A STUDY OF THE SCOPE, SEQUENCE, AND OBJECTIVES OF ELEMENTARY SCHOOL SCIENCE AS REVEALED BY STATE SCIENCE GUIDES

By

VERDINE E. TROUT

Bachelor of Science
Southeastern State College
Durant, Oklahoma
1949

Master of Education
The University of Oklahoma
Norman, Oklahoma
1953

Submitted to the Faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
May, 1966

A STUDY OF THE SCOPE, SEQUENCE, AND
OBJECTIVES OF ELEMENTARY
SCHOOL SCIENCE AS
REVEALED BY STATE
SCIENCE GUIDES

Thesis Approved:

W. Ware Marsden
Thesis Adviser

Kenneth E. Wiggins

Walter W. Hansen

Roy W. Jones

John E. Susky

J. W. Boggs
Dean of the Graduate School

PREFACE

The investigation reported in this study concerns the analysis of state elementary school science guides. These guides are examined to determine the major areas of science, the sequence of treatment, the science concepts, the laboratory experiences, and the objectives of elementary school science as suggested by state departments of education. The study is limited because nineteen state guides are not available. Literature concerning the teaching of elementary school science is reviewed to determine if there is a uniform approach to the teaching of elementary school science.

Grateful acknowledgement is made of the contributions to this study by members of the writer's graduate advisory committee: Dr. Ware Marsden, Dr. Kenneth Wiggins, Dr. Roy Jones, Dr. John Susky, and Dr. Walter Hansen. To Miss Edna Donley of the Oklahoma Education Association, indebtedness is acknowledged for help in securing the state science guides, and to Mr. Clyde Boyd, Superintendent, Sand Springs Schools for encouragement and for making possible a year's study at Oklahoma State University.

Appreciation is expressed to my wife Lawana and my son Eddie for their faith, patience, and understanding.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE PROBLEM

Introduction

Before science can assume its proper place in the elementary school curriculum, thoughtful consideration should be given to the elements of effective, sequential programs. Present science experiences vary from a few "show-share-do-and-tell" activities to programs that have been carefully designed to fit children's needs, interests, and abilities.[1]

Today there are extensive programs for revision in the sciences. Elementary school science presents special problems because it has often been a neglected area in the elementary school curriculum and because elementary school science is basic to improvement programs in the secondary schools.[2]

In the past the science curriculum has often been developed from advanced levels downward to the beginning level. This reversal has led to serious duplications and omission of material at various grade levels. Since time is of prime consideration for instruction in the

---

[1]Glen O. Blough, It's Time for Better Elementary School Science, National Science Teachers Association (Washington, 1958), p. 9.

[2]Albert Piltz, Science Equipment and Material for the Elementary Schools, United States Department of Health, Education, and Welfare (Washington, 1961), p. 1.

elementary school, this overlap and omission of material is of major importance.[3]

Contents of elementary school science courses have been restricted primarily to textbook material. It has been charged that regardless of the amount of thought and consideration given by authors and publishers, textbooks have been the results of three or four educators' decisions of appropriate content for a given grade level. The vast "explosion of knowledge" in the sciences makes it unlikely that even the most gifted can make such a decision.[4]

The National Science Teachers Association Committee on the K-12 Science Program reported, in 1961, that the program should be well organized so that work at each grade level is an integral part of the entire program.[5]

Blanc and Low reported, in 1958, the analysis of elementary guides from thirteen major cities in the United States. They found the subject matter falling into five major headings: plants and animals, the human body, the earth, the universe, and matter and energy. They reported a dearth of recent material on the human body and matter and energy.[6]

---

[3]Five Major Areas of Concern in Science Education, National Science Teachers Association (Washington, 1962), p. 4.

[4]Science Education News, American Association for the Advancement of Science (Washington, 1962), p. 1

[5]Donald G. Decker, "N. S. T. A. Committee Report on the K-12 Science Program," The Science Teacher, October, 1961, pp. 15-17.

[6]Sam G. Blanc and John Low, An Analysis of Selected Science Guides Grades K-12, Division of Instructional Services, Denver Public Schools (Denver, Colorado, 1958), p. 11.

In 1963 Smith examined the viewpoints presented in five recent books on elementary school science education. A part of the study concerns elementary school science content. Major points were that all agreed science would be taught as a separate subject, but closely related to other parts of the instructional program; that opinions on subject matter ranged from a miscellaneous approach to a carefully organized selection of concept-yielding subject matter planned around conceptual growth of children and that major differences lie in the sequence and depth of coverage.[7]

Constituents of a suitable elementary school science program are hazily defined. Efforts to identify specific grade placement of concepts have not met with success.[8]

Educators accept the premise that there should be science instruction in the elementary school. There is also agreement that science should be organized to provide for continuous, evolving learning experiences from kindergarten through elementary school. This premise causes state curriculum guides to come into prominence. To a varying degree every state has accepted the responsibility for setting guidelines for curriculum in its public schools. Some have accepted the responsibility to a greater extent than others as indicated by the

---

[7]Eugene H. Smith, "An Analysis of Some Prominent Viewpoints on the Teaching of Elementary School Science," Science Education, (XXXXVII), March, 1963, pp. 188-193.

[8]Hubert A. Smith and Kenneth E. Anderson, "Science," Encyclopedia of Educational Research, The Macmillan Co. (New York, 1960), pp. 1216-1232.

publications, State Curriculum Guides in Science, Mathematics, and Modern Foreign Language, A Bibliography[9] and Science Courses of Study.[10]

There has been no published research attempting to analyze state guides in elementary school science to find if there is a common basis for elementary school science curriculum. Review of research indicates that an efficient program demands definitely organized experiences rather than specific methods of instruction. Studies in the area of curriculum involving scope and sequence have been neglected.[11] This is an important area of research because of the influence exerted by State Departments of Education on the selection of textbooks and the certification of teachers for the public schools of the United States.

One of the most difficult tasks in organizing an elementary school science program is the selection of grade by grade content for the program. Zafforoni maintains the scope and sequence of a sound basic program are problems that remain to be resolved.[12]

Many studies are underway at present to bring order and unity to the science curriculum. Since great influence is exerted by State Departments of Education, and since many of them have appointed committees

---

[9] State Curriculum Guides in Science, Mathematics, and Modern Foreign Language, A Bibliography, United States Office of Education (Washington, 1961).

[10] Science Courses of Study, National Science Teachers Association (Washington, 1964).

[11] Paul C. Buras, "Research on the Teaching of Elementary School Science," The Science Teacher, March, 1960, pp. 48-49.

[12] Joseph Zafforoni, New Developments in Elementary School Science, National Science Teachers Association (Washington, 1963), pp. 5-6.

of educators and scientists to develop guides, an analysis of the state guides may make a valuable contribution in bringing order and unity to the elementary school science curriculum.

The Purpose of the Study

The purpose of this study is to examine the major areas of science, sequence of treatment, science concepts taught, laboratory experiences, and objectives of elementary school science as suggested by State Departments of Education in the United States. In pursuit of this study, current state elementary school science guides were analyzed to answer the following major questions:

1. What major areas of science are included in elementary school science by state elementary science guides? (The major areas examined included chemistry, physics, geology, astronomy, conservation, meteorology, biology, botany, zoology, health, and safety.)

2. What is the depth of treatment of the major areas of science at each grade level by state elementary science guides?

3. Is there a sequence in the presentation, by grades, of the areas of science recommended by state elementary science guides?

4. What science concepts are recommended by state elementary science guides to be taught at each grade level?

5. What are the stated objectives of elementary school science as indicated by state science guides?

6. What laboratory experiences are recommended for elementary school science by state science guides?

It is also the purpose of this study to examine, by means of a jury, the appropriateness of a program of elementary school science based on the concepts and laboratory experiences suggested by an analysis of state elementary school science guides.

The literature concerning the development of science concepts by elementary school children is reviewed to determine if there is a uniform approach to the teaching of elementary school science.

Importance of the Study

At present much thought is being given to the formulation of new science programs to give order to the science curriculum at all grade levels. Since the information in the various state guides has not been compiled and analyzed for the purpose of contributing order to elementary school science, and since State Departments of Education perhaps have great influence on the contents of the elementary school curriculum, it is important that state guides be studied to learn more about what is suggested to be taught in elementary school science, and to learn the degree of commonality in the elementary school science programs.

Results of this study may be used in the following ways:

A. As a resource in the preparation and revision of elementary school science guides.
   1. By the local school system.
   2. By State Departments of Education.

B. As a resource for the development of programs for the preparation of elementary school teachers.

1. In developing courses in science for students in elementary education programs.
2. In the preparation of in-service training programs for elementary school teachers.
3. In the preparation of science methods courses for elementary school teachers.

C. As a resource for authors in the field of elementary school science education.

1. In the preparation of textbooks for elementary school science.
2. In the preparation of standardized tests for use in elementary school science programs.

Scope and Limitations of the Study

In order to examine the major areas of science, sequence of treatment, science concepts taught, laboratory experiences recommended, and objectives of elementary school science as suggested by State Departments of Education, the study includes state science guides published or revised between 1955 and 1964. The study was limited by the fact that science guides from nineteen states were not available. However, guides were secured from thirty-one states and they were used in this study.

Procedure

Elementary school science guides that have been published or revised between 1955 and 1964 were secured from the State Departments

of Education. Information was classified concerning the major areas of science, the sequence of treatment, the science concepts, and the recommended laboratory experiences. The following classification system was used:

A. Physics
    1. Heat
    2. Mechanics
    3. Light
    4. Sound
    5. Electricity and Magnetism
    6. Modern Physics

B. Earth Science
    1. Astronomy
    2. Geology
    3. Meteorology
    4. Conservation

C. Chemistry
    1. Atomic Theory
    2. Elements
    3. Compounds
    4. Biochemistry

D. Biological Science
    1. Biology
    2. Botany
    3. Zoology

E. Health and Safety

The objectives not concerned with subject matter were classified under the following headings:

1. The use of the skills and tools of science in problem solving.
2. The ability to see relationships.
3. An understanding of the environment.
4. A change in attitude.
5. The scientific basis for social problems.
6. The interrelationships of science and other subjects.

The information from the state elementary science guides was studied in order to examine:

1. The major areas of science included.
2. The depth and sequence in the presentation, by grades, of the areas of science included.
3. The recommended science concepts to be taught at each grade level.
4. The stated objectives of elementary school science as indicated by state elementary science guides.
5. The laboratory experiences recommended for elementary school science.

The science concepts and laboratory experiences suggested at each grade level were submitted to a jury of educators whose training and experience qualify them to be actively engaged in elementary school science education. The reviewing jury examined the concepts and laboratory experiences suggested by state guides and expressed opinions as to whether programs based on the concepts and laboratory experiences would meet the objectives of elementary school science. The data was

compiled and tabulated. From the results, conclusions and implications were drawn and recommendations were made.

Definition of Terms

Concept - A concept is a generalized idea concerning an object, event, symbol, or situation. However, for this paper, a concept is any statement suggested as a concept by a state elementary school science guide.

Guide - Any curriculum guide published by a State Department of Education concerning only elementary school science, or one with science as a part of a more comprehensive elementary school curriculum guide.

CHAPTER II

A SURVEY OF RELATED LITERATURE CONCERNING THE DEVELOPMENT OF SCIENCE CONCEPTS IN ELEMENTARY SCHOOL CHILDREN

In developing concepts about science, the firsthand experiences of children are indispensable. John Dewey believed children should have experiences with the scientific method even though they may not be aware they are using it. Dewey's approach was that (1) the child should be engaged in a meaningful experience; (2) from such experiences a genuine problem should arise; (3) he should be guided in the collection of data relative to solving the problem; (4) he should set up tentative hypotheses or possible solutions to the problem; (5) the tentative hypotheses should be tested. As a result of this process it is assumed that the child will be able to continue his experiences with greater understanding.[1]

Similarily, experiments by Piaget, a Swiss psychologist, have led him to believe that the development of intellectual capacity passes through a number of stages whose order is constant, but whose time of appearance may vary with the individual and with society. Each level

---

[1]John Dewey, Democracy and Education, The Macmillan Company (New York City, 1916), p. 192.

is a new coherence, and a new structuring of elements which until that time have not been systematically related to each other. The four factors contributing to intellectual development are (1) maturation of the nervous system; (2) encounters with experience; (3) social transactions; and (4) equiliberation or auto-regulation. The first three factors are passive in nature; something is done to the child. The fourth is not passive and neither is intellectual development. An individual sees the world as coherent, as structured, to the extent that he acts upon it and succeeds in coordinating these actions and transformations. Development proceeds as partial understandings are revised, broadened, and related to one another. Piaget's model is one of auto-regulation to attain a broader and more suitable equilibrium in the individual's dealing with the world. The chief outcome of this theory of intellectual development is a plea that the child be allowed to do his own learning. Good teaching practices must involve presenting the child with situations in which he himself experiments, tries things to see what will happen, poses questions and seeks answers, and compares answers with other children.[2]

Another important idea in Piaget's theory is that children should be taught the underlying themes of a subject matter area, after which they will be able to relate individual items to the general structure. Piaget believes the teaching situation should be structured so that the child is active and creates structure himself. Situations should be created where structure can be discovered.[3]

---

[2]Eleanor R. Duckworth, "Piaget Rediscovered," Newsletter, Elementary Science Study, June, 1964, pp. 2-4.

[3]Ibid. p. 3.

This is similar to Bruner's idea that grasping the structure of a subject is understanding in a way that permits many other things to be related to the structure meaningfully. To learn structure is to learn how things are related.[4]

Bruner makes four general claims for the teaching of the fundamental structure of a subject. They are (1) an understanding of fundamentals makes the subject more comprehensible; (2) research indicates that if details of a subject are not placed in a structured pattern, they are rapidly forgotten; (3) the understanding of fundamental principles and ideas appears to be the primary apparatus of "transfer of training"; (4) by constant re-examination of material taught in the secondary and elementary schools for its fundamental character, the gap between "advanced" and "elementary" knowledge of a subject is narrowed.[5]

Bruner further points out that it is possible to present the fundamental structure of science in a way that presents some of the exciting sequences that lead a student to discover structure for himself.[6] Many of the new approaches to teaching science to children utilize the discovery process in teaching concepts in science. Teaching by this method is not easy. There are no guides available and according to Renner, if they were available they would be a series of provocative questions which would lead a student on a discovery "path". The "path"

---

[4]Jerome S. Bruner, The Process of Education, Vintage Books (New York, 1960), p. 7.

[5]Ibid., pp. 23-26.

[6]Ibid., p. 20.

is not the same for all pupils and to successfully use this method of teaching the teacher must first accept the fact that he is dealing with the discovery process.[7]

In the laboratory school at Colorado State College a science program was designed to lead the pupils in the ways that scientists work, think, and organize knowledge. This method was practiced by the children in the process of learning science. The children were closely observed and detailed records were kept of all activities. Conclusions were (1) learning through self-discovery is greatly enhanced by individualized and small group experiences and explorations; (2) certain unitary or conceptual themes function as structure for organizing the concepts or knowledge of science; (3) children's curiosity and inquisitiveness are forceful instruments for maintaining a high degree of interest; (4) achievement of the objectives of science is related to the nature and quantity of material and equipment used in the discovery process; (5) children can increase their ability to use the inquiry method; (6) both product and process of science develop under laboratory conditions when pupils use the discovery approach to learning.[8]

Glen Heathers suggests three types of processes in elementary school science. They are (1) the process of inquiry in the use of the scientific method; (2) the process of nature in the cause and effect

---

[7]John W. Renner, The Thrill of Discovery in Science Education, Educators Progress Service (Randolph, Wisconsin, 1962), p. 5.

[8]Louise A. Neal, "A Discovery Approach for Developing Productive Thinking," Science and Children, November, 1964. pp. 16-17.

relationship; (3) the process of applying knowledge through the use of the process of inquiry and nature.[9]

The Commission of Science Education of the American Association for the Advancement of Science states that science is more than a body of facts. The Commission believes that science should include ways of investigating and exploring. The ways of investigating - the process of science - are stressed in the early grades. The process includes recognizing space-time relationships, observing, classifying, using numbers, measuring, communicating, inferring, and predicting. Material has been developed to implement these processes in a program. For example, one exercise entitled Observations on a Rolling Ball includes observations and experiments with a hollow and solid ball rolling down an inclined plane. At the end of the exercise, the student should have discovered certain concepts concerning hollow and solid balls rolling down an inclined plane.[10]

Lundstrom and Lowery believe that science programs should be concerned with two dimensions: the processes of science and the conceptual structure of science. Within this framework science courses should (1) illustrate the many different processes in a pattern that lead to the conclusions of science; (2) provide an understanding of generalizations and theories that are the basis of modern science (the pattern

---

[9]Glen Heathers, "A Process Centered Elementary Science Sequence," Science Education, (XXXXV), April, 1961, p. 202.

[10]Arthur H. Livermore, "Science - A Process Approach," Science and Children, May, 1964, pp. 24-25.

of structure); and (3) provide the opportunity of encountering the uncertainty of the frontiers of knowledge. The pattern of conceptual growth should begin in the elementary school and continue in the secondary school. Secondary school science content should be integrated with and dependent upon the elementary school science curriculum.[11]

David Hawkins, a college teacher of long experience, believes that the difficulty college students have with the intellectual process does not come from the complexity of college work, but mainly from their home background and the first years of formal education. For example, a student who can not understand Ptolemaic astronomy has no concept of the relativity of motion, or the simple geometrical relationships of light and shadow. If the student has a structure on which to build new concepts and expand old ones, this difficulty with the intellectual process may be avoided.[12]

The Utah State University Elementary School Science Project has shown that elementary pupils are capable of mastering sophisticated scientific information not taught them in the past. This is not accomplished by moving junior high school general science down into the elementary school. The idea is to teach science as the professional scientist practices it, as a duality, a process and a product. The pupils learn not only the facts of the subject, but also its "structural features." Pupils are led through an orderly series of activities in which they practice the skills used by the scientist, starting with the

---

[11]Donald Lundstrom and Lowrence Lowery, "Process Patterns and Structural Themes in Science," The Science Teacher, September, 1964, pp. 16-19.

[12]David Hawkins, "Messing About in Science," Science and Children, February, 1965, pp. 5-9.

most elementary skills and progressing to the more complex. The scientific method and the discovery approach are used in developing concepts about science in children.[13]

A similar program in elementary school science is being developed at the University of Minnesota; however, the purpose of the Minnesota project is to develop a science curriculum accompanied by a corresponding development in mathematics and to correlate the two at all levels. Science is classified into the following operations: observation, measurement, description, experimentation, generalization, and deduction. The program is based on a spiral structure which is not the familiar repetition of subject matter topics that one finds in the usual curriculum. The spiral is based on the operations previously mentioned. The objective in the early grades is to acquire an overview and limited experience in the entire structure of scientific activity. As a result, subsequent activities will have more meaning when they are related to the overall structure. This is a conscious attempt to incorporate the ideas of Piaget into the science program.[14]

The Science Curriculum Improvement Study of the University of California has based its program on the involvement of the child in science. The child is confronted by systems of objects he chooses or which are chosen from the environment, and he observes the objects and what happens to them. The observations are individual and based on

---

[13] A. L. Barswell, "Science in the First Grade," Science and Children, February, 1965, pp. 10-13.

[14] Robert B. Aherns, "Minnemast, the Coordinated Science and Mathematics Program," Science and Children, February, 1965, pp. 16-18.

the child's direct experience with phenomena. From this experience the child formulates concepts. It is felt that some of the developmental learnings contributed by such activities will not be evident verbally for many years.[15] This idea also has its basis in work done by Piaget.

Concepts in science can be developed from the natural activities of children when they are encouraged to pursue their problems to a satisfactory conclusion. Their understandings of the conclusions function as concepts which may be verbalized and used for further experience. The teaching methods that provide experiences leading to concepts in this manner are quite different from telling a child about experiences and asking him to exemplify the concept already given. Although the latter is faster and easier, it is not meaningful, developmental and conducive to real understandings. The teacher's role in developing concepts about science may be summarized as follows: (1) willingness to explore and find out with the group; (2) knowledge of where to find further necessary information about simple problems which may arise; (3) background to which more knowledge is being added about plants, animals, and other objects of scientific interest to children; (4) a conviction that children's experiences, fumblings, and efforts to solve problems within their capabilities, though time consuming, are far more valuable than the learning of a quick rote answer; (5) a conviction of the importance of trying out, of failing, of reassessment, and of re-trial; (6) an awareness of the opportunities

---

[15]Herbert D. Thier, "The Involvement of Children in the Science Program," Science and Children, February, 1965, pp. 19-21.

to utilize new concepts and of the possibilities of constantly expanding them; (7) an awareness of how to relate scientific concepts through continuous, meaningful experiences. The role of the teacher requires the realization that adult knowledge comes as a result of reformulating experienced situations in which there has been enough interest to work through a problem to a satisfying conclusion. The conceptual results are a mere resting place for further experiences and the problems that arise from them utilize this concept as data in the next development of learning.[16]

According to Paul DeHart Hurd, the first task of the science teacher is to teach the processes of inquiry in science. Inquiry skills provide the child with tools for independent learning. Experiences in inquiry enable the student to place objects and events in categories or classes. He discovers the utility of coding systems and becomes aware that systems of classification are not inherent in nature but are man-made. The student establishes a conceptual framework. This conceptual framework helps him build new categories which are more comprehensive and abstract. This structure ties past experiences to the present and serves as a guide for the assimilation of new facts and concepts. It serves as a basis for the child to predict what will happen when faced with a new problem and situation. Research has provided some suggestions as to how to teach the inquiry process. It is wasteful to teach facts divorced from a meaningful concept. The

---

[16]Grace K. Pratt, "Developing Concepts about Science in Young Children," Science and Children, December, 1963, pp. 21-22.

facts, which are to have meaning to the learner, must be tied into a logically related conceptual pattern. This improves retention, and insight is more likely to occur. After learning one pattern a student will respond more systematically to the alternatives of a new situation. The extent to which a student can use a conceptual pattern and the associated skills in a new problem situation is the crucial test of learning.[17]

Summary

According to the literature reviewed for this study, the development of concepts about science in elementary school children depends upon several factors. First, the teacher must understand how science concepts can be developed through the discovery process. Second, the teacher must be willing to create situations where structure may be discovered by the children as they work out problems. Third, experiences should be planned for individuals and small groups. Fourth, the teacher should realize that science is not merely a product, but a process and that it should be taught as a process. He must also understand that the development of science concepts is affected by the amounts and kinds of material used by him in the discovery process. The emphasis should be on action in contrast to the traditional passiveness of the learner.

---

[17]Paul DeHart Hurd, "Toward a Theory of Science Education Consistent With Modern Science," Theory Into Action - In Science Curriculum Development, National Science Teachers Association (Washington, 1964), pp. 5-15.

CHAPTER III

THE SEQUENCE OF THE TREATMENT OF CONCEPTS IN EACH AREA OF SCIENCE RECOMMENDED BY THE STATE GUIDES

The State Science Curriculum Guides

Science guides were requested from the State Superintendents of Public Instruction in each of the fifty states. Replies were received from all fifty states. Six states do not publish guides, and six are at present in the process of writing and publishing them. The guides published by North Carolina and New Mexico are out of print, and Oregon will not send its guide out of state. The guides from Florida and Minnesota are for health only, and the Colorado and Ohio guides include conservation only. The writer believes that guides used in this study should deal with all phases of science and that health and conservation should be included only when they are a part of the regular science program. This study is based on the remaining thirty-one guides. South Dakota's guide deals with upper elementary grades only, but it includes objectives of the elementary school program, and they are used in this study. Twenty-three states publish separate guides for science and eight states include science as a part of

a larger elementary school curriculum guide. An analysis of all of these are included in this study. The guides used in this study are listed in Table I, and Table II indicates the states not included in this study.

TABLE I

THE STATE GUIDES INCLUDED IN THIS STUDY

State	Science as a Separate Guide	Science as a Part of a Larger Elementary Guide
Alaska		X
Arizona	X	
Arkansas	X	
California	X	
Connecticut		X
Georgia	X	
Hawaii	X	
Idaho		X
Illinois	X	
Indiana		X
Iowa	X	
Kansas		X
Maine		X
Michigan	X	
Missouri		X
Montana	X	
Nebraska	X	
Nevada		X
New Hampshire	X	
New Jersey	X	
New York	X	
North Dakota	X	
Oklahoma	X	
Pennsylvania	X	
South Carolina	X	
South Dakota	X	
Tennessee	X	
Texas	X	
Vermont	X	
Washington	X	
West Virginia	X	
Total	23	8

TABLE II

THE STATES NOT INCLUDED IN THIS STUDY

State	Guides in Process	Guides out of Print	Guides not Published	Will not Send Guides out of State	Health Guide	Conservation Guide
Alabama	X					
Colorado						X
Delaware			X			
Florida					X	
Kentucky			X			
Louisiana			X			
Massachusetts	X					
Minnesota					X	
Maryland	X					
Mississippi	X					
North Carolina		X				
New Mexico		X				
Ohio						X
Oregon				X		
Rhode Island			X			
Utah	X					
Virginia			X			
Wisconsin	X					
Wyoming			X			
TOTAL	6	2	6	1	2	2

Areas of Science Included in State Guides

Four of the thirty-one guides analyzed in this study list only non-subject matter objectives. The subject matter areas included in the other twenty-seven guides are classified and shown in Table III. A few of the state guides do not include all areas of science. For

TABLE III

AREAS OF SCIENCE INCLUDED IN STATE GUIDES

State	Mechanics	Light	Heat	Sound	Elect. & Mag.	Modern Physics	Astronomy	Geology	Meteorology	Conservation	Chemistry	Biology	Botany	Zoology	Health & Safety
Alaska	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Arkansas	Non-subject matter objectives only														
Arizona	x	x	x	x	x	x	x	x	x	x	x	x	x		
California	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Connecticut	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Georgia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hawaii	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Idaho	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Indiana	x				x	x	x	x	x	x	x	x	x	x	x
Illinois	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Iowa	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Kansas	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Maine	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Michigan	Non-subject matter objectives only														
Missouri	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Montana	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Nevada	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
N. Hampshire	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
New York	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
N. Jersey		x	x	x	x	x	x	x	x	x	x	x	x	x	
Nebraska	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
N. Dakota	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Oklahoma	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Pennsylvania	x	x			x	x	x	x	x	x	x				
S. Carolina	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
S. Dakota	Non-subject matter objectives only														
Tennessee	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Texas	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Washington	Non-subject matter objectives only														
W. Virginia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

example, the Pennsylvania guide lists a great number of concepts in the area of earth science, but none in the life sciences. All guides do not

cover all areas of science equally well. Some guides list, in detail, the concepts and laboratory work to be covered. Other guides indicate only the areas of science to be covered.

The Sequence of the Treatment of Concepts

The concepts stated in each guide are classified and summarized in Appendix D according to grade level and subject area. The following is a summary of this material:

Area	Grade	Material Included in Concepts Most Often Recommended by State Guides
PHYSICS:		
Light	1	Source, shadows, colors
	2	Reflection, colors
	3	Speed, energy
	4	Reflection, radiant energy, absorption
	5	Radiant energy, heat energy, human eye
	6	Lenses, photosynthesis
Heat	1	Sources, conduction, measurement, effect
	2	Sources, measurement, radiation, effect, conduction, absorption
	3	Heat energy, molecular motion, burning, evaporation
	4	Oxidation, combustion, friction, heat energy, mechanical energy
	5	Effects, condensation, boiling point, melting point, kindling temperature
	6	Work, transfer of heat, nuclear fission.

Sound	1	Sources, conduction, communication
	2	Sources, conduction, waves, speed, pitch
	3	Vibrating matter, human ear, conduction, music
	4	Waves, vibrations, transmission, absorption, reflection, recording and reproduction
	5	Energy, communication, human ear, vibrating strings, reflection, absorption
	6	Speed, Doppler effect, high pitch
Mechanics	1	Simple machines, floating bodies
	2	Simple machines, work, power sources, friction
	3	Sources of energy, friction, simple machines
	4	Work, simple machines, sources of energy
	5	Mechanical advantage, work, compound machines, energy, gravity, friction
	6	Energy and machines, compound and simple machines, falling bodies
Electricity and Magnetism	1	Magnets, uses of electricity
	2	Magnetic poles, magnetic material, dry cell batteries, compass, static electricity
	3	Magnetic fields, conductors, magnetic poles, static electricity, electric charges
	4	Utilization, electromagnets, electric power sources
	5	Energy, static electricity, electric charges, conductors, insulators, measurement
	6	Radio, magnetic theories, electric circuits conductors, insulators

Modern Physics	1	Molecular motion, energy
	2	Molecular motion, structure of matter
	3	Matter, energy
	4	Matter, energy
	5	Matter, energy
	6	Classes of matter, radiation, energy
EARTH SCIENCE:		
Meteorology	1	Precipitation, seasons, wind, weather, evaporation
	2	Seasons, weather, wind, evaporation, air pressure
	3	Evaporation and condensation, winds, sun, climate
	4	Evaporation and heat, water cycle, air pressure, radiant energy, instruments
	5	High and low pressure, climate, atmosphere, precipitation, winds, clouds
	6	Instruments, temperature, atmosphere, precipitation, climate
Conservation	1	Wind, plants, animals, soil
	2	Wind, water, soil, erosion, resources
	3	Soil, living things
	4	Resources, erosion, natural resources
	5	Soil, weathering, erosion, wildlife, human resources
	6	Resources, legume plants, erosion, floods, wildlife

Geology	1	Rocks, soil, minerals, sand, mountains
	2	Soil, rocks, wind and water, erosion
	3	Erosion, rocks, minerals, volcanoes
	4	Weathering, soils, oceans, fossils
	5	Minerals, rocks, soil, change
	6	Minerals, change, fossils, earthquakes
Astronomy	1	Sun, earth, moon, day, seasons, planets, stars
	2	Rotation, stars, sun, planets, moon, earth, light, seasons
	3	Sun, earth, planets, reflection, radiant energy, solar system, motion, stars
	4	Planets, satellites, gravity, inertia, tides, time, solar system
	5	Solar system, instruments, gravity, tides, rotation, orbit
	6	Solar radiation, eclipse, space travel, instruments, galaxy
CHEMISTRY:	1	Elements, burning, composition of material
	2	Matter, atoms, compounds, elements, foods, mixtures, mass
	3	Molecules, elements, compounds, atoms, chemical change
	4	Molecules, elements, compounds, atoms, digestion
	5	Atoms, matter, compounds, chemical change, carbon compounds
	6	Elements, matter, atoms

BIOLOGICAL SCIENCES:

Biology	1	Seasonal changes, environment, interdependence of living things
	2	Adaptation, diversity, requirements of living things
	3	Dependency of living things, sunlight, food, reproduction, energy
	4	Communities, growth, adaptation, balance of nature, the cell
	5	Protoplasm, balance of nature, heredity, taxonomy, evolution, reproduction
	6	Evolution, balance of nature, natural selection
Botany	1	Needs of plants, diversity, seasonal changes
	2	Reproduction, distribution, uses of plants, seasonal changes
	3	Photosynthesis, distribution, diversity, uses
	4	Growth, reproduction, seed dispersal, photosynthesis, seasonal changes
	5	Photosynthesis, growth, reproduction
	6	Taxonomy, food, photosynthesis, uses to man
Zoology	1	Needs, diversity, locomotion, reproduction
	2	Usefulness, reproduction, seasonal changes
	3	Distribution, growth, adaptation
	4	Reproduction, sizes, adaptation, diversity
	5	Reproduction, taxonomy, diversity, sizes
	6	Taxonomy, adaptation, importance

Health	1	Cleanliness, foods, rest, health habits, exercise, dress
	2	Diet, dress, eyes, ears, teeth, food preservation
	3	Rest, recreation, disease, responsibility for health
	4	Cleanliness, clothing, diet disease
	5	Cleanliness, disease, diet, the human body, digestion
	6	Rest, diet, recreation, the human body, infection
Safety	1	Safety rules, play, prevention of accidents
	2	Hazards to health and safety, safe work and play, fire, first aid
	3	Fire, work, play, electricity
	4	First aid, rules for work and play
	5	Bicycle safety, toys, rules for play
	6	Safety rules, water safety, responsibility for safety

A study of state guides reveals that many concepts are presented in a sequential order. For example:

In the area of physics

1st. Gr. - Sources of heat

2nd. Gr. - The transfer of heat

3rd. Gr. - The kinetic theory of heat

4th. Gr. - Heat equivalent of slow and rapid oxidation

5th. Gr. - Idea of heat gain equals heat lost (First Law of Thermodynamics)

6th. Gr. - The use of heat to do work (Mechanical equivalent of heat)

In the area of earth science

1st. Gr. - The earth

2nd. Gr. - The planets

3rd. Gr. - The sun and stars

4th. Gr. - How the solar system works (Copernican system)

5th. Gr. - The idea of gravity (Universal Law of Gravitation)

6th. Gr. - The Universe

In the area of the biological science

1st. Gr. - Living things and the diversity of life

2nd. Gr. - Adaptation and types of living things (Classification)

3rd. Gr. - Relationships of living and non-living environment (Dynamic equilibrium and balance of nature)

4th. Gr. - Energy systems in life

5th. Gr. - The idea of change and diversity (Evolution and natural selection)

6th. Gr. - Natural balance through cycles in nature (Continuity of protoplasm)

During the six year program many of the major concepts of science are introduced and developed. The concepts are not completely developed. It is obvious that the entire concept of the kinetic theory of heat and other concepts can not be developed in the elementary school. They can be introduced and developed through a certain degree of sophistication. The ideas leading to the development of concepts are presented sequentially in state guides.

Laboratory Experiences Recommended by State Guides

Nineteen of the state guides list either partial or complete details concerning the science laboratory activities for children. The states listing laboratory activities are:

Arizona	Montana	South Carolina
California	Nebraska	Tennessee
Georgia	New Hampshire	Texas
Hawaii	New Jersey	Vermont
Illinois	New York	West Virginia
Indiana	North Dakota	
Iowa	Pennsylvania	

A compilation of recommended laboratory work is shown in Appendix D. The exercises are reported by title only as space does not permit a detailed account. Also no grade level is suggested for the exercises. Since state guides are intended to suggest exercises the teacher can choose from, it is assumed that the teacher would adapt the exercise to the respective grade level.

The following is a summary of the suggested laboratory activities in each area of science:

Area	Recommended Activity
PHYSICS:	
Heat	Conduction, evaporation, absorption, radiation, thermometer, combustion
Light	Magnification, reflection, refraction, absorption
Sound	Sound waves, vibrations, telephone

Mechanics	Inclined plane, levers, pulleys, inertia, jet propulsion, buoyancy, pressure, screw, density, surface tension, forces
Electricity and Magnetism	Magnets, electromagnets, compass, dry cell, static electricity, conductors, telegraph, motors, electroscope
Modern Physics	Atomic models, ping pong ball chain reaction
EARTH SCIENCE:	
Meteorology	Air pressure, water cycle, convection, heat and air, thermometer, weather map, rain gauge, humidity, anomometer, weather vane
Astronomy	Eclipse, sun dial, star box
Geology	Sediment, rocks, minerals, geysers, field trips
Conservation	Erosion, bird census, field trip
CHEMISTRY:	Reactions, oxygen, air, combustion, fire extinguisher, electrolysis, carbon dioxide, electroplating
BIOLOGICAL SCIENCES:	
Biology	Aquarium, terrarium, field trips, protein, starch, microscope, fats, sugars
Botany	Seed germination, field trips, taxonomy, plant structure, food production, uses
Zoology	Pets, feeding animals, taxonomy, blood circulation
HEALTH AND SAFETY:	First aid

None of the state guides suggest activities in health or safety other than in the area of first aid.

Summary

There are thirty-one guides used in this study. They suggest a great number of concepts in each area of science, but only a few laboratory exercises are included. According to state guides, many of the major concepts of science are introduced during the six year

elementary school science program. The great number of concepts introduced are not supported by an equally great number of laboratory experiences for children.

CHAPTER IV

THE NON-SUBJECT MATTER OBJECTIVES OF ELEMENTARY SCHOOL SCIENCE AS REVEALED BY STATE GUIDES

The state guides define a common purpose. They are to serve as an aid to the local school in improving programs. The state guides suggest two types of objectives: subject matter concepts on which to build a program, and non-subject matter or behavioral objectives. Twenty-three of the state guides suggest this latter type of objective.

The author has divided the non-subject matter objectives into the following classifications: (1) a change in attitude, (2) the use of the skills and tools of science in problem solving, (3) the ability to see relationships, (4) understanding the environment, (5) the scientific basis for social problems, and (6) the interrelationships of science and other subjects. Below the objectives are listed under the proper classification and the state of origin is shown:

Objective	Origin	Number
A CHANGE IN ATTITUDE:		
1. To encourage children to ask questions.	Arkansas	1

2.	To help children develop attitudes consistent with the methods and contents of science such as open-mindedness, critical thinking, withholding judgments, willingness to accept a new idea, understanding that knowledge is continuous, and an appreciation of the contributions of science and respect for the human body.	California	5
3.	An increased interest in science and growth in moral and spiritual values which exalt and refine life of the individual and society.	Hawaii	2
4.	The development in children, the work habits of the scientist, i.e., accurate work habits and a devotion to the truth.	Idaho	1
5.	To develop the proper attitude toward science.	Illinois	1
6.	Development of recreational interests, love of nature, responsibility, and independence, and practice in acceptable rules for health and safety.	Iowa	4
7.	To contribute to the development of a scientific attitude and a method of problem solving which seeks objectively for the truth.	Kansas	1
8.	The development of scientific attitudes	Maine	1
9.	Attitudes that contribute to a better living at home and in society, aesthetic contributions toward a fuller realization of self and others and an appreciation of the value of work.	Missouri	3
10.	To develop the understanding that in the study of science all related evidence is analyzed and applied without prejudice or superstition.	Nevada	1
11.	To stimulate and maintain an active imagination in elementary school children.	N. H.	1
12.	To learn that a great deal of knowledge remains to be discovered.	Penn.	1

13.	To acquaint students with leaders in science, to encourage favorable attitudes toward science, and to discover students with scientific aptitudes.	S. Carolina	3
14.	To arouse an interest and appreciation in science and the fact that it has freed man from superstition and lifted the burden of toil from millions of people	S. Dakota	4
15.	To organize the learnings of science around the experiences of boys and girls so they will result in certain desirable outcomes such as the beginnings of the habit of systematic observations, quantative thinking, and a desire for scientific exploration.	Tennessee	2
16.	To develop an awareness of the dynamic nature of science, and an appreciation of the role of science and intellectual achievement and a realization that the universe and man's knowledge about it is constantly changing.	Texas	5
17.	Growth in scientific attitude.	Vermont	1
18.	To develop an appreciation for the tools and methods of science.	W. Virginia	1

THE USE OF THE TOOLS AND SKILLS OF SCIENCE IN PROBLEM SOLVING:

1.	To give children practice in problem solving by different methods and approaches.	Arizona	1
2.	To use approaches, materials, methods, explorations, and measurements of science as a way of finding out.	Arkansas	4
3.	To develop scientific techniques for solving problems.	Connecticut	1
4.	To gain experience, skills, and confidence in solving problems and using the methods of science.	Hawaii	2
5.	To provide experience so the student can discover understandings, concepts, and knowledge through the problem solving method of science.	Idaho	1

6.	To help children acquire the basic skills of science in formulating and carrying out experiments in science.	Illinois	2
7.	Sufficient knowledge and understanding to use the scientific method in solving a problem intelligently.	Iowa	2
8.	To provide an opportunity for experimentation and to make discoveries for themselves, to provide scientific understandings that grow out of the need for problem solving.	Indiana	1
9.	To solve many problems of health, safety, and the conservation of natural resources.	Kansas	1
10.	To gain practice in the methods of science, critical thinking, and the use of science equipment.	Maine	3
11.	To develop and use fundamental skills.	Michigan	1
12.	To develop social and intellectual skills and an inquiring mind seeking solutions to social and physical problems.	Missouri	2
13.	To provide opportunities for the children to practice and use previously learned facts and skills in problem solving.	Nevada	1
14.	To help children acquire those skills and techniques necessary to gain further information, such as reading science content with understanding, and clarifying concepts from facts, principles and scientific knowledge.	S. Carolina	2
15.	To provide experiences through which boys and girls can arrive at some of the concepts of science through observation, inquiry, problem solving, and the cause and effect relationship.	Tennessee	1
16.	To provide a set of continuous and well rounded activities which will relate to critical thinking, vocabulary, building, problem solving, and practice in the practical application of scientific principles.	Texas	4

17. To increase the use of skills in solving problems, gathering data, relating information, preparing written reports, observing and recording, reading, and critical thinking.	Vermont	2
18. To develop problem solving abilities.	W. Virginia	1

THE ABILITY TO SEE RELATIONSHIPS:

1. To learn that scientific observations and thinking are based on observations and happenings.	Arizona	1
2. To help children to have a clear understanding of what they seek to learn and to increase the techniques of recording and observing.	Arkansas	3
3. To help children understand and organize their knowledge of science, including information, concepts, and generalizations that have been or can be verified by the scientific method.	California	1
4. To develop the ability to consider evidence and to discover and apply scientific principles.	Connecticut	2
5. Growth in the ability to think clearly and logically, i.e., scientifically, and in the ability to distinguish fact from fancy, and superstition from proven principle.	Hawaii	1
6. The development of an appreciation, utilization, and intelligent action.	Idaho	1
7. Children should learn the skills of observation and accurately reporting the observations.	Indiana	1
8. Ability to make valid and accurate comparisons and observations and to distinguish between pertinent and irrelevant information.	Illinois	4
9. Understanding the cause and effect relationship and ability to draw tentative conclusions and a willingness to change when wrong.	Iowa	2

10.	To recognize the cause and effect relationship in evaluating pertinent information and identifying likeness and differentness among objects and phenomena.	Michigan	3
11.	To develop an understanding of science concepts that will help children describe and discover the cause and effect relationships that exist in the natural occurences about them.	Nevada	1
12.	There is a cause for every effect.	Pennsylvania	1
13.	To encourage children to develop scientific ways of working, including planning, observing, and forming tentative conclusions.	S. Carolina	1
14.	To emphasize through observations the orderliness of the universe.	Texas	1
15.	Students learn to observe, collect and make conclusions.	Washington	1
16.	To help children apply scientific knowledge and understandings to their personal and cultural needs.	W. Virginia	1

UNDERSTANDING THE ENVIRONMENT:

1.	To help children develop an understanding of concepts that will help them describe the natural phenomena persisting about them.	Arizona	1
2.	To provide children with experiences that will help answer their questions about the world about them.	California	1
3.	To acquire functional understandings of the nature of their relationship with the environment.	Hawaii	2
4.	The imparting of factual knowledge and basic principles of modern science.	Idaho	1
5.	To help interpret the world and the universe through accurate observations.	Michigan	2

6. To help children develop their abilities to understand the environment through their senses.	N. Hampshire	2
7. To help discover and understand ourselves and the universe in which we live.	Pennsylvania	1
8. To develop in children an understanding of their environment.	S. Carolina	2
9. To develop a growing awareness and understanding of the environment and its importance to the individual.	Texas	4
10. To increase an understanding and appreciation of the environment.	Vermont	1
11. Students learn about the environment and its interrelationships.	Washington	1
12. To develop an understanding of the natural environment.	W. Virginia	1

A SCIENTIFIC BASIS FOR SOCIAL PROBLEMS:

1. To help children in the application of the scientific method to problems in all areas of learning.	California	2
2. To gain an appreciation for the potentialities of science for the improvement of human welfare and the dangers to civilization of its misuse.	Hawaii	1
3. Growth toward socially desirable behavior.	Indiana	1
4. To aid in a more intelligent selection of consumer goods.	Kansas	1
5. Recognition of the contributions and social implications of science in everyday life, reflecting this behavior through living.	Michigan	1
6. A growing understanding of the necessity of conserving all resources.	Missouri	1
7. To help children acquire and develop scientific knowledge and practices of all phases of health.	S. Carolina	2

8. To know that science has increased our health, lifespan, comfort, efficiency, and also an understanding of the social relationships involving science.	S. Dakota	6
9. To increase the ability to act cooperatively in social situations.	Vermont	1
10. To know the interdependence of science and all other subject areas.	Washington	1

THE INTERRELATIONSHIPS OF SCIENCE AND OTHER SUBJECTS:

1. To provide children with an opportunity to express ideas and share the ideas of science and other subjects.	Indiana	1
2. To provide an opportunity for vocational and recreational pursuits.	Kansas	2
3. Growth in understanding of the basic ideas of science and in perception of the relationships between science and the non-science areas.	Michigan	1
4. Knowledge of social and physical facts and processes.	Missouri	1
5. To help youngsters recognize the interrelationships of science with their personal and social lives.	N. Hampshire	1
6. To encourage interests which develop creative hobbies	S. Carolina	1
7. To apply the methods of science to other subjects.	Tennessee	1
8. To develop an understanding and appreciation for the contributions of science to our culture.	W. Virginia	1

Table IV is a summary of the classification of the non-subject matter objectives. The number of objectives suggested by each state is shown. The objectives are ranked according to the number of objectives suggested in each classification.

TABLE IV

CLASSIFICATION OF NON-SUBJECT MATTER OBJECTIVES, SHOWING THE RANK AND NUMBER OF TIMES EACH OBJECTIVE IS RECOMMENDED BY EACH STATE

State	A Change in Attitude	Use of Tools and Skills of Science in Problem Solving	Ability to see Relationships	Understanding the Environment	Scientific Basis for Social Problems	Interrelationships of Sci. and Other Subjects
Arizona		1	1	1		
Arkansas	1	4	3			
California	5		1	1	2	
Connecticut		1	2			
Hawaii	2	2	1	2	1	
Idaho	1	1	1	1		
Illinois	1	2	4			
Indiana		1	1		1	1
Iowa	4	2	2			
Kansas	1	1			1	2
Maine	1	3				
Michigan		1	3	2	1	1
Missouri	3	2			1	1
Nevada	1	1	1			
N. Hampshire	1			2		1
Pennsylvania	1		1	1		
S. Carolina	3	2	1	2	2	1
S. Dakota	4				6	
Tennessee	2	1				1
Texas	5	4	1	4		
Vermont	1	2		1	1	
Washington			1	1	1	
W. Virginia	1	1	1	1		1
TOTAL	38	32	25	19	17	9
RANK	1	2	3	4	5	6
NO. OF STATES	18	18	16	12	10	8

CHAPTER V

THE APPROPRIATENESS OF A PROGRAM BASED ON THE CONCEPTS AND LABORATORY EXPERIENCES SUGGESTED BY THE STATE ELEMENTARY SCHOOL SCIENCE GUIDES

Science concepts and laboratory experiences recommended by the guides were summarized. The summary was reviewed by a group of educators who had extensive experience in elementary education. They consisted of administrators, classroom teachers, college teachers of elementary science methods, and a science supervisor from one of the largest public schools in Oklahoma. Each reviewer was asked to read the concepts and recommended laboratory experiences and to record his reaction on a check sheet. Each was asked to express a written opinion if he desired. Some of the written opinions were as follows:

"An adequate elementary school science program could be based on state guides only if the teacher uses ingenuity and imagination in carrying out the suggested program. With the present knowledge students have through their watching TV and space flights and listening to the explanations, the present science curriculum is too outdated to create a challenge for the interested and capable student. Most of the concepts suggested for grades one through three could be learned in the first grade if the students were given the opportunity. Instruction in health and safety is also inadequate."

"I believe a local school system could develop an adequate elementary science program based on the concepts and laboratory work found in state guides. However, with the excellent films and machines now available and the stress placed on physical fitness, I believe more laboratory work should be developed in the area of health and safety."

"As is the case with most state guides or most developed guides, the emphasis is placed on what to teach rather than how to teach it. Perhaps the assumption has been made that if the teacher knows what to teach he will automatically know how to go about teaching it. I think our best experience in elementary science would indicate this is a false assumption. It seems to me that curriculum guides, in the area of elementary science should stress the need for personal discovery and flexibility in the program rather than such a detailed list of concepts to be developed. If a large number of concepts are to be suggested, it seems only sensible to suggest an equally large number of experiences, field trips, and other aids in developing these concepts. As is true with any curriculum area, some method must be devised to cause the elementary teacher to show a willingness to spend time with an elementary science program. It is my opinion that these factors are far more important than any group of concepts or laboratory work to be learned by the children."

"I feel the students could gain a most adequate background in science from a program based on the concepts and laboratory experiences recommended by state guides."

"The concepts and laboratory work suggested by state guides would provide the basis for a <u>good</u> local science program."

"Concepts introduced at the elementary school level are useful in vocabulary development. Concepts should not be rigidly placed at any grade level. The concepts introduced at the elementary level should be broken into many simple understandings which lead to the concept. Only a very few concepts can be fully developed at the elementary school level."

"Certainly the success of any program will depend on the teacher and the provisions made by the local school. It would seem to me that a local program could be developed from the laboratory work and concepts suggested by state guides that would give the student an adequate background for further study."

"The concepts for health and safety are inadequate, for there is a growing need for instruction in health and safety in the elementary schools. I would also suggest more laboratory work in the areas of motion and earth science."

"The entire science program is in need of updating. More work should be included in the area of space, conservation, and oceanography. First year students are capable of learning many of the concepts placed at the higher grade levels."

"Science for the elementary school should stress basic fundamentals. Many of the concepts are not useful in developing a background for junior high school and high school science courses."

"An elementary school science program could be based on information found in state science guides. They seem broad enough to satisfy the child's need-to-know. I consider the state guides adequate at each grade level in concepts and laboratory work recommended."

"I feel the information in state guides is sufficient to base an elementary school science program on. The only limitations on the program would be the lack of imagination and ingenuity of the teacher. Also with the present 'explosion of knowledge,' many of the science areas need almost yearly updating."

Part one of the checksheet is summarized in Table V. All of the reviewers considered the concepts concerning mechanics, heat, light, geology, and botany adequate for an elementary school science program. The concepts in sound, modern physics, astronomy, conservation, compounds, biology, zoology, health, safety, magnetism, and electricity were considered inadequate by one or two reviewers. Three reviewers considered the concepts in meteorology inadequate and four considered the atomic theory concepts inadequate. None of the laboratory experiences were considered adequate by all of the reviewers. The laboratory work suggested by the guides in the areas of heat, geology, and botany were considered adequate by all but one reviewer. All suggested laboratory experiences in other areas were considered inadequate by two or more of the reviewers.

Part two of the checksheet is summarized in Table VI. All reviewers considered the objective of "a better understanding of the environment" adequately met by the suggested concepts and laboratory experiences. From three to six reviewers considered the concepts and laboratory experiences inadequate in meeting all other non-subject matter objectives of the elementary school science program.

TABLE V

THE NUMBER OF REVIEWERS CONSIDERING THE CONCEPTS AND LABORATORY WORK RECOMMENDED BY STATE GUIDES ADEQUATE OR INADEQUATE AS A BASIS FOR AN ELEMENTARY SCHOOL SCIENCE PROGRAM

Areas of Science	Concept		Laboratory Work	
	Adequate	Inadequate	Adequate	Inadequate
PHYSICS:				
Mechanics	12	0	10	2
Heat	12	0	11	1
Sound	11	1	9	3
Light	12	0	10	2
Electricity & Mag.	11	1	10	2
Modern Physics	11	1	9	3
EARTH SCIENCE:				
Astronomy	11	1	9	3
Geology	12	0	11	1
Meteorology	9	3	10	2
Conservation	10	2	8	4
CHEMISTRY:				
Atomic Theory	8	4	8	4
Elements	10	2	9	3
Compounds	11	1	9	3
Biochemistry	10	2	9	3
BIOLOGICAL SCIENCE:				
Biology	11	1	10	2
Botany	12	0	11	1
Zoology	11	1	10	2
HEALTH AND SAFETY:	11	1	9	3

All but two of the reviewers believed that an adequate science program could be developed from state guides. The two dissenting reviewers believed the success of a program would depend on the methods used rather than the material taught.

TABLE VI

THE NUMBER OF REVIEWERS CONSIDERING A PROGRAM OF SCIENCE BASED ON THE STATE GUIDES ADEQUATE IN MEETING THE STATED NON-SUBJECT MATTER OBJECTIVES OF THE ELEMENTARY SCHOOL SCIENCE GUIDES

Non-subject Matter Objectives Recommended by State Guides	Adequate	Inadequate
1. A change in attitude.	7	5
2. Experience in the use of the tools and skills of science in problem solving.	9	3
3. Development of the ability to see relationships.	9	3
4. A better understanding of the environment.	12	0
5. An understanding of the scientific basis for social problems.	9	3
6. An understanding of the inter-relationships of science and other subjects.	6	6

Summary

Ten reviewers felt that an adequate elementary school science program could be based on state guides. Five of the reviewers thought that state guides should be updated almost yearly, while three thought that the areas of health and safety should be expanded. One believed that concepts should not be placed rigidly at any grade level. Another thought the amount and type of laboratory experiences should be expanded, and an emphasis should be placed on how to teach, rather than on what to teach, in elementary school science.

CHAPTER VI

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

In this study, elementary science guides from thirty-one states were analyzed for the major areas of science included, sequence of treatment, science concepts taught, laboratory experiences recommended, and the non-subject matter objectives of elementary school science. The concepts and laboratory experiences were classified and arranged according to grade level and subject area. The non-subject matter objectives were classified under six main headings. A summary of the concepts and laboratory experiences were reviewed by a group of educators. The reviewers expressed opinions as to whether an elementary school science program based on state guides would adequately meet the stated objectives of elementary science. They also expressed opinions regarding the possibility of a local school building an adequate science program based on state guides.

The literature concerning the development of science concepts by elementary school children was also reviewed for this study.

Conclusions

All of the major areas of science are included in the state guides. The different areas are not covered equally well and nine

guides omit one or more areas of science. None of the recommended laboratory experiences is considered adequate in all areas of science by the reviewers. Many concepts are suggested in each area of science, but insufficient laboratory exercises are suggested to support the large number of concepts. Over twenty-five per cent of the reviewers considered the concepts and laboratory work recommended by state guides inadequate in meeting the stated non-subject matter objectives of elementary school science. Each reviewer judged the concepts and laboratory work adequate in meeting the objective of "a better understanding of the environment." All but two of the reviewers believed that an adequate elementary school science program could be developed from state guides.

A study of state guides reveals that many concepts are presented in a sequential order by grades.

According to the reviewed literature, the elementary school science program should be based on the structure of science and the discovery approach.

Implications

A study of the concepts and laboratory work recommended by state guides reveals implications for teacher training. The goal is not to teach the complete kinetic theory of heat to elementary school children but rather, to prepare teachers who, understanding the kinetic theory themselves, will lay a foundation upon which their pupils can build a progressively more sophisticated knowledge of science. The teaching of elementary school science also requires a

teacher who can draw from a wide range of laboratory work and who can adapt the experiences to the various levels of the students. The state and local school system should constantly revise and update the information on which the teacher can build the classroom science program.

In some areas of science twenty-five per cent of the reviewers believed a program based on the recommended concepts and laboratory work would fail to meet the stated non-subject matter objectives of elementary school science. If the subject matter concepts are considered adequate and the objectives are not being met, this would imply a possible re-evaluation of the objectives. The re-evaluation should be done in the light of the findings from the various elementary school science programs being developed at the centers discussed in the survey of literature of this study.

Recommendations

It is recommended that:

1. A study be made of the grade placement of science concepts and supporting laboratory experiences in elementary school science.
2. A study be made of the major areas of science to determine if they can be broken into small parts and can be organized in a conceptual structure for elementary school science in a way that aids the development of the discovery process of science in children.
3. A comparative study be made of state and local school system guides.

4. Any state or local school system planning to develop a science guide should give consideration to the findings of the various elementary school science centers discussed in the survey of literature section of this study.
5. Any state or local school system planning to develop a science guide should give consideration to the structure of science and the discovery approach as advocated by Bruner and Piaget.
6. A study of the science subject matter preparation of elementary school teachers be made in relation to what they are expected to teach in elementary school science.
7. Consideration should be given to the development of science as a continuous process from the lower grades upward with each grade being an integral part of the whole sequential program.
8. Science in the elementary school should be a separate organized subject providing a continuous evolving learning experience from kindergarten through the elementary school.
9. A study be made of such areas as health, safety, biochemistry, the human body, energy, and atomic theory in order to expand and achieve a better balance of subject matter in elementary school science.
10. All state and local science guides be revised and updated at frequent intervals.
11. A comparative study be made of the science concepts recommended by guides published in the various geographical regions of the United States.

12. Consideration be given the interrelationships of science and other subjects in the development of an elementary school science guide.

A SELECTED BIBLIOGRAPHY

Aherns, Robert B. "Minnemast, the Coordinated Science and Mathematics Program." Science and Children, II (February, 1965), 16-18.

Anastasion, Nichalos. "Experiments in Elementary Science." The Science Teacher, XXVII (October, 1960), 14-17.

Atkins, Myron J. "The Elementary School Science Curriculum." The Science Teacher, XXVII (March, 1960), 51-54.

Barnes, Cyrus W. "A Definition of Science Education Curriculum Research." Science Education, XXXXV (December, 1961), 394-396.

Barswell, A. L. "Science For the First Grade." Science and Children, II (February, 1965), 10-13.

Blanc, Sam G. and Low, John W. An Analysis of Selected Science Guides, Grades K-9. Denver: Division of Instructional Services, Denver Public Schools, 1958.

Blough, Glenn O. It's Time for Better Elementary School Science. Washington: National Science Teachers Association, 1958.

Bruner, Jerome S. The Process of Education. New York: Vintage Books, 1960.

Burns, Paul C. "Research on the Teaching of Elementary School Science." The Science Teacher, XXVII (March, 1960), 48-29.

Decker, Donald G. "N. S. T. A. Committee Report on the K-12 Science Program." The Science Teacher, XXVIII (October, 1961), 15-17.

Dewey, John. Democracy and Education. New York: The Macmillan Company, 1916.

Duckworth, Eleanor R. "Piaget Rediscovered." Newsletter, Elementary Science Study, (June, 1964), 2-4.

Five Major Areas of Concern in Science Education. Washington: National Science Teachers Association, 1962.

Heathers, Glen. "A Process Centered Elementary Science Sequence." Science Education, XXXXV (April, 1961), 201-206.

Hill, Katherine. "Issues and Problems in Elementary Science in a Changing World." Science Education, XXXXVII (March, 1963), 109-113.

Hurd, Paul DeHart. "The New Curriculum Movement in Science." The Science Teacher, XXIX (February, 1962), 6-9.

_____. "Toward a Theory of Science Education Consistent with Modern Science." Theory Into Action - In Science Curriculum Development, Washington: National Science Teachers Association, 1964.

Livermore, Arthur H. "Science - A Process Approach." Science and Children, I (May, 1964), 24-25.

Lundstrom, Donald and Lowery, Lowrance. "Process Patterns and Structural Themes in Science." The Science Teacher, XXXI (September, 1964), 16-19.

Neal, Louise A. "A Discovery Approach for Developing Productive Thinking." Science and Children, II (November, 1964), 16-17.

Piltz, Albert. Science Equipment and Materials for the Elementary Schools. Washington: United States Department of Health, Education, and Welfare, 1961.

Pratt, Grace K. "Developing Concepts About Science in Young Children." Science and Children, I (December, 1963), 21-22.

Renner, John W. The Thrill of Discovery in Science Education. Randolph, Wisconsin: Educators Progress Service, 1963.

Science Education News. Washington: American Association for the Advancement of Science, 1961.

Science Courses of Study. Washington: National Science Teachers Association, 1964.

Scott, Lloyd. "An Experiment in Teaching Basic Science in the Elementary School." Science Education, XXXXVI (March, 1962), 105-108.

_____. "The University of California Elementary School Science Project: A Two Year Report." Science Education, XXXXVI (March, 1962), 109-113.

Smith, Eugene H. "An Analysis of Some Prominent Viewpoints on the Teaching of Elementary School Science." Science Education, XXXXVII (March, 1963), 188-193.

Smith, Herbert A. and Anderson, Kenneth E. "Science." Encyclopedia of Educational Research (3rd. ed.), 1216-1232.

State Curriculum Guides in Science, Mathematics, and Modern Foreign Language, A Bibliography. Washington: United States Office of Education, 1961.

Their, Herbert D. "The Involvement of Children in the Science Program." Science and Children, II (February, 1965), 19-21.

Victor, Edward, "Why are Elementary School Teachers Reluctant to Teach Science?" The Science Teacher, XXVII (October, 1961), 17-19.

Zafforoni, Joseph. New Developments in Elementary School Science. Washington: National Science Teachers Association, 1963.

APPENDIX A

STATE SCIENCE GUIDES

Elementary Courses of Study, Scope and Sequence for Alaska Schools, State Department of Education, Juneau, Alaska, 1962.

A Basic Outline of Science in the Arkansas Elementary Schools, State Department of Education, Little Rock, Arkansas, 1964.

Science Guide for the Elementary Schools of Arizona, State Department of Public Instruction, Phoenix, Arizona, 1962.

Science Curriculum Development in the Elementary Schools, California State Department of Education, Sacramento, California, 1964.

Looking Ahead in Science, California State Department of Education, Sacramento, California, 1960.

Elementary Education: A Guide to Curriculum Development. State Department of Education, Hartford, Connecticut, 1962.

Science for Georgia Schools, Vol. I, State Department of Education, Atlanta, Georgia, 1960.

Science for Georgia Schools, Vol. II, State Department of Education, Atlanta, Georgia, 1960.

Science Guide for the Elementary Schools of Hawaii, Department of Education, State of Hawaii, Honolulu, Hawaii, 1962.

Idaho Course of Study Outline for Elementary Education, Grades 1-6, State Department of Education, Boise, Idaho, 1963.

A Good Start in School, State of Indiana, Department of Public Instruction, Bulletin No. 226, 1958.

Strengthening Science Teaching in Elementary Schools, Illinois Curriculum Program Subject Field Series, Bulletin C-3, State Department of Public Instruction, Springfield, Illinois, 1960.

Science for Iowa Schools, Grades K-3, State of Iowa, Des Moines, Iowa, 1964.

A Curriculum Guide for the Elementary Schools of Kansas, State Department of Public Instruction, Topeka, Kansas, 1958.

A Guide to Learning in Grades Four, Five, and Six, State of Maine Department of Education, Augusta, Maine, 1959.

Guidelines for the K-12 Science Program, The Department of Public Instruction, Lansing, Michigan, 1961.

A Guide for Elementary Education, Publication No. 100, State Department of Education, Jefferson City, Missouri, 1955.

The Study Guide in Science, Grades 1-6, State Department of Public Instruction, Helena, Montana, 1963.

Nevada Elementary Course of Study. State Department of Education, Carson City, Nevada, 1964.

Elementary Science Guide, Grades 1-6, New Hampshire Department of Education, Concord, New Hampshire, 1961.

Science for Children, Grades K-3, The State Education Department, Albany, New York, 1963.

Science for Children, Grades 4-6, The State Education Department, Albany, New York, 1963.

Teaching Science, A Guide to the Problem Approach, State of New Jersey Department of Education, Trenton, New Jersey, 1958.

Science for the Nebraska Elementary School Children, Course of Study and Instructional Guide. State Of Nebraska Department of Education, Lincoln, Nebraska, 1960.

Handbook of Science for the Elementary Schools of North Dakota, Department of Public Instruction, Bismarck, North Dakota, 1960.

The Improvement of Science Instruction in Oklahoma, Grades K-12, The Oklahoma State Department of Education, Oklahoma City, Oklahoma, 1960.

Earth and Space Guide for Elementary Teachers, Curriculum Service Series No. 3, Pennsylvania Department of Public Instruction, Harrisburg, Pennsylvania, 1961.

Guide for Teaching Science, Grades 1-6, State Department of Education, Columbia, South Carolina, 1962.

Course of Study, Bulletin No. 44A, South Dakota Department of Public Instruction, Pierre, South Dakota, 1960.

Science in the Elementary Schools, Grades 1-6, State of Tennessee Department of Education, Division of Instruction, Nashville, Tennessee, 1964.

Science, Grades 1-9, Bulletin No. 643, Texas Education Agency, Austin, Texas, 1961.

Science, Grades 1-6, Vermont, Vermont State Department of Education, Division of Instruction, Montpelier, Vermont, 1960.

Guidelines for Developing the K-12 Science Program, Department of Public Instruction, Olympia, Washington, 1964.

Science, A Source Book for Elementary Teachers, Grades 1-12, State Department of Education, Charlestown, West Virginia, 1961.

APPENDIX B

THE REVIEWING EDUCATORS

Name	School	Position
Berlin, Lucile	Tulsa Public Schools	Science Coordinator
Blaire, Mae	Temple Public Schools	Teacher
Downing, Carl	Central State College	Methods Teacher
Haught, Sue	Central State College	Methods Teacher
Hosey, J. Willard	Tulsa Public Schools	Administrator
Hudson, Lyndall	Oklahoma City Public Schools	Teacher
Jones, Florence	Oklahoma City Public Schools	Teacher
Loafman, Letha	Sand Springs Public Schools	Teacher
Martin, Julia	Sand Springs Public Schools	Teacher
Miller, Eugene	Waurika Public Schools	Administrator
Rout, Ray	Sand Springs Public Schools	Administrator
Tilmon, Manila	Sand Springs Public Schools	Teacher

APPENDIX C

THE CHECK SHEET

Name_____Position_____

School_____Years of Experience in Elementary Education_____.

I. Are the areas of science treated adequately by the concepts and laboratory work found in state guides?

AREAS OF SCIENCE	CONCEPTS		LABORATORY WORK	
	Adequate	Inadequate	Adequate	Inadequate
PHYSICS:				
Mechanics				
Heat				
Light				
Electricity & Magnetism				
Modern Physics				
EARTH SCIENCE:				
Astronomy				
Geology				
Meteorology				
Conservation				
CHEMISTRY:				
Atomic Theory				

Elements				
Compounds				
Biochemistry				
BIOLOGICAL SCIENCE:				
Biology				
Botany				
Zoology				
HEALTH & SAFETY:				

II. Will an elementary school science program based on the concepts and laboratory work, found in state guides, adequately meet the objectives of elementary school science?

Objectives Recommended by State Guides	Adequate	Inadequate
1. A change in attitude		
2. Experience in the use of the tools and skills of science in problem solving		
3. Developing the ability to see relationships		
4. A better understanding of the environment		
5. An understanding of the scientific basis for social problems		
6. An understanding of the inter-relationships of science and other subjects		

III. Could a local school system develop an adequate elementary school science program based on the concepts and laboratory work found in state guides?

YES_____, NO_____

IV. Please discuss briefly the areas of science you consider to need more emphasis, or less emphasis, for an adequate elementary school science program.

APPENDIX D

SUMMARY OF CONCEPTS AND LABORATORY WORK RECOMMENDED BY STATE ELEMENTARY SCIENCE GUIDES

Concepts	No. of States Recommending the Concept
PHYSICS:	
Light Concepts, Grade One:	
1. Light lets us see and the sun is our main source.	16
2. Light will pass through some objects and not through others; shadows are made when light will not pass through an object.	12
3. The sun, fire, and electric lights can produce light.	10
4. There are many colors in sunlight.	10
5. Light comes from hot objects and atoms under certain conditions.	4
6. Light is a form of energy.	4
7. Light usually travels in a straight line, but it can be bent.	3
8. Some objects glow even when not hot.	2
Light Concepts, Grade Two:	
1. Shadows are formed when objects will not allow light to pass through.	13
2. Light comes from the sun, electricity and fire.	12

3.	Some objects will allow more light to pass through than others.	10
4.	Sunlight is made of many colors.	9
5.	Light travels in a straight line, but it can be bent.	6
6.	Shadows can indicate direction; as the sun rises, shadows shorten.	6
7.	Light is a form of energy.	3

Light Concepts, Grade Three

1.	Light travels in a straight line, but it can be bent under certain conditions.	9
2.	The sun is our primary source of light, but we also get light from fire and electricity.	8
3.	Light energy does not depend upon a medium for transmission.	7
4.	White light is made up of all the colors of the rainbow.	7
5.	Light travels very fast.	6
6.	The color of the light is determined by the energy of the photon.	5
7.	Light consists of bundles of energy (photons) that travel in a straight line.	5

Light Concepts, Grade Four:

1.	Visible light is a form of radiant energy and the sun is the primary source.	14
2.	Most of the energy reaching the earth comes to us as radiant energy.	13
3.	Light energy can be changed to other forms of energy; when it is absorbed it is heat energy.	11
4.	Some objects are opaque to light thus forming shadows.	9
5.	The speed of light is 186,000 miles per second.	9

6.	Light can be reflected, absorbed, and directed.	8
7.	Sunlight is made of all colors.	6

Light Concepts, Grade Five:

1.	Light is a form of energy.	16
2.	Light can be absorbed, directed, transmitted, reflected, and broken into its different colors.	15
3.	Light energy can be transformed into heat energy.	15
4.	The darker the color of a surface the better it will absorb heat and light.	15
5.	Light travels at the speed of 186,000 miles per second.	14
6.	A rough surface will reflect light in all directions while a smooth surface reflects light in only one direction.	13
7.	The human eye is similar to the camera.	13

Light Concepts, Grade Six:

1.	Most of our light comes from the sun in the form of radiant energy.	19
2.	Light energizes chlorophyll in green plants.	18
3.	Light can be transmitted, directed, reflected, absorbed, and broken into its colors.	18
4.	There are many kinds of lenses.	18
5.	Visible light is only a very small segment of the electromagnetic spectrum.	18
6.	Light affects living things in many different ways.	17
7.	Various substances are opaque, transparent, or translucent.	17
8.	Light travels out in a straight line from its source.	17

9.	The reflection of light follows certain laws of nature.	16
10.	The speed of light is 186,000 miles per second.	16
11.	The color of an opaque object depends upon the energy of the reflected photon.	16

LABORATORY EXPERIENCES IN LIGHT:

1.	A Magnifying Glass	13
2.	A Rainbow	12
3.	The Refraction of light	12
4.	The Absorption and Reflection of Light	11
5.	How Light Travels	14
6.	A Periscope	4

Heat Concepts, Grade One:

1.	The sun is our main source of heat.	13
2.	Heat will travel better through some things than through others.	11
3.	Thermometers are used in measuring the intensity of heat.	10
4.	There are sources of heat other than the sun.	8
5.	Heat makes things expand.	8
6.	Fire produces heat, and air is necessary for fire.	7
7.	Heat has many uses.	5
8.	Heat flows away from warmer things toward cooler things.	5
9.	We get heat from fuels, electricity, chemical reactions, friction, food, and the breakdown of atoms.	5
10.	Our bodies give off heat.	3
11.	Dark colored substances absorb heat faster than light colored things.	2

Heat Concepts, Grade Two:

1.	Things tend to expand when heated.	13
2.	Heat is measured with a thermometer.	13
3.	The sun is our greatest source of heat and energy.	12
4.	Heat tends to flow from hot to cold bodies.	7
5.	Three things are necessary for burning; fuel, air (oxygen), and heat.	7
6.	Heat can be produced by friction.	6
7.	Some materials are better conductors of heat than others.	6
8.	Heat energy can be transmitted by conduction, convection, and radiation.	6
9.	Heat is liberated or absorbed when liquids, solids, or gases change from one state to another.	6
10.	Good absorbers of heat are also good radiators of heat.	4

Heat Concepts, Grade Three:

1.	Heat is a form of energy.	14
2.	Temperature changes are measured with a thermometer.	12
3.	Heat causes molecules to move faster.	12
4.	Evaporation is speeded up by heat.	11
5.	Some materials are good conductors of heat, others are not.	10
6.	Most materials expand when heated and contract when cooled.	10
7.	Some materials will burn faster than others.	9
8.	Fuels must be heated to the kindling temperature before they will burn.	9
9.	The earth gives off heat into the air.	8
10.	Burning takes place on the surface of materials.	7

11.	Bundles of heat (heat photons) have less energy than light photons.	7
12.	The boiling point can be raised by increasing the pressure on the surface of a liquid.	6

Heat Concepts, Grade Four:

1.	Heat from friction is wasted heat.	12
2.	Heat is a form of energy.	11
3.	Heat energy is used to run machines.	11
4.	The total amount of heat produced from a given amount of matter is the same whether it is produced slowly or rapidly.	11
5.	Heat can be produced by fire, friction, and electricity.	10
6.	Some materials are good conductors of heat; others are not.	10
7.	Dark surfaces give off heat better than light surfaces.	10
8.	Heat causes the molecules of a material to move faster.	9
9.	When water changes into ice, it expands and becomes less dense.	8
10.	Heat helps operate the water cycle in nature.	8
11.	Rapid oxidation or combustion will release heat.	8
12.	Anything will cease to burn when it is cooled below its kindling temperature.	7

Heat Concepts, Grade Five:

1.	Heat causes solids to melt and liquids to evaporate, and speeds up chemical reactions.	17
2.	Heat is a form of energy.	16
3.	Most substances expand when heated and contract when cooled.	15
4.	Heat is conducted by the transfer of kinetic energy from molecule to molecule.	15

5. Heat is transmitted primarily by convection in fluids. 15

6. Cold is the absence of heat. 14

7. When two bodies of different temperature are in contact there is a continuous exchange of energy. 14

8. Radiant energy travels in straight lines from its source. 14

9. Loss of heat causes gases to condense. 14

10. Every substance has its own boiling and melting point. 14

11. When a substance is dissolved in a liquid, the freezing point is lowered and the boiling point is raised. 14

12. Pressure will change the boiling point of liquid. 14

13. Fuel, oxygen, and kindling temperature are necessary for burning. 14

Heat Concepts, Grade Six:

1. Heat can be used to do work. 18

2. Heat may be transferred from one substance to another. 17

3. Nuclear fission and fusion release great amounts of heat energy. 17

4. Heat is transferred by conduction, convection, and radiation. 17

5. Heat travels from molecule to molecule in matter. 14

6. When sunlight strikes the earth, it is converted into heat. 13

7. Friction can produce heat. 13

LABORATORY EXPERIENCES IN HEAT:

1. The Conduction of Heat 15

2. The Cooling Effect of Evaporation 16

3. The Absorption and Radiation of Heat	14
4. The Expansion of Air When Heated	14
5. The Effect of Heat on A Solid	13
6. The Thermometer	13
7. Spontaneous Combustion	11

Sound Concepts, Grade One:

1. There are many different sounds.	11
2. Sound can travel through air and water.	9
3. Sounds are made when things vibrate.	8
4. Some sounds are pleasing to the ear.	5
5. We use sound when we talk to each other.	5
6. Sound will not travel through a vacuum.	4
7. Sound can be reflected.	3
8. Sound is a form of energy.	2

Sound Concepts, Grade Two:

1. Sounds are produced by vibrations.	13
2. Sounds will travel through water, air, and solids.	12
3. Sound travels out in waves in all directions from a vibrating body.	11
4. It takes time for sound to travel.	10
5. Sound is all about us, and it is a form of energy.	9
6. The faster the vibrations, the higher the pitch of the sound.	8

Sound Concepts, Grade Three:

1. Sound waves spread in all directions from the source.	13
2. Sound waves can be directed.	11

3.	When sound waves strike our ear drum, vibrations are set up.	11
4.	Sound is used for communication.	10
5.	Sound is a form of energy.	10
6.	An echo is a reflected sound.	9
7.	Sounds differ in pitch.	9
8.	Sound is conducted by liquids, solids, and gases.	9
9.	Sound is produced by musical instruments.	8

Sound Concepts, Grade Four:

1.	Sound is a form of energy, and the loudness is determined by the amount of energy carried by the sound wave.	11
2.	Sounds differ in pitch, quality, and intensity, depending upon the vibrations per second.	11
3.	Sound is produced by vibrating matter and sound can cause matter to vibrate.	11
4.	The speed of sound depends on the transmitting medium.	11
5.	Sound can be directed, reflected, and absorbed.	10
6.	Pitch can be changed with the length and tension of a vibrating string.	9
7.	Pitch produced by a vibrating column of air changes with the length of the column of air.	9
8.	Sound can be recorded and reproduced.	7
9.	Musical sounds are produced by wind, strings, and percussion instruments.	7

Sound Concepts, Grade Five:

1.	Sound is a form of energy.	17
2.	Sound is used in communication.	15
3.	The speed of sound depends upon the transmitting medium.	14

4.	The human ear transmits vibrations into nerve impulses.	14
5.	The pitch produced by a vibrating string depends on its length, tension, and weight.	14
6.	Sound can be directed, reflected, and absorbed.	14

Sound Concepts, Grade Six:

1.	The speed of sound is about 1100 ft. per second.	18
2.	An approaching sound seems to be higher in pitch than a receding one (Doppler Effect).	17
3.	Some sound waves can not be detected by the human ear.	17
4.	Sound is produced by vibrations, high and low sounds depend on the vibrations per second.	17
5.	Sound is used in communication.	13

LABORATORY EXPERIENCES IN SOUND:

1.	What Makes Sound?	14
2.	The Sound Waves	13
3.	A Vibrating Wire	11
4.	Magnifying Sound Waves	9
5.	A Tin Can Telephone	7
6.	Sound Rings in Action	1

Mechanics Concepts, Grade One:

1.	There are many different kinds of machines and they help make man's work easier.	13
2.	The simple machines are the screw, wedge, wheel and axle, lever, inclined plane, and pulley.	10
3.	Machines help people do work faster and easier.	9
4.	Some objects are lighter than air while others are heavier than air.	8
5.	Some objects will float in water while others sink.	6

6.	When things are moved from place to place, work is done.	5
7.	Simple machines are combined to make complex ones.	4
8.	Wind can be a source of power and do work.	4
9.	When two objects are rubbed together, friction occurs.	3

Mechanics Concepts, Grade Two:

1.	Machines make man's work easier.	15
2.	Water, wind, electricity, heat, animals,and machines help man work.	14
3.	Work is done when something is moved and energy is used.	10
4.	Man has invented machines to travel in water, air, and on land.	10
5.	Wind is a source of power.	10
6.	Complex machines are a combination of simple ones.	10
7.	The weight of an object is due to the force of gravity on its mass.	9
8.	Wood, coal, and gas are fuels used to produce energy.	9
9.	Some objects will float; others will not.	7
10.	There is friction when two things slide over each other.	5

Mechanics Concepts, Grade Three:

1.	Machines make work easier.	16
2.	Man has learned to make use of energy from many sources.	15
3.	Air occupies space and has weight.	14
4.	Wheels and rollers will reduce friction.	14
5.	Friction is produced when one object slides over another.	13

6.	The use of simple machines or a combination of simple machines gives a mechanical advantage.	13
7.	Some things will float; others will sink.	11
8.	Most machines are compound.	5

Mechanics Concepts, Grade Four:

1.	Friction is resistance to motion, and work is required to overcome it.	14
2.	Machines are used to make work easier.	14
3.	Air exerts pressure and has weight.	10
4.	All machines may be analyzed into simple machines.	10
5.	Simple machines are the inclined plane, lever, screw, wedge, wheel and axle, and pulley.	10
6.	Water is a source of mechanical energy.	9
7.	Matter occupies space and has weight.	9
8.	Inertia is a basic property of matter.	8
9.	Friction is reduced by lubrication and bearings.	8
10.	Density varies with the kind of matter.	8

Mechanics Concepts, Grade Five:

1.	Machines are used to increase force and speed.	19
2.	Work obtained with a machine is always less than work put into the machine because of friction.	18
3.	Complex machines are a combination of simple ones.	17
4.	Energy is the ability to do work.	16
5.	Weight is a measure of the pull of gravity.	15
6.	Energy resulting from a body in motion is kinetic energy.	15
7.	The energy possessed by a body because of its position is potential energy.	15

8.	Friction depends on the surfaces in contact and the force pushing them together.	15
9.	Rolling friction is less than sliding friction.	15
10.	There are ways of reducing but not eliminating friction.	15
11.	Water exerts pressure and has weight.	15
12.	Modern transportation has revolutionized our way of life.	13
13.	Forces work in pairs.	5

Mechanics Concepts, Grade Six:

1.	Man uses energy to run machines.	19
2.	A machine is anything that connects energy to a place where work is to be done.	18
3.	Man combines simple machines to form complex ones.	18
4.	All bodies fall with a constant velocity when air resistance acts on them.	18
5.	Acceleration of a body depends on the mass and the force applied.	18
6.	Pressure at any given point in a fluid is the same in all directions.	18
7.	For every action there is an equal and opposite reaction.	18
8.	Rocket engines do not depend on the air or oxygen from the earth's atmosphere.	17
9.	Automobile engines are internal combustion engines.	1

LABORATORY EXPERIENCES IN MECHANICS:

1.	An Inclined Plane	16
2.	The Lever	16
3.	The Pulley	16
4.	Inertia	15
5.	Rockets and Jet Propulsion	14

6.	Why Objects Float or Sink	13
7.	The Pressure of Water	13
8.	The Density of Liquids	13
9.	The Screw	12
10.	The Surface Tension of Water	11
11.	Centrifugal Force	11
12.	Centripetal Force	9
13.	The Venturi Effect	7
14.	A Cork Fisherman	1

Electricity and Magnetism Concepts, Grade One:

1.	Magnets will attract some things and not others.	17
2.	Magnets are strongest at the ends.	17
3.	Electricity produces heat, light, and power.	12
4.	Magnetism can pass through many substances.	11
5.	Magnets can remove iron from a mixture.	10
6.	Natural magnets are called lodestones and they can be used to make other magnets.	9
7.	Things that are run by electricity have two wires, and they carry electricity.	9
8.	Some things conduct electricity better than others.	9
9.	The earth acts as a giant magnet, and a magnetic needle always points north.	9
10.	Electricity can be used to do many kinds of work.	8
11.	Electricity can be very dangerous.	8
12.	Magnets are very useful and can be used in machines.	6

13.	Some toys are run by electricity; the batteries are called dry cells.	5
14.	Lightning is static electricity.	3
15.	There are different kinds of magnets, like magnetic poles repel each other and unlike magnetic poles attract each other.	3

Electricity and Magnetism Concepts, Grade Two:

1.	Electricity and magnetism can be used to do work.	15
2.	Magnets attract things made of iron, nickle, and cobalt.	12
3.	All magnets do not have the same strength.	11
4.	Magnetism can be induced into iron.	9
5.	Current electricity is a movement of charged particles along a wire in a closed circuit.	9
6.	Electricity can produce heat and light.	9
7.	There are permanent, temporary, and natural magnets.	8
8.	Dry cell batteries are sources of electricity.	7
9.	A free swinging magnet will act as a compass.	6
10.	Like magnetic poles repel; unlike ones attract.	6
11.	The earth acts as a hugh magnet.	6
12.	Magnetism appears every time a current of electricity flows through a wire.	5
13.	Friction can produce static electricity.	5

Electricity and Magnetism Concepts, Grade Three:

1.	Like magnetic poles repel and unlike ones attract.	17
2.	Electricity is a form of energy and can do work.	16

3.	A compass needle points to the earth's magnetic north pole.	16
4.	Electricity will flow in a conductor when it has a complete path.	15
5.	Some materials are good conductors of electricity; others are not.	15
6.	The earth acts as a huge magnet.	14
7.	Soft iron can be made a temporary magnet.	14
8.	Many objects will collect static electricity when they are rubbed.	13
9.	Man uses electricity for communication.	13
10.	There are two kinds of electric charges; positive and negative.	12
11.	Like electric charges repel each other and unlike charges attract each other.	12

Electricity and Magnetism Concepts, Grade Four:

1.	Man is constantly improving his use and utilization of electricity.	14
2.	Magnets always have two poles and they are unlike.	14
3.	The earth has a magnetic north and south pole.	14
4.	Electricity creates an electromagnet in electric motors which exerts a push and pull on magnetic parts.	13
5.	Materials that permit the easy flow of electrons are called conductors.	13
6.	Iron, nickel, and cobalt are magnetic substances.	13
7.	When an excess of electrons are stored in one place it is called static electricity.	12
8.	Steam, water, and fuel can be used as a source of electric power.	11
9.	When an electric current passes through a wire a magnetic field is set up around the wire.	11

10.	Insulation will prevent the flow of an electric current.	10
11.	A current of electricity can be produced by magnetism.	10
12.	Direct current flows in one direction while alternating current flows in both directions.	9

Electricity and Magnetism Concepts, Grade Five:

1.	Magnets possess energy.	19
2.	Electricity is a form of energy and can be converted into mechanical energy.	19
3.	Electrons have a magnetic and electric field.	18
4.	Static electricity is produced by friction and is lost in moist air.	18
5.	Like electric charges repel and unlike attract each other.	17
6.	Electricity is a flow of electrons and can be produced by a chemical change.	17
7.	There are two kinds of electric charges.	16
8.	An uncharged body has an equal number of negative and positive charges.	16
9.	A deficiency of electrons is a positive charge, and an excess is a negative charge.	16
10.	Charges flowing in a conductor tend to stay on the surface of the conductor.	16
11.	Lightning is a form of static electricity.	16
12.	Electric power is measured in watts, kilowatt hours, and volts; resistance is measured in ohms.	16

Electricity and Magnetism Concepts, Grade Six:

1.	Electricity can be produced by friction, chemical action, and magnetism.	20
2.	There are many theories of magnetism.	20
3.	Radio waves are formed by electrical energy.	19

4.	An electromagnet is a magnet formed by electricity.	19
5.	Conductors carry electric current while insulators prevent its flow.	19
6.	Electricity can produce heat and light.	19
7.	Electric circuits can be wired in series or in parallel.	19
8.	A magnetic field is formed around wires carrying electric currents.	18
9.	All magnets have two unlike poles.	18

LABORATORY EXPERIENCES IN ELECTRICITY AND MAGNETISM:

1.	How Magnets Act Toward Each Other	17
2.	Building an Electromagnet	17
3.	The Production of Static Electricity	16
4.	A Dry Cell Battery	15
5.	What Materials Conduct Electricity?	14
6.	A Telegraph Set	13
7.	Wiring Lights in Series and in Parallel	13
8.	The Magnetic Compass	12
9.	A Simple Electroscope	10
10.	The Electric Motor	10
11.	The Fuse	9

Modern Physics Concepts, Grade One:

1.	Molecules are always in motion.	2
2.	There is much energy in the atom.	2
3.	Atoms are made of particles that are electric in nature.	2

Modern Physics Concepts, Grade Two:

1.	Heat causes molecules to move faster.	6

2.	All matter is composed of molecules.	6
3.	Atoms are made of electrons, protons, and neutrons.	2

Modern Physics Concepts, Grade Three:

1.	Matter and energy are different forms of the same thing.	10
2.	Large machines have been built to use atomic energy.	10
3.	The ultimate source of all energy is the conversion of matter into energy by the atomic process.	9
4.	The total amount of energy in the universe remains constant.	8
5.	A small amount of matter can produce a great amount of energy, but a large amount of energy is required to produce a small amount of matter.	7
6.	The energy from the sun is the results of the fusion of hydrogen to form helium.	7

Modern Physics Concepts, Grade Four:

1.	Matter is the basic building material of the universe and we are familiar with the liquid, solid, and gaseous states of matter.	14
2.	Matter can be converted from one form to another.	14
3.	Molecules are in a constant state of motion.	12
4.	Energy acting on matter can cause a change in physical state.	12
5.	Matter has weight and occupies space.	12
6.	Physical states of matter change by altering the speed and space between the molecules.	11
7.	Atomic energy is becoming increasingly more important in our lives.	11
8.	Solids have a definite shape and volume; liquids have a definite volume but not shape; gases have neither a definite shape nor volume.	10

9. Matter and energy can not be created or destroyed, but they can be converted from one form to the other.	10

Modern Physics Concepts, Grade Five:

1. Energy can be changed from one form to another.	18
2. Molecules are in constant motion.	16
3. Molecules are held together tightly in solids.	16
4. Molecules move freely in liquids.	16
5. Molecules move very fast in gases and have much space between them.	16
6. The breaking of an atom into its parts releases much energy.	16
7. Electrons have a magnetic and electric field.	15
8. The speed of molecules varies as the temperature.	15

Modern Physics Concepts, Grade Six:

1. Matter may be a liquid, solid, or gas.	18
2. Some atoms are radioactive and release energy naturally.	18
3. Man has learned to use atomic energy.	18
4. There are great quantities of energy in the atom.	18
5. Matter and energy are interchangable.	18
6. Radioactive elements constantly change.	17
7. Radioactive elements are both man made and occur in nature.	17
8. By radiation it is possible for one element to change into another element.	17
9. All bodies of matter have a gravity field the strength depending upon the mass of the body.	17

LABORATORY EXPERIENCES IN MODERN PHYSICS:

1.	A Ping Pong Ball Chain Reaction	1
2.	Drawings of Nuclear Structure	1
3.	Tinker Toy Atomic Models	1

EARTH SCIENCE:

Meteorology Concepts, Grade One:

1.	Rain and snow come from water vapor in the air, and warm air will hold more water vapor than cold air.	20
2.	The four seasons of the year are spring, fall, summer, and winter; they are not the same everywhere.	19
3.	Air takes up space and is all around us.	18
4.	Wind is moving air and it moves from different directions and at different speeds.	18
5.	Life on earth is affected by changes in the seasons.	15
6.	Wind helps evaporate water and to dry things.	11
7.	Life on earth depends on the energy from the sun.	10
8.	The wind can be both helpful and harmful.	10
9.	Most containers which we say are empty are really filled with air, which has weight and occupies space.	9
10.	The surface of the earth is warmed by day and cooled by night; this in turn warms and cools the air above it.	9
11.	Clouds have different shapes.	7
12.	The weather can change daily, so man has developed instruments to help him perdict the changes in the weather.	7
13.	When the air is heated it rises, and when it is cooled it sinks.	6

14.	The seasonal changes affect the water and food supply of living things.	4
15.	The earth is part land, part water, and part air.	4
16.	The evaporation of water cools things.	3
17.	Days and nights are about equal in length at the beginning of fall and spring.	3

Meteorology Concepts, Grade Two:

1.	The seasons of the year have characteristic weather.	19
2.	The heat from the sun causes changes in the weather and man can predict the changes.	18
3.	Water evaporates and forms clouds and it rains; then the process starts over (water cycle).	16
4.	The weather brings about many changes in the work and play habits of man.	16
5.	Wind is moving air and it exerts a force.	15
6.	Evaporation of water causes the temperature to change.	14
7.	Warm air can hold more water vapor than cold air.	11
8.	Clouds are very tiny droplets of water or ice crystals.	11
9.	Large bodies of water affect the climate.	11
10.	Cold air pushes warm air upward.	10
11.	The earth and all life on it are affected by the weather.	10
12.	Air exerts a pressure.	10
13.	Water expands when it freezes and is less dense.	8
14.	In the spring the days grow longer and the nights shorter.	3

Meteorology Concepts, Grade Three:

1.	Water evaporates and condenses with temperature changes and warm air can hold more water vapor than cold air.	18
2.	Local winds are caused by the uneven heating of the surface of the earth.	17
3.	Weather is a major cause of the changes in the earth's surface.	17
4.	Clouds are formed by condensed water vapor.	16
5.	Air expands and rises when heated and contracts and descends when cooled.	16
6.	During the day the air moves from bodies of water to the land; during the night the process is reversed.	15
7.	Air is matter and wind is moving air.	15
8.	The earth has distinct climatic zones.	14
9.	The weather changes from day to day.	14
10.	Trapped still air is a good insulator.	12
11.	Heat from the sun evaporates ocean water.	12
12.	Air is warmed when it is compressed and cooled when it expands.	12
13.	Ocean currents influence the weather.	7
14.	Many different instruments are used to measure the conditions in the atmosphere.	6

Meteorology Concepts, Grade Four:

1.	Heat causes water to evaporate into an invisible vapor.	16
2.	When water vapor is cooled it condenses into a liquid.	15
3.	The process of evaporation and condensation is called the water cycle.	15
4.	Air is matter and exerts a pressure.	15
5.	The angle of the sun's rays determines the amount of solar (heat) energy received by the earth.	15

6.	Man uses many instruments to study the weather.	15
7.	The earth's atmosphere acts like a blanket to reduce the loss of heat from the earth.	15
8.	Large bodies of water change the temperature of the surrounding land.	15
9.	Condensed water vapor falling to the ground is rain.	14
10.	An area of the earth will begin to heat up when the amount of solar radiation received is greater than the amount of heat lost (seasonal change).	14
11.	The weather can change rapidly from day to day.	14
12.	Convection currents in the air are caused by heat.	14
13.	Warm air will hold more moisture than cold air.	12

Meteorology Concepts, Grade Five:

1.	The wind blows from high pressure areas to low pressure areas.	22
2.	The weight of the air (atmospheric pressure) can be measured.	22
3.	Climate is affected by latitude, altitude, mountains, and nearness to large bodies of water.	22
4.	Heat radiating from the earth's surface warms the atmosphere.	21
5.	Warm air rises and cool air sinks causing convection currents.	21
6.	Winds are affected by the rotation of the earth as well as the unequal heating of the surface.	20
7.	Weather is the changing conditions of the atmosphere.	19
8.	Clouds are made of water or ice particles suspended in the atmosphere.	18
9.	Air must be cooled to cause precipitation.	18
10.	The rate at which water evaporates is affected by temperature, humidity, and the speed of the wind.	18
11.	The land heats and cools more rapidly than the water.	16

Meteorology Concepts, Grade Six:

1.	The conditions in the atmosphere can be measured with instruments.	21
2.	Atmospheric conditions vary from place to place and from time to time.	21
3.	Low pressure areas are associated with storms and high pressure areas with fair weather.	21
4.	The temperature changes more slowly over water than over land.	21
5.	Temperature generally decreases with altitude.	21
6.	The atmosphere is divided into three regions for convenience of study; the troposphere, the ionosphere, and the stratosphere.	20
7.	The atmosphere is about four-fifths nitrogen and one-fifth oxygen.	20
8.	Precipitation is all forms of moisture from the atmosphere.	19
9.	Climate is the average weather conditions over a long period of time.	19
10.	Air expands when heated and contracts when cooled.	18

LABORATORY EXPERIENCES IN METEOROLOGY:

1.	The Pressure of Moving Air	16
2.	The Water Cycle	16
3.	Convection Currents	16
4.	The Effect of Heat and Burning on Air	15
5.	Air is a Mixture of Gases	15
6.	Drinking Through a Straw	14
7.	The Thermometer	14
8.	A Weather Map	13
9.	A Pinwheel	11
10.	A Rain Gauge	11

11.	Testing Air For Humidity	11
12.	A Field Trip to a Weather Station	10
13.	A Diving Bottle	9
14.	A Ping Pong Ball Anomometer	9
15.	Melting Snow	8
16.	A Weather Vane	5

Astronomy Concepts, Grade One:

1.	The sun is much larger than the earth; it is a star and gives off light and heat.	21
2.	The earth is round.	17
3.	The earth turns on its axis once in twenty-four hours and revolves around the sun once each year.	17
4.	The moon is much smaller than the earth and revolves around it.	15
5.	As the sun rises the shadows grow shorter and as it sets shadows grow longer.	13
6.	The moon shines by reflected light.	13
7.	There are four seasons of the year: spring, summer, fall, and winter.	12
8.	The sun is very important to life on earth.	12
9.	There are several planets; the earth is a planet and a part of the solar system.	12
10.	There are many stars in the sky and they are all very hot.	11
11.	The stars and moon can be seen at night.	9
12.	Wherever people live on earth the sky is above and the earth is below and a force called gravity pulls them toward the center of the earth .	7
13.	The moon does not always appear in the same shape.	6
14.	There are groups of stars that make pictures in the sky.	4
15.	The moon shows only one face toward the earth.	4

Astronomy Concepts, Grade Two:

1.	The earth turns once every twenty-four hours from east to west and the result is day and night.	15
2.	The sun is a star and appears to be the brightest object in our sky.	15
3.	The moon is the earth's nearest neighbor and it shines by reflected light.	15
4.	The earth is almost round.	15
5.	The sun is very large, hot, and far away.	13
6.	The earth travels around the sun once each year.	13
7.	The moon moves around the earth once each twenty-eight days and turns once on its axis during that time.	
8.	Stars are made of hot gases.	13
9.	The sun gives us heat and light.	13
10.	The earth and the sun and the planets are all a part of the solar system and are held in place by forces.	12
11.	The tilting of the earth on its axis results in the seasons.	12
12.	The moon appears to change its shape during its twenty-eight day period.	11
13.	Gravity pulls things toward the center of the earth.	9
14.	The sun, moon, stars, and other planets are in space with the earth.	8
15.	Some of the stars are arranged so they make pictures in the sky.	7
16.	The speed of the earth and the forces of gravity hold the earth in its orbit about the sun.	6
17.	Man uses the motions of the universe to tell time.	6

Astronomy Concepts, Grade Three:

1.	The sun is a star and the center of our solar system.	20
2.	Each of the planets in our solar system rotates on its axis and revolves around the sun in its own orbit.	19
3.	Some planets such as the earth have moons in orbit about them.	19
4.	The earth is large and nearly round.	19
5.	Planets shine because they all reflect light.	17
6.	The earth is in constant motion.	17
7.	All stars are suns and are made up of hot gases and give off radiant energy.	16
8.	The sun rises in the east and sets in the west.	16
9.	The shape of the moon depends upon the shape of its sunlit surface seen from the earth.	16
10.	Man has placed satellites in orbit about the earth.	14
11.	In the universe there are other galaxies.	14
12.	Individual stars are located in relatively fixed positions forming pictures in the sky.	13
13.	Gravity pulls things toward the center of the earth.	13
14.	The moon has no air or water.	12

Astronomy Concepts, Grade Four:

1.	The moon rises at a different time each day and revolves around the earth once each lunar month.	22
2.	Planets and their satallites are held in orbit by gravity and inertia.	21
3.	The sun rises in the east and sets in the west because of the motion of the earth.	21
4.	The sun is an average size star of hot glowing gases.	20

5.	The tides are caused by the gravitational pull of the sun and moon.	20
6.	Our time is determined by the motion of the earth.	20
7.	Our temperature zones on earth are caused by the tilt of the earth on its axis.	19
8.	Planets vary greatly in size and distance from the sun.	18
9.	Man uses the stars to tell direction and determine locations.	18
10.	Planets and moons shine by reflected light.	17
11.	Man has gained much knowledge from his study of the eclipse of the sun and moon.	16

Astronomy Concepts, Grade Five:

1.	The sun is the gravitational and energy center of our solar system.	20
2.	Man uses many different instruments to increase his knowledge about the universe.	20
3.	The elements found on earth are the same ones that make up the universe.	19
4.	All solar system bodies move about their centers of gravity in an eliptical orbit.	18
5.	The tides are caused by the gravitational pull of the sun and moon.	18
6.	Planets and moons reflect light, stars give off light.	18
7.	A year is the time required for a planet to complete one cycle in its orbit	18
8.	With enough initial speed large space ships can be placed in orbit about the earth or escape the gravity of earth entirely.	18
9.	The moon keeps the same face toward the earth at all times.	17
10.	Meteorites, asteroids, and comets are also found in the universe.	17

11.	The sun is a sphere of hot gases.	17

Astronomy Concepts, Grade Six:

1.	Energy from the sun is solar radiation.	22
2.	Eclipses of the sun and moon can occur.	22
3.	Planets differ in physical characteristics.	21
4.	To travel in space man must overcome gravity, inertia, and friction.	21
5.	Our units of time are based on the movements of the universe.	21
6.	Astronomers use many instruments to study the sky.	21
7.	The great distances in the universe are measured in light years.	21
8.	The heat and light from the sun comes from the fusion of hydrogen to form helium.	21
9.	Our solar system is a part of the Milkey Way galaxy.	20
10.	The earth's atmosphere shields us from radiation.	20
11.	Great speeds are required to escape the earth's gravitational field.	20

LABORATORY EXPERIENCES IN ASTRONOMY:

1.	What Makes Night and Day?	13
2.	An Eclipse	12
3.	The Sun Gives Us Heat	11
4.	A Star Box	6
5.	The Sun Dial	6

Geology Concepts, Grade One:

1.	The land on which we live is made up of many kinds of rocks and soil.	17
2.	Soil is made of broken rock, mineral, plant, and animal matter.	17

3.	Sand is broken bits of rock.	12
4.	There are many different kinds of rocks.	11
5.	There are many different land forms.	10
6.	Rocks contain many valuable minerals.	7
7.	Stone is used as a building material.	6
8.	Many different plants and animals help build soil.	6
9.	Man uses many products taken from the earth.	4

Geology Concepts, Grade Two:

1.	Soil is made of different kinds of rocks and plants and animals.	17
2.	The surface of the earth is covered with rock, soil, and water.	16
3.	Wind, weather, temperature, water, friction, and chemical reactions reduce rock to soil.	14
4.	Some rocks contain many minerals; others only one.	12
5.	There are many different land forms on earth.	12
6.	The top of the land is soil and below the soil is rock.	11
7.	Air and water can wear down rocks.	10
8.	Living organisms in the soil play a very important part in making it suitable for plants.	9
9.	Many valleys have streams.	5
10.	Soils differ in the ability to hold water.	2
11.	The oceans are salty because of dissolved minerals.	2

Geology Concepts, Grade Three:

1.	The surface of the earth is covered by land and water and it is constantly changing.	18
2.	Running water will cause erosion of soil.	17
3.	Some rocks are formed and then changed by pressure and temperature.	16

4.	Rocks are formed over a very long time.	16
5.	Soils are younger than rocks and contain bits of plant and animal matter.	16
6.	The minerals that make up rocks are older than the rocks.	15
7.	Geysers and volcanoes are proof that the earth is hot internally.	14
8.	Minerals are rocks.	12
9.	Limestone is formed in the sea partly from shells and bones of sea animals.	12

Geology Concepts, Grade Four:

1.	There are many kinds of rocks.	17
2.	Rocks are composed of minerals and some of them are useful to man.	16
3.	The oceans contain many minerals.	15
4.	Rocks are broken up by weathering.	15
5.	Fossils are evidence of past life.	14
6.	Some precipitation goes underground and helps form the water table.	14
7.	There are many different geological features on earth.	14
8.	About three-fourths of the earth is covered with water.	14
9.	Some changes in the surface of the earth take place slowly; others very rapidly.	13
10.	A geologist is a scientist that studies rocks and minerals and the history of the earth they reveal.	12

Geology Concepts, Grade Five:

1.	The earth is very old and is constantly changing.	21
2.	Wind, water, heating, cooling, and chemical action breaks rocks into various kinds of soil.	21

3.	The earth is made of many kinds of rocks and minerals.	20
4.	Minerals are very important to man.	20
5.	Mountains and volcanoes are formed because of the great pressures on the earth's crust.	19
6.	There are sedimentary, igneous, and metamorphic rocks.	18
7.	Minerals are made of elements.	18
8.	Sedimentary rock contain fossils of past life.	18
9.	The interior of the earth is very hot.	18

Geology Concepts, Grade Six:

1.	Rocks and soil are a mixture of minerals.	19
2.	Some minerals are very valuable minerals.	19
3.	Minerals have a definite chemical composition; some are called ores.	18
4.	Minerals have definite chemical and physical properties.	18
5.	Soils contain animal and plant organic material.	18
6.	Vast changes have taken place on earth over a very long period of time.	18
7.	There are sedimentary, igneous, and metamorphic rocks.	18
8.	Weathering is a combination of chemical and physical processes.	18
9.	Past life and history of the earth are revealed by fossils.	18
10.	Sudden movements in the earth's crust result in an earthquake.	17

LABORATORY EXPERIENCES IN GEOLOGY:

1.	Observing Layers of Sediment	13
2.	A Collection of Rocks and Minerals	8

3.	The Principle of the Geyser	8
4.	Freezing Can Crack Rocks	8
5.	Field Trips	8

Conservation Concepts, Grade One:

1.	Helpful plants and animals need care.	10
2.	Wind and water can destroy soil.	9
3.	Plants can protect soil from wind and water and at the same time build up the soil.	9
4.	Soil is used to grow our food.	6
5.	There are many materials on earth and man uses them in many ways.	5
6.	There are many different land forms.	5
7.	We should take care of the things we use.	5
8.	People should be very careful with fire, especially when camping.	3
9.	Wind, water, and man can change the face of the earth.	2

Conservation Concepts, Grade Two:

1.	Good top soil is valuable and should be conserved.	7
2.	Wind and water can destroy soil; plants can protect it.	7
3.	We should take care of the resources we use.	7
4.	Water should be conserved.	6
5.	Man, animals, and plants can change the face of the earth.	6

Conservation Concepts, Grade Three:

1.	The welfare of man depends upon how well he uses and cares for the soil.	10
2.	Living things should be protected so as not to disturb the interrelationships of all living things.	10

3. Water flows down hill	8
4. Water sinks into the soil to different depths.	8
5. Our forests are useful and need our protection.	7

Conservation Concepts, Grade Four:

1. Man must practice wise utilization of all natural resources.	16
2. Excess precipitation can cause floods and destroy the soil.	14
3. Soil is one of our most important natural resources.	14
4. Trees and other plants can slow the work of erosion.	14
5. When plants and animals die they decay and return minerals to the soil.	13
6. Water is a very important natural resource.	12
7. Plants and animals are natural resources.	8

Conservation Concepts, Grade Five:

1. Soil forms very slowly; it should be protected.	21
2. Wind, water, gravity, chemical reactions, and man can destroy the soil.	21
3. Erosion takes place faster on some soils than on others.	21
4. Muddy streams are a sign of erosion.	21
5. Soil conservation practices are important.	20
6. Wildlife is an important natural resource.	17
7. Human life and energy is our greatest natural resource.	15

Conservation Concepts, Grade Six:

1. Our mineral resources are exhaustible.	21
2. Legume plants add nitrogen to the soil.	19

3. Cover crops protect the soil from erosion.	19
4. Flood waters can do great damage.	19
5. Wildlife should be conserved.	12

LABORATORY EXPERIENCES IN CONSERVATION:

1. The Erosion of Soil	13
2. How Plants Protect the Soil	13
3. Field Trips	13
4. A Bird Census	1
5. A Bird Sanctuary	1

CHEMISTRY:

Chemistry Concepts, Grade One:

Elements:

1. Things are made of different sizes, shapes, and colors.	10
2. The materials of the earth are composed of many different elements.	10

Compounds:

1. Burning is the most common of all chemical changes.	8
2. Water causes both chemical and physical changes.	6
3. Air is a mixture of gases.	5
4. Chemistry is the study of the composition of the materials of the earth.	4
5. When things mix and a new product is formed it is a chemical change. If a new product is not formed it is a physical change.	4
6. Water is the most common compound known to man.	3
7. Rusting and decaying are both chemical changes.	3
8. Energy occurs in different forms; chemical energy is potential energy.	2

Biochemistry:

1. The food we eat undergoes chemical changes in our body and supplies us with heat and energy.	1

Atomic Theory:

1. The forms of matter are liquids, solids, and gases.	10
2. Matter is everything that occupies space and has weight.	7
3. Matter is composed of tiny particles called atoms.	6
4. Solids have many different properties.	5
5. Heating and cooling will produce changes in matter.	4
6. Atomic energy can be used for the good of man.	3
7. Atoms are the basic building units of matter.	2

Chemistry Concepts, Grade Two:

Elements:

1. There are many different materials in our world.	5
2. All material is composed of elements.	5

Compounds:

1. Burning is the most common chemical change.	8
2. Air is a mixture of gases.	7
3. Some matter is made of combined elements.	6
4. Man can combine many materials to make a more useful material.	5
5. Water can cause chemical and physical changes.	5
6. Rusting is a chemical change.	5
7. All materials change with time.	5
8. Chemistry is the study of the composition of the materials of the earth.	4
9. Solids have many different properties.	3

10. Burning needs a constant supply of air.	3
11. Mixtures can be physically separated.	3
Biochemistry:	
1. Foods are classed as fats, proteins, and carbohydrates.	1
2. Foods undergo chemical changes in the body and release energy and heat.	1
Atomic Theory:	
1. Matter is either liquid, solid, or gaseous.	9
2. All matter has mass and inertia.	8
3. Air occupies space and has weight.	6
4. No two objects can occur in the same place at the same time.	3
5. All matter is subject to change.	3
6. All matter does not have the same weight.	3
7. Matter and energy are interchangeable.	3
Chemistry Concepts, Grade Three:	
Elements:	
1. The earth contains many different kinds of materials.	7
2. Matter is made of small particles called molecules which in turn are made up of atoms.	5
3. When all the atoms in a material have the same properties, the material is referred to as an element.	5
Compounds:	
1. Compounds may be either liquids, solids, or gases.	8
2. Many substances will dissolve in water.	7
3. Decaying and rusting are forms of chemical change.	5
4. Many of the materials made by man are synthetic.	2

Biochemistry:

1.	All foods undergo chemical changes in the body to provide energy and heat.	2

Atomic Theory:

1.	Matter and energy are interchangeable.	8
2.	There are many different kinds of atoms.	7
3.	The atom is the basic building unit of matter.	6
4.	Man has made use of atomic energy.	6

Chemistry Concepts, Grade Four:

Elements:

1.	Molecules are made up of atoms that represent elements.	12
2.	There are many different elements.	12
3.	There are ninety-two natural elements.	9
4.	Chemists have developed tests to identify elements.	9

Compounds:

1.	Molecules of one substance can undergo a chemical reaction with molecules of another substance and produce a new product.	13
2.	Air is a mixture of gases.	12
3.	There are several different kinds of compounds.	11
4.	Many man-made compounds are used as a substitute for natural ones.	10
5.	Chemists have developed tests to detect compounds.	10
6.	Compounds have a fixed boiling and melting point.	9

Biochemistry:

1.	Digestion is a process of breaking the food down chemically.	4

Atomic Theory:

1. Everything is made up of tiny particles called atoms.	11
2. Molecules are made up of atoms and they are in constant motion.	10
3. Atoms are made of smaller particles held together by energy.	9

Chemistry Concepts, Grade Five:

Elements:

1. The simplest part of an element is an atom.	14
2. Matter exists as elements, compounds, or a mixture of the two.	12
3. An element is made of the simplest unit of matter, the atom.	12

Compounds:

1. A compound is a combination of two or more elements which loose their individual properties.	16
2. Elements are combined in definite proportions to form compounds.	15
3. A mixture is composed of two or more substances which retain their properties.	15
4. A physical change takes place when a substance changes in appearance but retains its original properties.	15
5. A chemical change occurs when a new substance is formed.	15
6. The smallest part of a compound is a molecule.	14
7. When a material burns, it combines with oxygen.	13
8. Compounds may be classified as acids, salts, or bases.	11

Biochemistry:

1. Carbon, nitrogen, oxygen, and hydrogen are the basic elements found in protoplasm.	10

2. The amount of oxygen and nitrogen in the atmosphere remains constant, pursuing cycles.	10
3. Enzymes and digestive juices help with the digestion of food.	1

Atomic Theory:

1. An electron is a tiny electrically charged particle.	11
2. A proton is a positively charged particle.	11

Chemistry Concepts, Grade Six:

Elements:

1. A substance made of only one kind of atom is called an element.	18
2. Matter is composed of atoms.	18
3. There are over one-hundred known elements.	17
4. Elements combine to form compounds.	17

Compounds:

1. Groups of atoms join to form molecules.	17
2. Compounds are made of elements.	17
3. Burning is a release of chemical energy.	17
4. A chemical change results in the formation of a new substance.	16
5. Some compounds such as water are very good solvents.	14
6. Classes of compounds are acids, salts, and bases.	14

Biochemistry:

None

Atomic Theory:

1. All matter is composed of atoms.	18
2. Atoms are composed chiefly of electrons, protons, and neutrons.	17

3.	The nucleus of the atom is composed of protons and neutrons.	16
4.	There are vast amounts of empty space within the atom.	16
5.	The number of orbital electrons corresponds to the number of protons in the nucleus.	15

LABORATORY EXPERIENCES IN CHEMISTRY:

1.	A Chemical Reaction	12
2.	The Removal of Oxygen From the Air	11
3.	Incomplete Combustion	9
4.	The Electrolysis of Water	9
5.	A Carbon Dioxide Fire Extinguisher	9
6.	Plants Produce Oxygen	8
7.	Electroplating	4
8.	Chemical Reactions With Copper	3
9.	Dancing Moth Balls	1
10.	The Extraction of Plant Pigments	1
11.	The Burning of Steel Wool	1

BIOLOGICAL SCIENCES:

Biology Concepts, Grade One:

1.	Living things undergo seasonal changes.	17
2.	Certain conditions are necessary for all living things.	15
3.	All things are either living or non-living.	12
4.	All food must come from green plants.	10
5.	Living things are interdependent.	10
6.	Plants and animals can be helpful or harmful.	10
7.	Plant and animal life exist on earth in many different forms.	8

8.	Living things need food to grow and reproduce.	7
9.	Living things come from similar living things.	6
10.	We should be kind to all pets.	5
11.	Man learns many things by using his senses.	4
12.	A large part of every living thing is water.	2

Biology Concepts, Grade Two:

1.	Plants and animals exist on earth in many different forms.	11
2.	Changes in the seasons bring about changes in living things.	8
3.	The food for all living things comes either directly or indirectly from green plants.	8
4.	The sun furnishes energy for all living things.	8
5.	Living things need water to live.	8
6.	Living things need air to live.	7
7.	Animals and plants protect themselves from seasonal changes.	6
8.	Living things change and adapt as they grow.	5
9.	Certain temperature ranges are necessary for most living things.	4
10.	When living things grow energy is used.	4
11.	Food comes from the soil indirectly.	4
12.	Living things depend on each other.	3
13.	Man is capable of carrying on many activities.	3
14.	Man makes use of plants and animals in many ways.	3

Biology Concepts, Grade Three:

1.	All living things are dependent upon other living things.	15
2.	Living things reproduce their own kind.	14

3.	Water, food, and oxygen are necessary for life.	14
4.	Most plants and animals need sunlight.	9
5.	Living things respond to a stimulus.	7
6.	There is a definite size limit to each species of living thing.	5

Biology Concepts, Grade Four:

1.	Some plants and animals live in communities and depend on each other.	17
2.	Living things grow, change, adjust, and adapt.	17
3.	Man has classified living things and given them scientific names for convenience and study.	16
4.	Living things are produced by similar living things.	14
5.	Every living thing dies but life continues.	14
6.	All cells are derived from previously living cells.	14
7.	Plants and animals have lived on earth for a very long time.	13
8.	All living matter is made up of cells which differ greatly in size, shape, and function.	13
9.	A balance of nature is important.	13
10.	Different parts of the digestive tract perform a different function, yet each is a part of the total process.	12
11.	Some plants and animals live as parasites.	11
12.	Life as we know it is confined relatively close to the earth's surface.	11
13.	Large quantities of food are produced in the light zones of the oceans, and it sustains much life.	10.

Biology Concepts, Grade Five:

1.	All living things require food and oxygen for releasing energy and building new protoplasm.	21

2.	All living things are engaged in a constant struggle for survival.	21
3.	Similar organisms are grouped together for convenience of study and classification.	21
4.	The sun is the basic source of energy for all living things.	20
5.	Protoplasm is the physical and chemical basis for life.	19
6.	The smallest unit of protoplasm is the cell, and there are many different kinds of cells.	19
7.	Plant and animal protoplasm are similar.	19
8.	There is a definite order in the life processes of an organism.	19
9.	The cell nucleus transmits hereditary characteristics.	17
10.	Most cells have a nucleus and outer cytoplasm.	16
11.	Carbon dioxide is used in photosynthesis and set free in respiration.	16
12.	There are more living things produced than ever reach maturity.	11

Biology Concepts, Grade Six:

1.	Living things have developed slowly over a long period of time.	22
2.	Living things carry on all the processes of life such as reproduction, growth, nutrition, excretion, respiration, and possess irritability.	22
3.	There is a constant struggle for existence.	22
4.	Changes constantly occur in living things; new species appear and others become extinct.	21
5.	Living things depend on each other for food and shelter.	20
6.	There is an interrelationship between living things and the environment.	20

7.	Classification systems emphasize development from the simple to the complex.	19
8.	Plants and animals are basic to many industries.	18
9.	There is a natural cycle in the living world; life to decay, decay to life.	18
10.	Every organism has a range of tolerance to the chemical and physical conditions of the environment.	18
11.	Air containing oxygen is necessary for almost all living things.	18
12.	Living things contain a high percentage of water.	17

LABORATORY EXPERIENCES IN BIOLOGY:

1.	An Aquarium	14
2.	A Terrarium	14
3.	Field Trips	14
4.	Foods That Contain Starch	6
5.	Foods that Contain Protein	6
6.	The Microscope	6
7.	Foods That Contain Fats	5
8.	Foods That Contain Sugar	5
9.	Additional Tests for Protein	4
10.	Artificial Respiration	2
11.	Hay Infusion	1

Botany Concepts, Grade One:

1.	Most plants need water, soil, air, and sunlight to grow.	20
2.	Plants change from season to season.	17
3.	Green plants need sunlight to grow and manufacture food.	17

4.	Many plants grow from seeds but others grow from parts of plants.	14
5.	There are many different kinds of plants.	12
6.	Plants grow in many different places; they can not move about as animals do.	10
7.	Some plants provide man with food, shelter, and clothing.	10
8.	Different kinds of plants have different kinds of leaves, seeds, and flowers.	10
9.	Plants store food in seeds, roots, leaves, stems, and fruits.	10
10.	Plants live on land and in water.	8
11.	Some plants grow green in the spring; others remain green all during the year.	8
12.	Seeds are distributed in many different ways.	6
13.	Temperature is very important to plant growth.	5

Botany Concepts, Grade Two:

1.	Plants reproduce their own kind.	15
2.	Plants grow in many different places.	14
3.	Some plants grow from seeds and parts of plants.	13
4.	Plants change with the seasons of the year.	12
5.	Some plants provide man with food, clothing, and shelter.	11
6.	Many plants need care to grow.	11
7.	Plants respond to sunlight.	11
8.	Many plants have roots, stems, and leaves.	10
9.	Seeds contain stored food for the young plant.	10
10.	Chlorophyll-bearing plants provide food for all living things including themselves.	9
11.	Non-green plants must get their food from plants or animals or decaying plants and animals.	7

12.	Trees are plants.	4

Botany Concepts, Grade Three:

1.	Green plants use water, carbon dioxide, and energy from the sun to manufacture food.	17
2.	Different plants live in different geographical regions.	17
3.	Plants are useful to man.	17
4.	Plants store food in roots, stems, leaves, seeds, and fruits.	16
5.	Plants are similar yet, they are different.	16
6.	Growth and appearance of plants are affected by the seasons of the year.	16
7.	Plants use food to grow and release energy.	14
8.	Some plants grow in soil, others in air, and some in water.	14

Botany Concepts, Grade Four:

1.	Seeds are produced in the flower, which is a reproductive organ.	18
2.	Some plants reproduce by bulbs, tubors, and spores.	17
3.	Plants use some of the food they manufacture and store some.	17
4.	Chlorophyll-bearing plants release oxygen and provide food for all animals.	17
5.	Fruit develops from parts of the flower.	15
6.	Seeds are distributed by wind, water, and animals.	15
7.	Plants can change the surface of the earth.	14
8.	Some plants are dormant during the winter.	14
9.	Plants are widely distributed over the earth.	14
10.	Plants are made of cells containing a living material called protoplasm.	13

5.	The Structure of Plants	14
6.	The Structure of Flowers	13
7.	The Storage of Food in Plants	10
8.	The Production of Food by Plants	10
9.	Plants for Man's Use	10
10.	The Production of Oxygen by Plants	9
11.	Gravity and Plants	9
12.	Leaf Identification	7
13.	Plant Transpiration	7

Zoology Concepts, Grade One:

1.	Many animals depend upon man for care and man depends on some animals for food.	17
2.	Animals need food, shelter, water, and air to grow.	15
3.	Animals differ in size, shape, and body color.	12
4.	Animals move in different ways.	11
5.	Animals live in many different kinds of places.	10
6.	Many baby animals are born in the spring; some animals care for their young; others do not.	10
7.	Most animals can move from place to place.	9
8.	Animals build homes best suited to their needs.	8
9.	Some animals resemble their parents when born; others go through many changes before they become adults and resemble their parents.	8
10.	Animals protect themselves in different ways.	7
11.	Different kinds of animals need different foods.	7
12.	Some animals are harmful to man.	5
13.	Some animals hatch from eggs; others are born alive.	5
14.	Some animals hibernate during the winter.	4

15.	Some animals migrate.	4
16.	Some animals store food for the winter.	4
17.	The earthworm lives underground and gets its food from the soil.	3
18.	Some animals can fly.	3
19.	Some insects die after laying eggs.	2

Zoology Concepts, Grade Two:

1.	Animals get their food in many different ways.	15
2.	Many animals are useful to man.	14
3.	Animals live in ways best suited to their needs.	13
4.	Animals reproduce their own kind.	13
5.	Animals need food, shelter, water, and air.	12
6.	Animals depend on plants and other animals for food.	11
7.	Some animals prepare for seasonal changes.	11
8.	Animals move in many different ways.	9
9.	Some animals migrate.	7
10.	The habitat of an animal is the place where he is commonly found.	7
11.	Some animals receive little or no care from their parents.	7
12.	The most common animals are the insects.	5

Zoology Concepts, Grade Three:

1.	Animals use food for growth and release of energy.	18
2.	Animals are found in all geographical regions of the earth.	18
3.	Animals change as they grow.	17
4.	Many kinds of animals are useful to man.	17

5.	Animals are affected by seasonal changes.	16
6.	Animals store food in their bodies and in special hiding places.	15
7.	Special adaptations protect animals from their enemies.	12
8.	All animals have enemies.	12
9.	Animals that grow hair are called mammals.	11
10.	Mammals and birds are warm blooded animals.	11
11.	Most mammals are born alive and fed milk from a mammary gland.	11
12.	Insects are animals.	3

Zoology Concepts, Grade Four:

1.	Some animals lay eggs; others bear living young.	16
2.	Some microscopic animals reproduce by dividing into two animals.	15
3.	Some animals hibernate; some migrate; some adjust to seasonal changes.	14
4.	Some animals maintain a constant temperature.	14
5.	Animals depend directly or indirectly on plants for food.	14
6.	There is a slow but constant change in all animals.	14
7.	Some animals have an outer skeleton; others have an internal one.	13
8.	Some animals store food for winter.	13
9.	Man has developed varieties of animals suitable to his needs.	8
10.	Some animals are invertebrates.	8
11.	Some animals live in water; some on land; and others can fly.	2

Zoology Concepts, Grade Five:

1.	Animals range in size from one cell to billions of cells.	20
2.	There are many kinds of vertebrates. They are fishes, amphibians, reptiles, birds, and mammals.	18
3.	Animals fall into two classifications; they are vertebrates or invertebrates.	18
4.	A great number of animals have become extinct.	17
5.	Food must be transported to each cell of the animal body before it is used.	17
6.	Animals reproduce their own kind.	16
7.	Animals utilize muscles in movement.	7

Zoology Concepts, Grade Six:

1.	Animals are classified into similar groups.	19
2.	All animals have digestive juices.	17
3.	All animals reproduce their own kind.	17
4.	Animals are adapted for survival in many different environments.	17
5.	Animals are very important to man.	16
6.	Temperature affects the activities of cold blooded animals.	16
7.	Some animals live in communities with definite social organizations.	16
8.	Some animals go through major changes as they grow.	16

LABORATORY EXPERIENCES IN ZOOLOGY:

1.	Observing Your Pets	14
2.	Feeding Animals	13
3.	Animal Groups	5
4.	Observation of the Circulation of Blood	4

HEALTH AND SAFETY:

Health Concepts, Grade One:

1.	Cleanliness improves our health and personal appearance.	8
2.	Proper food is necessary for health.	7
3.	Our body is a wonderful machine and we must take good care of it.	7
4.	We need rest, exercise, and good food for health.	7
5.	We need sunshine for good health.	6
6.	We need more of some foods than others.	5
7.	People should dress according to the weather for health.	5
8.	Good health habits help us grow and keep well.	5
9.	As we grow we change in weight and size.	
10.	Proper lighting is necessary when we study.	3
11.	Man has built refrigerators to keep his food cold and fresh.	3
12.	Some water is not safe to drink.	1
13.	Health is a community problem.	1

Health Concepts, Grade Two:

1.	Human bodies need a well balanced diet.	14
2.	Proper dress is important for health.	10
3.	Our bodies, like machines, need much care.	8
4.	Good health habits are important.	7
5.	We should take good care of our eyes and ears.	7
6.	Teeth decay because of acids produced in the mouth and bacterial action on the food we eat.	5
7.	Sweet sticky foods are more harmful to the teeth than hard crisp foods.	5

8.	We should protect our teeth with correct brushing and visits to the dentist twice each year.	5
9.	Refrigeration is an aid to man's health.	4
10.	Molded food should not be eaten.	4
11.	Our skins protect us from germs.	2
12.	Dirty hands can spread germs.	2
13.	Every person is responsible for the health of the community.	1

Health Concepts, Grade Three:

1.	The human body requires many things such as rest, sleep, food, and exercise to function properly.	8
2.	Man needs proper rest and recreation for physical and emotional health.	7
3.	Some foods provide energy; others aid in growth.	7
4.	Natural water is not always safe for drinking.	5
5.	Most harmful bacteria can be killed with heat or made dormant by the lack of it.	5
6.	Good health habits are important to growth and development.	4
7.	There are many safe ways to preserve food over a long period of time.	3
8.	Microorganisms are everywhere.	2
9.	Health is a community responsibility.	1

Health Concepts, Grade Four:

1.	Cleanliness is very important to good health.	8
2.	Proper clothing is important to good health.	7
3.	Only completely digested food can give us its full benefits.	6
4.	Certain activities and emotions can have an adverse effect on digestion.	6

5.	Water is seldom pure, but with proper treatment it can be made safe for drinking.	6
6.	Many diseases are caused by animal or plant organisms.	6
7.	Virus can cause the common cold and other diseases.	6
8.	Most bacterial diseases can be controlled.	6
9.	Undigestable material is necessary for the proper function of the digestive system.	5
10.	Fresh air is important to health.	4
11.	Our eyes should be cared for properly.	3
12.	A good citizen has a responsibility to his community for health.	2

Health Concepts, Grade Five:

1.	The family doctor is important for good health.	10
2.	Cleanliness is necessary for good health.	10
3.	All humans are succeptable to some microorganism.	9
4.	Bacteria can enter the body through a break in the skin.	7
5.	Man's diet must include vitamins.	6
6.	Different foods have different values to man.	6
7.	Chemical changes take place in our bodies.	6
8.	The body has its own method of stopping bleeding, but we can help.	6
9.	Temperature, moisture, and air movements are important to good health.	5
10.	Tobacco, alcohol, and narcotics are harmful.	4
11.	Some diseases can be controlled by immunization.	2

Health Concepts, Grade Six:

1.	Rest, food, and exercise are important to good physical health.	12

2.	Knowledge of the human body is important to good health.	12
3.	Physical activity is important to good health.	11
4.	Knowledge of good health habits is important.	11
5.	Muscles increase in strength with proper use.	9
6.	For an infection to occur these things must be present: (1) avenue to host (wound), (2) the infectious organism present in sufficient number, (3) the organism must be virulent, and (4) the host be receptive.	9
7.	Our eyes, ears, and teeth should be properly cared for.	8
8.	Alcohol, tobacco, and narcotics are harmful to the health.	7
9.	Health is a community problem.	7
10.	Knowledge of body function is important to good health.	2

LABORATORY EXPERIENCES IN HEALTH:

None

Safety Concepts, Grade One:

1.	Observation of safety rules will help prevent accidents.	7
2.	There are safety rules to follow at home and at school.	6
3.	Matches are very useful but can be very destructive if not used properly.	5
4.	Knowledge of first aid is important.	4
5.	We must learn to work and play safely.	4
6.	We must learn the safety rules for riding a bicycle.	4
7.	Toys are for pleasure, but they can cause accidents if not used properly.	2

8. Sand and ashes on icy walks will help prevent accidents.	2

Safety Concepts, Grade Two:

1. Some plants and animals are hazardous to health and safety.	6
2. We should observe all safety rules.	5
3. We must learn to work and play safely.	5
4. Fire is dangerous when not handled properly.	5
5. Many people are responsible for the safety of a community.	1
6. Toys can cause accidents.	1
7. Knowledge of first aid is important.	1

Safety Concepts, Grade Three:

1. We should handle fire very carefully.	6
2. We should learn to work and play safely.	5
3. Animals can sometimes be dangerous.	3
4. Electricity can be dangerous.	2

Safety Concepts, Grade Four:

1. Electricity should be handled with caution.	6
2. Knowledge of first aid is very important.	5
3. Safety precautions should be taken when on a picnic.	3
4. Rules should be observed in all play.	2
5. There are many water safety rules we should follow.	2

Safety Concepts, Grade Five:

1. Toys, tools, and machines can be dangerous when not used properly.	4

2. We should always observe safety rules when riding a bicycle.	4
3. Some animals and plants are dangerous.	1
4. Fire is dangerous.	1

Safety Concepts, Grade Six:

1. Knowledge of safety rules is important.	3
2. Safety rules should be practiced in all places and at all times.	2
3. We are all responsible for safety.	2

LABORATORY EXPERIENCES IN SAFETY:

1. First Aid	3

VITA

Verdine E. Trout

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY OF THE SCOPE, SEQUENCE, AND OBJECTIVES OF ELEMENTARY SCHOOL SCIENCE AS REVEALED BY STATE SCIENCE GUIDES

Major Field: Higher Education (Science Education)

Biographical:

Personal Data: Born near Waurika, Oklahoma, September 19, 1924, the son of George E. and Mable E. Trout.

Education: Attended grade school at Rocky Knob elementary school Waurika, Oklahoma; graduated from Irving High School, Ryan, Oklahoma, 1943; attended Southeastern State College, Durant, Oklahoma, graduated with a Bachelor of Science Degree in 1949 with a major in Biology; attended the University of Oklahoma, received the Master of Education Degree in 1953 with a major in School Administration; additional graduate work at Colorado State College, Greeley, Colorado; completed requirements for the Doctor of Education Degree at Oklahoma State University in May, 1966.

Professional Experience: Served in the U. S. Army from August, 1943 to February, 1946; appointed science teacher Comanche Public Schools, Comanche, Oklahoma, 1949; served in the U. S. Air Force 1950-51; returned to Comanche as science teacher 1951; appointed science teacher Sand Springs Schools, Sand Springs, Oklahoma, 1954; appointed chemistry teacher Classen High School, Oklahoma City, 1964; appointed Instructor of Science Central State College, Edmond, Oklahoma, 1964.