THE DEVELOPMENT OF INTERESTING AND USEFUL
SCIENCE UNITS IN THIRD GRADE

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Margaret Mary Greene
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by

Margaret Mary Greene

Approved by Committee:

William P. Swardon
Chairman

Earle L. Campfield
Dean of the Graduate Division
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CHAPTER I

INTRODUCTION

Events of recent years are evidence that science is a necessity in the curriculum of elementary grades. To preserve our well being pupils must be educated in the problems and solutions of science. They must be able to intelligently use their environment.

I. THE PROBLEM

It was the purpose of this study in elementary school science to: (1) examine the needs for interesting and useful science units in third grade, (2) study the present methods and materials, and (3) present some of the units designed to help a group of third grade girls and boys develop a more useful knowledge of science.

II. IMPORTANCE OF THE STUDY

The crisis in science education is not an invention of the newspapers, or scientists, or the Pentagon. It is a real crisis.

The Union of Soviet Socialist Republics is not the cause of this crisis. The cause of the crisis is the breath-taking movement into a new technological era.
The United States is moving with rapid speed into a new phase in man's long struggle to control his environment, a phase beside which the industrial revolution may appear a modest alteration in man's affairs. Nuclear energy, exploration of outer space, revolutionary studies of brain functioning—all point to changes in our lives so startling as to test to the utmost our adoptive capacities, our stability, and our wisdom.

Educators must develop guidance efforts designed to reach all able youngsters. They must engage in a major expansion of the facilities for science teaching.

They must insist that every scientist be broadly educated. They must see to it that every educated person be literate in science. In the "short run" this may contribute to our survival. In the "long run" it is essential to the survival as a society.¹

"The science teaching in elementary schools, except for some notable exceptions, is years behind the times. The content, organization, and methods of instruction are totally inadequate for today's youth," declared Glenn Blough before the National Science Teachers Association meeting in Denver, March, 1958.

Unimaginative, hit or miss elementary science programs are turning would-be scientists away from the field before they even reach high school. Among the needs in the

elementary schools, perhaps none is more critical than the need for well qualified, devoted, and enthusiastic teachers of science. Elementary teachers who do not know about the environment in which they live are unprepared to teach today's children.

We should be more concerned over whether we are keeping up with today's children than over whether we are keeping up with Russia. We should find out whether the science we teach in grade school is challenging enough to make students want to take science in high school and college.¹

Studies by Pelz, Strauss, and Breechbill, as well as reports made at a recent convention of the American Society of Engineering, seem to suggest that, once a graduate is acclimated to his job, his productivity, either in basic or applied research, is far less likely to be related to his intellectual level than to a number of other motivational factors that need not be mentioned here. One of the studies indicates categorically that men of mediocre intelligence, in so far as tests measure intelligence, equal and in many cases exceed in productivity, men of higher levels of intelligence.

The science program in the public schools is not prepared to recruit these lesser able people for science and technology. Unfortunately, it is in this span of years that the science program is usually least effective.²


The elementary school science curriculum in most American schools today is based on a pioneering study reported by Craig in 1927.¹ The results of this study have served the public well for over thirty years. The appropriateness of this curriculum for present day science must now be questioned.²

III. PROCEDURE

The investigator reviewed the literature in the field to determine: (1) the objectives for which a science unit should be planned; (2) the needs for interesting and useful science areas as shown by a survey of trends, expressed by authorities; and (3) present methods and materials.

On the basis of this review the investigator constructed two science units for third grade, one, on the rocks and soil of the earth's surface; the second, on the universe.

¹Gerald S. Craig, Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School (New York: Columbia University, Teachers College, Bureau of Publications, 1927).

CHAPTER II

REVIEW OF THE LITERATURE

Science of the present age is exciting and constantly changing. The investigator of this study has felt the need for new materials and methods as an elementary science teacher. This chapter is divided into the following parts: definition of science, objectives of elementary school science, and methods and materials.

I. DEFINITION OF SCIENCE

First it is necessary to determine what science is not. It is not a cloistered area reserved for the special few; it is not a field of specialization (from the standpoint of the elementary school child); it is not shrouded in mystery and magic; and it certainly is not an area requiring a broad technical and informational background. 1

Science is the knowledge obtained individually by the study of facts, principles, causes; the habit or possession of exact knowledge. 2

Science is for all the people. Obviously the things of science influence people's lives profoundly; appliances,
automobiles, insecticides, paints and polished fabrics and materials are essential devices in every household. It is found in the expression of man's insatiable curiosity, his everlasting spirit of wonder, his desire to know himself and the world in which he lives.\(^1\)

II. OBJECTIVES OF ELEMENTARY SCIENCE

In science, as in all other subject-matter fields, there are certain broad goals or objectives toward which learning experiences should be directed. The acquisition of scientific information is, of course, one of these goals or objectives. The amount and kind of scientific information that is taught will vary with the backgrounds, interests, and abilities of the children. This does not mean, however, that elementary pupils should be expected merely to learn vast amounts of scientific knowledge and unrelated facts. Rather, there are essential skills and abilities that science teaching can help develop in children. The knowledge and facts that are taught are the vehicles by which the skills and abilities are developed. A list of these skills and abilities follows.

1. To observe the objects that exist, and the phenomena that take place, in his environment and to report accurately what he observes.

\(^1\)Branley, loc. cit.
2. To compare objects and phenomena with respect to their likenesses and their differences.

3. To evaluate the relative importance of information and the relevancy or irrelevancy of data to a situation.

4. To determine whether there is enough information available to warrant making a conclusion or a tentative answer or deciding how much of an answer can be made from the information available.

5. To determine what kind of information is still needed in order to formulate an answer to a question, or locate data for a problem.

6. To decide on the most efficient way to obtain the needed information.

7. To teach children how to carry out an experiment with the materials available, if it is decided that an experiment is the best way to obtain the answer to problem.¹

An examination of this list will indicate that these basic skills are important in the training of all children, regardless of what their future occupations may be. They are the skills of "doing" which should become the primary goals of all elementary science teaching. In other words, this is what a child should be able to do better as a result of his science training.

Obviously, no single science experience, whatever it may be, will contribute to all these skills. Some will contribute to only one; others to several. Further, children at any one grade level cannot be expected to become equally

proficient in all skills. It is possible that the early elementary children can only begin to learn to observe and report. However, as they mature, their observations will become more precise and they will become more adept in the other skills.\(^1\)

Hence, it becomes the task of the teacher to select science activities and areas of study that are of interest and value to specific age groups, and to use them to help develop in children proficiency in these basic skills. The exact science activity selected is not nearly so important as the skill-practice that it provides.\(^2\)

Hanigan stated that science is exciting and ever-changing and no one, however capable can hope to "master" it. He further stated that children should be helped to achieve the following goals or objectives:

1. Develop an interest in science and work to acquire knowledge and skill in as many areas as possible.
2. Develop open minds so that they can look objectively at things without having ignorance, bias, or superstition dictate reactions.
3. Be ever critical in their thinking to the point of making decisions with their minds and not their emotions.
4. Demand accuracy of themselves and other people at all times.

\(^1\)Ibid. \(^2\)Ibid.
5. Be willing to accept responsibility for their actions.

6. Display resourcefulness in all situations.

7. Acquire an attitude or a behavior that is consistent with health, economy, and safety.

8. Follow a basic procedure in problem solving that has been called by some the scientific method.

Renner, Bray, and Powell in planning principles for secondary school science teaching made this list of "guiding criteria" for kindergarten through grade six to progress from elementary school:

1. Science should contribute to the total growth and development of the child.

2. Science should contribute to the child's understanding of his environment. Such topics as weather, climate, and plants can all be made subject material for lessons in the elementary grades.

3. Science content should be presented so that it reflects the principles of child development and should proceed from the known and simple to the unknown and more complex. Study of how oxygen sustains the life functions can begin by observation of breathing in chicks and continue to a higher level at which time

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the use of oxygen, expiration of carbon dioxide, and inspiration of oxygen in the human body can be investigated.

4. In elementary science children should

a. Acquire skill in the scientific method. This means children should be encouraged to make simple observations, ask questions, and seek to answer them from observations.

b. Acquire the ability to relate basic health and body care.

c. Be encouraged to experiment. A scientific experiment does not require elaborate equipment. Many experiments can be performed simply and easily with available material.

d. Begin to appreciate the relation between science and industry. Visits to local industries and the use of industrial films are suggestions.

e. Investigate the use of science in their own community. Studies of the telephone, water, and sanitation are possibilities.

5. Science should keep alive the natural curiosity of all children.

6. The student should start thinking about the relationship between physical and biological science as well as the relationships among the separate disciplines.
within these fields. The value of chemistry in the field of medicine can be shown by a visit to a drugstore.

7. In all elementary grades experimental procedures should be kept as simple as possible. "Stick" with the familiar and simple equipment to avoid confusing children.¹

Blough and Huggett stated objectives or "intentions" for elementary school science:

The study of science should, (1) help girls and boys come to know some generalizations or big meanings or science principles which they can use in solving problems in their environment, (2) help pupils to grow in ability to solve problems effectively, (3) develop in children scientific attitude, and (4) create in children an interest and an appreciation for the world in which they live.²

Bloom stated that in order to determine how effective science teaching is at the elementary level, a re-examination must be made of the following three basic purposes for the teaching of science:

1. To help all children develop an inquiring mind concerning environmental phenomena.

2. To help children acquire a substantial background of useful scientific information.


3. To help children acquire an appreciation of science as it affects their daily living.¹

From this study of objectives, the investigator used the following objectives in planning the units which followed:

1. Acquaintance with the scientific method including:
   - a. Inquiring
   - b. Observing
   - c. Recording
   - d. Comparing
   - e. Experimenting
   - f. Concluding

2. An appreciation of the environment.

3. Actual science participation by the child. Each child must be thought of as a little scientist in an active science program.

III. TRENDS IN ELEMENTARY SCIENCE

Many people responsible for our schools have believed for a number of years that improvement was needed in the teaching of science. With the advent of "Sputnik" the entire country became concerned. This led to the passing of the National Defense Education Act of 1958. One phase of this

act deals with aid to teachers in broadening their science education and to provide more adequate science instructional materials.

Some trends reported by the National Science Teachers Association are presented below:

1. A trend re-emphasizing the importance and necessity of pupil experimentation using controlled experimentation and testing of hypotheses in problem-solving situations.

2. A trend toward experiences which run over a much longer time—perhaps several class periods or even weeks to bring to completion—and which may require equipment set-ups for the entire time.

3. A trend toward more adequate recognition of science instruction as a necessary component for all liberally educated people whether college bound or not.

4. A trend toward diversified science instruction as far as the variety of different experimental approaches is concerned, and in which different students seek solutions to different problems.

5. A trend toward the increased use of science clubs, science fairs, science congresses, and other supplemental devices to encourage and challenge academically able students, and to provide opportunities
for all interested pupils to perform experiments and carry on projects in exploratory activities which may not be possible in the regularly scheduled periods.

6. A trend toward the increased use of audio-visual aids by individuals or small groups of pupils.

7. Many state, city, and county units are developing or have completed more or less definite courses of study or curriculum guides to enrich the study of science. Such course outlines help to insure a sequence of subject matter from grade to grade through the elementary school.

8. Science experiences are being built around the solving of problems which are significant to pupils rather than on the answering of unimportant problems that stress the recall of unrelated scientific facts.

9. Effort is being made to use actual experiences whenever possible to make learning in science more meaningful. In other words, there is more doing on the part of children and less reading and hearing about science. These experiences include among other things, experimenting and observing real applications of scientific principles.

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10. Persistent effort is being made to fit the science offerings and the learning methods to the needs, interests, and abilities of the learners.

11. Much stress is laid on using community resources in order to bring science to life.

12. Administrators, teachers, and pupils are working together to an increasing extent to plan and carry out an effective program.  

Dr. Gerald S. Craig, one of the most eminent authorities in the field, has said this about schools and science: 2

Traditionally schools have been designed for an era of certainty, with a tendency toward fixed intellectual goals and a more or less absolute and authoritarian view of subject matter. But we do not know what the future will be for the children in our classrooms today. Furthermore, we are learning through science that what we know today may need revision tomorrow. Man's conception of truth changes. Our children will need the ability to reconstruct their ideas throughout their lives. . . . We can be confident that if we assist them to develop democratic and resourceful behavior, they will make their own future, and make it a good one. 3

Barnard, Stendler, Spock, and Reynolds stated that the view of science today is vastly different from that of twenty-five years ago. No longer does anyone think, of science as merely a body of facts. Science is not only facts; it is working concepts, and it is a method of thinking. It is a way

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1 Blough and Huggett, op. cit., p. 8.
2 Hanigan, loc. cit.
of solving problems— not just the problems of the laboratory
but the problems of living as well.¹

The newer concepts of science as developed during the
past century tends to focus more and more on how to under-
stand the world around us. The factual content of science
is, and always will be important, but the emphasis is
increasingly on scientific methods. The "laws of science"
are no longer to be only defined, but means to be used in
further scientific study.²

The investigator herewith summarizes the present
trends as stated by science authorities in the study. The
materials, methods, and objectives of elementary school
science are changing from the stereotyped in order to meet
the problems of children, and to meet the needs for their
proper growth and development in a scientific age. With the
use of these materials, methods, and objectives, children
will understand and participate in science; they will think
for themselves. Realizing that science is probably only in
its beginning in the present age and its importance is ines-
capable in the world, educators are constantly working
together for a more effective elementary science program.

¹J. Darrell Barnard, Celia Stendler, Benjamin
Spock, and others, Teacher's Manual for Book Three The Mac-
millan Science - Life Series (New York: The Macmillan
Company, 1959), pp. 5-6.

²Herbert S. Zim, Science for Children and Teachers
(Washington: Association for Childhood Education Inter-
national, 1953), pp. 3-4.
IV. METHODS OF TEACHING ELEMENTARY SCIENCE

Shortcomings in elementary science teaching. When the editorial department of the *Macmillan Science-Life Series* made a study of current science teaching in the elementary schools, beginning in 1952, the department found leaders in science education concerned about three shortcomings in elementary science education:

1. Science was being taught as a reading course in an area where direct action learning is of prime importance.

2. Science was still being presented as a collection of facts only; whereas leaders in the field recognized that science is not only facts, but concepts, the working tools of the scientist, the generalizations such as the atomic theory, and a method of thinking... of asking significant questions, of suggesting and testing answers.

3. There was an attitude towards science implicit in the courses and textbooks. It treated science as a magic wonderland inhabited primarily by professors and research people.¹

How science should be taught. There is no one method of

¹Barnard, Stendler, Spock, and others, "A Message from the Publisher on the *Macmillan Science-Life Series*," op. cit., p. 2.
teaching science. Nor is there a method that will be equally effective for any one teacher in all teaching situations. Science is dynamic. Students change from class to class and from year to year. The science teacher's techniques of working with young people must frequently be evaluated and modified to make his teaching more effective.1

The acquisition of new facts, by which problems can be solved, is the goal of science. This reaffirms the point of view that the method of science is fundamentally the method of observation, and that the practice of science without firsthand observation is an impossibility. What is called experimentation is the validity of observations. This does not mean that science does not involve the study of books. The study of books is essential because the discovery of new facts clearly implies a knowledge and understanding of the old; for how else can "newness" be established?

However, the use of books and the use of facts, already discovered as tools in the scientific process, are used in such a large measure in the elementary science classroom that the scientific process itself is forgotten. Literally, what is called the content of science courses is nothing more than background material, on which science can be built. Facts are the products of science and the tools of science. To emphasize or teach facts without reference to a specific scientific

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purpose, question, or problem is something other than scientific. Science should be taught in a way which enables a pupil to discover new facts in relationship to some question or problem.

Children must not only read about science they must participate in it. A child can participate in science in the same way he participates in music and in art. The science of the elementary school child is not the science of the professional, but it can be bona fide science, involving firsthand experiences, discovery, and communication. It makes full use of those methods which are characteristic of science and yields the rich, creative, intellectual stimulation which such experiences can give.

With youngsters a sound approach to science can almost come from letting your pupils engage in "doing what comes naturally." Children are curious, interested and observant. A teacher can channel these into valid observations that make for science.\footnote{Herbert S. Zim, "Where Is the Science in Science Education?," The Science Teacher, XXV, Number 1 (February, 1958), 14, 46.}

The question of what facts of science should be taught is a timely one. From the point of view of content, science is built upon facts. But to teach facts, in and of themselves, is not to teach science. The evidence from research clearly indicates that to teach science in this way is a waste of time and effort. It has been found that up to 70 per cent of the
specific facts learned in a science course are forgotten within one year after the completion of the course.

When science is taught to help students understand principles and generalizations, the retention curve does not drop. Some studies indicate that it may even rise lightly above its position at the completion of the course.

Teachers should keep this evidence in mind when they are tempted to enrich science courses by merely making longer assignments in the textbooks. The validity of the tests to measure achievement in science should be judged in light of this evidence also.¹

In reference to the memorization of such elements as the names of species in biology, rocks in earth science, or the periodic table in chemistry such elements are remembered only when they are taught in terms of usage and application. It is therefore reasonable to suggest that the objectives of science teaching should be the elements likely to be retained rather than those that are forgotten. Research would indicate also that the abilities related to (1) applying principles of science, (2) habits of critical thinking, and (3) skills in problem solving are retained long after courses are completed. Hence the aim of science teaching should be to develop these objectives by means of factual experiences.²

¹Barnard, op. cit., p. 110.
²George Greisen Mallinson and Jacqueline V. Buck, "Science Education Research and the Classroom Teacher," The Science Teacher, XXII, Number 1 (February, 1955), 20. (A
Lesson planning. In making a lesson plan a teacher might proceed something like this:

1. Discuss subject with children and build on what is already known.
2. Help organize the pupil's knowledge.
3. Aid children in raising some new problem about the subject.
4. Discuss with children how answers to problems can be found.
5. Give children an opportunity to do some careful thinking and problem solving.\(^1\)
6. Involve children in planning the science study. This means all the children. All children will make suggestions of questions to study, topics to consider, resources at hand, and ways to proceed.
7. Continually think of science as a kind of inquiry that requires investigation in a validity of ways--experimenting, observing, talking with experts, reading and seeing films. Science is investigation through which knowledge about our universe is acquired. When teaching reduces science to inquiry through any one source

\(^{1}\)Blough and Huggett, *op. cit.*, p. 74.
of information, then it is teaching that "limps" along.  

8. Remember: when one begins to work with children, the plan may change entirely. It is almost certain to be somewhat modified.  

Desirable elements in elementary school science.  

1. Critical Thinking  
To develop critical thinking is generally supported as an objective of science teaching. The teacher must provide situations where students are motivated to ask questions, to speculate about answers, to plan ways of getting evidence, and to evaluate it.  

2. Motivation  
The best way to motivate children to study science is found in psychological, rather than in science education research. A well-trained enthusiastic teacher has proven to be the greatest form of motivation. With the child, pubescent, and adolescent motivation tends to be extrinsic rather than intrinsic. Hence, motivational factors are more likely a

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1Paul E. Blackwood, "Rebuilding the Science Program Elementary Science Teaching Elementary Science to Gifted Children," The Science Teacher, XXX, Number 5 (September, 1958), 262-263.  

2Blough and Huggett, op. cit., p. 73.  

3Barnard, loc. cit.
function of the teacher than the student himself. One must therefore seek to motivate students, rather than to hunt for characteristics inherent in the student, at these grade levels.¹

3. Flexibility

Flexible planning requires that a teacher have a broad knowledge of the larger purposes which she believes are essential for democratic living and a knowledge of the possible steps by which these purposes are to be achieved. She cannot know where the instruction is to begin until she has learned where the children are in their growth with respect to these larger values.²

4. Activity

Children learn science through doing things; by making collections; making observations; taking field trips; doing experiments; discussing what they have observed and done; and through reading. An effective science program is an activity program.³

5. Child Growth and Development

Teachers will find their teaching enriched if they will study children while they teach them. The greatest concern in studying children is not how

¹Mallinson and Buck, op. cit., p. 21.
²Craig, op. cit., pp. 139-140.
³Bloom, op. cit., pp. 93, 132.
much information children have secured. The main emphasis should be on what kind of boys and girls the teachers have.¹

6. Climate, Literacy, Understanding

There is a way to use our knowledge of current science to improve science teaching.

First, to teach science and to produce scientists, there must be a climate of opinion that is favorable to intellectual achievements--all intellectual achievements.

Second, there must be more emphasis on reading, writing, and arithmetic. Children who are to be successful in any area of intellectual work must have a well planned and comprehensive program throughout their school life.

Third, teachers and all other adults are going to have to understand science. So long as each generation of Americans thinks that science is carried on only or even mainly in the laboratory; whereas most of it is actually carried on in the head, there cannot be produced an appreciably large number of good scientists.²

Blough further emphasized that a good program in science is assigned time in the daily and weekly schedule. This is as

¹Craig, op. cit., p. 23.

²Duane H. D. Roller, "How Can We Use Knowledge of Current Science," The Science Teacher, XXV, Number 5 (September, 1958), 280.
true for science as for other areas considered essential to the growth and development of girls and boys.

The investigator found that the desirable method of teaching science is that in which the teacher:

1. Establishes objectives
2. Starts where the child is
3. Considers and uses the child's background and environment
4. Plans for the child's continuous growth and development
5. Knows and understands science
6. Allots time for science
7. Evaluates
8. Plans pupil participation in science

V. MATERIALS IN ELEMENTARY SCIENCE TEACHING

Science in the elementary school is inherently associated with experiment and activity. Without materials of some kind a satisfactory science program is almost impossible. In the elementary school there is emphasis on the use of simple, low-cost, homemade equipment. Although the use of simple equipment and of pupil participation in getting it is commendable, this use represents an oversimplification of the problem. The best science teaching will not be achieved until the question of materials is reconsidered in the light of the value of children's
activities and the most effective use of the teacher's time.

A common assumption is that the teacher will independently obtain whatever equipment and materials he needs by whatever means available. This assumption just does not fit the realities of life and often reduces science to the level of just another reading lesson.

Long experience makes possible accurate estimates of the cost of various school programs. In science, a new instructional area, this experience is lacking so teachers and administrators have had little or no guidance. In too many cases there are no budget appropriations for elementary science at all.¹

Ordinarily a yearly science supply is sufficient for an entire building, with the various classes using the resources as needed. Most of the equipment once acquired, can be used by many classes for many years. In anticipation of such a supply order, the teacher throughout the year should make a list of desired materials, adding items as the need arises. The order will be thoughtful and realistic rather than a hastily conceived list and a lost opportunity to obtain what is needed.²

The school itself is a good place to begin finding scientific material. It is important for pupils to discover

¹Zim, op. cit., pp. 13-14.

them in the school not only because they make ideas clearer to the pupils but because seeing helps pupils to realize how real science is.

There are countless places to visit, people to enlist, and other resources to use if teachers begin to look for them and if they challenge pupils to suggest them and help provide them. Whether or not they will be useful depends on the vision and ingenuity of the teacher and how the study of any given problem proceeds.

Blough further stated much of the elementary science material could be obtained from the homes of the children and elsewhere in the community and should be of the simplest kind.¹

Constructing apparatus can be one means of learning facts in functional circumstances. Ordinarily the device that a child prepares himself not only is better understood but is used with greater enthusiasm. Hubler listed ways for constructing apparatus such as animal cages, insect cages, ant nest, dip net, bird feeder, ventilation box, convection box, aquarium and terrarium tanks, lamp socket, and a balance.²

The school budget should make adequate provision for the commercial materials needed for science. It is more economical in both time and money for the schools to obtain needed

¹Blough and Huggett, op. cit., p. 64.
supplies in advance and have them available for classes when needed.

Suggested sources of supply material and help are:

1. Scientific Supply Houses

   Ward's Natural Science Establishment
   3000 Ridge Road East
   Rochester 9, New York
   (minerals, rocks, biological specimens and supplies)

   W. M. Welch Scientific Company
   1515 Sedgwick Street
   Chicago 10, Illinois
   (general scientific equipment)

   General Biological Supply House
   761 - 763 East 69th Place
   Chicago 37, Illinois
   (biological supplies and equipment, live and preserved specimens)

   In writing to scientific supply houses elementary teachers should explain their needs in order that material may be found which best meets the need.

2. Scientific Games and Toys--Erector sets, Chemcraft sets, microscope sets, mineral sets may be used in the elementary school.

3. Local Health, Water Supply, Fire, and Other Municipal Agencies.

4. Industrial and Commercial Materials.¹

5. Federal publications which may be secured from the Government Printing Office, Superintendent of Documents, Washington 25, D. C.

¹Zim, op. cit., pp. 21-23.
6. Materials currently available, listed in each issue of the National Education Association Journal and other educational magazines.

7. Films, slides, bulletin boards, newspaper clippings, photographs from newspapers and magazines, creative drawings, creative posters, charts, graphs, and real objects should be used in teaching elementary science.¹

8. A school project with teachers and children all helping could be undertaken to gather and organize needed materials from the community, and from commercial sources as far as the budget will permit. Certain articles collected for one undertaking may be worth saving for future activities. Points of interest within range of the school could be catalogued and their significance listed.²

9. Science kits contain essential materials already selected and boxed for use.

Science kits may be obtained from:

Gustave H. Kock
204 Dexter Street
Tonawanda, New York

Tunis Baker
State Teachers College
Paterson, New Jersey
(Elementary Science Equipment Units)

Science Associates
Post Office Box 216
Princeton, New Jersey
(Learn-by-Doing Kits)

¹Ibid., pp. 155-158. ²Ibid., p. 193.
Whatever arrangement for material is used, care should be taken that the material does not become stereotyped. If school children were provided with the resources for an active, interesting, worthwhile program of investigations in science, many of the disciplinary problems that take so much of the administrator's time, as well as that of the teacher, would cease to exist. In a vital science program the child is encouraged to develop an interest in something outside himself.²

The Association Conference suggested that materials, facilities, and supplies be selected always in terms of what the science program intends to accomplish. This is a more sound basis than blind following of a "standard" prepared list.³

In summarization the investigator has found that materials in elementary science teaching should be obtained:

(1) in the school itself, (2) from the homes of children, (3) by construction, and (4) from scientific supply houses.
CHAPTER III

PRESENTATION OF SCIENCE UNITS

Although units of science work are sometimes published, the investigator does not feel they often meet the needs of the elementary teacher and pupil. The investigator of this study has need for very flexible, thorough, pre-planned units to aid in the teaching of science during the busy school year.

I. GRADE PLACEMENT

To choose the grade placement of many scientific principles is extremely difficult in practice. For example, some children can understand the principles of levers as early as second grade. The principle of simple magnetism is not beyond the comprehension of many primary children. Yet, of necessity, some difficult decisions must be made concerning the grade placement of scientific concepts at each level.¹

A unit of work is a series of learning experiences organized around a central theme or problem.²

The investigator has chosen to develop the units on rocks and soil of the earth's surface, and the universe. These

¹Bloom, op. cit., p. 41.
²Barnard, Stendler, Spock, and Reynolds, op. cit., p. 9.
are frequently placed in grade three, appearing in such series of textbooks as Heath\(^1\) and Singer\(^2\) for grade three.

II. UNITS

Following are the units developed by the writer for use in grade three:

The Rocks and Soil of the Earth's Surface

I. Suggested References for Teaching Background


Williams, Henry Lionel. Stories in Rocks.

Loamis, Frederick Brewster. Field Book of Common Rocks.

Hubler, Clark. Working with Children in Science.

Blough, Glenn O., and Albert J. Huggett. Elementary-School Science and How to Teach It.


\(^1\)Herman Schneider and Nina Schneider, Science Far and Near (Boston: D. C. Heath and Company, 1959).

\(^2\)George Willard Frasier, Helen Dolman MacCracken and
II. Teaching Objectives

A. Growth in using the scientific method

B. Growth in appreciating the environment

C. Growth in participating in science

D. Growth in acquiring core knowledge by the scientific method:

1. Soil, man, plants, and animals are all dependent upon one another for life.

2. Conservation of grasslands and forests is necessary to prevent erosion of the soil on which life depends.

3. The surface of the earth is slowly but constantly changing due to the action of natural forces.

4. Rocks have commercial value.

5. The history of the earth can be learned from a study of rocks, minerals, and fossils.

6. The earth is changed by erosion, volcanoes, earthquakes, and floods.

7. Man also changes the earth.

8. Rocks are formed in different ways.
9. Soil is broken bits of rock mixed with plant and animal matter, both living and dead.

III. Motivation or Introduction
A. Observing a display of pictures, books, and a rock collection (free rock collection obtainable from University of Illinois Geological Survey, Urbana, Illinois)
B. Observing neighborhood erosion
C. Observing and discussing the spreading of gravel on the playground
D. Continuous developing from the study of plants
E. Sharing individual collections, current happenings, or magazine articles
F. Vacation reporting

IV. Discussion and Recording of Present Knowledge

V. Possible Inquiries Resulting from Discussion and Motivation
A. Why is the land of Colorado so different from the land of many states?
B. Why are rocks different colors and weight?
C. Where is gravel obtained?
D. What causes soil or rocks?
E. How are stones of rings related to rocks?
F. Is gravel made by man?
G. Are rocks of any value?
H. What causes mountains?
I. What causes earthquakes?
J. How is the topsoil different from the remaining soil?
K. Of what value are fossils?
L. In what ways can erosion be prevented?
M. Where can different rocks be found?
N. What causes lines in some rocks?
O. Where do the minerals in our plants come from?

VI. Children's Organization of Inquiries
A. Record and group questions
B. Speculate on answers
C. Record and list methods and sources for additional information

1. Pupil reference books

Cormack, M. B. *The First Book of Stones.*


Schneider, Herman, and Nina Schneider. *Rocks, Rivers and the Changing Earth.*
New York: 8 West 13th Street, William R. Scott, 1952, Grades 6-12.


Let's Read about Mountains and Volcanoes. Webster Publishing Company.


2. Pupil textbook series


3. Films from the Des Moines Schools

a. "Volcanoes in Action"

b. "What Is Soil?"

c. "Soil and Water Conservation"
d. "Rocks"

e. "Earth's Rocky Crust. Ways to Better Conservation"

f. "Building Roads"

g. "What Makes a Desert"

h. "Erosion"

i. "Mountain Building"

j. "Iron and Steel"

k. "Peat and Coal"

4. Filmstrips from the Des Moines Schools

a. "Changing Surface of the Earth"

b. "Our Changing Earth"

c. "How Rocks Are Formed"

d. "Series: Conservation Is Everybody's Business"

e. "Harnessing Rivers"

f. "Irrigation"

g. "Series: On Soil Conservation"

5. Source of other visual aids

a. State film library

6. Record learnings for: clarity, validity, reliability, or for future reporting

7. Illustrate learnings for clarification and comparison

8. Record and compile equipment list

a. Rock collection
b. Hammer for breaking rocks

c. Vinegar to test limestone

d. Glass to test hardness

e. Samples of soil

f. Glass jar

g. Magnifying glass

9. Homemade equipment

a. Divisional shelves for rocks

10. Exhibit

a. State Historical Building

11. Community resources (appreciation of the environment)

a. Soil Conservation Office

b. Local chemical companies

c. Local quarries

12. Observation through activities

a. Crack small stones on a concrete slab, brick, or other hard surface to see the insides. Compare texture of other materials in the classroom.

b. Explain formation of pebbles. Observe stones under a large magnifying glass.

c. Walk through the school to observe how rock is used in its construction.

d. Place pebbles in a jar of water in order to observe their colors.
e. Set up standards for a rock display. Classify rocks:
   Labeling
   Displaying artistically
   Listing origin
f. Visit an excavation to observe soil layers.
g. Observe and compare stones for differences and likenesses.
h. Place reference material with rock display.
i. Form a club of "rock hounds."
j. Take a rock treasure-collecting walk to the waste pile on a quarry.
k. Consult local library for information concerning geological history of the region.
l. Press a leaf or shell against a smooth lump of clay. Observe result.
m. Observe which wet stones will make marks on other stones.
n. Observe rocks which have set in strong vinegar. What might this compare to?
o. Locate some of the places within walking distance of your present location where geological principles are exemplified. Describe the features observed; explain what they reveal.
p. Prepare artificial fossils for display.
   Display with real fossils for comparison and explanation.
q. Examine different crystals under microscope after evaporation. Why is there a difference in shape?
r. Report and share findings.

VII. Evaluation
A. How can the class know how well they have done?
B. What were the recorded problems the children started with?
C. Can children speculate on answers to existing problems?
D. Are there differing opinions?
E. Can children prove their learnings?

VIII. Children List Methods to Clarify Differing Opinions and Prove Facts Learned (recording and comparing)
A. Record differences of opinion
B. Record facts learned
C. Compare readings, observations, and activities
D. Record facts to be proven by experimentation

IX. Experiments (observe, record, compare, conclude)
A. To understand how water freezes in rocks and crevices causing them to split, fill a sturdy bottle with a tight screw type can and freeze.
B. To determine the best soil for plant growth, plant seeds in different kinds of soil. Experiment also with commercial fertilizer.

C. To find why rocks are of different texture, prepare crystals by differing liquid evaporations. This also shows how crystals are formed and how minerals can be identified by the shape of the crystals.

D. To demonstrate a geyser in action, make coffee in percolator. The heat of the stove is the hot rock of the earth; the water in the percolator is the underground stream; the funnel is the crack in the rock formation.

E. To demonstrate a volcano, fill a deep pan with mud, allow it to dry until the crust is formed, then press down on the surface until the still fluid mud from below is forced to flow out through fissures in the crust. The Hawaiian Islands are volcanoes of the effusive type similar to the mud illustration. The more spectacular and dangerous volcanoes that explode and hurl ashes for many miles are similar. An overheated pressure cooker will explode because the cover is not resistant. A kettle boils over because its cover is resistant.

F. To demonstrate erosion, place a mound of soil and a mound of sod in a large flat pan. Subject the two
mounds to erosion by running equal amounts of water down over them. This can also be used for exhibit. Experiment to find why there is a difference in crystals.

G. To prove how sand can be formed, beat rocks together. Put several small, clean rocks in a tin can. Put cover on can and shake vigorously for a minute. Empty contents of can on dark sheet of paper. How then are rocks formed? How do rocks become rounded?

H. To prove that rocks in moving rivers are deposited first, whereas the sand may be carried on and deposited where the water moves more slowly, put sand, gravel, pebbles, and soil in a glass jar. Mix and let settle. The heavier particles settle first. Leave for some time without disturbing. The water will become clear.

I. To demonstrate the formation of mountains, place several thin layers of modeling clay one upon the other, then pressing in upon the sides, causing the clay to fold. If cracks are formed in the clay they correspond to joints and faults in rocks.

J. To prove how moving water picks up sediments, place a handful of dirt in a glass jar, another of sand, and a few pebbles. When the water is stirred the fine pebbles are picked up first. When the stirring
is discontinued the heavy particles settle first, finer particles settle only after a period of time. During floods both large and fine particles are moved; but, fine particles are carried faster.

K. To demonstrate stratified layers in rocks, stir dirt in a glass jar and allow it to settle. Without disturbing the dirt, powdered chalk can be added to the water and allowed to settle into the dirt. Repeat this process.

L. To show how a flood washes soil, put a mound of soil into a dishpan and allow water to slowly trickle over it from a bottle. Pour rapidly to show what a flood does.

M. To demonstrate the change in crystals, purchase blue vitrial and dissolve in a small amount of warm water in a glass jar. As water evaporates crystals will be formed. Pour some of the solution on a plate. Observe which evaporates faster the plate or the glass jar. Observe change in crystals. Put liquid solution on glass. Add epsom salts to another liquid solution on glass. Observe the crystals after evaporation.

X. Conclusion

A. Observe experiments for validity.

B. Form conclusions on valid experimentation.

C. Summarize procedure used to solve problems of the unit.

D. Plan an exhibit or a creative play to show learnings acquired.
E. Discuss disposal of materials.

F. Use the appreciation of the environment developed in this unit to study means of helping in soil conservation.

The Universe

I. Suggested References for Teaching Background


Neely, H. M. *Primer for Star-gazers.* Harper Brothers.

Olcott, William T. *A Field Book of the Stars.* G. P. Putnam's Sons.

Poole, Lynn. *Your Trip Into Space.* Whittlesey House, 1953.


II. Teaching Objectives

A. Growth in using the scientific method

B. Growth in appreciating the environment

C. Growth in participating in science

D. Growth in acquiring core knowledge by the scientific method:

1. Large objects seem small when seen from a distance.

2. The light and heat from the sun are necessary to life on the earth.

3. There are unfounded beliefs about the stars and their influence on our lives.

4. Scientists have found out a great many scientific facts about the sky. They have invented instruments to help them.

5. No one knows what man will discover in space.

6. Stars are huge suns.
7. Each year our knowledge of the universe increases.

8. The sun is the center of a huge system of heavenly bodies which revolve around it.

9. Physical conditions vary on the different members of the solar system.

III. Motivation or Introduction

A. Observing many varied teaser tags about the room. These tags announce coming attractions of the unit to be taught such as: Spacemen Visit The Earth.

B. Sharing and discussing current newspaper clippings

C. Sharing a space book of interest

D. Discussing a space program seen on television

E. Continuous developing from a unit on "The Earth's Surface" (depending upon how the previous unit was developed)

F. Observing the moon in the morning sky

IV. Discussion of Present Knowledge

V. Inquiries Resulting from Discussion and Motivation

A. Why is the sun so hot?

B. Why does the sun shine longer in summer than in winter?

C. What does "race for space" mean?

D. Why does the moon shine in the daytime?

E. Has the sky changed with time and weather like the earth's surface?
F. Have spacemen tried to reach the earth?
G. Are space stories true?
H. What instruments are used to study the sky and space?
I. What causes stars?
J. Is there a man in the moon?
K. How does the sun get hot?
L. Why is the sun warmer in the summer?
M. Is the sun red or yellow?
N. What makes the moon different sizes?
O. What is space?

VI. Children's Organization of Inquiries

A. Record and group questions.
B. Speculate on answers.
C. Record and list methods and sources for additional information.

1. Pupil reference books


Freeman, Mae, and Ira Freeman. *You Will Go to the Moon.* New York: Random House, 1959, Grade 2.


Ruchlis, Hyman. *Thank You, Mr. Sun.*


2. Pupil textbook series

3. Filmstrips from the Des Moines Schools
   a. "Now We Learn About the Sky"
   b. "The Sky Series"
   c. "Light"
   d. "What Is in the Sky"
   e. "Day and Night"

4. Films
   a. "Light and Heat," Gateway Films
   b. "Light and Shadow," Young America Films
   c. "Big Sun and Our Earth," Coronet

5. Filmstrips
   a. "Light," Young America Films
   b. "Our Earth in Motion," Jam Handy Organization
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6. Slides on Astronomy from the Des Moines Schools

7. Other sources of visual aids
   a. Coronet Films, 65 East Street, Chicago, Illinois
   c. Film Strip of the Month Club, 353 Fourth Avenue, New York
   d. The Complete Index of Educational Filmstrips, Filmstrip Distributors, Madison, Wisconsin
   e. Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan
   f. Encyclopedia Britannica Films, 1150 Wilmette Avenue, Wilmette, Illinois
   g. National Audubon Society, 1130 Fifth Avenue, New York
   h. Young America Films, 18 East 41st Street, New York

8. Room encyclopedias

9. Observation field trip, Drake Observatory, Waveland Park, phone Mr. Riggs, CR 9-4131, open Monday and Friday evenings

10. Record learnings for: clarification, validity, reliability, or for future reporting

11. Illustrate learnings for clarity and comparison
12. Record and compile equipment list
   a. Mirrors, various sizes and shapes
   b. Globe or large rubber ball
   c. Modeling clay or small rubber ball
   d. Two magnifying glasses and another convex lens that is smaller to illustrate the principle of a telescope
   e. Binoculars for evening use
   f. Flashlight for evening sky use

13. Observation through activities
   a. Make a mural or a model of the solar system.
   b. Keep a scrapbook of newspaper articles about the universe.
   c. Learn the names of the constellations observed such as: Orion, Cassiopeia, The Big Dipper, and The Little Dipper.
   d. Compare the orbit of the earth around the sun with a revolving ball on a string.
   e. Plan and make a sundial. See Childcraft, Volume VIII, page 229, or Fun With Astronomy, page 11.
   f. Obtain an almanac and discuss and observe "planting by the moon."
   g. Record, create and share stories, and poems.
   h. Plan and set up a science activity center--work surface, bookshelf, display facilities.
i. Make papier-mache models of brilliantly painted planets, add glitter and hand about the room for space atmosphere. Use different colors.

j. Use *Singing and Rhyming Music Book: III*, to create atmosphere with these songs:


k. Observe and record sunrise and sunset over a period of time.

l. Plan and write for $5.00 Solar Mobile Kit, Central School Supply Company, Louisville.

m. Compare the planets to foods such as plum, cherry, small pea, rice grain and prepare model.


o. Make a sun-planet model using various size styli-form balls and coat hanger wire. Compare differing models created for accuracy.

p. Compare, record, and measure the temperatures of black, white, and orange objects placed in the sun.
q. Record distinguishing facts concerning the planets.

r. Observe the sunset for different colors.

VII. Evaluate

A. How can the class know how well they have done?
B. What were the recorded problems the class started with?
C. Can children speculate on answers to existing problems?
D. Are there differing opinions?
E. Can children prove their learnings?

VIII. Children List Methods to Clarify Differing Opinions and Prove Facts Learned (recording and comparing)

A. Record and compare differences of opinion.
B. Record and compare facts learned.
C. Compare readings, observations, and activities.
D. Record facts to be proven by experimentation.
   1. Record material needed and source.

IX. Experiments (observe, record, compare, conclude)

A. To show the greenhouse effect, put sand or soil in a glass container such as an aquarium or battery jar. Put a thermometer inside the container. Cover the top with glass. Place a second thermometer on the top side of the container. Set this outside in direct sunlight. Observe the initial temperature. Observe both thermometers
periodically for about one-half hour.

B. Support a large concave mirror or reflector directed towards the sun. Roast marshmallows at the focal point. (While doing this protect your eyes from the sun.)

C. Observe the liquid in a thermometer by focusing sunlight through a magnifying glass so that it comes to a point on the thermometer.

D. Fill two cans of the same size, one shiny the other painted dull black, with water of the same temperature. Cover each can with cardboard or wood which has a hole for a thermometer. Take the temperature of the water of each can at five-minute intervals.

E. Use the telephones supplied by the telephone company with the flashlight batteries. Remove the batteries, insert strips of brass as connectors so as not to break the circuit, and use a solar battery as the source of energy. If the sun is shining place the solar battery in direct sunlight. Have children test the phones. If the sun is not shining, use the photoflood light provided by the company. Turn off the lights. Test the phones.

F. If two magnifying glasses of different focal lengths are available, they can be used as a simple telescope by holding the short one close to the eye and the
longer one at arm's length, or at whatever distance is necessary to bring objects into focus. The greater the difference in the focal lengths of the two lenses, the greater the magnification. If several lenses can be obtained compare the magnification of one combination of lenses with that of another. The image will be inverted. For observing objects in the sky the inversion does not matter, but for a terrestrial telescope the image must be reinverted by another convex lens.

G. Using the globe or rubber ball, children can observe that a small portion of the earth's surface looks and feels flat, while a large portion of the earth's surface looks round. Photographs can be taken far enough away from the earth's surface to show its curvature.

H. On a starry night place an unlit lamp on the window sill. Turn out all the lights in the room. Look out the window and see how many stars can be counted. Turn on the lamp. Fewer stars will be seen. The light from the lamp made many of the stars disappear just as the bright light of the sun seems to make all the stars disappear.

I. In this experiment the following are needed: a ball for the moon, a light for the sun, and a child for the earth. Child should elevate the moon ball in
front of him. Use lights as needed. The moon would then be comparable to a full moon. If the child moved the ball moon slowly to the left it shows another shape of the ball moon. Continue turning the moon ball to obtain other shapes of the moon.

X. Observe
   A. Observe experiments for validity.
   B. Observe and record results.

XI. Conclusion (appreciation of the environment)
   A. Summarize procedure used to solve problems of unit (inquire, observe, record, compare, experiment, and conclude).
   B. In summary, stress appreciation of the universe.
   C. Plan culminating activity such as creative play.
   D. Discuss disposal of material.
   E. Use appreciation of the environment (the universe) to plan sequential pattern to the unit "Light and Sound."
CHAPTER IV

SUMMARY

The problem for consideration in this study was the development of interesting and useful science areas in third grade.

It was the purpose of this study in elementary school science to: (1) examine the needs for interesting and useful science units in third grade, (2) study the present methods and materials, and (3) present some of the units designed to help a group of third grade girls and boys develop a more useful knowledge of science.

The investigator summarized present trends as follows:

The materials, methods, and objectives of elementary school science are changing from the stereotyped in order to meet the problems of children, and to meet the needs for their proper growth and development in a scientific age. With the use of these materials, methods, and objectives, children will understand and participate in science; they will think for themselves. Realizing that science is probably only in its beginning in the present age and its importance is inescapable in the world; educators are constantly working together for a more effective elementary science program.

From the study of objectives the investigator used the following objectives in planning the units which followed:
1. Acquaintance with the scientific method including
   a. Inquiring
   b. Observing
   c. Recording
   d. Comparing
   e. Experimenting
   f. Concluding

2. An appreciation of the environment

3. Actual science participation by the child. Each child must be thought of as a little scientist in an active science program.

   The investigator found that the desirable method of teaching science is that in which the teacher:

   1. Establishes objectives
   2. Starts where the child is
   3. Considers and uses the child's background and environment
   4. Plans for the child's continuous growth and development
   5. Knows and understands science
   6. Allots time for science
   7. Evaluates
   8. Plans pupil participation in science

   In summarization the investigator has found that the materials in elementary science teaching should be obtained:
(1) in the school itself, (2) from the homes of children, (3) by construction, and (4) from scientific supply houses.

Units developed were: "The Rocks and Soil of the Earth's Surface," and "The Universe." The units were based upon the desirable objectives, trends, needs, interests, materials, and methods found in this study.
BIBLIOGRAPHY

A. BOOKS


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


C. PERIODICALS


D. UNPUBLISHED MATERIALS