Some Applications of the Scientific Method as Applied to the Teaching of Elementary-School Science.

Henry Judson Jacob

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SOME APPLICATIONS OF THE SCIENTIFIC METHOD AS APPLIED TO THE
TEACHING OF ELEMENTARY-SCHOOL SCIENCE WITH SPECIAL REFERENCE
TO RESOURCE EDUCATION

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Education

by

Henry Judson Jacob
B. A., Mississippi College, 1929
M. A., George Peabody College for Teachers, 1946
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This study is concerned with the scientific method as related to the teaching of elementary-school science with emphasis on resource education. The first part of the study traces the development of the scientific method as related to science education at the elementary-school level. It was found that the methods of Rousseau, Pestalozzi, and Herbart closely approximated the scientific method as used by modern educators. The concepts advanced by these European scholars were further developed in America by the McMurrys, Dewey, and Kilpatrick. The study shows that, as the scientific method became more widely used in the solution of social and educational problems, more and more emphasis was placed on elementary-school science. A review of present-day objectives of science education indicates that one of the major objectives of elementary-school science is the development of skills in using the scientific method.

The second phase of the study deals with the development of the resource education movement. Since the Regional Conference, held in Gatlinburg, Tennessee, in 1943, considerable literature has been produced emphasizing the need of education for wise use of natural resources. The rapid spread of this movement throughout the Southern States was due primarily to the activities of the Committee on Southern Regional Studies and Education of the American Council on Education. A survey of
recent literature revealed that many schools have included resource education in the science program at the elementary level. Some schools base the entire elementary science curriculum on the study of local resources. Reports from such schools are included in the study.

The final chapter includes four units, illustrating the use of natural resources in teaching science at the elementary-school level. Units on soils and forests were developed for the third and sixth grades. They were planned according to accepted criteria for unit construction. The general objectives were selected to conform to the general objectives of elementary-school science. Activities which provide pupils with experiences in using the scientific method to solve problems were included in each unit. Problems presented for solution in the units were based on local community problems of social significance which were simple enough for pupils to understand and appreciate. Sufficient factual information was provided and directions for procedure given to permit teachers to use the units without assistance from the author. A bibliography of films and reference materials for pupils and teachers was included in each unit.
CHAPTER I

INTRODUCTION

I. THE PROBLEM

The method of science, called the scientific method, has become the accepted method of solving problems in many areas of human endeavor. Education has come to use it as a means of improving content and instruction throughout the school program. It has become the generally accepted method for the solution of educational problems and also a basic objective of science education.

The problem facing the school administrator and the classroom-teacher of today is how to make the most effective use of the scientific method in the improvement of instruction, and what experiences will be of the most value in helping children develop the ability to use this method with their every-day problems. Since it is the method of science, the science class is the most logical place for pupils to learn its use and importance; and since science is now an accepted part of the curriculum throughout the elementary grades, elementary teachers must concern themselves with the proper applications of the scientific method to the teaching of science to children.

In its broadest sense, the term is more than a method, it is a concept, a way of thinking, a way of acting, and a way of approaching all of life's problems. It is as valuable to the
banker, the farmer, and the merchant as it is to the pure science research worker.

Due to its broad implications, the term is difficult to define in a concise statement. In order that the reader may understand the term as it is used in this study several definitions are quoted:

The scientific method is essentially a method of solving problems that present either a utilitarian or an intellectual appeal.¹

Briefly, the scientific method deals with actual situations, is a utilization of the principles of analysis, sets up hypotheses that are based upon this analysis, employs careful and accurate measurement, includes quantitative methods in the treatment of data, and is free from prejudice or emotional bias.²

It is more than a precise method however; it is as much the spirit in which humanity approaches all pressing problems as the exactitude with which these problems are solved. It is the spirit of open inquiry, of tireless investigation, of willingness to listen to opposing ideas and to give them a chance to prove their worth. Above all, it is the belief in man's ability to face the world with his own skills and powers and to solve his problems through his own active intelligence.³

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Some writers explain the phrase in terms of its characteristics. Following are six features which have been called the "distinguishing characteristics of the scientific method."

1. Science is based on facts.
2. Science employs the principles of analysis as a fundamental procedure in the comprehension of complex phenomena.
4. Scientific thinking is characterized by freedom from emotional bias.
5. Science utilizes accurate measurement.
6. Science employs quantitative methods in the treatment of its data.4

Other explanations are in terms of the characteristics of those who are scientific in their actions.

Characteristics of one who habitually uses the scientific method.

1. Shows discrimination in selecting and defining significant problems.
2. Shows discrimination and skill in formulating hypothesis.
3. Is adept in using experiments to test hypothesis:
   (1) Is critical of each step,
   (2) Sees alternative to conclusions,
4. Is versatile and critical-minded in using past experiences and authoritative sources in testing hypothesis.
5. Is objective in the rejection, modification or acceptance of hypothesis as conclusions.

6. Recognizes the assumptions that underlie conclusions.
7. Has skill in selecting and defining new and significant problems "next steps."

Noll recognized that some steps in the scientific method may be too difficult for all children to grasp but pointed out the fact that they can learn to recognize and arrive at satisfactory solutions to simple problems as, "What happens to snow when it melts" or "Why do we have summer and winter". In solving such problems children learn to (1) define problems, (2) suggest and test hypotheses, (3) draw conclusions and test them, thus bringing into use the basic principles of scientific procedure.

The importance of the scientific methods to every-day life and as a means of solving social problems has received considerable emphasis in recent literature. According to Baker:

Many problems facing the world can and will be solved by scientific procedure. Thinking people can be trained to solve problems by developing skill in using the "scientific method". That is, they can be trained to gather sufficient evidence and data relative to problems which they face as individuals and as members of society; they can be trained to draw conclusions in terms of objective evidence; and they can be acquainted with the underlying scientific facts, principles, and concepts that are related to living in the Scientific Age. When people have this kind of training we can look forward to more clearly defined national policies,


desirable legislation, and a society geared to the promotion of better living for all people.\textsuperscript{7}

Kilpatrick summarized the contributions of the scientific method as follows:

1. Through science man gets new faith in himself.
2. Science with the aid of technology has made the modern world modern.
3. It has changed the thinking of modern man from main reliance on deductive \textit{a priori} reasoning to main reliance on inductive reasoning.
4. Science has taught man that the world is not governed by caprice, but is understandable.
5. The spirit actuating science shows the highest standards of honesty and truthfulness known among men.
6. Science allows self-interest no place in determining results of research or in reporting thereon.
7. It has provided methods of constructive creative study far and away more effective than any explicit in use prior to Galileo.\textsuperscript{8}

From the standpoint of the elementary-school pupils the scientific method is a matter of asking reasonable questions, seeing simple problems, finding the answers and solutions through systematic, orderly efforts, and applying the knowledge thus acquired to other situations. Simple problem-solving experiences not only develop scientific habit but according to Olsen are the actual bases of functional learning.


Real education comes about when children intelligently attack real problems, think them through, and then do something to solve them. Every chance should therefore be given pupils to discover, define, attack, solve, and interpret both personal and social problems within the limitations of their own present abilities, interests, and needs.9

The elementary teacher is constantly faced with the following type of questions: What facts of science are most important in the lives of children? What problems are most useful in developing problem-solving skills? What experiences will best serve to develop scientific attitudes and habits? What materials are available to provide these facts, problems, and experiences? The answer to these questions may be found in the local environment. Regardless of the type community, whether it is rural or urban, there is an abundance of materials and problems, which may be used to provide satisfactory science experiences for the elementary-school child. The type of environment should determine the type of science experiences provided by schools.

In discussing the community as a living laboratory Olsen said:

Within every community, large or small, urban or rural, go on the basic social processes of getting a living, preserving health, sharing in citizenship, rearing children, seeking amusement, expressing religious impulses, and the

like. When pupils study familiar though actually unknown processes, develop intellectual perspectives, improve emotional outlooks and serviceable personal skills as they observe and participate in these processes, they are discovering for themselves not only the problems they face, but also the resources they can utilize in attacking those problems.

The materials used may vary according to the community but the basic problems of life and principles of science remain constant in any location.

II. PURPOSE OF THE STUDY

The purpose of this study was to trace the development of the scientific method as it has affected the teaching of elementary-school science and to illustrate by the use of units how this principle may be applied to the problems of land and forest conservation. By using natural resources and local problems to provide science experiences, pupils develop the ability to solve problems according to the scientific method and at the same time develop an awareness of such problems. To provide assistance for elementary teachers in using the natural resources of a community as a means of training children to think reflectively and govern their actions accordingly was the primary concern of this study.

10 Olsen, op. cit., p. 34.
III. DELIMITATION

In this study the scientific method was considered only as it applied to the teaching of elementary-school science. Teaching units have been developed on forests and soils. These are two of the nation's most important resources and are accessible to elementary schools. For the purpose of this study grades one through six were considered as elementary grades.
CHAPTER II

DEVELOPMENT OF THE SCIENTIFIC METHOD AS RELATED TO THE TEACHING OF ELEMENTARY-SCHOOL SCIENCE

I. INTRODUCTION

Through the ages man has used various means of explaining the phenomena of nature. The early Greek Philosophers practiced a kind of deductive reasoning which enabled them to explain to their satisfaction, the laws of the universe. By means of their reasoning powers they were able to formulate certain so-called laws of nature which were satisfactory to them and their contemporaries. Although Aristotle did conduct some investigations himself, his followers were content to accept his writings as authority in matters of science and philosophy. He had taught, for example, that a five-pound ball would fall five times faster than a one-pound ball because it was five times heavier. This seemed to be a reasonable conclusion, based on common sense, which stood almost two thousand years without being challenged. Aristotle's laws were accepted as authority which no one challenged or questioned. When an important question arose it was not settled by experimentation, but by the word of authority. The practice of testing theory by experiment and observation had not come into use. Not until late in the sixteenth century did experimentation begin to replace the word of authority; then, not without hardships on the part of the experimenter.
When Galileo conducted his famous experiment from the Leaning Tower of Pisa, late in the sixteenth century, he proved the fallibility of authority and gave the world the scientific method of solving problems. He had stated that except for air resistance all bodies fall at the same rate. Learned scholars of the time pointed to the authority of Aristotle to show the young man his error. In a dramatic setting, with University Professors present, Galileo dropped two balls of different weights from the Leaning Tower to prove his hypothesis. Contrary to the expectations of the scholars and to established authority, the balls reached the earth at the same time. The simple fact thus discovered had little influence on the world at large but the act of "testing thought" revolutionized man's way of thinking and gave him a new "mental outlook".¹

Kilpatrick considered this experiment the "key to the interpretation of the modern world". He further stated:

If the modern world has superiority, it is not due to the quality of its dialectic, but rather to the principle which Galileo introduced—namely, that thought, to be acceptable must be tested by its observed consequences.²

² Loc. cit.
II. EARLY APPLICATIONS OF THE SCIENTIFIC METHOD TO THE
TEACHING OF SCIENCE

Before scientific discoveries were applied to the problems of every-day living, education placed little emphasis on the subject of science, especially at the elementary level. As Parker said, "Not until natural science as applied science profoundly affected practical life did it find a place in elementary-school practice".3

When it was realized that science could improve living conditions and that its method might be used as an instrument for solving social problems, educators saw a need for science training in the public schools.

Rousseau was one of the early thinkers to stress the importance of science for children. At the age of twelve Émile was engaged in the study of physics, conducting experiments on air pressure, contraction and expansion, equilibrium, thermometers, and barometers. He was not provided instruments to work with but invented his own. When an experiment was decided upon Émile devised the instruments that were needed.4 In the following statement, Rousseau emphasized the value of science not only as

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a means of developing the power of reasoning and the habit of investigation, but also as a motivating factor.

Call your pupil's attention to the phenomena of nature, and you will soon render him inquisitive. But if you would keep this curiosity alive, do not be in haste to satisfy it. Ask him questions that he can comprehend, and let him solve them. Let him know a thing because he has found it out for himself, and not because you have told him of it. Let him not learn science, but discover it for himself. If once you substitute authority for reason, he will not reason any more; he will only be the sport of other people's opinions.\(^5\)

By this method of teaching science, children not only developed an interest in the subject but were also trained in the habit of critical thinking.

Rousseau was also concerned with science as a method of acquiring knowledge. In discussing this point he said:

The thing is, not to teach him knowledge, but to give him a love for it, and a good method of acquiring it when this love has grown stronger. Certainly this is a fundamental principle in all good education.\(^6\)

From these statements it may be said that Rousseau's objectives of science were:

1. To develop an interest in learning,
2. To develop the habit of critical thinking, and
3. To acquire a method of investigation.

\(^5\) Ibid., p. 124.
\(^6\) Ibid., p. 131.
Parker summarized Rousseau's principles of science instruction as follows:

Such are the general principles of science instruction according to Rousseau; namely, (1) the child to discover science, not merely to learn facts; (2) to develop a taste for science and a command for its method instead of learning a great deal; (3) to begin with the common phenomena from his experience; (4) to follow a psychological rather than a logical order; and (5) to construct his own apparatus. 7

During the time of Rousseau, geography was the principle phase of elementary science, consequently his influence was largely limited to this subject. However, his methods of teaching home geography were copied by Pestalozzi and became the generally accepted methods in this field. 8 Still later, Herbert refined these same methods and applied them to the teaching of Heimatkunde.

Rousseau's principle of letting the child discover facts by the process of investigation was a basic concept leading to the development of the scientific method in education as it is known today.

Influenced somewhat by the writings of Rousseau, Pestalozzi promoted a reform in elementary education which influenced educational method both in Europe and America.

Pestalozzi believed that the way to knowledge was through the senses. He therefore rejected the traditional textbook method of teaching in favor of object lessons. All subject matter

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7 Parker, op. cit., pp. 199-200.
8 Ibid., p. 201.
should be reduced to simple concrete elements and the observations of these elements by the pupil, be considered the basis of methods in teaching. Observation of things, and not words, was one of his fundamental principles of instruction, which he called the "A B C of observation". In applying this principle to the teaching of geography, Pestalozzi had his pupils study the conditions in the immediate environment of the school. After making careful observation and recording all facts observed they would then draw a map of the area. From this beginning the pupils would gradually proceed to the study of world geography and its relations to human activity.9

Pestalozzi summarized the importance of observation in these words:

... consider no human judgement ripe that does not appear to you to be the result of a complete sense-impression of all parts of the object to be judged; but on the contrary, look upon every judgement that seems ripe before a complete observation has been made as nothing but a worm-eaten and therefore apparently ripe fruit, fallen untimely from the tree.10

The primary contribution of Pestalozzi to the scientific method of instruction was his "A B C of observation". Although observation is an important aspect of the scientific method it is not always scientific within itself. Observation without

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10 Johann Heinrich Pestalozzi, How Gertrude Teaches Her Children (Syracuse: C. W. Bardeen Publisher, 1898), p. 132.
purpose may be totally unscientific. As Herbert Spencer stated: "The most diligent observation, if not aided by science, fails to preserve from error."

Even though Pestalozzi placed all instruction into only three classes, number, form, and language, the study of science was by no means neglected in his schools. He placed geography, physical science, and natural history under the heading "language" and gave these subjects a regular place in his weekly schedule. According to Eby and Arrowood, "The lower class from ages eight to twelve years in Pestalozzi's school spent two hours each week in nature study, two hours in geography, and two hours in knowledge of country."

The contributions of Rousseau and Pestalozzi were important steps in systematizing a method of instruction. However, it remained for Johann Fredrick Herbart to formalize education into a science and apply systematic thinking to the process of teaching. Through his insistence on accuracy, education was changed from a primarily institutional kind of thought and practice into a scholarly discipline. His theory of mental processes, although now questioned from an intellectual standpoint, nevertheless, did serve as a basis for systematic educational methodology.


explained his philosophy and methods in outlines of *Educational Doctrine*, which, according to Parker "is one of the most systematic, sane, and practical discussions of pedagogy ever written". In this writing Herbart gave the basis for the science of education as follows:

Ideas spring from two main sources, . . . experience and social intercourse. Knowledge of nature—incomplete and crude—is derived from the former; the latter furnishes the sentiments entertained toward our fellowmen, which, far from being praiseworthy, are on the contrary often very reprehensible. To improve these is the most urgent task; but neither ought we to neglect the knowledge of nature. If we do, we may expect error, fantastical notions, and eccentricities of every description. Hence, we have two main branches of instruction, the historical and the scientific. The former embraces not only history proper, but language study as well; the latter includes, besides natural science, mathematics.

Having thus classified knowledge, Herbart divided instruction into four stages—clearness, association, system, and method. DeGarmo gave the following explanation of these four stages:

In teaching we need to have (1) **clearness** in the presentation of specific facts, or the elements of what is to be mastered; (2) **association** of these facts with one another, with other related facts formerly acquired, in order that assimilation, or apperception, may be adequately complete; (3) when sufficient facts have been clearly presented and sufficiently assimilated, they must be systematically ordered, so that our knowledge will be more perfectly unified than it could be did we stop short of thorough classification, as in the study of botany, or of the perception of rules and principles, as in mathematics and grammar; (4) finally the facts, rules, principles, and classifications thus far assumed must be secured for all time by

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14 Parker, op. cit., p. 379.

their efficient methodical application in exercises that call forth the vigorous self-activity of the pupil.16

The followers of Herbart made these steps the basis for organization of instructional units, and later changed them into the following so-called five formal steps:

1. Preparation—Analysis Appreception of precepts
2. Presentation—Synthesis
3. Association Thought. The derivation and arrangement of rule, principle, or class.
4. Systemization
5. Application. From knowing to doing; use of motor powers.17

In considering these steps as they relate to modern, inductive, scientific research and as steps in reflective thought, modern critics find certain defects in them. Parker18 pointed out that the construction of hypotheses and their verification were not mentioned in the formal steps. He also brought out the fact that in reflective thought, the facts necessary to solve a problem are not "presented" to an individual but must be found through research.

It is not the purpose of this study to go into the merits or demerits of Herbart's methods. They are presented here as an important step in the development of modern method. They represented a systematic method superior to anything which had preceded them.

16 Ibid., pp. 53-54.
17 Ibid., p. 59.
Harcourt placed special emphasis on the teaching of history and language but also recognized the need for science in the curriculum. In discussing the importance of science he said:

To others, science may be a pair of spectacles, to me it is an eye, and the best of eyes, too, which human beings possess for the contemplation of their environment—he who considers himself clever without scientific knowledge, fosters errors in his opinions.19

The formal steps were particularly suited to the teaching of science and served as a much needed stimulus in that area. Many evidences may be found of their applications to science instruction in the schools of Germany. The following lesson in "natural history" is an example of one planned for thirteen-year old boys according to the five formal steps. It was translated from Dr. Schultze's Deutsche Erziehung by Felkin.

THE HONEY-BEE (Apis melifica L.).
By Ferdinand Werneburg (Eisenach).

Aim. We shall learn today about the honey-bee.

First step: Preparation. Before we examine its structure and manner of life more closely, tell us what you already know about it.
(A summary of what the children know follows, which is omitted here for want of space.)

Second step: Presentation of the new.
(I only give the main heads (the concentrations), omitting the combinations (reflections) which follow them, and which are strengthened by looking at live bees and their

productions, and by pictures, drawings, and microscopical
specimens).

a. There are three kinds of bee: queen, workers, and
drones. Their structure.
b. The bee community and their social life.
c. The religious significance of bees among different
nations.
d. The countries, especially in Germany, where honey is
now chiefly produced.

Third step: Association, or formation of concepts.

a. Comparison of the working bee with the queen and drone
(1) in respect to their common, (2) to their diverse
characteristics.
b. What difference is there between the wing of the honey-
bee and the wing of the cockchafer? (A lesson on the
latter had been previously given).
c. Comparison between these two insects in the structure of
the mouth and its parts, and their mode of feeding.
d. Comparison of their mode of development.

Fourth step: Recapitulation, or system (here the systematic
summary of the acquired concepts).

a. Summary (orally) of the chief characteristics of the
honey-bee.
b. The pupil writes in his natural history note-book, "The
honey-bee belongs to the Hymenoptera; its mouth organs
are masticators and lickers; its development takes place
through metamorphosis. The product of the egg is a
larva without feet, which becomes a pupa, which changes
into a perfectly developed insect. Queens and workers
possess a sting; male bees (the drones) have no such
weapon."

c. What activity of the bee exhibits a kind of higher mental
process?
d. How do you explain the meaning attached to the bee by all
nations, especially the ancients?
e. What countries of Europe (1) in ancient times produced,
(2) in modern times chiefly produce, honey and wax?
f. From what plants (1) in countries bordering on the
Mediterranean Sea, (2) in North Germany, do bees collect
the largest amount of honey? (The geographical distribution
of the most important plants had been taught in the previous
summer term).
g. Describe the twofold relation of the bee to flowering plants. How can we, in the light of what we have just said, explain the following poem of Goethe's (esthetic interest)?

"In colours rare
A flower bell
Had early bloomed
In leafy dell;
Its sweets to sip
Bee came to glade:
Each for the other
Was surely made."

h. What do you mean by saying, "He is as industrious as a bee"? (moral interest)

i. Draw as seen under the microscope (1) an eye; (2) a foot; (3) the sting of the honey-bee.

j. Draw the front view of a honeycomb, etc. (esthetic interest).

In spite of the obvious weaknesses of this lesson, certain aspects compare favorably with a modern science unit. It was planned according to a definite aim; utilized previous experiences of the pupils; provided an opportunity for individual investigation; provided an opportunity for reflective thought; was correlated with other subjects; and above all, it moved away from the mechanical process of memorizing facts into the realm of dynamic experiences.

As was true in the time of Rousseau, geography was still the principal phase of science in the lower schools during Herbart's time. Herbart's methods were widely accepted in the study of home geography, or Heimatkunde. Through the "instructional walk" and

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"school journey" the principle of individual investigation and scientific observation were utilized.

According to Dodd, the "school journey" became quite extensive under the Herbartian influence. They were planned according to age level, becoming more and more extensive each year. Young children first studied the school building, measuring doors, windows, desk, and other objects in the classroom. Older children used the same method in studying trees, flowers, insects and other forms of life on the school ground. Each child carefully recorded his findings, later discussed them in class, and related their observation to previous experiences. No unrelated information was introduced on these excursions, only those things actually observed by the children were considered. As the child grew older these trips were increased in distance from the school. At the third school-year level boys sometimes made trips of several days duration into the Thuringian Forest or other places of national importance.

Instruction in the German Elementary Schools of the nineteenth century probably reached its nearest approach to the scientific method in the Heimatkunde classes.

Herbart established a practice-school in connection with his lectures at Konigsberg to teach his methods to prospective

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teachers. Two of the students, Ziller and Rein, became well known teachers of the Herbartian principles. It was through the students of these teachers that Herbart's methods were later brought to America.

III. BEGINNING OF THE SCIENTIFIC METHOD IN AMERICAN SCHOOLS

One of the important contributions of Europe to American education was the formalized Pestalozzianism Object-lesson. About the middle of the nineteenth century Edward A. Sheldon introduced the object-lesson into the normal school at Oswego, New York. As the graduates from Oswego went into the public schools as teachers they carried the object-lesson method with them. The method thus became rather widely used throughout some parts of the country.

Sheldon* prepared several textbooks on the object-lesson method which exerted considerable influence on elementary education at that time. His Lesson on Objects, presented a graduated series of lessons for children between the ages of six and fourteen years. It contained 218 object lessons, covering almost every item included in elementary science books of the present time. Although the books contained no reference to the teaching of science, all lessons were centered around scientific subjects. It covered plants, insects, shells, minerals,

* E. A. Sheldon, Lessons on Objects (New York: Charles Schribner and Company, 1869).
metals, textiles, and various items which are now dealt with only in science classes. In general the object lessons were rather informal. However, some of them became quite formalized and provided some systematic training, as students were required to classify objects and describe them in scientific terms.

For a time the object-lesson method was the accepted procedure for teaching science subjects in many schools throughout the country. The chief difficulty was that the object-lesson became too technical and gave little thought to science as a method. As Slavson and Speer said:

"... elementary science in turn grew into a mass of information taught by teachers as separate, unrelated lessons on a great variety of natural objects of a highly technical nature." 22

According to Parker 23 many teachers thought of the object-lessons as elementary science, even though the term "elementary-science" did not come into general use until later. Parker pointed out that the difference between the two was a matter of classification rather than content.

The transition from object lessons to elementary science occurred in the St. Louis schools about 1870. N. T. Harris, Superintendent of St. Louis schools at that time, carried the

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23 Parker, op. cit., pp. 332-333.
formalized concept of science into the elementary school. He justified this action on the grounds that science furnished the theoretical basis of productive industry, and the consequent elevation of the masses of all the people by means of the wealth created thereby. In addition to its practical values, Harris saw in science an opportunity to develop "scientific culture". He attempted to establish order in science teaching, which up to his time had been on a more or less unsystematic basis. The nearest approach of Harris's method to the scientific method was the definiteness and precision of its organization. His method grew in popularity and became widely used, but it, too, soon became a matter of learning scientific classifications.

IV. INDEFINITE PLACE AND PURPOSE OF SCIENCE IN THE ELEMENTARY CURRICULUM

Science occupied only a very minor place in the elementary school curriculum at the close of the nineteenth century. The traditionalists saw little disciplinary value in the study of science, and the importance of scientific method to children was still a controversial issue.

The Report of the Committee of Fifteen on Elementary Education favored the teaching of science but expressed some doubt

24 Parker, op. cit., p. 336.
25 Slavson and Speer, op. cit., p. 20.
concerning the value of the scientific method for children. The committee issued the following statement in regard to the teaching of science.

Natural science claims a place in the elementary school not so much as disciplinary study side by side with grammar, arithmetic, and history, as a training in habits of observation and in the use of the technique by which such sciences are expounded. With a knowledge of the technical terms and some training in the methods of original investigation employed in the sciences, the pupil broadens his views of the world and greatly increases his capacity to acquire new knowledge. For the pupil who is unacquainted with the technique of science has to pass without mental profit the numerous scientific allusions and items of information which more and more abound in all our literature, whether of an ephemeral or a permanent character. In an age whose proudest boast is the progress of science in all domains, there should be in the elementary school, from the first, a course in the elements of the sciences.

While thus favoring the teaching of science itself, the following statement revealed some doubt concerning the value of the scientific method.

Here your Committee finds in its way the question of the use of the full scientific method in the teaching of science in the elementary school. The true method has been called the method of investigation, but that method as used by the child is only a sad caricature of the method used by the mature scientific man. . . . An attempt to force the child into the full scientific method by specialization would cause an arrest of his development in the other branches of human learning outside of his speciality. . . . your Committee does not attempt to state the exact proportion in which the child, at his various degrees of advancement, may be able to

dispense with the guiding influence of teacher and textbook in his investigations, but they protest strongly against the illusion under which certain zealous advocates of the early introduction of scientific method seem to labor.27

Concerning the value of the scientific method, the report did state, however, that: "Nevertheless this good should be kept in view from the first year of the elementary school, and there should be a continual approach to it."28

The following statements indicate considerable disagreement among the members of the Committee concerning the use of the scientific method. One member stated:

While agreeing fully with the majority of the Committee that the full scientific method should not be applied to the study of elementary science by young children, yet I am compelled to favor more of experimentation and observation by the child, and less of telling by the teacher than the report would seem to favor.29

Another member gave a somewhat different opinion in these words:

Natural sciences, as studied in elementary schools do very little pedagogically for the mind. These studies may or may not cultivate habits of observation. Science involves generalizations that belong to a stage of development later than the primary schools.30

This confusion and conflict concerning the place and purpose of science in the elementary school continued well into

27 Ibid., p. 78-81.
28 Ibid., p. 81.
29 Ibid., p. 107.
30 Ibid., p. 187-188.
the twentieth century. Meanwhile, the nature-study movement had made its beginning and subsequently there arose some differences of opinion concerning nature-study and natural science.

The first issue of the *Nature-System Review,* in an attempt to clarify the situation, defined the scope of nature-study in a rather broad sense. According to this report, nature-study covered all "natural-science" studies in the elementary grades and included all phases of both physical and biological sciences. Such specific subjects as: the natural history of plants and animals, elementary agriculture, physical science, the physical side of geography, physiology, and hygiene were included in the nature-study program.

Nature-study was criticized on the grounds that it taught few scientific facts and had only aesthetic values. There can be no doubt, however, that the proponents of the movement saw an opportunity to teach both the facts and method of science while at the same time developing a lasting appreciation for nature. The aims of nature-study as stated by Bigelow were:

1. To give general acquaintance with and interest in common objects and processes in nature.
2. To give the first training in accurate observing as a means of gaining knowledge direct from nature, and also, in the simplest comparing, classifying, and judging values of facts; in other words, to give the first training in the simplest processes of the scientific method.

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3. To give pupils useful knowledge concerning natural objects and processes as they directly affect human life and interests.\textsuperscript{32}

Apparently the difference between nature study and science was a matter of approach and method rather than content.

Comstock\textsuperscript{33} pointed out that nature-study was not elementary science because of its point of attack. Science follows a logical order, beginning with the simple and moving to the complex. Nature-study began with any chance object which attracted the child's attention, such as a robin, a leaf, or a butterfly. She considered nature-study a good science within its limits, but did not claim that it was as comprehensive as science itself. Nature-study was not meant to be a drill, and Comstock warned that it should be dropped as soon as it became a task.

Other students of the movement took an entirely different viewpoint. Rapeer said:

Finally, and most important, it is a function of nature study to drill the child in scientific thinking . . . to teach him to reason for himself and to reason to correct conclusions on the basis of his own observations. The term observe is now used, not in the sense of seeing, but means achieving impressions through any or all of the senses.\textsuperscript{34}

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He pointed out the importance of nature-study as a means of teaching the method of science as follows:

Nature study has one of the largest opportunities in education. If the average child can be so taught the value of the scientific method of thinking and so drilled in it that he will use it in the solution of the daily problems of later life, the school will have admirably served its day and generation.\(^{35}\)

The ultimate value of nature study to the development of scientific thinking was determined by the methods of the individual teacher. Memorizing names of trees, flowers, birds, and butterflies, obviously contributed no more to scientific thought than memorizing lines of poetry or dates in history. If, on the other hand these objects were studied in terms of their relationships to one another and to human beings, if systematic investigations of natural phenomena were conducted and proper generalization made, then nature study was an instrument for advancing the methods of science.

Nature study, though serving a valuable purpose in its place, did not always produce desirable results in habits of scientific thinking. Certain educational leaders felt a need for more specific science training at the elementary level, but recognized the lack of proper methods for its teaching. Charles McMurry placed natural science next to history in importance as

\(^{35}\) Ibid., p. 346.
an elementary-school subject, but deplored the state of affairs at that time by the following statement:

But on account of the present lack of system and of clear purpose in natural science teachers, the first great problem in the field of common school effort is to select the material and perfect the method of studying nature with children.36

For a number of years there was little improvement in the situation. Almost ten years later McMurry again called attention to the deficiencies with these words:

In the nature study and science instruction of the common school, teachers and specialists in elementary science have not yet reached a consensus of opinion as to the topics best suited for the grades. The methods of study are also variable.37

A study by Craig in 1927 to determine the "practice in the teaching of elementary school science" showed that conditions had not improved. His report stated in part:

The outstanding characteristic of the nature study and science program in elementary school seemed to be a lack of organization. . . .

The majority of courses of study had very little organization which might be termed "functional". . . .

. . . nature study came to be, in many schools, merely a disconnected series of object lessons. . . . The lack of organization in the content in this field has definitely interfered with the successful teaching of science. . . .

An examination of the content of courses of study, syllabi and source books of natural science also indicated a chaos of goals. . . .


Observation and identification have become the predominant notes in nature study. . . . Hence, with the vital elements of both scientific method and content lacking, nature study has become, in many cases, a conglomeration of busy work and object lessons.

Another attendant weakness noted in the content and objective of current practices in elementary school science is the failure to develop a well-balanced program. . . .

V. EARLY IMPROVEMENTS

Two outstanding weaknesses were evident in the elementary-school science program in the early part of the century. The first was a lack of well defined purposes for science at the elementary level, and second, no satisfactory method had been developed for its teaching.

The writer does not wish to imply that no efforts were being made to improve such unfavorable conditions. From the beginning of the century certain leaders were working toward a more scientific method of instruction for all subjects. New methods were being introduced and tried out in laboratory schools and in some public schools. Many years were to elapse, however, before these methods came into general use throughout the country.

Arthur and Charles McMurry studied under the followers of Herbart in Germany and brought his methods to America before the close of the nineteenth century.

38 Gerald S. Craig, Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School, Contribution to Education No. 276 (New York: Teachers College, Columbia University, 1927), pp. 2-4.
Charles McMurry developed "projects" of instruction which he also referred to as "units". In explaining the project he said:

The project well worked out is simply a big object lesson in the process of learning. . . . a demonstration of the right method of collecting, organizing, and mastering knowledge.39

These projects were a definite improvement over Sheldon's "object lessons" in that they were centered around a broad general topic and included all subjects related to the central theme. They provided a means of integrating science into the curriculum without setting it apart as a separate subject.

The main features in a unit of study were summarized by McMurry as follows:

1. It has in it a basal idea, a center for the grouping of facts. . . .
2. The unit of study has in it a developing process of thought which is its principle of growth. . . .
3. Such a topic is concrete. Its idea is embodied in some object, or person or process, like a machine or manufacturing plant, . . .
4. The purposive idea as it develops gathers to itself an instructive and valuable body of knowledge which it organizes into its own structure, . . .
5. Such a large unit of study centers in some practical project like the building of a railroad or the laying of an ocean cable. It is not bookish and school made, but practical and life made.
6. This life project when worked out, is found to be the key and interpretation to a large number of similiar undertakings, . . .

7. Let this idea grow and it will develop out of its small, local, concrete beginnings into a national importance.
8. As this central idea takes root and develops naturally in a child's mind, it organizes his knowledge into a growing habit of thought... 

McMurry saw in the works of nature large scale projects which he considered natural units of study. He saw in these natural units a most satisfactory means of teaching science and said:

It is these very projects, objective and directly practical in their bearings, that children are best able to see the meaning and value of modern science in its influence upon life. What children in elementary schools need is not abstract scientific principles, not the systematic study of any or all the sciences (an impossible thing), but simple, objective, convincing demonstrations of the main ideas and uses of science in the home and neighborhood and in the larger world beyond. What could be better for children than to allow them to see these tangible projects developing and working out their proper, practical influence upon the conditions of life that surround them?

For units in science, McMurry suggested such topics as:
the respiratory system, the life history of the thousand-year pine, growth of the corn plant, and forest reserve and forest conservation. The project was developed around one of the general topics and other information such as history, grammar, and number work was introduced at such times as it would best contribute to the over-all progress of the unit.

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40 Ibid., pp. 58-59.
41 Ibid., p. 8.
Along with McMurry and his project method came John Dewey and progressive education with its powerful influence on instructional methods throughout the country. Dewey rejected Herbart's methods as being too formal and too teacher-centered. In comparing Dewey's methods to the formal steps of Herbart, Meyer reduced the methods of Dewey to the following five steps:

1. Activity
2. Problems
3. Data
4. Hypothesis
5. Testing

Dewey's methods were a much closer approach to the scientific method, and thus more useful in the teaching of science than the formal steps of Herbart.

Dewey put his methods into practice in the Laboratory School at the University of Chicago. Here experiments in instruction were conducted with exact scientific procedure. Science classes were planned for the definite purpose of training children in the use of the scientific method. In a report on the Dewey School, Mayhew and Edwards said:

Scientific method was the constantly used tool not alone in the science laboratory. By common consent it was the method at all times and in all instructions where processes and activities were such that active investigation, testing out of guesses or theories, imagining possible results of this or that physical or social relation could be carried on.43

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In this school every class room became a social and scientific laboratory where scientific experiments were selected and performed on the basis of their social value. Activities were planned according to the children's interests. These activities were conducted in a manner which gave the children an opportunity to learn the use of the scientific method. Extreme care was exercised to select science content materials in keeping with the psychological age of the child. Teachers discovered the fact that seven and eight year old children could conduct certain types of scientific experiments provided those experiments were planned according to the child's viewpoint.

While conducting his own experiments and comparing the results to a natural force the child is able to recognize underlying principles governing both, and "thus comes naturally into possession of the scientific method". Furthermore, "he will do this without divorcing the play of emotion, and color of feeling from his thinking".44

The success of the experiments in teaching children the scientific method is shown in the following summary of results:

... the mental attitudes of being objective in sizing up a problem, a willingness to try to see and ability to direct that seeing effectively was so characteristic of the majority of the children who had been in the school for five years that this result seemed to fulfill the hopes with

44 Ibid., pp. 275-281.
which the science work had been planned. The general use of
the scientific method in all lines of the school work had
exceeded the early expectations.\textsuperscript{45}

The Dewey School thus proved that with proper experiences,
thermoelectric Children can grasp certain aspects of the
scientific method, and will use scientific procedure in connection
with other problems.

Closely associated with the twentieth century improvement
of educational method was the work of Kilpatrick. Under his
influence, the project method reached a high degree of perfection.
Kilpatrick did not claim any credit for introducing the project
concept as an instructional method. Nevertheless, he gave a new
meaning to the term. To him "a project was simply a purposeful
act with emphasis on the purpose."\textsuperscript{46}

The project method as developed by Kilpatrick provided
actual problems solving experiences which were related to the
previous experiences of the child, and was based on objectives
of the child. Furthermore it made provision for individual
differences and at the same time provided for cooperation and
responsibility in group action. This method gave the elementary
teacher an instrument for teaching science according to a

\textsuperscript{45} Ibid., pp. 308-309.

\textsuperscript{46} William Heard Kilpatrick, \textit{The Project Method}, Teachers
College Bulletin, Tenth Series, No. 3 (New York: Teachers College,
Columbia University, 1918), p. 6.
scientific procedure and marked the beginning of a new era in the field of elementary science.

VI. RECENT TRENDS

The Thirty-First Yearbook of the National Society for the Study of Education published in 1932, was an attempt to establish a definite place for science in the elementary and secondary schools. The Yearbook offered considerable criticism of the science program then in existence, particularly in the multiplicity of objectives and the methods of instruction. The Committee did not set up specific objectives for science, but said:

This committee, then, recognizes the aim of science teaching to be contributory to the aim of education; viz., life enrichment, it recognizes the objectives of the major generalizations of science and the development of associated scientific attitudes.47

An outline for a science program for each grade was given and recommendations were made for "a continuous science program, beginning with the kindergarten and continuing every year through the elementary and secondary schools".48

The Forty-Sixth Yearbook of the Society published in 1947 was also devoted to the teaching of science and was an attempt to


48 Ibid., p. 151.
establish a definite place and purpose for science in the public school curriculum. The report made three important recommendations regarding science instruction:

1. Science instruction should begin early in the life of the child.
2. All education in science at the elementary and secondary level should be general.
3. The development of competence in use of the scientific method of problem-solving and the inculcation of scientific attitudes transcend in importance other objectives in science instruction. 49

Throughout the study emphasis was placed upon the desirability of the scientific method as a teaching procedure.

The Committee stated:

Of all methods that have been proposed for use in the elementary school, one method must have first consideration in the teaching of science, namely the scientific method.

The elements of scientific method can be adapted to the level of the children in such a way that they will know what they are doing and why they are doing it and will have some control over the process. 50

In order to clarify the thinking of those who still felt that children did not have the ability to learn certain aspects of the scientific method the Committee made the following statement:

1. Children can orient themselves to problems.
2. Children can test hypotheses.
3. Children can define problems.


50 Ibid., p. 93.
4. Children can draw conclusions.
5. Children can check conclusions with authentic material.
6. Children can focus attention upon the elements of the scientific method.\(^{51}\)

While thus emphasizing the importance of the scientific method the Committee warns against letting it monopolize all instruction. For the sake of maintaining interest, children should not be forced to use all their time in science classes working with problems concerning the scientific method.

Certain trends have been noted recently by some writers. Blough and Huggett called attention to the following factors which they reluctantly called "trends in elementary-school science".

1. There is definitely an increased emphasis on science as an integral part of the elementary-school program, . . .
2. Science experiences are being built around the solving of problems which are significant to pupils rather than on the answering of unrelated questions that stress the recall of unrelated scientific facts.
3. Effort is being made to use actual experience whenever possible to make the learning in science more meaningful. In other words, there is more doing on the part of the children and less reading and hearing about science.
4. Persistent effort is being made to fit the science offerings and the learning methods to the needs, interests, and abilities of the learners.
5. Much stress is laid on using community resources in order to bring science to life.

\(^{51}\text{Ibid.}, \text{pp. 93-94.}\)
Increasing effort is being made to determine exactly how science can most effectively make its unique contribution to the total development of children and fit into the total learning situation. These items are mere indications of the direction in which elementary-school science is progressing. More and more emphasis is being placed on science as a method rather than a source of classified information. It is being used as a means of teaching boys and girls how to use and control their environment to the best advantage of all people and the conservation of natural resources has become a part of the regular science courses.

Wells also noted certain trends and emphasized the importance of teaching the scientific method to children in the following statement:

The stress today—as it should be—is put on the basic principles of science rather than on detail. In working with young children, content knowledge must to a degree be a secondary objective, serving as foundation for and building toward a scientific attitude of mind. Students must learn at an early age to apply their learning to new situations and strange conditions. We must train our young students to think accurately and analytically, to reason from premise to conclusion on a factual basis. This training in the scientific method is a most important phase of the development of children’s minds, for certain habits of intellectual honesty thus acquired will remain through life.


Current literature has a tendency to state objectives in terms of broad general outcomes, thereby leaving specific objectives to be developed at the local level. This is as it should be. Objectives are neither static nor universal, they are constantly changing and must be stated in terms of local needs, interests, and conditions. Instead of setting up definite objectives for science education in the public schools, Wells stated that it should:

1. Develop functional understanding of scientific principle, such as realization of balance and interdependence in nature.
2. Emphasize the scientific method in obtaining and sifting evidence, leading to the basing of conclusion upon the basis of that evidence.
3. Inculcate an attitude of respect for natural laws, scientific truth, and research.
4. Develop in the field and in the classroom demonstrable methods of effective learning.

Teachers are expected to take such statements as sources of ideas from which to develop specific objectives. In order that learning experiences may be more closely related to the learner's interest, children themselves are given an opportunity to help with the selection of objectives.

Instead of specifying a certain classroom method to be used in teaching pupils the use of the scientific method, present day writers suggest that the teacher find the best method by experimentation. There is no "one best" method suitable for all

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54 Ibid., p. 43.
times and places. The teacher must use the scientific method of investigation in order to determine the method or methods which best suit the needs of a local situation.

The Forty-Sixth Yearbook made no attempt to establish a definite classroom procedure for the teaching of science, but gave the following statements concerning the overall plan of instruction:

1. Instruction should begin with children where they are.
2. There is vitalization within the content of science.
3. Identifications and observations should be viewed as means to interpretation.
4. Problems and topics should not be pursued beyond the level of the children's span of interest or their level of ability.
5. Children should be given opportunity to participate in planning.
6. Children need rich experiences with experimentation.
7. Children need rich experiences with science books.
8. Provisions should be made for the development of special interest.

In answer to the question of "how to achieve the aims of science?" and "how do children solve problems?" Blough and Huggett called attention to the common practices of "experimenting, reading, observing, and taking field trips". These practices have been successfully used on all grade levels in developing problem solving skills. The authors gave the following directions for experimenting:

1. Keep the experiment simple.
2. Perform experiments in such a manner as to cause children to think.

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55 Forty-Sixth Yearbook, op. cit., p. 95-98.
56 Blough and Huggett, op. cit., p. 24.
3. Plan experiments exactly and carefully, and let pupils do as much of the planning as possible.

4. Don't let children make sweeping generalizations from one little experiment. The experiments which pupils perform generally do not prove anything; they merely help pupils understand an idea or answer to question.

5. Let pupils themselves perform the experiment. Experiments ought to be simple enough and safe enough for them to do.

6. Children themselves can originate some—in fact, many of the experiments they do in order to solve a problem.

7. The basic purpose for performing an experiment is something much broader than just to answer the question raised. If an experiment is going to be worthwhile, it should also help answer questions about things children see in the world about them. It is this application to real-life situations that is often missed. The ideas gained through experimenting explain things that happen in our everyday living, and children should be helped to see that this is true.

8. Experimenting should not be done aimlessly. It should have a specific purpose, and this purpose should be known and understood by all.

9. It is not always necessary or desirable to have complete records of all experiments performed in the elementary school. The old idea of writing up in a notebook for each experiment the object, material used, drawing, procedure, and results and conclusions is deadly and is certain to take away the natural interest in experimenting which children seem to possess.

Reading must also be done for a purpose. Children should read science to find the answer to questions and to gain more information about the subject. "It is not only useless, but is injurious to the mental habits of the pupils to assign them reading without some definite purpose."

57 Blough and Huggett, op. cit., p. 27.

58 Twiss, op. cit., p. 93.
Observation has been recognized as a desirable means of learning science since the days of Comenius. It means more, however, than just looking at something. Children must be taught skillful observation. They need to know what to look for, how to find what they are looking for, and what generalizations may be made from their observations.

Field trips are made for the purpose of observing, but they, too, must have a specific purpose, and must be carefully planned. Just walking about in the woods, school ground, or parks, contributes little knowledge to the pupil and even less to the development of desirable habits of observation. To be effective, field trips should be made as a regular part of the classroom work and planned as carefully as any other part of the instructional program.

In a recent publication, Wells suggested the following procedure in solving problems according to the scientific method:

1. A survey of the general field is the first step in a scientific preview of any situation.
2. Definition and clarification of the problem constitute the second step in procedure according to the scientific method.
3. Setting up of working hypothesis follows clarification of the nature of the problem.
4. Evaluation of contributory material is an essential step.
5. Experimentation is the most extensive phase of the scientific method, for during this period the testing of validity is carried on.
6. Summary of results obtained and a comparison of these results with those of similar experiments in the same or in related fields is next in sequence.
7. Formulation of conclusion or conclusions based upon all the previous steps is the final phase.\(^59\)

The types of procedures outlined above represent, not only, the opinions of authorities in the field of elementary-school science but have been verified by research. They represent the full use of the scientific method in classroom instruction. They are presented here with a recommendation from the writer that elementary teachers modify them according to the age level of the group and adjust them to the abilities of the individual child.

VII. SUMMARY

The scientific method has been developed as a way of teaching science and as an objective of science education through the efforts of many pioneers in the field of educational method. Beginning in the classrooms of Rousseau, Pestalozzi, and Herbart it has slowly evolved into an instrument of instruction which has brought revolutionary changes in the teaching of science in the public schools. Content is no longer considered the chief objective of science; its method is now accepted as the major purpose of science training. Its importance to elementary-school children and their ability to grasp scientific principles

is no longer a matter of doubt. Research has shown that children can learn to solve problems by scientific procedure and that the habits formed in science classes are used in new situations. Authorities agree that if children are to develop the habit of scientific thinking necessary for a successful life in the atomic age, training in use of the scientific method to solve everyday problems must begin at an early age. Since habits and attitudes must be controlled at the time they are being formed, the elementary-school must be concerned with the development of those habits and attitudes which will be of most value to the average citizen.

Recent changes in methods of instruction have brought about changes in the content and materials of science classes. The scientific minded teacher no longer expects pupils to memorize remote and unrelated facts but bases content material upon local community problems and uses community resources as instructional materials. Wise use and proper care of community and national resources have become an integral part of elementary science courses. The writer therefore proposes the organization of the elementary-school science program on the basis of community problems and resources. Such a program, well planned and carefully administered, would not only afford ample opportunity to teach the scientific method but would also give pupils practical experience in applying scientific principles to local problems.
CHAPTER III

RESOURCE EDUCATION IN THE ELEMENTARY-SCHOOL SCIENCE PROGRAM

I. BACKGROUND

Education for wise use of resources has developed in the United States in response to the problems of soil erosion, forest depletion, floods, wild life destruction, and exploitation of minerals. These factors are common enough to cause even the most casual observer to view with alarm the rapid shrinkage of American's supply of natural resources. Visible danger signs were well pointed out by the statement:

The warnings that our natural resources are being depleted and have reached the danger point are written just as plainly everywhere across the face of our continent—in million-acre patches of denuded forests, abandoned farmlands, dust bowls, and dried-up rivers, springs, and lakes. These warnings likewise have been shouted from the rooftops by the prophets of conservation, while tens of thousands of so-called "okies" (refugees from wrecked land) within the last decade have paraded back and forth before our eyes on the public highways crying for "relief".

The very abundance of resources led to destructive practices throughout the country. Man could see no end to the vast forests or limit to the fertile soils of the forest floor, hence used them

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without thought of the future. "Exploitation became almost a national symbol, and a national scandal."2 This "national scandal" continued well into the present century and according to Whitaker:

The results include the lowered productivity of the affected area, the shrinkage of economic opportunity, the greater outlay of human energy required to meet given needs, the declining tax base of the governmental units involved, the weakening of national defense, the shrinkage of resources of value for national trade, unemployment in the depleted areas, the forced migration of people, and the loss of the margin of living above a level of mere existence.3

The steps leading to the decline and ultimate abandonment of a community are illustrated in the following account of an actual situation:

Economic and cultural decline followed the vanishing land. As the topsoil washed away, crop yields dwindled until farms could no longer support their owners or tenants. Land taxes went delinquent. Farmers and their families had less and less to spend in town, and finally nothing at all. Stores had so few customers that they could not stay in business. One by one the people moved away, leaving behind them a desolate community.4

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When "tested in terms of human welfare, the destruction of natural resources stands as one of the major problems facing the people of the world today."  

Some efforts had been made to cope with the problem of resource destruction prior to the twentieth century. "In 1903, however, came the first effort to create a wide public support for careful use of United States natural resources." In that year President Theodore Roosevelt, called the first White House Conference on conservation. Members of Congress, governors, scientists, and educators were invited to the White House to consider the matter of conservation of the nation's resources. The interest created at this conference caused Charles R. Van Hise, President of the University of Wisconsin, to deliver a series of lectures on conservation to the students of that university. His lectures were published in 1910 under the title *The Conservation of Natural Resources in the United States* and became a text for college courses in conservation. The work of Van Hise set the pattern for courses in conservation and was a beginning in formalized conservation education which gradually worked its way into the elementary grades.

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5 Whitaker, op. cit., p. 12.
6 McGlothlin, op. cit., p. 27.
7 Whitaker, op. cit., p. 27.
II. BEGINNING OF THE RESOURCE EDUCATION MOVEMENT

The term "Resource-use Education" is of Southern origin and the movement is particularly associated with the Southern States. In 1943 the American Council on Education appointed the Committee on Southern Regional Studies and Education for the purpose of studying educational and resource problems of the South. In August of that year the Committee held its first conference in Gatlinburg, Tennessee. During this conference the term "Resource-use Education" came into being. This new term applied to the old phrase conservation education carried a somewhat broader concept than the older phrase. It involved a study of both human and natural resources. For the purpose of this study the word use was discarded to conform with present trends in literature dealing with the improvement of community life through the wise use of resources. The terms, resource-use education, resource education, and conservation education were found to carry the same connotation and were used interchangeably in this study.

In relating accounts of schools which had definitely improved living conditions through a better understanding and wiser use of...
the environmental, the 1948 Yearbook of the Association for Supervision and Curriculum Development, said:

They broadened the ideas lying within conservation that the southern states began to call their educational efforts in the field resource or resource-use education rather than conservation education. The purpose was the same—to build a better life now and in the future from the materials at hand.  

The same report further stated that resource-use education is based upon the belief:

(a) that the purpose of education is to insure continuing improvement in living for all the people and, (b) that the school as a specialized educational institution is a functioning, integrated part of a dynamic community life.

Funderburk found that some "preferred to think of resource-use education as an attitude, a point of view, an orientation, with emphasis on a functional educational program." While others "pointed out that anything which improves the living of people is resource-use education.

In an attempt to define resource education, Ivey said:

Resource study, so concerned, is a point of view for appraising the environment as it functions, or could function, in meeting the wants of the people. As a subject matter it cuts across the several fields of learning, presenting one type of emphasis which is held in common by the physical sciences, social sciences, and

9 Mclothlin, op. cit., p. 42.
10 Ibid., p. 113-114.
humanities. It is this inescapable unity in education for resource use which broadens it beyond the horizons of conservation education.12

The following criteria for resource education are given here to illustrate the implications of the term as used in this study.

1. Resource Education includes and shows the relationships of the natural, human, social, and economic resources.
2. Resource Education is an integral part of the curriculum.
3. Resource Education is fitted to the experiences, needs and interests of the pupils.
4. Resource Education develops proper attitudes toward the wisest use of all resources.
5. Resource Education provides stimulating activity experiences.
6. Resource Education is a cooperative enterprise between school and community, bringing about a better understanding of resource problems and developing plans for the solution of them.
7. Resource Education is well balanced with respect to content. It involves a knowledge of the biological and physical sciences.
8. Resource Education is taught as a science and scientific research provides data for the development of plans and procedures.
9. Resource Education begins at home, but eventually includes the problems of the county, state, and nation.
10. Resource Education applies to all people, rural and urban and to be most effective a common viewpoint with respect to resource use should be established which shows the interdependence of all groups.13


13 Adapted from "Conservation Project Circular," National Association of Biology Teachers, Richard L. Weaver, State College Station, Raleigh, North Carolina.
The 1943 Gatlinburg Conference led to the publication of *Channeling Research into Education*, which gave the following concepts concerning resource education:

(1) It is concerned with the translation of research studies into usable classroom materials; (2) It calls for community-centered schools; and (3) It is regional in scope, with the over-all purpose of improving the quality of living in the South.14

The conference at Gatlinburg was followed by others of regional significance, held at Chapel Hill, North Carolina, Daytona Beach, Florida, and again at Gatlinburg in 1944 and 1947. The Southern States Work Conference in cooperation with the Committee on Southern Regional Studies and Education sponsored a series of conferences at Daytona Beach, Florida, which were attended by hundreds of educators and conservation specialists from fourteen southern states. The report of these conferences were published in 1950 under the title, *Learning by Living, Education for Wise Use of Resources*. It was divided into four parts. The first part contained examples of school programs and activities illustrating the resource education approach. The second part described methods and procedures for planning and carrying out such programs. Part three dealt with the problems of school administration in relation to resource

14 Funderburk, op. cit., p. 94.
education and part four discussed the role of teacher education in making possible a resource education approach to local school problems. The report made no attempt to set up a "blueprint" of action but recognized the fact that every school has different needs and problems and must devise its own program to meet them.15

A conference held at Daytona Beach in June, 1950, produced a Tentative Guide to Resource-use Education Workshops which has served to stimulate workshops in resource education throughout the South. The purpose of this guide was "to help administrators, directors, consultants, and participants plan, organize, conduct and evaluate Resource-use Education Workshops."16

The work of the Committee on Southern Regional Studies and Education gave considerable momentum to the movement. National educational organizations turned their attention to this phase of education and a number of Yearbooks were devoted to its promotion. In its Yearbook of 1943, the Department of Rural


Education stressed the importance of conservation education in the public schools. The report stated:

If a nationwide job of conservation is to be done, the principle will have to be instilled in youth in the public schools. Men and women who have toiled long and diligently for the cause of conservation have come to the conclusion that unless we can begin with the youth of this country and have them grow up into a nationwide majority, with an understanding knowledge of the fundamental principles of conservation, we will go on wasting and squandering our soils, waters, forests, and other gifts of nature until it is too late to mend and patch and restore.17

The Twenty-Fourth Yearbook of the Department of Elementary School Principals, National Education Association published in 1945 was concerned with Community Living and the Elementary School. This publication dealt with the "philosophy underlying the improvement of learning the community approach to educational planning" and "presents material which demonstrates how the community may be used as a laboratory for learning". The challenge of resource education to the public schools was expressed in the opening chapter by John E. Brewton in these words:

The resources and needs of American communities challenge American public schools to develop a program that will contribute to the wise use and development of these resources and to the meeting of community needs.18

17 Bathurst, op. cit., p. 10.
The Association for Supervision and Curriculum Development published *Large Was Our Bounty* as its yearbook for 1948. The authors felt that "the school is obligated to make the facts of resources known", and wrote the book with "the hope that schools can point to better understanding and wiser use of our resources".\(^{19}\) The book gave considerable space to the role of education in saving the nation's resources and gave a review of the practices then in use.

*Conservation Education in American Schools* was published in 1951 as the Twenty-Ninth Yearbook for the American Association of School Administrators. This was an administrator's guide which defined the schools responsibility and indicated what could be done about conservation education. It pointed out what schools were doing, but stated "unless conservation becomes much more general and effective than it has in the past, needless shortages soon will undermine the prosperity and welfare of our people.\(^{20}\)

The seriousness and urgency of the problem was brought out by the statement:

> Whether or not there is progress in conservation rapid enough to assure the vitality and security of America in

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\(^{19}\) McGlothlin, *op. cit.*, p. 8.

years to come will depend, in large measure, on how quickly and how well we educate the people about resource needs and problems.21

Many teacher training institutions over the country include courses in resource education in their training program. The Twenty-ninth Yearbook22 gave a review of such courses in twenty-one colleges and universities.

III. PURPOSE AND PLACE OF RESOURCE EDUCATION IN ELEMENTARY-SCHOOL SCIENCE

Resource education developed from the concept that:

Elementary education has a dual function: first, to guide and direct the physical, mental, social, and emotional growth of boys and girls; and second, to improve the quality of community life.23

Its purposes as defined by the Southern States Work Conference in 1947 were to:

(1) lead people to become more sensitive to and concerned about the problems of using resources,
(2) help people to become more intelligent in the use of resources, and
(3) lead people in the solution of problems of resource use, to be concerned about the present and long-term welfare of the total social order.24

21 Ibid., p. 60.
22 Ibid., pp. 218-222.
23 Twenty-fourth Yearbook, op. cit., p. 13.
Ivey explained the purpose of resource education in terms of five "elements". First, the basic facts which people learn pertaining to their resources and problems should always be held in proper perspective the interrelationships and unity of the many aspects of the natural environment and man's part in maintaining that unity; and how individuals and groups can use their environment to develop the maximum satisfactions.

Every environment which supports life has its own unique characteristics, either in its physical materials or its social materials. Such characteristics can serve as a starting point for the application of the general scientific principles involved in resource education. The second element is a matter of motivating individuals and groups to use resources in the most effective manner. Resource education should develop a feeling of individual and group responsibility for maintaining proper relationships between man and his environment. The acceptance of responsibility in such problems as soil erosion, forest fire, and stream pollution should be an outgrowth of resource education.

The third element is to assist people in knowing when they need further information. This calls for the development of proper attitudes towards the use of scientific facts and a knowledge of

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sources of such information. The fourth element in resource education is that it provides experiences in group decisions and actions, and the fifth element is the development of skills in implementing decisions. If it is to fulfill these purposes, resource education must be concerned with defining and developing those skills which are necessary to solve the problems that affect the quality of living in a community. Specific skills called for in the solution of resource problems include: (1) Ability to secure from such sources as people, landscapes, pictures, maps, graphs, statistics, and reading significant information about human, natural resources; and the ability to present this information in written, graphic, and oral form. (2) The ability to recognize and interpret problem conditions and to identify and classify problems. (3) Ability to apply the scientific problem-solving process.26

The school which accepts the resource education concepts necessarily accepts the development of problem-solving skills as one of its basic purposes. Furthermore, it will provide opportunities for children to solve problems by scientific methods.

Such a school knows that it can never provide its people with ready made solutions to all of the problems they will face in life, and that it must help them acquire internal security, skills of democratic problem-solving and a basic

26 Learning by Living, op. cit., pp. 43-44.
understanding of the relationships between man and his
environment. If it succeeds, it can be confident that
people will develop solutions as problems arise—solutions
no text, no teacher, no curriculum could possibly have
anticipated.27

The authors of Living by Learning made the following
statement concerning the place of resource-use education in the
curriculum:

... resource-use education should not be introduced
into the school curriculum as a separate subject or at
the expense of other major educational objectives such
as the development of basic skills, expression through the
creative arts, and others.28

The Twenty-ninth Yearbook for the American Association of
School Administrators29 called attention to the necessity of
beginning resource education as soon as a child enters school
and continuing it as long as he remains in school. There are
too many aspects of conservation for children to grasp in one
or two years, therefore, the program should be continuous.
Furthermore, a large number of pupils never go above the elementary
grades, hence, would not receive any instruction along this line
unless it is given them during their elementary days.30

28 Ibid., p. 44.
29 Twenty-ninth Yearbook, op. cit., pp. 64-65.
30 Ibid., p. 66.
If resource education is not to be a separate subject and if it is going to be continuous throughout the elementary school it must be a part of the integrated curriculum. The teacher, therefore, is confronted with the problem of where it best fits into such a program. A review of recent literature indicated that the principles and concepts of resource education could be taught best in the science classes. In this connection Carter said:

> The great virtue of elementary science is that it lends itself to direct observation. The great virtue of conservation as a vehicle for teaching such science is that the conservation viewpoint makes science significant to the individual and the community. This significance arises from the fact that conservation deals with current problems which have social repercussions, and which will yield to scientific treatment.\(^{31}\)

A comparison of objectives revealed a very close relationship of resource education to the general objectives of elementary school science.

General objectives of elementary-school science from Croxton\(^{32}\) are:

1. To cultivate scientific attitudes and methods of procedure.
2. To lead to broader concepts, generalizations, and outlooks.

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3. To open new attitudes of interests and satisfaction.
4. To enable the individual to meet the problems of existence with the scientific knowledge and requisite skills.
5. To develop social attitudes and appreciations.

General objectives of Resource Education.

1. To develop sensitiveness to resource depletion.
2. To understand the basic problems of a community.
3. To build new customs and practices.
4. To develop new ideologies.
   a. resources are not inexhaustible
   b. science cannot free us from dependence on natural resources
5. To build a new community ambition. 33

In achieving the objectives considered under resource education the pupil also achieves the objectives established for science.

The solution of resource problems depends upon the facts furnished by the sciences. The information must then be applied according to scientific procedure in order to solve the problems.

The following steps suggested by the Committee on Southern Regional Studies and Education as procedure for resource education are essentially the same as the steps in the scientific method given in a preceding chapter.

1. Define and classify the problem to be attacked: understand what the group is up against.
2. Make tentative suggestions for possible solutions of the problem based on available information.

33 Adapted from Whitaker, op. cit., pp. 66-67.
3. Secure the necessary information to test the solutions suggested; get the evidence; provide the proof; learn to recognize, evaluate, and weigh such sources of information as the following in reaching a decision:
   a. Experience—information and conclusions growing out of actual experience with the problems.
   b. Judgments of experts
   c. Reports of surveys and scientific research projects
   d. Textbooks
   e. The current press
   f. Observation
   g. One-sided presentations of data; vested-interest or propaganda approach
   h. Hearsay
   i. Opinions of lay-persons (representing different points of view)

4. Withhold final decisions until an adequate amount of information has been amassed.

5. Draw conclusions from the evidence secured: accept, reject, or modify suggested solutions in the light of evidence; arrive at functional solutions in terms of the evidence and the welfare of the group.

6. Do not decide upon final, "All-or-nothing" alternative. Adopt, instead, an experimental attitude, and be prepared to modify procedures as experience reveals better ways.

7. Put the accepted solution into practice. Make plans for democratic group action in making the solution work.34

By following such procedure pupils may develop skills in the scientific method along with an appreciation of soil, forests, and other resources.

In reporting the results of science experiments dealing with soil, Strong said:

The most valuable outcomes of this and many other experimental activities for older pupils and small children will be an

attitude of interest in the land, and a habit of watching what goes on around them in the soil, on the ground, in the trees, on fields and pastures. They will look upon land and soil as a part of their own life. Such observation and thinking will lead them to love and protect the land, because they will know it provides life and living to each individual and to the nation.35

IV. RESOURCE EDUCATION IN PRACTICE

The examples given below are illustrations of schools which have applied the resource education concept to actual community problems with desirable results in terms of community improvements. The reports cited were selected from a large number of similar cases because each used a different type problem but followed the same general pattern of action. In each case the principles of the scientific method were followed to a certain degree. The problem was first recognized; information was collected from various sources; a plan of action was agreed upon; and the accepted solution was put into action.

In a North Carolina school an elementary teacher and her class decided to develop a year's program of study around the central theme "The Wise Use of Available Resources for Health and Better Home Living". The specific problem which led to this topic was mal-nourished children in the school area. Influenced

by their own experiences and guided by the teacher, pupils recognized this as a basic problem that must be solved if they were to obtain maximum satisfaction from life in the community. A preliminary study revealed the cause of the problem to be: a lack of knowledge of body requirements; a lack of appreciation of home grown foods; scarcity of many food items; a lack of scientific knowledge of producing and conserving home grown foods; a lack of training in planning and preparing meals; and, a lack of appreciation of the many resources which the family has at its disposal, including time, energy, aptitudes, and skills.

As a first step in attacking the problem a survey was made to determine the food needs and resources of the community.

Objectives set up for the year were:

1. To raise the economic status of the family by making possible a more adequate, but less expensive food supply to meet body requirements.

2. To raise the health and social status of the family and community by encouraging initiative and experimentation in the production and conservation of foods and in preparing well-balanced meals from home grown foods.

3. To help families through the pupil to use their resources to solve the problem of food scarcity.

4. To give children an opportunity to better understand and appreciate the value of all farm produce, especially food.
5. To encourage better teacher, pupil, and parent relationship and better pupil-to-pupil relationship.

6. To stress the participation of each student according to his or her ability in planning, executing and evaluating experiences in the problem-solving program.

7. To provide pleasant and satisfying learning situations and experiences which will help pupils to develop such characteristics as co-operation, self-control, tolerance, kindness, friendliness, and respect for others.

Group experiences

The class first visited a successful farmer in the community to see the source of the family food supply. They observed the family milk cow, pigs, chickens, and a large barn filled with corn, oats, wheat, apples, potatoes, and cured meat. The farmer and his wife explained the care and feeding of farm animals and told about the products derived from each. Children were given an opportunity to help with some of the farm chores, as gathering eggs, churning, and feeding the pigs and cows.

Sources of information were later investigated to find scientific facts related to the things observed on the farm. The teacher in charge of the project said she could "think of no lesson in science that could be more practical for rural children than the study of the proper feeding, the general care of the family cow; how the food is changed to milk, and why milk is the most nearly perfect food."
The local curb market was visited to find out the prices of foods being sold and to encourage pupils to develop enterprises that might add to the family income.

A visit to a nearby grocery store served to illustrate the high price of many foods that could be grown at home.

The community cannery was visited to see how food was prepared and canned.

The county health officials and Farm Agent showed films to the class on foods, nutrition, health and deficiency diseases.

Individual cookbooks were prepared containing recipes for cooking home grown foods. The Home Economics teacher and Home Demonstration agent helped prepare simple recipes.

One corner of the room was arranged as a reading nook with materials for individual study and research.

Activities

Some children brought wheat from home and with the use of a food chopper made whole wheat flour which was used to make cookies, muffins, and rolls. Others brought peanuts and made peanut butter, candy, roasted, and salted peanuts.

Early in the spring, tomatoes, pepper, cabbage, and other vegetables were planted in boxes in the classroom to produce plants that were later carried home and transplanted in home gardens. This project led to a study of plant diseases, cultivation practices, and food requirements of plants.
A study of the various ways of preserving foods, such as drying, cold storage, canning, salting, and smoking brought on an investigation of molds and bacteria as a part of the child's environment.

A rat-feeding experiment was carried on with the help of the High School Biology teacher. The pupils saw how rats responded to a well-balanced diet and a deficient one. They weighed the rats daily and kept a record of changes in weight as a result of a good or inadequate diet. This experiment resulted in a study of food requirements of the body, food composition, and the preparation of a well-balanced meal from home grown produce.

Children wrote letters to the farm family which they had visited, thanking them for their kindness. Experiences in English composition were thus obtained.

Culmination

At the close of the school session a parent-teacher-pupil party was planned and conducted by the students. Whole wheat cookies and peanut butter sandwiches, made by the students, were served as refreshments. Exhibits included student made cookbooks, menus of well-balanced meals, preserved foods, and charts showing results of the rat-feeding experiment.

Students demonstrated to their parents how to make whole wheat flour and peanut butter with a food chopper.
Outcomes

There was a definite increase in the food supply of the community. Many families had year round gardens and canned food for the first time.

The planned activities made the subject matter more easily understood.

Relationship between parents, teachers, and students was improved. Some parents visited the school and others wrote in asking for help in preparing home grown foods.

Students improved in the ability to live and work together.

Home projects were developed which added a little extra income to the family budget. Some students began to sell eggs, butter, and vegetables at the curb market.

The students learned to eat new vegetables and to prepare home grown foods.\(^{36}\)

The following report from Florida is an illustration of how a school used the problem of forest fire as a means of: increasing students knowledge of their community and its resources; and teaching the interdependence of forests and other natural resources, and the interrelation of natural, human, and social resources. The

study was not confined to a particular grade or subject but involved several classes and extended throughout the entire school year.

Selection of the problem

The school was located in a heavily forested area with one side of the grounds bordered by a forest. Most of the people in the community depended upon the forests for a living. Fires commonly burned over the forests each year and seriously damaged the only source of income for many people.

After hearing a talk by a state forest worker, teachers and pupils agreed that forest fires were a community problem and decided to plan some activities that should lead to a solution.

Activities

Early in the school year the first grade teacher took her class for a walk in the forest bordering the school ground. On this trip they saw different kinds of trees, different size trees, decaying leaves, humus and other aspects of life in a forest. On returning to the classroom they wrote a story of their trip which the teacher used in making a reading chart. They painted pictures of trees and selected other pictures from magazines to display on the bulletin board. They made booklets on the prevention of fires and usefulness of trees to send to their parents.
One day, one of the children saw a fire in the nearby forest and asked the principal to call the fire warden. The warden came, extinguished the fire, then carried the children to the burned area and explained to them the damage that had been done. They then wanted to know what they, as first grade children, could do to prevent forest fires. After discussing the matter with the fire warden, the principal, and the teacher, they decided to do the following things:

1. Write a letter to their parents asking them to help prevent forest fires.
2. Place forest fire posters in the school.
3. Place forest fire posters in business houses.
4. Tell other grades about their plans.
5. Ask car owners to place a "Smokey" sticker on their cars.
6. Report to the warden any fires seen.

These activities called for the making of more posters and booklets to display in the room.

The next activity was the presentation of an assembly program for which the children had written the lines, planned the costumes, and painted the scenery.

The work of the first grade created an interest which led to activities among other classes.

An upper grade class invited the forestry representative to come and explain more in detail the techniques of preventing and
fighting fire and methods of growing timber. They planned a series of trips to a state forest and some sawmills. During their visits to the forest they learned how to measure and mark timber for selective cutting; observed the difference in timber that had been burned each year and that which had been protected from fire; and saw what the state was doing to develop forest resources. At the sawmill they learned the different grades of lumber and were convinced that a good quality of timber was needed to raise the standard of living in the community.

The group then collected more materials and obtained additional information to be used in attacking the total problem of forest conservation.

Forestry became the central topic in various other classes. Science classes studied plant and animal life of the forest; mathematics classes calculated the volume of timber in board feet; history classes learned the contributions of timber to the development of the country; and, English classes wrote themes on forests.

Outcomes

The work of the students resulted in the following benefits to the community:

1. Ten acres of the school campus were planted in pine trees.
2. Some land owners started the practice of selective cutting.

3. 50,000 pine seedlings were planted on farms in the community.

4. Only one forest fire occurred in the community during the year following the school project.*

A consolidated school in central Mississippi built a year's program around the theme "Developing Better Citizens Through the Study of Elementary Science". This theme grew out of the philosophy that "the aim of all education is to improve the citizenship of the world".

The faculty studied the needs, interests, and problems of the pupils and community and reached the conclusion that a well-planned, well-balanced, long-range program of science instruction based on local problems and resources was the most feasible answer to the question of "How can we best help our students to develop into free, happy, and independent citizens, and thereby improve the quality of world citizenship?"

The science program, therefore, became the core around which all other classroom activities were centered. The science program itself was built around the natural resources of the community, which were primarily land and timber.

The problem

The school building was located on a hill which sloped sharply in front of the building. There were no grass or shrubs growing on the hillside, consequently serious erosion had taken place. Gullies not only presented an unsightly approach to the school, but were a problem on the playground.

Guided by the teachers, children of all grades studied the situation and came to realize that the unsightly condition of the school ground was a detriment to the happiness and satisfaction of their school life. They agreed that something should be done, and made plans for an attack on the problem.

Activities

Experiences were planned in connection with the problem, by each teacher, according to the grade level of the pupils. Lower grade children learned that soil was made up of different size particles, had different colors, and unless protected by grass or other vegetation it would wash away. Older children measured the size of gullies and estimated the amount of soil that had washed away. They studied the composition of soils, learned why plants cannot grow in some soils, and found out what happens to rain when it falls to the earth.

All classes collected reading material and pictures on erosion control. A specialist on soil came to the school and
talked to the students about soil erosion. After carefully studying the problem, students came to the conclusion that the school ground should be "remodeled" but realized such an undertaking was beyond the range of their ability so they sought help from the community. They talked to different ones in the community about working on the school ground and showed pictures which they had made to show the unsightly conditions. As a result of these activities the School Board employed a contractor to fill in the gullies and smooth the land. While this work was going on students had an opportunity to study various types of machines. After the work was completed, students put out fertilizer and planted winter grass. They watched the seeds come up and saw that plant roots have the ability to hold soil together during a rain. These experiences led to a study of plants and their food requirements. A study was then made to determine the best types of shrubs to plant on the grounds. Shrubs were brought in from the community and planted according to a landscape plan which they had worked out with the aid of the principal. When the grass and shrubs had started growing, pictures were made and put on public display with those that had been made before work began to show the "before and after" effect.

When the work was completed an evaluation of results was undertaken. Pupils and teachers working together made the following list of results which they considered significant outcomes of their efforts.
1. Pupils had acquired a fund of scientific facts.
2. Pupils had developed a new interest in the total school program.
3. Pupils had developed an appreciation of soil as a basic resource.
4. Pupils had developed the ability to use the scientific approach in solving problems.
5. Pupils had developed the ability to plan and work together as a group.
6. Teachers had developed an appreciation of community problems.
7. The community had developed a new interest in the school and its problems.
8. A serious problem had been solved.
9. The schoolground, once an unsightly scene, was now the beauty spot of the entire community.37

Planning the Resource-Use Unit

Many schools may not find it desirable to plan a total year's science program around one central theme, as in the cases cited above, but would prefer to use short units based on specific topics.

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37 Reported to the writer by letter from J. G. Jacob, Superintendent, Goodman Consolidated School, Goodman, Mississippi.
The units proposed in this study are suitable for use in; science as a separate subject; science taught as a part of the integrated curriculum; or, a program developed around a central theme. They may be adapted to various natural resources and used in either rural or urban areas.

Concepts of unit teaching. The term unit has been defined as "the type of procedure in which teacher and children plan, obtain materials from various sources, integrate their findings around a central theme, and form their own generalizations." 38

This plan of teaching has become a generally accepted practice in many elementary school. It offers certain advantages not found in the recitation type of instruction. It lends itself to the scientific method of solving problems; is adaptable to a wide range of situations; and, provides for individual differences in the learners. Ritter and Shepard found at least six distinct values resulting from the use of unit teaching.

1. It helps prepare children for democratic living.
2. It provides good opportunities for personality development.
3. Units of work offer opportunities for developing leadership as well as the ability to follow and assist through committee procedure effectively employed.
4. Such a plan increases ability to make adjustments essential to happy community living.

5. Facts take on real meanings and skills may be acquired with less effort under this plan than under some others, because there are definite motives back of the efforts and the learning takes place in natural settings.

6. Units furnish splendid opportunities to organize for future use knowledge which children acquire when working on the theme.\(^{39}\)

**Teacher preplanning.** Careful preplanning on the part of the teacher is essential to the success of any unit. The total program and anticipated outcomes must be well thought through in advance. Wells pointed out that: "Methods of approach must be considered, and virtually the entire procedure at least tentatively decided upon before the new project is brought to the attention of the class."\(^{40}\)

To plan a unit successfully the teacher should have thoroughly in mind what constitutes a good unit. Various criteria of good units have been established for different subject fields. The following criteria of a good unit are general in nature and may be applied to any course of study.

1. It should involve a variety of direct sensory experiences.
2. It should provide for some free, informal association of the pupils.
3. It should provide an opportunity for manipulation or bodily activity.


\(^{40}\) Wells, *Elementary Science Education*, *op. cit.*, p. 133.
1. Discover interests of children
   a. Observe them at play, in the classroom, on the streets, in their homes
   b. Listen to their conversations, discussions, suggestions
   c. Check books read during free time
   d. Check on hobbies, leisure time activities

41 Henry Harap, How to Construct a Unit (Nashville, Tennessee: Curriculum Laboratory, George Peabody College, November 30, 1931), pp. 7-8. (Mimeographed)
e. Study their drawings and paintings
f. Note materials which they bring to school on their own initiative

2. Ascertain the needs and abilities of children
   a. Observe them at their play, at their work, in the classroom, on the playground
   b. Listen to their conversation, discussions, suggestions
   c. Study their drawings and paintings
   d. Study cumulative records
   e. Hold conferences with parents
   f. Diagnose basic skills

3. Determine the activities and interests of the community
   a. Make a survey of the community
   b. Converse with citizens
   c. Attend civic functions, such as forums, concerts
   d. Observe community activities
   e. Take part in a community group or organization, such as church activities
   f. Study major occupations
   g. Study local newspaper

4. Locate natural resources, community resources, human resources as sources for profitable experiences for children
   a. Make a survey of the community
   b. Note industries
   c. Note museums
   d. Note libraries
   e. Note parks, playgrounds, swimming pools
   f. Keep a file of newspaper clippings pertaining to persons who have visited other countries, etc.
   g. Make a survey of homes for materials, such as pictures, models, exhibits

5. Source materials available in school
   a. Books, children's encyclopedias, magazines, bulletins
   b. Audio-visual aids
   c. Construction materials and art materials, such as clay, paints, paper, saws, nails, scissors
   d. Microscopes, magnets, electric plate, work bench, easels, etc.

6. Teacher's informational background based on content needed in various units
   a. Read authentic materials
b. Interview key persons in industries
c. Attend workshops
d. Join an educational tour
e. Attend illustrated lectures

According to Wells at least ten factors should be considered in planning a science unit.

Analysis of the problem. The question "In what ways will the study of this unit constructively contribute to each individual child as well as the class as a whole?" should be clearly answered in the mind of the teacher and every pupil who is to study the unit.

Location of the classroom. Every aspect of the classroom environment, including parental attitudes, is an important factor in unit planning.

Grade level of the children. The teacher would need to know the previous science training of the children and if the class as a whole was ready for the study.

Availability of contributory materials and information. "What books, pamphlets, pictures, and films are readily available which will contribute to the study undertaken?" is a question to be answered before work begins.

Time allotment. The length of time covered by the unit must be determined in advance. It should be flexible enough to take care of unexpected interruptions.


Establishment of basic objectives. Certain questions are to be considered in setting up objectives. What fundamental comprehensions, ideas, and growth opportunities are to be considered? What attainment in viewpoint and habits of thought, what skills and attitudes may be developed by this study?

Motivation procedure. Oral talks by teacher and pupil are suggested along with motion pictures and slides.

Developmental activities. Projects by individuals and committees, collection of materials, field trips, reports, and round-table discussions are some of the suggested activities.

Integration of allied knowledge and skills. Attention must be given to the basic three R's and fundamental skills. A unit does not disregard factual information.

The culmination. The unit generally closes with a class play, assembly program, exhibits or a party.

Evaluation and diagnosis. This is an integral part of the unit and is a measure of attainment of objectives. It may be carried on by testing, reviews, observation, or a self-evaluative process.

The final stage in the teacher-planning process is determining the desired outcomes. "Anticipated outcomes" are not to be confused with student objectives. They may include some student objectives, but they are the outcomes that the
teacher expects from the unit. Mehl\textsuperscript{44} suggested four types of anticipated outcomes,

1. Attitudes and appreciations.
2. Understandings.
3. Abilities in using tools of learning.
4. Habits and skills.

Each type is further broken down into the specific outcomes expected.

**Teacher–pupil planning.** After the unit has been planned by the teacher, a classroom discussion takes place in which students are given an opportunity to make their contributions to the plans. The problem is clarified and stated in terms of student understandings. Questions from students are used in formulating specific objectives for the unit. Tentative plans for culminating and evaluating activities are made with the help of the class. The extent of pupil planning must be governed by the grade level of the group. All groups, however, may make some decisions in regard to "(1) finding ways for solving the problem; (2) making provisions for solving the problems; (3) organizing committees for various activities; (4) noting those activities for which individuals may be responsible."\textsuperscript{45} The total plan is subject to change as work progresses and new interests arise.

\textsuperscript{44} Mehl, et al, op. cit., p. 229.

\textsuperscript{45} Ibid., p. 233.
V. SUMMARY

In recent years schools have made an effort to improve the standard of living in America by training people to use natural resources in a more efficient manner. This type of education, generally called resource-use or resource education, has become somewhat of an educational movement and has produced many desirable results. Examples have been cited to illustrate how elementary science classes have applied the principles of the scientific method to community problems and improved the quality of living in a particular area.

The content of resource education cuts across several subject matter fields but is largely scientific in nature. Its place at the elementary-school level is, therefore, in the science program. By the use of well planned units the study of any given resource may be brought into the science class, or the study of resources may be used as the core around which all science experiences are built.
CHAPTER IV

ILLUSTRATIVE UNITS IN RESOURCE EDUCATION

I. INTRODUCTION

Four units are presented in this chapter to illustrate the use of natural resources in teaching science at the elementary-school level. Units on soils and on forests were prepared for the third and sixth grades. Several factors entered into the selection of soils and forests as subjects for the units.

1. Soils and forests are basic resources.

2. Soils and forests are important in all types of communities, both rural and urban.

3. Some knowledge of these resources and their conservation is important to people of all occupations.

4. Some phase of soils and forests may be studied in any type school.

Activities and content were based on similar units developed and used in different type schools in several states. They were planned primarily for rural or small town schools, but may be modified for use in urban situations.

The same general plan was used for each unit. Specific objectives were used as problems and each one developed individually. A short written test was planned at the conclusion of each problem.
Some repetition of third-grade material is found in the sixth-grade units. This is in keeping with the opinion of authorities. In regard to repetition in science instruction Blough and Huggett said:

We also intend to help pupils become more scientific in their attitudes, become better problem solvers and more interested in an appreciative of their environment. With respect to attaining these objectives, there seems to be little likelihood that there will be too much overlapping from grade to grade. The skills of problem solving and the attitudes and appreciations we seek to develop come to be a part of pupil's thinking only after long experiences and many repetitions. If we consider our total objectives and if we are willing to plan cooperatively for a continuous program, the problem of who will teach what, and whether or not there is repetition, largely disappears.¹

Field trips are an important part of each unit. In planning field trips the teacher should keep in mind the following definition: "Field trip used here means a carefully planned and evaluated excursion outside the school building, which is still an integral part of the instructional program, and in which each student may take an active part."² All trips are planned well in advance according to the following directions:

Secure, from principal permission to make trip.

Secure, from parents permission for children to make trip.


Secure, from property owner permission to visit property.
Arrange for a specialist in the subject being studied to accompany the class.
Arrange for transportation.
Decide on type of clothes to wear.
Decide on equipment to carry.
Arrange for refreshments.
Set up rules of conduct.

Each unit was planned to provide training in the scientific method. A problem is defined, all possible information is collected regarding the problem, and conclusions are made on the basis of information collected. Information is obtained by experimentation, observation, and reading. The experiments are short and within the ability level of the class. Controls are provided in each experiment. Teachers planning experiments for comparative purposes must keep in mind that without controls the experiment is valueless. "A control in an experiment is any condition which gives a basis for comparison." Unless the experiment contains a control factor and a variable factor there can be no comparison.

The scientific method does not mean that experimentation is always necessary or desirable. According to Lampkin:

"Experimental verification is extremely important, but many kinds of events cannot be studied experimentally because they are controllable only partially or not at all." When children make accurate observations for the purpose of finding the answer to a question, they are using the scientific approach to solve a problem. "Accurate observation and measurement are sometimes characterized as the most important scientific practices."

In planning the units presented in this chapter the writer has endeavored to plan experiences both in experimentation and observation.

UNIT I. SOIL, ITS USE AND PROTECTION
(for third grade)

I. Objectives

A. General

1. To develop some understanding of the nature and importance of soil.

2. To develop an appreciation of the need for taking care of soil.

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5 Loc. cit.
3. To develop skills in finding answers to questions.

B. Specific
1. To learn some of the ways in which soils are different and how these differences affect plant life.
2. To develop an understanding of the relationship of soil to food.
3. To develop an understanding of how soil fertility is lost and how this loss may be prevented.

III. Motivation procedure

A unit on soils for the third grade must be simple and brief. Such activities as growing plants are continued after the main body of the unit has been completed. Field trips are made with a specific problem in mind. Questions asked by pupils form a large part of the discussion and the basis for many activities both in the classroom and on trips. Pupils are encouraged to find answers to their own questions. They are directed to possible sources of answers by being told what books to read and where the desired information may be found.

The unit is introduced by showing the film The Golden Secret. This is a short animated film designed especially for young children. It depicts, in fairy-tale style, what happens when people are careless with soil and shows the rewards of good soil management. The film opens a discussion in which the teacher explains the unit plans and records questions asked by children. Each specific objective is explained until the children thoroughly understand the purpose of the unit.
III. Developmental activities

Problem I. How do soils differ? How do these differences affect plant growth?

Content outline.

A. Differences in soils

1. Color
   - Red
   - Yellow
   - Gray
   - Brown

2. Texture - size of particles
   - Sand - large particles
   - Silt - next smallest particles
   - Clay - smallest particles
   - Loam - mixture of sand, silt, and clay

B. Causes of differences

1. The way soils were formed
2. Kinds of plants that grew on them
3. The way man has used them

C. How these differences affect plants

1. Color
2. Size
3. Amount of fruit produced
4. Rate of growth
Activities

A short trip is made to see different kinds of soil and the plants growing on each kind. Notice the color of plants and the amount and size of fruit. A ditch bank serves to show the different layers of soil. The different layers of soil in a wooded area are given special attention. Soils are collected from cultivated hill tops, cultivated bottom lands, woods, and a sand bar.

In the classroom a part of each soil sample collected is placed in a separate jar and labeled according to where it was collected. The remaining soil is saved for the next activity.

Pupils set up the following experiment to find out how different soils affect plant growth.

Make some boxes, four inches square and six inches deep, out of plywood or apples crates. Fill each box with a different kind of soil and plant ten radish seeds in each. Red radishes are used because they germinate and grow fast enough for children to see results. Boxes are placed in windows, turned and watered each day. After seeds have germinated and plants reached the two-leaf stage, their height is measured at the same time every other day. The height of plants in each box is recorded on a wall chart.

Test

Make a cross (X) mark by the best answer for each of the following statements.
1. Red soil was found:
   a. In the woods
   b. On bottom land in a pasture
   c. On a cultivated hill top

2. Brown soil was found:
   a. In the woods
   b. On a cultivated hill top
   c. On a sand bar

3. Radishes grow best on:
   a. Clay
   b. Loam
   c. Sand

4. Radishes grow poorest on:
   a. Clay
   b. Loam
   c. Sand

5. In my garden I would rather have:
   a. Sand
   b. Clay
   c. Loam

Selected references for Problem 1.


Nellrose, Mary, et al., *Would You Like to Have Lived Then?*
Problem II. How does soil help in making food?

This problem is introduced with a discussion of foods and where they come from. When the statement is made that man must depend on green plants for food, another problem presents itself for solution: "How do green plants get food?" Plants obtain air through tiny openings in their leaves. They get water and minerals from the soil through their roots. With the help of sunshine green plants are able to make sugar from air and water. Food is made in the leaves, but much of it is carried to other parts of the plant and used. Plants do not use all of the food at the time it is made. Some of it is stored in different parts of the plant. We then eat the part that contains the stored food. In this way we get the foods necessary to make our bodies grow. Animals also depend upon plants for food, so when we eat meat or other animal products we are still getting our food from plants.

The following outline is used to supplement the above discussion.

Plants as food makers.

A. Things plants must have in order to make food.

1. Sunshine
2. Air
3. Water
4. Minerals
B. Where plants store the food they make.

1. Leaves
   a. cabbage
   b. lettuce
   c. turnip greens
   d. spinach

2. Stems
   a. celery
   b. asparagus
   c. rhubarb
   d. sugar cane

3. Fruits
   a. apple
   b. tomato
   c. peach
   d. strawberries

4. Seeds
   a. corn
   b. beans
   c. peanuts
   d. rice

5. Roots
   a. carrot
   b. turnip
   c. sweet potato
   d. radish
Activities

Pupils are now ready to answer a question that comes from the experiment in Problem I: Why do radishes grow better on some soils than on others? Each pupil writes the answer to this question without help from the teacher.

On the field trip in Problem III, plants growing on very poor soil are contrasted with those on fertile soil. Small yellowish plants are pointed out and pupils are asked to give reasons why these plants are not growing as well as others.

Pupils make a list of food they like best and find out as much as they can about where they came from and how they grow. They draw pictures in their notebooks of foods listed.

Test

1. How do plants obtain air?
2. What do plants get out of the soil?
3. Does the food we eat come from the soil or from plants?
4. In what part of the plant is food made?
5. In what parts of the plant is food stored?
6. Why do we eat the roots of some plants and the seeds of others?

Selected references for Problem II:


Problem III. How is soil lost? How is this loss prevented?

To introduce this problem the teacher explains what is meant by soil being "lost". Children are told that when soil washes away it is lost just as a coin is lost when it falls into a river. They are made to realize that when soil is lost, money needed to buy food, clothes, and playthings, is also lost. The fact is emphasized that such losses can be prevented and that each individual has a part to play in saving soils.

Such questions as: "what causes gullies?" and "why are rivers so often muddy?", serve to open a discussion in which children ask questions and relate their experiences and knowledge of gullies, floods, and dust storms.

Content outline.
A. Loss of soil.
   1. How soil is lost
      a. Water washes it away
      b. Wind blows it away
   2. Causes of soil washing and blowing away
      a. Improper cultivation
      b. Forest fires
      c. Cutting too much timber
      d. Cultivating hills that are too steep
      e. Overgrazing pastures
   3. Effect on our lives and the community
a. We have less food
b. The food we do have does not contain the minerals that make us healthy
c. We have dust storms
d. We have floods
e. Streams fill with mud and fish cannot live
f. The farmer does not make as much money
g. The merchant does not sell as much
h. People lose their jobs
i. We do not have as good schools
j. People move from the community

B. How to prevent this loss

1. Proper cultivation
   a. Terracing
   b. Plowing around the hill instead of up and down
   c. Not planting the same crops on the land every year

2. Prevent forest fires

3. Do not cut too much timber off the land

4. Do not put too many cattle in a pasture

5. Do not cultivate land that is too steep

6. Keep land covered with growing crops the year round

7. Everyone do his part
C. Who is responsible for saving the soil?

1. The landowner
2. The tenant
3. The businessman
4. The school
5. The government

Activities

A field trip is planned for the purpose of studying the questions related to this problem alone. Eroded lands and a well-managed farm are both observed on the same trip. On eroded lands the class notices gullies, muddy water in streams or ditches, and the conditions of plants growing on such lands. They then go to a well-managed farm where they see terraces, contour plowing, good pastures, and cattle. The farmer is asked to explain the purpose of terraces and how they are constructed.

Pupils next collect pictures of gullies, floods, forest fires, and well managed land.

Pupils are now ready to conduct a simple experiment to solve the problems; "What causes gullies?" and "What makes river water muddy?"

Find a spot of good sod on a slope. (The steeper the slope the better). Measure off two plots, each two feet square. Scrape the sod from one plot and pulverize the soil with a hoe. By using a sprinkling can wet each plot until water runs from it freely.
Use the same amount of water on each plot. Collect a milk bottle of water from each and let it stand for an hour. Each plot is studied carefully to see what changes have taken place.

Pupils write a short discussion, giving in their own words, the answers to the above questions.

A well-managed farm is constructed on a sandtable showing terraces, contours, pasture, woodlot, orchard, garden, barn, and home.

Test
1. Name three things that cause soils to wash away.
2. What causes muddy water in rivers?
3. How does the loss of soil affect the farmer?
4. How does the loss of soil affect the businessman?
5. Name three ways to prevent the loss of soil.
6. Who is responsible for saving the soil?

Selected references for Problem III


IV. Culmination

The class writes an article on the importance of soil for the school paper and illustrates it with drawings of foods from the soil.

The fourth grade is invited to the room to see an exhibit consisting of posters, pictures, soil samples, and radishes grown in boxes. The film Once Upon a Time is shown while the fourth grade is present.

V. Evaluation

Each pupil writes a story on "Why I Should Take Care of the Soil".

In evaluating the unit from the teacher's standpoint the following questions are considered.

1. Were the general and specific objectives attained?
2. Did the pupils develop an awareness of the relationship of soil to their own welfare?
3. Did pupils develop an attitude of responsibility toward "saving soil"?
4. Did the unit provide experiences which would lead to the development of problem-solving skills?

BIBLIOGRAPHY FOR THIRD-GRADE UNIT ON SOILS

I. FOR TEACHERS

A. Books


Chapman, Paul W., and Frank W. Pitch Jr., *Conserving Soil Resources—A Guide to Better Living.* Atlanta: Turner B.


B. Other Publications


II. FOR PUPILS

A. Books


B. Other Publications


C. Films

**Once Upon A Time.** Soil Conservation Service Department of Agriculture, Washington, D. C. 10 minutes, silent, black and white.


UNIT II. SOIL: ITS USE AND CONSERVATION

(for sixth grade)

I. Objectives

A. General

1. To develop some understanding of the nature of soil and its importance to human welfare.

2. To develop some understanding of the principles involved in protecting soil.

3. To develop an attitude of responsibility toward soil conservation.

4. To develop skill in solving problems by the scientific method.

B. Specific

1. To develop an understanding of the origin of soils and their classification.

2. To develop an understanding of how man depends upon soil.

3. To develop an understanding of how soils are destroyed.

4. To develop an understanding of some practices in soil conservation.
II. Motivation procedure

This unit is introduced by showing the film *Living Rock*. This fifteen minute color film follows the same general outline as the unit. It briefly reviews the formation of soil, how man's life is dependent upon soil, how soil is lost, and how it is protected.

Pupils and teacher then go over the unit plans and make a list of soil problems in the community. The unit requires considerable outdoor study, therefore, trips are planned to cover as much material as possible. All parts of the unit are closely related. Trips are, therefore, planned in terms of the unit as a whole, rather than in terms of specific problems of the unit.

III. Developmental activities

Problem I. What is the origin of soils and how are they classified?

The film *Birth of the Soil* is used as a preview of this problem. This ten minute color film shows how nature produces topsoil from the basic raw materials of rock, air, water, and sunlight in combination with plant growth and decay. The film is followed by a discussion to clear up any points that may be confusing. A list of significant points brought out in the film is placed on the blackboard for pupils to put in their notebooks. This is used as a check list of things to look for on field trips.
The content outline is given to pupils and checked to see how many items mentioned can be seen in the community and where they are found.

A. Formation of soils

1. Weathering of rocks

   a. Disintegration—physical changes

   Changes in temperature cause rocks to expand and contract, thus breaking into smaller pieces.

   Glaciers. Huge ice masses gather rocks as they move over the earth. The rocks they carry grind and break other rocks into small particles.

   Streams. Rocks are ground into small pieces as they are carried along by flowing water.

   Waves. Waves of oceans and large lakes roll rocks back and forth grinding them to pieces.

   Wind. Sand and dust carried by wind have the power to grind rocks into very fine particles.

   b. Decomposition—chemical changes

   Oxidation of iron compounds in rocks.

   Carbonic acid in rainwater dissolves limestone.

2. Biotic agencies

   a. Plants and animals decay and add organic matter to the ground up rock.

   b. Burrowing animals, such as earthworms, ants, larvae
of certain insects, gophers, and woodchucks serve to mix soil particles and reduce their size.

c. Micro-organisms assist in plant growth and decay.

B. Classification of soils

1. According to origin

   a. Residual—soils which remain where they were formed. Weathered rock often remains where it originated. Lakes fill in with sediment forming residual soil.

   b. Transported—Soils which have been moved from the point of origin by:

      Gravity.

      Colluvial soils

      Water.

      Alluvial soils

      Flood plains

      Deltas

      Ice.

      Glacial soil

      Wind.

      Loess—very small particles
2. According to texture—size of particles
   a. Gravel—contains little or no organic matter.
      Not suitable for agricultural purposes.
   b. Sand—large particles
   c. Silt—next smallest particles
   d. Clay—smallest particles
   e. Loam—a mixture of sand, silt, and clay.

Activities on field trip

Rocks and pebbles are studied to see the rounded edges and cracks in them. Pupils are asked to explain how the rocks came to be in that condition.

Pupils are asked to explain the presence of silt in roadside ditches.

Decaying vegetable matter is studied in a wooded area. A hole is dug to see the layer of dark colored soil under the leaves. Its depth is measured and some of the soil is collected. A field is visited to check the kind of soil. The farmer is contacted to see what kind of soil is best for different crops.

The work of glaciers is illustrated by dragging a heavy piece of lumber over bare ground. Clods of dirt are broken and streaks left on the ground very much as glaciers did on a large scale.

A piece of rusty iron is used to explain the oxidation of iron compounds in soil and how this process helps in breaking up rocks.
Activities in the classroom

An equal amount of each soil collected is weighed and placed in jars. The jars are labeled, giving the name and weight of the soil and where it was collected.

Some hydrochloric acid is obtained from the chemistry laboratory and placed on a piece of limestone or marble to show how acid decomposes rock.

Things observed on the trip are checked against the list of facts from the film and the content outline. A separate list is made of things seen which are not included on either list. The next day after the field trip, the film Formation of Soil is shown. This fifteen minute film includes some technical information on the formation and transportation of soils. For this reason it is used as a summary and review of materials covered in the study of this problem.

Test

1. How do temperature changes help in forming soils?
2. Why do rocks along streams have smooth rounded edges?
3. Explain how wind helps in soil formation.
4. How do earthworms help in forming soils?
5. How do you account for the sand beds along streams?
6. Why are the flood plains of rivers usually fertile?
7. Name four classes of soil according to texture.
8. The mountains of the West are very rugged and have sharp peaks. Those in the East are much smoother and more
rounded on top. Which group of mountains do you think is older? Why?

Selected references for Problem I.


Problem II. How is man dependent upon the soil?

The film Hunger Signs is shown to illustrate the answers to this question. This twenty-two minute color film shows in a very vivid manner the effect of soil deficiency on plants and animals. By means of animated photography it depicts the process of plants taking minerals from the soil and using them to build plant tissues. It also shows the amount of minerals used in producing 100 bushels of corn on an acre. Questions related to other parts of the unit are dealt with in the film. These questions serve to relate all parts of the unit and are discussed at the time the film is shown. The school or county health nurse is invited to talk to the class on the importance of proper diet to health. Bulletins are obtained from the county Agent's Office, the U. S. Soil Conservation Service, and the county Health Office for reading material in connection with this problem. The following outline serves as a base for content material.
A. Soil and health

Health is determined to a large extent by the quality of food eaten. Certain minerals are necessary for the growth and development of the body. They are obtained from food which in turn gets them from the soil. If soil is deficient in minerals so are the foods.

1. Minerals required by the human body

   Calcium
   Phosphorous
   Sodium
   Chlorine
   Sulphur
   Nitrogen
   Iron

2. Sources of minerals

   a. Plants.

      Plants require minerals which they take from the soil.

      Major elements used by plants
      - nitrogen
      - phosphorous
      - potash

      Other elements used in small amounts
      - calcium
magnesium
sulphur
Minor elements used by some plants
boron
copper
manganese
zinc
cobalt
iron
b. Meat and other animal products
Animals secure their minerals from plants
c. Fish
Minerals wash into the sea from land. Fish get these minerals in the food they eat.

B. Soil and economic security

Pupils do individual research in connection with such problems as:

1. How many people in the community make their living directly from the soil?
2. How many people in the community make their living indirectly from the soil?
3. Price of land in the community.
4. The average per acre yield of various crops in the community.
5. How does the community average compare with the state average?

6. The value of all crops grown in the entire county.

7. The value of livestock grown in the county.

8. The number of acres of land per person in the state.

Activities

Many aspects of this problem cannot be seen on field trips. The most important thing to be observed on trips is the difference between plants growing on poor land and those growing on fertile land. Evidences of "hunger signs" in plants are also pointed out.

The mineral content of plants is determined by burning a plant and weighing the ashes. Grass is collected from very poor soil and some from the most fertile soil available. Both samples are dried in the sun for several days and equal amounts of each are weighed on scales from the chemistry laboratory. Each sample is placed in a separate crucible and burned completely over a laboratory burner. The ashes are then weighed. Pupils draw their own conclusions.

Two rabbits of the same weight and sex from the same litter are placed in separate pens. A small slit is made in the ears of one rabbit to assure identification. One is fed grass from the poorest soil that can be found; the other is fed grass from very fertile soil. Neither rabbit is given anything except grass and
water for six weeks. They are weighed at the same time every other day and weights plotted on a large graph. Pupils write conclusions and generalizations in the form of a theme on "Soils and Animal Growth".

Pupils make charts of food chains. The charts show both interdependence of living things and interpretations of food chains. Pictures are used on the charts. A chart is made showing an Indian using fish as fertilizer and how this process was a means of completing the cycle of certain elements.

Test
1. Explain the relation of soil to health.
2. Name four minerals that are required by both man and plants.
3. Approximately 90% of all people in some areas have bad teeth. What does that lead you to believe about the soil in those areas?
4. Name four minor elements used by plants.
5. How many pounds of the following elements are used in growing 100 bushels of corn on an acre of land? Nitrogen, phosphorous, and potash.
6. Explain how the use of fish as fertilizer completes a food cycle.

Selected references for Problem II.
Problem III. How is the fertility of soil lost?

Problems III and IV are studied simultaneously. Content for Problem III is presented and discussed first, then Problem IV is taken up. Both outlines are carried in the field to guide observations. Reading material is obtained from the County Agent’s office and U.S. Soil Conservation Service.

A. How soil fertility is lost

1. Harvesting crops.
   Growing plants remove large quantities of minerals from the soil. When crops are harvested from the land these minerals are carried away.

2. Leaching.
   When water seeps through the ground it takes minerals with it. Leaching is very severe in some types of soil.

3. Erosion
   a. Kinds
      sheet
      rill
      gully
   b. Factors influencing erosion
      slope of land
amount of vegetation
amount and kind of rainfall
climate
kind of soil
the man who tills the soil
c. Results of erosion
loss of mineral nutrients
reduced amount of cultivable land
floods
bottomlands covered with silt
reservoirs filled with silt

B. Results of loss
1. Reduces crop yield
2. Reduces income
3. Lowers the quality and quantity of food
4. Produces poor health
5. Reduces the amount of taxes paid for the support of schools and other public institutions
6. Causes population migration
7. Leads to a general decline in the standard of living

Activities
Various types and degrees of erosion are observed on a field trip. The different colors of soil in a field are noticed, some spots appear much lighter in color than others. Pupils are asked
to find out what causes these light spots. The width and length of a gully is measured. The size area lost from cultivation is then calculated. This loss is stated in terms of values to the community based on the average price of land. In large areas where the land appears level, a bottle of water is collected from a roadside ditch after hard rain. The water is allowed to stand for several days and the sediment measured. Pupils are then asked to write an answer to the question, "Does erosion take place on level land?"

In the classroom a simple experiment is conducted to show the effect of falling water on bare soil. A fruit jar top of soil is placed on a newspaper on the floor. A spoonful of water is poured on the soil from table-top level. The distance of the "splash" is measured and also the distance soil particles are carried. The same experiment is repeated with the soil well covered with grass. Pupils make their own conclusions and discuss the topic, "Cover crops and erosion control".

The following problems are worked out by each pupil.

1. A farmer had two forty-acre fields. Only one of them had been terraced. During a heavy rain four tons of soil per acre were washed from the unterraced land, while only one-half ton per acre was lost from the terraced land. How much more soil was lost from the unterraced land?

2. Soil is being washed into a farm pond at the rate of fifteen acre-feet per year. The pond averages twelve feet deep
over twenty acres. How soon will the pond be filled? (An acre-foot is an acre of land one foot deep).

The extent of erosion in this and other countries is obtained by reading *The Lord's Land* and other publications from the Soil Conservation Service.

Pictures are collected to make a frieze in the classroom. Pictures are arranged to show the beginning of erosion, its progressive stages, effects on man and animals, and finally preventive and remedial measures.

**Test**

1. How does harvesting crops reduce the fertility of soil?

2. Explain what is meant by the term leaching.

3. Name four factors influencing erosion.

4. What is the relationship of the man who tills the soil to erosion?

5. How does soil erosion lower the quality of food?

6. Why should the school principal be especially interested in erosion control?

7. A landowner said, "My land is all level, therefore I have no erosion problems". How could you prove that his statement was incorrect?

**Selected references for Problem III,**


Problem IV. What are some of the methods used in soil conservation?

A soil conservation specialist visits the class and discusses the practices in common use before a field trip is made to study this problem. After the talk, pupils ask questions which are recorded and used as a guide for observations in the field. Pupils read Muddy Water and The Land Renewed in order to understand the principles of what they see on a field trip.

The following outline serves as a guide for the study.

A. Reduce leaching

1. Keep some vegetation growing on the land throughout the year.

B. Return of minerals lost by harvesting crops

1. Return organic matter
   a. Barnyard fertilizer
   b. Plow under, never burn, crop residues such as: cotton stalks, corn stalks, oat stubble, etc.
   c. Plow under cover crops

2. Add nitrogen
   a. Legumes
   b. Atmospheric nitrogen
   c. Nitrates beds


3. Add phosphorous
   a. Underground deposits
   b. Bone meal
4. Add potassium
   a. Underground deposits
   b. Saline lakes
   c. Industrial wastes
5. Add calcium to correct acidity
   a. Lime
   b. Slag
   c. Oyster shells
6. Add minor elements when needed
7. Crop rotation

C. Control of erosion
1. Build terraces
2. Practice crop rotation
3. Cultivate on contour
4. Prevent over-grazing of pastures
5. Plant grass or trees on land not used for crops

Activities

Most of the items mentioned in the outline are seen on a well managed farm. Particular emphasis is placed on methods of erosion control. Pupils learn the meaning of the various terms used in connection with the study.
Letters are written to various fertilizer companies requesting samples of fertilizer and information concerning its production.

Find out from the County Agent the amount of fertilizer sold in the county each year and the price per ton.

Using the figures given in the film Hunger Signs, calculate the amount of nitrate of soda, superphosphate, and muriate of potash that must be added to maintain the fertility of an acre of land that produces 100 bushels of corn.

Collect pictures and make a poster showing: the formation of soil, the types of soil, the uses of soil, and its protection.

Make a list of state and federal agencies that give direct assistance to landowners in soil conservation work. List any other organizations in the community that are active in this type of work.

Pupils find a small gully on the schoolground or nearby field as a problem in erosion control. Information on the treatment of gullies is secured by reading and talking with conservation workers and farmers. Plans are submitted for filling up the gully and preventing any further erosion. The plans submitted are studied to see which one seems to be the most practical. The plan adopted by the class is tried out. The gully is checked after each rain to see if the work was successful. If the gully is not filling up as desired other plans are put into use.
Test

1. How is leaching reduced?
2. How is organic matter returned to the soil?
3. What crop is used to return nitrogen to the soil?
4. What are other sources of nitrogen?
5. What element is obtained from bone meal?
6. What element is used to correct acidity?
7. What is meant by crop rotation?
8. What is a terrace?

Selected references for Problem IV.


IV. Culmination

All posters, charts, and other materials produced during the study of this unit are placed on display in the room. The two rabbits used in the experiment and a record of their weights are included in the exhibit. The principal is asked to proclaim a "Conservation Day" for the school. Parents and friends are invited to visit the school during day to see the classroom exhibit and the work done by the class on the outside.

Visitors and students above the sixth grade are invited into the auditorium to see the motion picture, *The River*. This
thirty-minute documentary film is a very dramatic presentation of the general problems connected with conservation. It is not suitable for use below the sixth-grade level.

V. Evaluation

Attitudes and appreciations developed by the study of this unit are evaluated by a teacher-made test consisting of a series of statements with which pupils agree or disagree.

Type of question used.

Read each of the following statements carefully. If you agree with a statement place an "A" in the blank. If you disagree with a statement place a "D" in the blank.

1. The federal government should pay landowners for terracing land.
2. Laws should require landowners to terrace their land.
3. Soil erosion is a natural process that man should not attempt to control.
4. Soil erosion is a community problem that affects everyone in the community.
5. The health of people is influenced by the type of soil they live on.
6. Soil erosion affects no one except the man who owns the land.
7. Every man has a right to treat his land as he pleases.
8. Soil conservation is essential to national defense.
BIBLIOGRAPHY FOR SIXTH-GRADE UNIT ON SOILS

I. FOR TEACHERS

A. Books


B. Other Publications

II. FOR PUPILS

A. Books


B. Other Publications


C. Films


*Living Rock*. Georgia Agricultural Extension Service, Athens, Georgia, 1944. 22 minutes, sound, color.


UNIT III. TREES: HOW THEY SERVE US AND WHY THEY MUST BE PROTECTED

(for third grade)

I. Objectives

A. General

1. To understand and appreciate the importance of trees and their products to man.

2. To develop an attitude of responsibility toward the protection of trees.

3. To develop skills in finding answers to questions.

B. Specific

1. To develop the ability to recognize some common trees.

2. To learn some of the ways in which trees serve us.

3. To develop an understanding of how birds and wild animals depend upon trees.

4. To learn some of the enemies of trees and why they must be protected.

II. Motivation procedure

A short discussion is given by the teacher to create an interest in trees and a desire to learn something about them.

The people who first settled this country built their homes and made their furniture and other household articles from the trees they cut from the forest. They used wood to build fences, to make tools to work with, and toys for the children to play with. They depended upon the wild animals of the forest for much of their food. People
of today still use wood to build homes, make furniture, toys, and other useful things just as the pioneers did. Wood is now used in many ways, however, that were not known to the early settlers. There are now so many things made from wood and so many people to use them that trees must be protected as never before.

In addition to all the things made from trees, they are helpful in other ways. They add beauty to the community, provide cool shade, and give food and homes to birds and wild animals. Their roots keep the soil from washing away when it rains.

There are many kinds of trees in the world. No one knows all of them, but everyone should know some of the ones they see every day and know something about taking care of them.

After a discussion of this nature, pupils are given an opportunity to ask questions and relate their knowledge of trees. The discussion is directed toward the type of trees in the vicinity of the school. Plans for the entire unit are explained. Pupils are given directions for keeping notes and making notebooks for the unit.

III. Developmental activities

Problem I. How are trees recognized?

To introduce this problem the teacher brings leaves and seeds of various trees into the classroom for the pupils to examine. Their attention is called to the different shape leaves and forms of seeds and how they are used in recognizing trees. Pupils name
the trees they know and a list of all trees known by the class
is placed on the blackboard. This activity serves as an inventory
test and is used in planning the activities which follow.

The following outline is presented and explained.

Trees are divided into two large groups or classes. Each
group has three different names.

A. Group one—Conifers, Evergreens, Softwoods. Leaves are shaped
like needles or tiny scales. They are called conifers because
their fruit is a cone. They are called evergreens because most
of them do not shed all their leaves in the fall. Cypress is an
exception. It is a conifer but not evergreen. They are called
softwoods because the wood is often soft.

1. Kinds

   a. Pine—Leaves shaped like needles in bundles of twos and
      threes.

   b. Cedar—Leaves very short needles or tiny scales that
      lie flat on the twig.

   c. Cypress—Leaves flat, grow along both sides of twig.

B. Group two—Broadleaf, Deciduous, Hardwoods. They are called
broadleaf because their leaves are broad and flat. They are
called deciduous because most of them shed all their leaves in
the fall. Holly and magnolia are exceptions. They are broad-
leaf, but not deciduous. They are called hardwoods because many
of them have very hard wood.
1. Kinds

a. Oaks

Leaves various sizes and shapes. Fruit an acorn.

b. Elm

Leaves oval-shaped with little "saw-teeth" along the edges. Seeds surrounded by a wing.

c. Maple

Leaves somewhat star-shaped with three or five points.

   Seeds with wings.

d. Sweetgum

Leaves star-shaped with five points. Fruit a spiny ball which contains the tiny winged seeds.

Activities

A short trip is made on the campus and vicinity to see as many different kinds of trees as possible. As each tree is named by the teacher, pupils study it to find out the general shape of the tree, the color and texture of the bark, the type of leaves, fruits, and seeds, and note any other characteristics that will help them to recognize the same kind of tree when they see one in another location. Pupils write a description of each tree studied in their notebooks. Leaves, fruits, and seeds are collected from each.

On returning to the classroom, pupils and teacher review the facts learned on the trip. Pupils transfer the tree descriptions to their permanent notebooks and draw the leaves of each tree. Some
of the leaves collected are pressed in heavy books for several days until they are dry. They are then mounted on typewriter paper with narrow strips of gummed paper. The name of the leaf, the date collected, and name of person who collected it, are printed in the lower right-hand corner of the paper. Spatter prints are made from some of the leaves by pinning them to sheets of art paper and spraying white shoe polish over them with a small hand spray. Some of the spatter prints and mounted leaves are displayed in the room. Pupils place some of each in their notebooks. Fruits and seeds collected are placed in small cellophane bags and fastened to a large piece of cardboard for display purposes. Pupils are encouraged to bring other kinds of leaves from home.

Test

1. What trees bear cones?
2. Why are some trees called evergreens?
3. Name two evergreen trees.
4. What tree has leaves shaped like needles?
5. What tree bears acorns?
6. What tree has "saw-teeth" on its leaves?
7. What trees have winged seed?

Selected references for Problem 1.


Problem II. How do trees serve us?

The importance of trees to the early settlers of America is discussed. The way they used trees is compared with present day uses. An explanation is made of the many ways in which trees serve man beside the products they give. Special emphasis is placed on the importance of trees to the child.

The question, "What things are made of wood?" is presented as a problem to the class. Pupils find the answer by looking in the classroom, in the home, and outside the school and home.

The following outline is used only as a check list.

A. Uses of wood

1. In the classroom
   Chairs
   Desk
   Bookcases
   Books
   "Writing paper
   Pencils
   Rulers

2. In the home
   Furniture
   Handles of tools and kitchen utensils
Match stems
Tooth picks
Toys
Picture frames
Newspapers
Rayon clothing

3. Outside the school and home
   Light poles
   Cross-ties
   Building material
   Fruit boxes
   Cellophane candy wrappers

B. Some foods obtained from trees
   Pecans
   Walnuts
   Hickory nuts
   Chestnuts
   Maple sugar
   Fruits

C. Other ways in which trees serve us
   Beautify the community
   Provide shade
   Christmas trees
   Keep the soil from washing away
Activities

The major activity for this problem is carried out by pupils collecting first hand information on the uses of wood from the sources previously mentioned. Additional information is obtained by reading the textbook and other materials.

Pictures, showing the uses of wood and trees are collected and made into posters.

The question "How do trees keep the soil from washing away?" is brought out as a result of a discussion on the benefit of trees to man. This question presents a problem to the class which is solved by an experiment on the school ground.

Enough loose dirt is dug up to make two small hills of exactly the same size. One "hill" is well covered with leaves, dead grass, and small sticks. Small branches are broken from green trees and stuck in the ground to represent trees growing on the hill. The hill should duplicate, as near as possible, a natural forest. The floor forest is well covered with litter and the tops of trees overlap forming a complete canopy. The other hill remain bare. A sprinkling can of water is poured over each hill. Be sure to use the same amount of water and hold the can the same distance from the ground each time. Allow several minutes for the water to settle, then remove the forest covering from the hill. Notice any gullies that have formed and any difference in the amount of soil that has washed from each hill. The loose soil is then put back into the holes and pressed down firmly. A discussion
period follows in which pupils tell what they learned from
the experiment.

Test

1. How did the Pilgrims use wood?
2. What are some things now made from wood that the
   Pilgrims did not know about?
3. What foods do we get from trees?
4. What cloth is made from wood?
5. Why do people plant trees along the streets?
6. Name five things made of wood that you use everyday.
7. What would happen if all trees were cut from a hill
   and the ground left unprotected?

Selected references for Problem II.

American Forest Products Industries, Paul Bunyan's Quiz.
Washington, D. C.: American Forest Products Industries,
undated.

Washington, D. C.: American Forest Products Industries,
undated.

General Comics, How Money Grows on Trees. Mobile, Alabama:

New York: Charles Scribner's Sons, 1947, pp. 159-172.

Problem III. How do birds and wild animals depend upon trees?

This problem is introduced by reading Smokey Bear's Story of
the Forest. The story serves to open a discussion in which the
relationship of trees and animals is brought out.
The following outline is used as a guide for the study. Pupils add to it as work progresses. When the study is completed each pupil has a complete outline based on information secured from observations and readings.

A. Ways in which birds and animals depend upon trees.
   1. For food
   2. For homes
   3. For protection from their enemies

B. Birds that build nests in trees
   1. Mocking birds
   2. Red birds
   3. Blue jays
   4. Doves
   5. Orioles
   6. Woodpeckers (in hollow trees)

C. Tree fruits and seeds eaten by birds
   1. Acorns
   2. Pecans
   3. Dogwood berries
   4. Mulberries
   5. Pine seed
   6. Cherries

D. Animals that make their homes in trees
   1. Squirrels
   2. Raccoons
   3. Opossums
Activities

Most of the activities for this problem are in the form of reading and observation. Unless squirrels live in a park or wooded area nearby pupils will probably not be able to see animals living in trees. Most observations are therefore concerned with birds.

Daily observations are made at school and at home to find out what birds build nest in trees and what trees supply food for them. A record is kept of all information secured.

The class is assigned reading in Animals Round the Year.

A letter is written to the State Wildlife Department for information on birds and animals in the state.

Pictures are collected for making posters and to place in notebooks.

Test

1. Name three birds that build nest in trees.
2. What bird builds its nest in hollow trees?
3. What foods do birds get from trees?
4. Name two animals that make their homes in trees.
5. Besides giving them food how do trees help animals?
6. What do you think would happen to the squirrels if all the trees were cut down?

Selected references for Problem III.

Problem IV. How does man take care of trees and why.

The teacher introduces this problem by reading Blaze in the Forest Fire. This dramatic story serves to create interest in protecting trees and opens a discussion on why they must be protected. The responsibility of each individual in protecting trees is discussed and children are given an opportunity to tell what experience they have had in taking care of trees.

A copy of the outline is given each pupil and discussed.

A. Some enemies of trees and how they damage the tree.

1. Fire

   Kills young trees
   Burns the bark on old trees, causing decay to start
   Destroys tree seeds
   Burns dead leaves and grass that should be left to enrich the soil

2. Insects

   Caterpillars eat the leaves
   Borers bore into the bark and wood

3. Diseases

   Damage the leaves and wood, causing the tree to die.

4. Man—Some people try to take care of trees, some, however, are careless or injure trees without knowing it.
People damage trees by:
Breaking limbs off of dogwoods and other trees to get flowers.
Letting fire get into the forest
Cutting trees that should not be cut
Breaking down small trees in playing

B. How man cares for trees

1. Forest trees
   Protects them from fire
   Keeps them properly thinned
   Cuts out old damaged trees
   Cuts only those that are ready to cut
   Plants trees where they are needed

2. Shade trees
   Sprays for insects and diseases
   Keeps them pruned
   Protects them from livestock

Activities

The field trip for this problem is the most extensive one of the unit. Extreme care is used in planning the trip according to the "directions for planning field trips." Several adults are invited to make the trip.

Things to look for on the trip

Fire lanes
Fire towers
Areas that have been well protected
Areas that have not been protected
Trees damaged by fire
Trees damaged by insects
Trees damaged by disease
Decayed trees
Small seedlings

Pupils dig into the ground under trees to see the layer of
leaf litter and kind of soil underneath.

A fresh stump is found so that pupils may see and count the
annual rings.

On returning to the classroom pupils write in their note-
books what was seen and done on the trip. The problem of protecting
trees is discussed and pupils tell what they can do to help.

A letter is written to the State Forest Service asking for
"Smokey" posters.

Pupils find out through individual investigations what is
being done to protect forests in the community.

Test
1. How does fire harm trees?
2. What parts of trees do insects eat?
3. What can be done to keep insects from damaging trees?
4. What can you do to help take care of trees?
5. Write a short discussion on why trees should be
protected.
Selected references for Problem IV.


IV. Culmination

At the completion of the unit a "Forestry Day" is observed by the class. Letters are sent out at least three days in advance inviting the principal, teachers, and pupils to visit the room to see the forestry exhibit. All notebooks, posters, and materials collected are put on display. Members of the class serve as guides to conduct visitors about the room and explain the various objects on display. During assembly period the third-grade presents a program in which the story of *Johnny Appleseed* is dramatized.

V. Evaluation

Evaluation is a continuing process, therefore no "final" test is given. The written questions given at the end of each problem are sufficient to determine the factual information acquired by the pupils. An oral discussion is held in which each child is given an opportunity to answer the question "What I liked best about the unit?"
Appreciation, attitudes, and abilities developed are evaluated by observing the behavior changes that have taken place in the pupils. By observing them as they work and play the teacher can determine if they:

- Respect the property of others and that of their own,
- Use some precaution in playing around trees on the campus, especially the ones recently planted,
- Use a systematic approach in finding answers to questions.

The teacher may evaluate the results of the unit from her own viewpoint by considering such questions as:

- Did the pupils make satisfactory progress toward the attainment of the general and specific objectives?
- Did the unit provide satisfactory experiences for the pupils?
- Did the unit stimulate the pupils to do further study in the subject?

BIBLIOGRAPHY FOR UNIT III

I. TEACHERS

A. Books


Fink, Ollie E., *The Teacher Looks at Conservation*. Columbus, Ohio: Division of Conservation and Natural Resources, 1940.


B. Other Publications


C. Films


*Little Friends of the Wild*. Bray Studios, Inc., New York, 1939. 15 minutes, silent, black and white.
II. FOR PUPILS

A. Books


B. Other Publications


UNIT IV: FORESTS, THEIR USE AND PROTECTION

(for sixth grade)

I. Objectives

A. General

1. To develop an understanding and appreciation of the importance of forests and their products to American economy.

2. To develop and understanding of and an appreciation for forest conservation.

3. To develop skills in solving problems by the scientific approach.

B. Specific

1. To learn some forest products and their values

2. To understand the importance of forests as a protector of resources.

3. To develop the ability to identify some trees.

4. To understand some principles of forest management.
II. Motivation Procedure

To create an interest in this unit, *The Enchanted Study*, is read to the class. Written in story-book form this reading is an exciting revelation of the contributions of forests to human life and the necessity of protecting them. It is written for upper elementary-school children and takes approximately ten minutes to read. A discussion period follows in which children give the names of trees they know, uses of wood, and what experiences they have had in protecting forests. Plans, purposes, and activities for the unit are explained in detail.

III. Developmental activities

Problem I. What products are derived from forests?

There are two main activities involved in this problem: first, a visit to a sawmill; second, collecting samples of forest products.

The following outline is presented and discussed. Other items are added to the list as they are discovered by pupils.

Products of the Forest

A. Things made of wood.

"Wooden" articles are of many forms and sizes, but they are still wood and are used as such. They are classified into groups as follows:

Lumber and its products

Fuel wood

Piling
Railroad ties
Veneer and plywood
Cooperage
Boxes and crates
Miscellaneous

B. Things made from wood

Wood is changed, by chemical processes, into new materials which are not at all like wood in appearance.

Paper
Fiber board
Rayon
Cellophane

C. Naval stores

Products of pine resin. Resin is obtained from living trees and old pine stumps. It is first distilled to produce turpentine and rosin. These substances are used in the manufacturing of such things as:

Oils
Plastics
Linoleum
Paints
Disinfectants
Other chemicals
Activities

Field Trip. Before making the trip, permission to visit the mill is obtained from the manager and arrangements are made for a guide. The class is given instructions as to precautions necessary to prevent accidents on the trip. A list of things to do and see at the mill is placed on the blackboard.

Things to do and see at the sawmill:

Watch logs being scaled

Learn what is meant by the term board foot

Study the different grades of logs and find out the price of each grade

Watch logs being sawed into lumber

See the dry kiln in action

Find out why lumber is dried before using

Study the different grades of finished lumber and find out the price of each grade

Find out where the lumber is shipped. Is it used as it leaves the mill or is it shipped to other factories for further processing?

Find out the daily "output" of the mill

Find out the number of people employed at the mill and the approximate average daily wage

Find out the difference in wages of skilled and non-skilled labor

Learn how to measure finished lumber
The next class period after the trip pupils enter in their notebooks the significant facts learned at the mill. A general review of the trip is made in which problems and questions are discussed.

Type of questions and problems to be emphasized.

Number one logs bring the highest prices. How can a landowner produce number one logs?

If a great amount of lumber is shipped out of the community for further processing, why is it not processed locally?

Calculate the approximate amount paid for logs each day.

Calculate the approximate daily income of the mill.

Calculate the approximate amount of wages paid each day.

What would happen to the workers if the supply of logs was exhausted?

If the mill closed down how would the business places in town be affected?

At $135.00 per M, what would the following amount of lumber cost?

12 pieces 1"x 6"x 8'
8 pieces 2"x 4"x 12'
15 pieces 1"x12"x 14'
6 pieces 1"x 4"x 10'
18 pieces 2"x12"x 12'
Some of the questions brought out in the discussion period cannot be answered from the information obtained at the mill. Pupils are encouraged to find the answers by reading and asking adults who are in a position to know.

**Collecting samples.** Samples of forest products are collected from the community and industries outside the community. Pupils bring in samples from their homes, places of business, and industries in the community. Some industries will send samples of their products to schools if the teacher writes for them on school stationery. Obviously all types of products cannot be brought into the classroom. Only those that can be successfully displayed are collected. As many as possible, however, are studied and observed.

**Test**

1. On what bases are logs graded?

2. In the statement, "Timber if $3.00 per thousand," what does the "per thousand" mean.

3. List ways in which sawmills help the community.

4. At **$35.00 per M.** what is the cost of a piece of lumber 2" x 8" x 16'?

5. What is the difference between things made of wood and things made from wood?

6. Do you think people in cities should be taxed to help support a state program of forest protection? Why?
Selected references for Problem I.


Problem II. How do forests protect other resources?

Many aspects of this problem are observed along with the study of forest management. Others are studied on the school ground, in wooded areas, along roadsides and creeks. Pupils do individual research to collect additional information, especially on those factors not available for observation. All pupils are expected to read The Forest: A Resource, A Protector of Resources. Since so many significant factors related to this problem are not observable in any one locality, two films are used: one as an introduction, and one to conclude the study.

The film Once Upon a Time is used to introduce the problem. It is a ten-minute animated cartoon which presents the interrelationships of resources in a manner very appealing to elementary children.

Outline of Content and Activities

A. Forests and soils
Forests are the most important protectors of soil—the most important of all natural resources.

1. Tree tops with their dense cover of leaves and branches check the speed of falling rain. Most forests also have an understory of smaller trees, shrubs, vines, and other plants which further check the speed of raindrops. By the time rain passes through the tree tops and understory, it has lost much of its force and ability to cut into the soil.

2. The forest floor is covered with a layer of litter several inches thick, containing leaves, twigs, and other dead vegetation. Leaf litter is constantly decaying and forming humus, and is constantly being replenished by plant materials falling to the earth. The layer of litter is capable of absorbing about four times its weight in water. The layer of humus, underneath the litter, is also capable of holding several times its weight in water. When rain strikes the forest floor, instead of running off and carrying soil with it, much of it is absorbed and gradually soaks into the earth below.

3. Trees and other plants form a dense mass of roots in the soil. They hold the soil together and keep it from washing away during heavy rains. Roots also take up great amounts of water for the plant. This leaves space for more water to be absorbed by the soil.
B. Forests and water

A large part of the water supply for industrial and domestic purposes is obtained from springs and wells fed by water stored underground. The underground supply of water is maintained by rainwater soaking into the earth. Unless sufficient water is absorbed by the soil the supply is exhausted, causing wells and springs to dry up. This has happened in some parts of the country. Three things happen to rain when it falls: it soaks in, runs off, or evaporates. As seen from the above facts, a large part of the rain which falls in a forest soaks into the soil and thus replenishes the supply of underground water.

C. Forests and wildlife

Wild game is an important resource, both from a recreational and economic standpoint. Many game birds and animals cannot exist without forests.

1. Quail, turkey, deer and squirrels are examples of game that depend upon forests to a large extent for food and shelter. One of the major causes of their decline has been the decrease in forest lands. Their numbers decrease in proportion to the cutting of timber.

2. Even though fish live in water, forest are essential to their welfare. Game fish thrive best in cool,
clear streams. A water shed well covered with trees keeps a stream clear and free from silt. Forest fires also harm fish by the ashes which wash into the stream. Good forest management is also good stream management.

Activities

Pupils observe the "two-story" effect of forests and study the forest floor while on the forest management trip. A hole is dug in the ground to study the distinct layers of litter, humus, and soil underneath, also to see the mass of roots. Three paper bags of equal size are each filled with litter, humus, and soil. On returning to school the materials are weighed and their weights compared. The materials are then placed in glass jars of equal size and a cup of water poured over each. The length of time necessary for water to soak through each one is recorded. Pupils then write their conclusions to the question, "How do trees help control the "run-off" of rainwater?"

The problem "How does stream pollution affect fish?" is introduced and solved by the following experiment.

Three goldfish of exactly the same size are obtained. Equal amounts of water from the same source are placed in three small fish bowls. Two tablespoonsful of clay soil is added to one bowl and stirred until it is well mixed with the water. Two tablespoonsful of ashes are stirred into another bowl. Water in the third bowl remains clear to serve as a control for the experiment. One fish
is placed in each bowl. The bowls are placed side by side near
the window, but not in direct sunlight. Pupils take turns and
watch the fish throughout the school day. All movements and
reactions of the fish are carefully recorded. Pupils then write
their conclusions to the problem, "How does stream pollution
affect fish?"

The study of this problem is concluded with the film
Realm of the Wild. This is a beautiful color film, running
twenty-five minutes, showing the relationship between forests
and wildlife.

Test

1. Explain what is meant by the statement "Forests are
   protectors of resources."

2. How is the underground water supply maintained?

3. Name the three layers of materials found in the
   forest floor. Tell what each is composed of.

4. Explain how the water supply of a town may be affected
   by the clearing of land miles away.

5. State one reason why game animals are less plentiful
   now than in former times.

6. How does soil erosion affect fish in a stream?

Selected references for Problem II.

of Resources. Nashville, Tennessee: State of Tennessee
Department of Conservation, undated, mimeographed.


Problem III. How to identify trees.

Pupils are given some of the fundamentals of tree identification and trained in the use of tree guides. They are expected to be able to recognize trees on the campus and vicinity at the completion of this study. Most of the study is carried on outside the classroom.

The following outline serves only as aid to the study of trees and is supplemented with a good tree guide.

Outline for tree study

Conifers.

Cone bearers, with needle or scale-like leaves. Also called softwoods or evergreens. Most of them have softwood and do not shed all their leaves in the fall. The cypress is a conifer that sheds its leaves in the fall.

Common conifers

Pine
Cypress
Cedar
Spruce
Fir
Broadleaf.

Leaves have netted veins and expanded blades. Also called hardwoods.

Leaves

Kinds

Simple—blades not divided.

Compound—blades divided into separate parts called leaflets.

Arrangement on stems

Opposite—two leaves at the same place on opposite sides of the stem.

Alternate—only one leaf at the same place on the stem.

Margin

entire
serrate
dentate
crenate
lobed

Shape

linear
lanceolate
oblong
cordate
deltoid
Common broadleaf trees

Leaves compound
opposite
ash
box elder
alternate
hickory
pecan
locust

Leaves simple
opposite
dogwood
maple
alternate
beech
cherry
cottonwood
elm
oak
sweetgum
holly
magnolia
persimmon
redbud
maple
sycamore
willow
sassafras

Activities

A trip is made to some convenient place to see as many different kinds of trees as possible. Leaves, bark, seeds, and shape of each is observed and recorded with the name of the tree. Characteristics and arrangement of leaves are of particular importance. Leaves and seeds are collected for future use.

Pupils make ink prints and blue prints from some of the leaves collected and mount others in their notebooks. They draw leaves and seeds in notebooks. The seeds collected are placed in cellophane bags and mounted on large pieces of cardboard to display in the room.

Test

1. What is the difference between conifers and broadleaf trees?
2. Draw a simple leaf.
3. Draw a compound leaf.
4. Show by diagram the difference between opposite and alternate arrangement of leaves.
5. When the written test is completed the class goes outside for the final question which is to test their ability to recognize trees. The teacher points out a tree, pupils write the name of it on a slip of paper
and give it to the teacher who checks it and records
the grade at once. This procedure continues until
fifteen trees have been checked.

Selected references for Problem III.

Brown, Clair A., Louisiana Trees and Shrubs. Baton Rouge,
Louisiana: Louisiana Forestry Commission, 1945.

Coker, W. C., and H. R. Totten, Trees of the Southeastern
States. Chapel Hill, North Carolina: University of North

Comstock, Anna Botsford, Handbook of Nature-Study. Ithaca,

Green, Charlotte Hilton, Trees of the South. Chapel Hill,

Hayes, Ralph W., Trees and Forests of Louisiana. Baton
Rouge, Louisiana: Bureau of Educational Materials, Statistics,
and Research, Louisiana State University, 1945.


Problem IV. What practices are used in forest management?

The film, Guardians of the Wild, is used to introduce this
problem. This eleven minute film is a detailed summary of the
work of a forest ranger in managing forests. It is well within
the ability range of sixth-grade pupils.

After the film has been presented and discussed the following
outline is distributed to each class member and explained in detail
so that children will have some understanding of the principles
involved in timber management before going on a field trip.
Outline on timber management

Why forestlands should be managed.

1. To maintain a renewable natural resource.
2. To maintain gainful employment and stable communities.
3. To permit additional cash income on an annual basis.
4. To prevent loss of income from woodlands which can be made to produce higher annual yields.

Good management practices

1. Selective harvesting
   a. Cut poles, piling, and sawlogs first, then pulpwood from low grade smaller trees.
   b. Cut crooked, diseased, and damaged trees.
   c. Cut fully developed, mature trees.
   d. Cut trees with large spreading limbs over most of the trunk.
2. Cut stumps low and go high into the tops.
3. If you own only a small woodlot cut the trees yourself.
4. Don't cut young thrifty growing trees.
5. Never sell more than one half of the volume of your timber stand.
6. Always sell to the highest bidder.
7. Always sell by written contract.
8. When selecting seed trees to leave, always select the healthy ones with good tops.

Adapted from Albert A. Legett and Meredith O. Stark, Steps in Timber Management (Jackson, Mississippi: Mississippi Forestry Commission, 1948), pp. 3-5.
9. Plant trees on poor hill tops, steep hill sides, and other lands not suited to cultivation or pastures.

10. Keep fire out.
   a. Pave fire lanes around and through the forest.
   b. Keep fire fighting equipment convenient.
   c. Know where to call for help in case of a fire gets started.

Activities

Field trip. The trip for this problem is a full half-day in length and must be carefully planned according to the "directions for planning field trips". A specialist in forestry is essential for a successful trip. One may be secured from the nearest U. S. Forest Service Office or State Forest Service.

Only a well managed forest is visited. The purpose is to show the class how good management is carried on and its results. The forester explains the points mentioned in the outline and pupils study those that are found. The problem, "how is standing timber measured?" is worked out according to the following plan:

One-quarter acre of land, containing a good stand of timber is measured off with a tape. The trees on the plot are counted and the number of each species is recorded. The diameter of each tree is measured and its height estimated by using a "tree-stick". The volume is then found by using a "log-scale". Pupils learn that volume given in the "log-scale" is in board feet, not cubic
feet, and that timber is generally sold by the board foot. The total volume of each species is determined and added to get the total for the plot. The price of the different species is obtained and total value of the timber is calculated.

How to grow a good grade of timber, is presented as a problem to the class. The forester points out trees that will produce number one logs and those that will not. He then shows the pupils how good cutting and thinning practices lead to the production of high quality timber.

The next day a review of the trip is held and pupils transfer their field notes to permanent notebooks. Pupils are asked to find information concerning the work of the U. S. Forest Service and the State Forest Service. A map is prepared showing the National Forests in the state. A letter is written to the State Forest Service to find out how many acres of forest lands in the state, how many acres are under scientific management, and the estimated value of standing timber in the state.

Test

1. Give three reasons why forests should be properly managed.

2. Give five good management practices.

3. What types of trees should be cut first?

4. What type of trees should be left for seed?
5. What precautions are used to keep down fire?

6. What kind of land should be planted in trees?

Selected reference for Problem IV.


Culmination

An assembly program is planned, which includes the playlet, *All Aboard The Forestry Special.* Written invitations are sent to parents, foresters, landowners, and businessmen, inviting them to the program. All materials collected are placed on display in the auditorium. A part of the program is an explanation of the articles on exhibit. Recognition is given any individual or business in the community that has contributed to the success of the unit. This would include the manager of the sawmill and the forester.

Evaluation

The tests given throughout the unit have evaluated factual information acquired by the pupils. Some of the questions have been directed toward the evaluation of ability to apply principles
to new situations. The final evaluation is concerned with attitudes developed. Attitudes are generally best evaluated by observation, however, teacher-made tests have some value in this connection. The following type of test is used for this purpose.

Mark the one statement out of the following five that best describes your view on the problem of forest conservation.

1. We should use fewer wood products and thus save our forests.
2. Forest conservation is largely a matter of preventing waste at sawmills.
3. Timber should be cut in a way that will permit land to produce a continuous supply.
4. Timber should be cut only on privately-owned land.
5. All forests should be in public ownership.

BIBLIOGRAPHY FOR SIXTH-GRADE UNIT ON FORESTS

I. FOR TEACHERS


B. Other Publications


II. FOR PUPILS

A. Books


B. Other Publications


C. Films

*Once Upon a Time*. Soil Conservation Service, Department of Agriculture, Washington, D. C. 10 minutes, silent, color.


*Trees for Today and Tomorrow*. Southern Educational Films, University of Georgia, Athens, Georgia, 1950. 22 minutes, sound, color.
CHAPTER V

SUMMARY

The literature reviewed in the early part of this study indicated a close relationship between the advancement of science education at the elementary-school level and the application of the scientific method to instruction. Science occupied a very minor place in the elementary curriculum until a satisfactory means of teaching it had been devised and the value of its method, to society, recognized.

In tracing the development of the scientific method it was found that some of the early European educators made certain contributions. Rousseau applied a basic principle of the scientific method to the teaching of science by having his pupils discover facts through their own efforts. One of his primary objectives in teaching science was to have children discover facts. Pestalozzi stressed the importance of observation as a means of acquiring information. In teaching his pupils to observe accurately and record information thus obtained, he brought certain aspects of the scientific method into use. Herbert considered education itself a science. In an attempt to place all educational method on a scientific basis, he developed the "formal-steps" in instruction.
The concept of applying the scientific method to instruction was first brought to America by Sheldon and later by the McMurrays. The method was further developed and promoted by Dewey and Kilpatrick. As it developed, a definite place and purpose of science in the elementary schools was established.

The rise of the resources education movement came about as a result of the rapid depletion of America's resources. A review of recent literature shows that many schools throughout the South include education for wise use of resources in the curriculum. The conservation of natural resources depends upon a knowledge of science. Many authorities agree, therefore, that the most satisfactory place for this type of training is in the science classes and that it should begin as soon as a child enters school. Authorities suggest that it should not be taught as a separate subject, but through the use of units integrated with science.

The units developed in this study illustrate how conservation of natural resources may be taught in the elementary science classes. They were based on a three-fold purpose: first, that the pupils learn some of the facts pertaining to plant and animal life, soil, water, and other factors related to the resource studied; second, that they develop the ability to use the scientific method in solving problems of social significance; and third, that they become aware of their responsibilities in the conservation of natural resources. By studying resources, as soils or forests,
social problems are brought up for consideration. As the study develops, the facts of science are learned. The necessary experiments and observations involved in the study provide experiences in using the scientific method. In seeing resources as they relate to everyday life, pupils become aware of the importance of conservation, and their responsibilities in its promotion.

By using such units the entire elementary science program may be based on local resources. This practice has produced desirable results in a number of schools. It is recommended as a most economical way of teaching science at the elementary-school level.
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A. BOOKS


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C. PUBLICATIONS OF LEARNED ORGANIZATIONS


D. MISCELLANEOUS MATERIAL


Harap, Henry, How to Construct a Unit. Nashville, Tennessee: Curriculum Laboratory, George Peabody College, November 30, 1931. (Mimeographed).


BIOGRAPHY

Henry Judson Jacob, youngest child of James Henry and Mary Josephine Anderson Jacob, was born September 29, 1904, near the town of Carpenter, Mississippi. After completing the Elementary and Junior High School at Carpenter he entered the Utica High School, Utica, Mississippi, and graduated in 1924. In the fall of 1925 he entered Mississippi College, Clinton, Mississippi, and received the Bachelor of Arts degree from that institution in May, 1929. He then taught in the public schools of Mississippi until 1946, having served as coach, science teacher and superintendent of several schools. He received the Master of Arts degree in rural education from George Peabody College for Teachers in 1946. At that time he went to Delta State Teachers College as Assistant Professor of Resource-Use Education. He still holds that position and at present is on leave of absence doing graduate work at Louisiana State University.

On August 11, 1940 he married Nell Slay of Silas, Alabama. Their daughter, Marynell, was born April 12, 1943.
EXAMINATION AND THESIS REPORT

Candidate:  Henry Judson Jacob

Major Field:  Education

Title of Thesis:  SOME APPLICATIONS OF THE SCIENTIFIC METHOD AS APPLIED TO THE TEACHING OF ELEMENTARY-SCHOOL SCIENCE WITH SPECIAL REFERENCE TO RESOURCE EDUCATION.

Approved:

Major Professor and Chairman

Acting Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination:  July 24, 1952