guides for the use of primary teachers should also be developed. When teachers overcome the feeling of inadequacy in connection with this area of classroom experience, many more children will have lives that will be enriched by the horizons that are thus opened up before them.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

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

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

Craig, Gerald S. Science for the Elementary School Teacher. New York: Ginn and Company, 1947.

Craig, Gerald S., and Beatrice D. Hurley. You Can Teach Elementary Science. New York: Ginn and Company, 1951.

Dowling, T. I., K. H. Freeman, N. Lacy, and J. S. Tippett. Helping Children Understand Science. Philadelphia: John C. Winston Company, 1956.

Greene, Gerberich, and Jorgensen. Measurement and Evaluation in the Elementary School. New York: Longmans, Green and Company, 1953.

McCracken, Helen D., and Lois G. Armstrong. A Teacher's Manual and Handbook. Syracuse: L. W. Singer Company, 1947.

Navarra, John G. The Development of Scientific Concepts in a Young Child. New York: Bureau of Publications, Columbia University, 1955.

Strayer, George D. Public Education in Washington (A Survey) Chapter Seven, Education in the Elementary Schools; The Curriculum on Science, pp. 245-46. Olympia: State Department of Education, 1946.

Strickland, Ruth G. The Language Arts in the Elementary School. Boston: D. C. Heath and Company, 1951.

B. PERIODICALS

Almy, Millie C. "Science Through the Eyes of Children and Youth." Science Education, 37:237, October, 1953.

Branley, Franklyn M. "Science in Childhood Education." The Grade Teacher, April, 1957.

Chase, John B., Jr. "Stimulating Scientific Thinking." The Grade Teacher, Special Science Section, April, 1957.

Etten, John F. "Audio-Visual Aids to Science." The Grade Teacher, Special Science Section, April, 1957.

Heffernan, Helen. "Science in California's Elementary School Program." Science Education, October, 1953.

Jacobson, Willard. "A Generation of Science and a Young Generation." Science Education, 37:219, October, 1953.

Joseph, Dr. Alexander. "What To Teach in Science." Elementary Science. Darien, Connecticut: Educational Publishing Corporation, 1950.

Meder, Elsa Marie. "Problem Solving for Today's Children." Science Education, April, 1952.

Navarra, John G. "Elementary Science as it Relates to the Developmental Aspects of Children." Science Education, October, 1953.

Schneider, Herman. "Science Books and You." The Grade Teacher. Special Science Section, April, 1957.

C. PUBLICATIONS OF THE GOVERNMENT, LEARNED SOCIETIES AND OTHER ORGANIZATIONS

Blough, Glenn O., and Paul E. Blackwood. Science Teaching in Small Town and Rural Schools. Pamphlet of the United States Office of Education, Washington, D. C., 1955.

Blough, Glenn O., and Paul E. Blackwood. Teaching Elementary Science. Bulletin Number 4, United States Office of Education, Washington, D. C., 1948.

Education Brief Number Twelve. Experimenting in Elementary Science. Washington, D. C.: United States Department of Health, Education and Welfare, United States Office of Education, 1954.

Report of The National Council for Elementary Science, Cleveland Meeting. Science Education, October, 1953.

Zim, Herbert S. Science for Children and Teachers, Pamphlet. Washington, D. C.: Association for Childhood Education.

________________. This Is Science. Bulletin of the Association for Childhood Education, Washington, D. C.