SUGGESTIONS FOR IMPROVING THE TEACHING OF SCIENCE IN THE INTERMEDIATE GRADES

by

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INTRODUCTION

Along with the controversy created by "modern" mathematics, there has been a somewhat similar change in the field of elementary school science. Prompted, perhaps, by our nation's race for the moon, the change in science education has been supported for even more important reasons.

People need an adequate science background for life, not just to be scientists. The population explosion requires better science and technology; a scientifically literate population is needed to be able to vote intelligently on such issues as water pollution, the "H" bomb, fluoridation of drinking water, atomic energy, etc.; and science interests and hobbies can help fill the leisure time gap which our modern way of life has created. Also, science has much to offer to the creative minds in the way of professional opportunities. "We live our daily lives in a science-based world . . . . It is not possible to understand ourselves or our surroundings without some knowledge of the principles of science. . . ."[1]

> Many school systems today still have either no elementary school science programs or programs which are based on the aims and objectives of 1910 [the cardinal principles], if not 1880 [the training of the mind]. Only within the past five or ten years have organizations such as the National Science Teachers Association given attention to building modern programs in elementary school science. Only since 1959 have experimental school science programs been supported by the National Science Foundation.[2]

What effect has this new interest in science education had on the teaching and learning of science? Science has been considered in the past a content

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[1] William J. Gruver and Albert Piltz, Modern Science and Your Child, United States Department of Health, Education, and Welfare, (Washington: U.S. Government Printing Office, 1963), p. 4.

[2] Harold E. Tannenbaum, Nathan Stillman, and Albert Piltz, Science Education for Elementary School Teachers (Boston: Allyn and Bacon, Inc., 1965), p. 8.

subject. This is interpreted to mean a subject taught to the pupils in terms of what to remember. If science is to be truly functional in a child's life it is best experienced as a skill subject. In teaching a skill subject, the teacher's task is to guide the pupils to discover how to learn and how to function.[1]

While most conscientious teachers agree with the above statement, many continue to teach science by the read-recite-write method. "Too many teachers still associate science teaching with memorizing a list of names or facts, or holding a recitation on a science reading lesson."[2]

However, in today's fast changing world these scientific facts and readings are continually changing because of new evidence. Therefore, we must remember that "Modern science is more than new knowledge. It is a way of thinking and working. . . . Modern science teaching is most concerned with developing an inquiring mind and a respect for scholarship, for science is essentially a method of learning---not a book of answers."[3]

Statement of the Problem

It is the purpose of this study to present activities for the teaching of elementary school science in the intermediate grades which will supplement the reading and discussing of the science textbook.

Objectives of the Study

This writer intends (1) to present a brief review of some of the well-

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[1] Alphoretta S. Fish, "Structuring an Elementary-School Science Program," Elementary School Journal, February, 1963, p. 277.

[2] M. F. Vessel, Elementary School Science Teaching (Washington: The Center for Applied Research in Education, Inc., 1963), p. 46.

[3] Gruver, op. cit., p. 3.

known experimental studies going on at this time in elementary school science education and (2) to suggest activities for use in the classroom that will "free" the teachers and students from total dependency on reading about science.

Limitations and Delimitations

This study was based on materials found in the Kansas State University Library. It has been limited to intermediate grades; however, many of the activities presented here are applicable to primary grades. The suggestions are in no way limited to any particular school system. The writer has not gone into the theories of learning and general methods of science education. Specific and limiting experiments have not been given as they can be easily obtained in any science method course textbook.

Definition of Terms

Discovery approach. The discovery approach refers to student problem-solving activities which are as individualized and as creative on the part of the student as possible.

In-Service improvement. This phrase is used to mean the "on-the-job" education of teachers, particularly those aspects that the teachers can control themselves.

Field studies. This term refers to various types of out-of-classroom activities that teachers and students engage in to improve or enrich the science programs.[1]

Nature center. An area of land set aside for the purpose of teaching and learning about the out-of-doors.

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[1]Paul DeHart Hurd, How to...Teach Science Through Field Studies (Washington: National Science Teachers Association, 1965), p. 2.

CURRENT EXPERIMENTAL PROGRAMS

One of the major reasons for the change in science teaching has been the active participation on the part of university professors in the science program. These professors are the directors of a number of good science curriculum projects across the country aimed at elementary school science. They feel that only by carrying out investigations himself can the student become acquainted with the experiences of solving a scientific problem.

> Elementary school science programs and textbooks have been criticized by scientists for not teaching how scientists discover knowledge of our universe. Instead they have traditionally emphasized the products of science. Because of this, groups of professional scientists working in conjunction with educators are beginning to produce science materials and programs of instruction for the elementary schools. These materials stress ways in which scientists find answers to their questions.[1]

Elementary Science Study[2]

The Elementary Science Study is a branch of Educational Services, Incorporated and has its headquarters in Watertown, Massachusetts, under the direction of Benjamin Nichols. This project has a permanent staff of about thirty scientists and science educators who are concerned with the development of materials and activities which will provide opportunities for the children to take part in laboratory-type investigations.

A group of units have been designed around such topics as Kitchen Physics; A Look at Some Properties of Liquids; Behavior of Mealworms;

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[1] Arthur Carin and Robert B. Sund, Teaching Science Through Discovery (Columbus, Ohio: Charles E. Merrill Books, Inc., 1964), p.12.

[2] Benjamin Nichols, "Elementary Science Study---Two Years Later," Journal of Research in Science Teaching, 2:288-292, 1964.

Microgardening; Bones; Butterflies; and others that are in varying states of readiness. They are not rigidly structured for one particular grade level and provide enough activities for many more class periods than most teachers would be able to allow. For example, Kitchen Physics is suitable for grades five to eight and could occupy from twenty to forty lessons. In many cases Elementary Science Study (ESS) has designed the needed equipment and in other situations materials are easily acquired by the teacher. The study units and written guides are planned to provide as much help to the teacher as possible while encouraging maximum freedom in their use.

These units are set up so that each pair of students receives a variety of supplies and a problem to solve or questions to answer. The students set out to collect data by conducting experiments and recording the information found. As they explain the results of their research they develop generalizations. The phenomena are so interrelated that seeking answers to one set of questions stimulates more questions and as they relate these they gain insight into scientific principles.

Trial teaching, evaluation, and revision are part of the ESS procedure. A "Sampler" package containing teachers' guides, students' worksheets, accompanying apparatus, and resource materials are being furnished to the trial teachers. These teachers are to play the role of guides and fellow-learners not the experts with all the answers.

Science Curriculum Improvement Study[1]

The Science Curriculum Improvement Study (SCIS), supported by a grant from the National Science Foundation, is under the direction of Robert Karplus, Professor of Physics at the University of California. The work of the SCIS is still at an early stage. Although the plans were begun in July, 1959, the longitudinal study didn't begin in the classrooms until the fall of 1966 when materials for the primary grades were ready.

The general strategy is to confront the elementary children with first-hand experiences of natural phenomena and with intellectual challenges that will stimulate their further development. Karplus feels that the principal objective of the elementary school science program should be scientific literacy which he defines as the functional understanding of science concepts.

A permanent staff is employed as well as a staff of selected scientists and teachers who are concerned with writing materials and testing them in the classroom. SCIS has constructed teachers' manuals, student manuals, kits of equipment and audio-visual aids. The student manuals are not textbooks and they do not contain scientific information. The manuals contain instructions for the experiments, space to record observations, and suggestive questions about interpretations. Scientific information, however, is obtained by the children through their own observations.

Since stimulation of intellectual development is an important goal, the different units of the curriculum fit into a predetermined sequence

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[1]The source for this section has been: Robert Karplus and Herbert D. Thier, "Science Curriculum Improvement," The Instructor, January, 1965, pp. 44-48; and Robert Karplus, "The Science Curriculum Improvement Study," Journal of Research in Science Teaching, 2:293-303, 1964.

in which each builds on the previous experiences and lays the groundwork for the subsequent ones.

Elementary School Science Project[1]

Also at the University of California and supported by the National Science Foundation is the Elementary School Science Project. In fact at one time, Dr. Karplus was working with this project. It is now under the direction of Herbert Mason, Professor of Botany, and Lloyd Scott, Associate Director.

This project was organized and conducted by science specialists who identified fundamental concepts within their disciplines which lent themselves to treatment at the elementary school level and prepared units of instruction. They are usually assisted by an experienced classroom teacher, a technical writer, and an evaluator. A series of lessons includes descriptions of equipment needed, teacher background information, and detailed directions for guiding the children's experimental activity. These units are then tried in classrooms, revised and tried again, usually in the University of California Laboratory Schools. When local experimentation is considered sufficient, the units are prepared for wider distribution.

The materials are distributed at cost to approximately one thousand teachers. These teachers are encouraged to complete summary evaluation reports and as these reports are accumulated, additional revisions may be indicated.

Units of study are being developed on the following topics: Animal Coloration, Plant Morphology, Human Physiology, Population Dynamics,

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[1]Lloyd Scott, "Science is for the Senses: University of California Elementary School Science Project," Science and Children, 2:19-22, March, 1965.

Evolution of Life, Insect Life, Heredity, Force, Matter, and Coordinates.

University of Illinois Elementary School Science Project[1]

Under the direction of J. Myron Atkin and Stanley P. Wyatt and supported by the National Science Foundation, this study is producing an astronomy sequence for grades five through eight. Based on the criticism that the astronomy program found in many schools consists primarily of descriptive information, astronomers, science education specialists, and teachers began preparing materials that would give children an understanding of how scientists work to obtain answers to problems in astronomy. This staff has identified relatively few but powerful concepts and principles that hold the subject of astronomy together.

A sequential series of six books and accompanying teachers guides are in various stages of writing, editing, revising and are on extensive trial in schools all over the country. These books are: Book 1, Charting the Universe; Book 2, The Universe in Motion; Book 3, Gravitation; Book 4, The Message of Starlight; Book 5, The Life Story of a Star; Book 6, Galaxies and the Universe. Astronomy is an outstanding example of an interdisciplinary field in the physical sciences. Concepts of physics, mathematics, physical chemistry, and geophysics are essential features of each book.

[1] Joann M. Stecher, "Astronomy for Grades Five Through Eight: University of Illinois Elementary School Science Project," Science and Children, 2:23-24, February, 1965.

American Association for the Advancement of Science[1]

The American Association for the Advancement of Science, (AAAS), also operating under a grant from the National Science Foundation and under the direction of John R. Major, Director of Education for AAAS and Arthur Livermore, Professor of Chemistry, has since 1962 been sponsoring an extensive program in elementary science.

The primary aim of the program is to develop children's skills in using science processes. This doesn't mean, however, that in the preparation of materials science content is neglected.

A group of scientists, science educators, and teachers met for eight weeks each summer from 1963-1966 to write materials. All exercises were written as instructions for teachers, not as reading material for children. Each exercise described a variety of activities which the children would do either individually or in small groups. Demonstrations by the teacher were avoided as much as possible, but materials which teachers would need to teach the exercises were designed and produced.

The AAAS group selected fourteen processes as being essential and has presented them in a series of seven books. Grade levels are not designated as the increase in difficulty is gradually blended from one book to the next. As the child moves along, certain processes he has mastered are dropped from active study, but continue in use as part of the complete system.

The processes identified in the primary grades are: observing, classifying, measuring, communicating, inferring, predicting, recognizing

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[1] "The Process Method of Teaching Science," Grade Teacher, January, 1966, pp. 60-61, 113; and Arthur H. Livermore, "The Process Approach of the AAAS Commission on Science Education," Journal of Research in Science Teaching, 2:271-282, 1964.

space/time relations, and recognizing number relations. At the intermediate level the integrated processes are: formulating hypotheses, making operational definitions, controlling and manipulating variables, experimenting, interpreting data, and formulating models.

The Process Approach is being tested in classrooms in various parts of the country by teachers having no special science skills and with children of widely varied cultural backgrounds. After teaching each exercise these teachers complete a feedback form which is used by the writers who revise the materials.

There are other smaller studies in the area of elementary science education which are not included here. The United States Office of Education has helped finance science study projects and invites additional proposals. The NDEA furnishes funds and financial support from NASA is available. The teachers must look at what is being done in science, and evaluate it in terms of the children's needs.

SUGGESTIONS FOR THE CLASSROOM TEACHER

The suggestions given in this chapter are not new or startling innovations. They are ideas that any intermediate grade teacher in this country could use in improving her science program. The suggestions are applicable to almost any unit taught.

There are three ways of teaching science. They are: incidental teaching; correlated teaching with other subjects such as health or social studies; and as a basic science program. There is a definite need for incidental and correlated science teaching but it is the opinion of the writer that these methods alone are not enough to provide adequate background in so important and broad a field. Therefore the following suggestions are presented as to be used in a basic science program.

The Discovery Approach and Creativity

The idea of "learning by doing," discovering or experimenting to solve a problem is recognized and accepted by most teachers. The writer believes that the idea that it is being practiced by most teachers is not true. Most science experiments in the elementary school classroom are demonstrated by the teacher. Even if the children perform the experiments, they read from the text how to do it, what's going to happen, and why. Most anyone will admit that this procedure is the easiest way and the quickest, but are the children learning science?

Reading and discussing science usually doesn't generate much enthusiasm for science and "Enthusiasm for learning, rather than facts, should be the important outcome of elementary instruction in science."[1]

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[1]Gladys S. Kleinman, "Needed: Elementary School Science Consultants," <u>School Science and Mathematics</u>, LXV (November, 1965), p. 39.

"Children have built-in wonderment and natural curiosity which can be nurtured and developed through the process of discovery."[1] They usually want to participate actively in learning situations whenever possible. "Investigations suggested by problems raised by the students are far more exciting, although more likely than not these problems have no clearcut answer or solution. This kind of teaching always involves more time, sometimes more materials, and possibly more space."[2] However, when one considers the interest and learning that results from this type of activity it is readily apparent that it is superior.

In using the experimental or laboratory approach to the teaching of science, one needs a longer science period. Perhaps this can be obtained by teaching two or three longer blocks of time per week instead of a brief daily science period.

Also in regard to the laboratory approach, the teacher should have the experiments precede rather than follow the reading and discussing, thus providing motivation by having a real purpose. The experiment should, too, raise as many, or more, questions as it answers. This way a particular activity opens up related areas for additional study.[3]

Another term for the discovery approach is the problem-solving method of teaching. While not limited to science by any means, it is easily exemplified in this area. However, "It should be pointed out that the traditionally taught 'scientific method' is not realistic; for there is no

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[1]Herbert D. Thier, "Quantitative Approaches to Elementary Science," The Instructor, January, 1966, p. 66.

[2]Vessel, op. cit., p. 50.

[3]Harry McAnarney, "Want to Get Out of the Rut of Reading About Science?" School Science and Mathematics, LXVI (January, 1966), p. 51-4.

single method. Scientists do not attack every problem utilizing the five or more neat steps one by one."[1]

It is important to keep in mind that the teacher does not need to know all the answers to the problems proposed by the students. In fact, ". . . this pattern of approach thrives on an 'I don't know; perhaps we can find out' attitude on the part of the teacher. But the teacher must be interested in finding out. 'Don't tell them all you know' is a good admonition for most teachers in such a situation."[2] In this way the science program can provide a wide range of activities and thus provide for the varied abilities and interests that the children have. A good science program thus aids in the individualized education of the children.

Problem-solving activities can be most effective in promoting creativity in the learning of science. "Creativity in science implies the ability to make a discovery in science even though such information is already known to others. . . . The student does not copy his original, novel, or experimental idea from a textbook but proposes the idea as a result of his own thinking."[3]

To promote creativity the science teacher should encourage students to identify and state the problems. The procedures to be followed by the teacher are: (1) write the anecdote or perform a demonstration in class that will enable students to identify and state the problem; (2) display various materials that will help the student suggest and test appropriate

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[1] Vessel, op. cit., p. 52.

[2] Ibid.

[3] Nathan S. Washton, "Teaching Science for Creativity," Science Education, February, 1966, p. 22.

hypotheses; (3) the teacher should know the scientific concept or principle to be taught.[1]

The teacher should be very perceptive in his assignment, for the students must be able to find a solution to the problem that they are encouraged to solve. The student must be supported in the belief that he is capable of solving problems on his own. He should also be taught to recognize factors that retard creativity. Among these are: (1) considering previous experiences that tend to lock the mind in a single track that leads to failure; (2) making judgments of his own ideas resulting in suppression of his own imagination because of a feeling of inability; and (3) not allowing his mind to operate freely because of his fear of the judgments of others.[2]

Real scientific investigation and creativity result from open-ended experiments. "The experiment does not necessarily have to arrive at well-known laws and principles. In all cases the experiments should reveal a need for further investigation."[3]

This type of problem-solving teaching and learning is exciting. The student can pursue the study during his free time and at home. It is time consuming, it requires more equipment and space for each child to solve his own scientific problem, and textbooks are not written this way. But science is not a subject that can be taught from a book, "It must be an action subject taught by an actively creative person."[4]

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[1] Nathan S. Washton, "Teaching Science for Creativity," Science Education, February, 1966, pp. 23-24.

[2] I. W. Chatham, "Imagination---Too Long Neglected," Science Teacher, October, 1965, p. 27.

[3] Edward, Victor, Science for the Elementary School (New York: The Macmillan Company, 1965), p. 18.

[4] "This is Teaching!" Grade Teacher, January, 1967, p. 78.

Audio-Visual Aids

Although personal, firsthand experiences furnish the best way for acquiring correct concepts in science, they are not always possible. Therefore, audio-visual aids comprise some of the most effective learning resources available. With students of limited experience and knowledge, the more concrete the resource, the more realisitc learning will be and the fewer misunderstandings will result.

With the help of money from such sources as the NDEA, few schools are without the audio-visual equipment necessary for an adequate science program. Now it is up to the teachers to learn to operate this equipment, aid in the selection of materials, and incorporate these into the science program in a way that will aid in the achievement of the previously adopted objectives.

Films and Filmstrips. Motion picture and filmstrip projectors have become almost standard equipment for most elementary schools. "When providing firsthand experiences for pupils is not feasible, teachers may use motion picture films and filmstrips to bring reality closer to the children."[1] More than any other aid, "The film can provide experiences that cannot usually be brought into the classroom, show materials and phenomena in their true or natural relationships, and explain in greater detail how the basic science information applies to the children's environment."[2]

One unique source of films comes from the teachers themselves. "Because of the growth in popularity of the home movie camera, many teachers

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[1]Albert Piltz, Science Equipment and Materials for Elementary Schools, United States Department of Health, Education, and Welfare (Washington: Government Printing Office, 1961), p. 12.

[2]Victor, op. cit., p. 98.

use it to photograph special experiments or demonstrations, objects and places that are too far away for a field trip, and other experiences that would be of interest and value to the children."[1] Since most schools have combination filmstrip/slide projectors, teachers could use slide cameras in a similar manner.

There are many possibilities for enriching learning through carefully prepared tapes. Recordings of talks by specialists, discussions of the children, bird songs, and animals are among some of the uses of tapes.

Microscope. A microscope is an instrument used in many areas of science, and as such deserves a place in the schoolroom. It is important to select these microscopes so that you have sufficient magnification. Also, it is desirable to have several of these in a school so one class can have several children using them at one time.

There is the problem, particularly in the elementary grades, as to what the children are seeing through the microscope. In this case the microprojector has some advantages. "Although limited in magnification, compared with some microscopes, the enlargement and projection will generally suffice for elementary school children. . . . each individual has the same focus on the image at the same time and various details of the specimen can then be readily pinpointed, stimulating group discussion without doubt as to the specific area of discussion."[2]

The microprojector is moderately priced and is particularly economical if only one slide and microscope is available for each class. Naturally,

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[1] Ibid., p. 99.

[2] Albert Piltz, "Getting the Most from the Equipment Dollar," The Instructor, January, 1964, p. 78.

students will profit more when microprojector viewing is followed with individual work with microscopes.

Opaque and Overhead Projectors. Most teachers are familiar with the use of opaque projectors to project nontransparent pictures. However, they can also be used to project flat specimens and even shallow pans containing live specimens.[1]

Overhead projectors and the commercial or teacher-made transparencies are very useful in the science program. "With the use of polarizing filters, it is possible to show (a) simulated motion such as in illustrating chemical reactions and (b) unidirectional flow to show direction of processes. . . ."[2]

Educational Television. In the last thirty years, programs dealing with science have been presented by radio and during the last ten years television has been used. The purpose for most of these programs has been to stimulate or supplement the science teaching occurring in the classroom.

The advantages of using television as a teaching aid are numerous. Television is the only medium that allows its viewers to see historical events, important happenings, and discoveries as they are made. It is able to create the illusion that the viewer is sitting beside the scientist as he demonstrates and explains his findings.[3]

Television programs working successfully in school systems frequently use this basic format: The program is geared to the textbook and course of study. Teachers' manuals or guides have been prepared and are distributed

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[1] Ibid.

[2] Ibid., p. 79.

[3] Victor, op. cit., p. 108.

to every teacher involved in the program. These guides usually contain background material for the teacher and children and a preview of each program. Thus the teacher is able to prepare the children in much the same manner as for any other teaching technique.[1]

The follow-up of the TV program by the classroom teacher determines the kind and amount of laboratory experience that the children will receive. "The 'on camera' teacher should also work closely with classroom teachers in developing the program and should receive 'feedback' of information to strengthen the telecast."[2]

As a new medium, educational television requires constant evaluation. Television teaching includes a great deal of talking and demonstrating on the part of the teacher. Therefore TV should not be used as a total program any more than any other single instructional aid.

Models. The value of direct purposeful experience in science for children is well recognized, but since a school program imposes various limitations on offerings, there is also a place for contrived experiences. Models, specimens, objects, and mock-ups are examples of aids which are used extensively by the elementary teacher to explain science phenomena. One must remember, however, to interpret these aids in relation to their appropriate environments.[3]

Science Kits and Concept Boxes. Science kits are abundantly advertised teaching aids which are often nothing more than a handy box filled with frequently used science equipment. One should be very careful about

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[1] Victor, op. cit., p. 109.

[2] Piltz, op. cit., p. 15.

[3] Ibid., p. 17.

purchasing these kits. They may cost more than the same items bought separately and stored another way. Teachers should be sure of the quality and serviceability as well as replacement of materials.

Some schools have made use of science-concept boxes. As science experiments develop, the materials for each science concept are placed in a box. Each box is labeled as to the concept it illustrates. The box contains all the materials necessary to perform one experiment. On the inside cover of the box, pupil-written instructions give explicit directions for the use of the material.

These boxes are made available for loan to the children just as libraries lend books. Children find the boxes interesting to work with at home. The box may also give parents the idea of contributing to the collection of the materials.[1]

In the case of both science kits and concept-boxes, it is not good for the teacher to gather all the materials. Some materials must be on hand to aid in incidental learnings but children should decide and help gather what is needed. One must keep in mind that they won't independently anticipate everything that will be needed.

Interest Centers. Many self-contained classrooms have science interest centers. These usually include a work area, display space, an aquarium, small animal cages, equipment for science experiments, and science books. In these science centers a child can observe more closely the results of an experiment performed before the whole class or he can repeat a demonstration if materials are provided. He can work on an unfinished project, or

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[1] John Gabriel Navarra and Joseph Zafforoni, Science Today for the Elementary-School Teacher (Evanston, Illinois: Row, Peterson and Company, 1960), p. 42.

look up information on a special science interest.[1]

Evaluation. Audio-visual materials may be used as evaluative or testing devices. A filmstrip lends itself more easily than the film for use as a test. With filmstrips the teacher merely shows the desired frame to the children, using a strip of paper to hide the caption or does not turn the frame far enough to expose the caption. There is also the added advantage of being able to show the frame to the children for as long as necessary.[2] Models, specimens, and other audio-visual equipment should be used to supplement reading and writing tests which handicap the less verbal children who have a good science understanding.

Today's science program is concerned with illustrating how to seek answers not just memorization of facts. If children are to acquire the problem-solving creative attitudes, they must find them reflected in the program through audio-visual aids, and demonstrated by the teacher.

Field Studies and Nature Centers

Field studies or field trips as they are frequently called are actually a form of audio-visual aids. They are unique enough however to be listed separately. With careful planning and pupil preparation, the field trip can add reality and concreteness which may spark deep interest in the subject.

> A field trip may be used to raise further problems in a study already underway; it may be used as a culminating activity to illustrate applications of methods which the pupils have been studying; or it may serve to gather information which can only be found outside of the classroom.[3]

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[1] Peter C. Gega, Science in Elementary Education (New York: John Wiley & Sons, Inc., 1966), p. 83.

[2] Victor, op. cit., p. 104

[3] Vessel, op. cit., p. 50.

The efficiency of field studies may be improved through careful teacher and pupil-teacher planning. There must be ample follow-up activities and an evaluation of the trip by both teachers and students. Other suggestions include a proper study guide which identified problems and questions to be resolved, observations to be made, responsibilities of students, data to be collected, maps of routes, lists of essential equipment, and suggested readings and references.

A properly planned and carried out field trip has many of the characteristics of research and provides for understanding of the practical applications of science. It offers greater student motivation for further study into the area. One of the goals the teacher should keep in mind is to make more careful observers of children. Children should learn to check their observations of natural phenomena with reliable sources, a necessary operation which requires the use of books.[1]

Frequently teachers complain of the administrative problems of arranging a field trip, the time spent, and the upsetting of school schedules. These problems can sometimes be solved by a ". . . field study done individually or by small teams. . . . In this type of study students are encouraged to conduct investigations outside of school hours, unaccompanied by a teacher. . . . The emphasis should be on work which, to the student at least, is new, original, and represents a genuine investigative effort."[2] This type of study definitely requires the study guide previously discussed. This study places more responsibility on the student and that can be an educational advantage in itself.

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[1]Hurd, op. cit., p. 5.

[2]Ibid., p. 2.

Resource sites should be evaluated both before and after the field study. Guides can be developed from individual teacher reports and can be a great deal of help for that teacher and others in the future. Suggestions for information to be included in these guides are: name of site, location, appropriate grade level, teaching units to which site is adapted, science data available, days and hours available for visiting, person to contact, restrictions and safety factors, and an evaluation and special comments from the person who has been there.[1]

The possibilities for field trips in both large and small communities are always greater than first imagined. Teachers need to be on the lookout and inquire about sites. "When opportunities seem to be quite limited or inappropriate, there is the possibility of developing outdoor laboratories, nature areas, museums, and science centers on the school ground. The planning and developing of these facilities is in itself a learning experience for all involved."[2]

There are other outdoor situations that lend themselves well as classroom environments for study and purposeful experiments. One of these is the community nature and conservation education center.[3] These facilities can bring children to an awareness of the outdoors in its natural, untouched state. "Minimum educational facilities are a one-half mile nature trail with trailside displays on soil, water, plants (including forests), animals,

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[1] Ibid., p. 9.

[2] Ibid., p. 11.

[3] Joseph J. Shomon, Manual of Outdoor Conservation Education, Information-Education Bulletin No. 3 (New York: National Audubon Society, 1964), p. 31.

and minerals."[1] Other educational facilities that would be applicable to these centers are weather stations, sundials, garden plots, a bee tree, bird feeders and baths, ponds stocked with plant and animal life, and geological land forms.

Field studies and nature centers offer many educational opportunities. They often serve as excellent culminating activities as well as furnish introductory ideas and methods of obtaining information.

In-Service Improvement

Elementary teachers have a wide range of subjects to teach children, who through mass media, are becoming more knowledgeable of the world around them. It is almost impossible to be experts in all of these areas but teachers should continually seek to improve themselves.

Science is an area where many elementary teachers feel particularly insecure. "The content is factual and the broad social picture is confusing as it fluctuates constantly with each new invention, improvement, and discovery."[2] In fact, pupils frequently know more about a particular area than the teacher. But this is nothing to be ashamed of. They don't expect the teacher to know everything and a wonderful example can be exhibited by admitting an error and making a correction gracefully.

While every elementary teacher doesn't need to be a science specialist, she should still be aware of what good science teaching is and should always be adding to her scientific knowledge. This can be accomplished in several ways.

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[1]Bryon L. Ashbaugh, Planning a Nature Center, Information-Education Bulletin No. 1 (New York: National Audubon Society, 1963), p. 48.

[2]Harrington Well, Elementary Science Education in American Public Schools (New York: McGraw-Hill Book Company, Inc., 1951), p. 3.

Workshops are a common means of in-service education. While individual teachers do not determine the program of their particular school system, administrators welcome suggestions and want to plan such programs in areas where teachers feel a particular need. It is important for the individual teachers to participate actively in such workshops and sincerely try to learn from the experience. "Informal workshops within a school are one practical way for teachers to improve in the 'doing' part of science. Such workshops allow teachers to try out materials and share skills and ideas."[1] Teachers need constantly to improve their skill in using science materials if they are to guide children in the use.

Conferences and conventions provide additional opportunities for teachers to meet experts, discuss with other teachers in similar situations and see new materials for improving science education.

Television has become popular as a method of in-service training of teachers. "These programs are intended to provide teachers with a basic background in the science areas and to assist teachers in keeping up with the new developments of science."[2]

Teachers should be on the alert for science articles in popular magazines such as Life, Time, Reader's Digest, and more specialized magazines but still written on the laymen's level such as Scientific American, Scientific Monthly, Popular Science, Popular Mechanics, and Science Digest. Reading science materials of all kinds will help a teacher build his background in science content. Also, "If the science background is weak, one should as a beginning, read some good high school text. . . ."[3]

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[1]Alan I. Dodd, "Updating Ourselves as Teachers of Science," The Instructor, January, 1964, p. 57.

[2]Vessel, op. cit., p. 71.

[3]Kenneth Freeman and others, Helping Children Understand Science (New York: Holt, Rinehart, and Winston, 1958), p. 22.

Taking university courses either in science content or teaching methods would be a valuable experience. Observing other teachers who are effective science teachers is well worth the time and effort. If the school system doesn't have teacher-visitation programs, this is a suggestion that can be made to the administration. Just as with the children, science is best learned by doing. Teachers should keep notes on successful efforts so they can be used again as well as suggestions made by the pupils.

"Resource people in science are generally most willing to assist teachers and many schools have found it helpful to keep a card file of such persons."[1] This extends the concept of resource persons beyond the idea of someone to come to the classroom and talk to the children. Frequently school systems furnish a type of resource person to their teachers ---the science consultant.

Science Consultants

"In view of the importance of science, the need for a science consultant is probably as great as the need for an art or music consultant."[2] This statement may be disputed by some who say art and music are based on a special talent and science is studied from a book. While in some aspects this may be true, a science consultant would be a definite aid to teachers.

The teacher should think of the science consultant as the person specifically to help broaden her understanding of science and improve teaching methods. The duties of the science consultant will vary from school to school but most of the following are typical. The science con-

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[1] Dodd, op. cit., p. 57.

[2] Vessel, Elementary School Science Teaching, p. 94.

sultant should be of specific help to the classroom teacher by providing materials, planning, locating references and resource people, and helping plan field trips. He may work with special groups of children and prepare guides of equipment and resources. Such activities as science fairs and clubs are usually organized by the science consultant.

The science consultant carries out a continuing in-service education program that assists administrators with planning of the over-all science program. He works closely with curriculum committees and continually evaluates the curriculum guides. The consultant aids in the evaluation of books and materials and also serves as a guidance bureau by alerting teachers and students to science career materials.

Now what can the teacher do to best utilize the services and knowledge of the science consultant? First of all, the teacher should invite the science consultant into the classroom. He can help teach a difficult concept, observe the teaching and offer suggestions, or he can actually teach the lesson while the teacher observes his new approach to the topic. The teacher should always arrange a follow-up conference after his visit.

Teachers should remember to request advice on specific problems. It is a good practice to have notes about the problem and a few possible solutions so that the consultant has more to work from in helping the teacher. Teachers should plan with the consultant for the needs of special students and for field trips and other special activities. The teachers need to feed back to the science consultant ideas that will help him enrich his services to all the teachers. The consultant would like materials and activities the teacher has tried in her classroom, and experiences children have contributed. The most important thing to remember is that the consultant provides the leadership but it is the teacher's job to use that leadership so that the true spirit of science will be taught.[1]

Reading in the Science Program

Reading does have a place in the science program. Learning science through reading is an important method of teaching as not everything can be learned directly or by using audio-visual aids. Reading is most effective when it has a purpose. The learner may have any of several reasons to consult a book. He may wish to check his own conclusions; to get added information; to learn how to do an experiment; or to answer a question.

It is hoped that the children will not be able to find all their answers in the textbook as this provides an opportunity for them to read from other sources. The teacher must help them find books consistent with their ability and interest level. Poor readers have often developed a real desire to read through the science program.

Thoughtful reading of science material often sparks discussions that further children's understanding of a given topic and of new topics as well. Varying points of view of authorities may cause children to question authoritative sources. "Lack of agreement may also help children sense the tentative nature of much that is now known and thought to be fact. This, in itself, is a valuable experience. A healthy skepticism is a wholesome attribute."[2]

Some teachers may use books only for an occasional reference or merely for ideas which they develop with the children during discussions and

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[1] Kenneth D. George, How to...Utilize the Services of a Science Consultant (Washington: National Science Teachers Association, 1965), pp. 1-7.

[2] Beatrice Hurley, "What is Science?" Science for the Eights-to-Twelves (Washington: Association for Childhood Education Internatiol, 1964), p. 25.

demonstrations. However, "A skillful teacher attempts to maintain a balance between reading and other learning activities and makes selections on the basis of what is best for the pupil in a given learning situation."[1]

[1] Piltz, Science Equipment and Materials for Elementary Schools, p. 12.

SUMMARY AND CONCLUSION

A major change in the teaching of science has been the shift from reading about science to combining reading with other activities. The trend is toward elementary science programs which stress creative thinking and the problem-solving aspects of science. A primary objective has been the development of intellectual abilities and skills to improve the thinking process of learners.

The emphasis is on the processes whereby discoveries are made as well as the products of the discoveries. Therefore, science is no longer the rote learning of accumulated facts. Children are to learn to measure, to use equipment, and to expand their ability to observe. They are provided opportunities that will expand their ability to recognize and define problems and to solve these problems by questioning, exploring, and discovering for themselves.

Trends in elementary science can be summarized as follows: help children understand science by suggesting ways of answering problems and of seeking answers rather than telling; use many references and resource materials rather than one book; emphasize how to find and create knowledge rather than accumulate scientific facts; set skills in inquiry as teaching goals rather than facts and factual concepts; think of science as something that grows out of experiences rather than as something learned from books; and use testing instruments that require thinking and reasoning ability rather than recall.[1]

Evaluating the progress of children when they are not regurgitating

[1]James R. Wailes, "Science Innovations," The National Elementary Principal, September, 1963, pp. 22-27.

from a textbook is difficult. Evaluation is a continuous experience, concurrent with a part of good teaching not just what happens at the end. Observation must become a more vital method of evaluation. It can be used to evaluate scientific attitudes and methods as well as many incidental science facts gained. These observations supply evidence that cannot usually be obtained by more formal methods and thus give the teacher a more complete appraisal of the child.

These observations may be recorded as anecdotal records and can be made as the teacher walks about the room while individuals or small groups of children are working on science problem-solving activities.

Other evaluative techniques are: "practical examinations" where the student may be required to handle equipment or materials in a correct way; another is the "situational test" with questions such as, a cup of water sweetened with a half a teaspoon of sugar is placed alongside another cup which contains a similar solution of salt water. How can you tell which cup contains the sugar without tasting the contents? Such a test measures the analytical process and the application of facts to a problem situation. These would be used with attainment tests to evaluate specific knowledge acquired during the study.[1]

No matter what research advocates or authorities publish, the elementary science program ultimately depends on the teacher. "The enthusiasm of teachers has been responsible for the development of countless numbers of scientists and for an even larger number of individuals who, each day, see their environment with greater perception. Unenthusiastic teachers often

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[1] Vessel, op. cit., p. 59.

destroy the zeal to learn which comes to school with most children."[1] Enthusiasm and confidence are infectious. A teacher must have the determination to improve, plus some definite steps as to how this can be accomplished.

Teach children how to be scientists not about science. Give them equipment, give them problems to solve using the equipment and let them learn. Avoid helping pupils until they are at the very edge of frustration. "It is better for the child to learn from a neighbor than it is for him to be told by the teacher. Why? Because learning from a neighbor involves observation--or investigation which originates with the child, and which is a form of research. Being told by the teacher is not a form of scientific pursuit."[2]

Perhaps elementary science can best be summarized with this quote:

> Science is not just an accumulation of facts; indeed, the "facts" of science today may not be facts tomorrow. Science is a composite of observations, facts, definitions, concepts, laws, principles, and theories. But perhaps more important are its components of attitudes and modes of reasoning which lead to the organization and applications thereof. Science is descriptive, analytical, and synthetic. It is both quantitative and verbal. No individual truly learns science who learns only the results of scientific activity; he must grasp the rules, logic, and procedure which characterize that activity. In a word, he must become, to a degree, scientific.[3]

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[1] Glenn O. Blough, "Sound Objectives for Today's Science Program" <u>The Instructor</u>, January, 1964, p. 39.

[2] Jackson Hand, "A Way to Teach Science for Every Teacher....for Every Grade," <u>Grade Teacher</u>, January 1965, p. 43.

[3] National Society for Study of Education, <u>Rethinking Science Education 59th Yearbook Part I</u> (Chicago: University of Chicago Press, 1960), p. 62.

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SUGGESTIONS FOR IMPROVING THE TEACHING OF SCIENCE IN THE INTERMEDIATE GRADES

by

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AN ABSTRACT OF A MASTER'S REPORT

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The purpose of this study was (1) to present a brief review of some of the well-known experimental studies in elementary school science education and (2) to suggest activities for use in the classroom that supplement the reading and discussing of the science textbook.

One of the major reasons for the emphasis on science education has been the active participation of university professors in the science program. Professional scientists working with professional educators have produced science materials and programs of instruction for the elementary schools.

Experimental programs include: the Elementary Science Study at Watertown, Massachusetts; the Science Curriculum Improvement Study and the Elementary School Science Project both at the University of California; the University of Illinois Elementary School Science Project; and the American Association for the Advancement of Science program in elementary science.

These studies emphasize the processes of science, as well as the products. Those who have developed the programs believe that only by carrying out the investigations himself, can the student become acquainted with the experience of solving a scientific problem.

Teachers can promote the active participation of pupils by using the experimental or laboratory approach to the teaching of science. The teacher should encourage students to identify and state the problems to be solved. It is not necessary for the teacher to know all the answers to problems proposed by the students but the teacher must be interested in finding out.

Although first hand experiences furnish the best way for acquiring scientific concepts, they are not always possible. Audio-visual aids can be the most effective learning resources available. Whatever the aid, the more concrete the resource the more realistic the learning will be and fewer misunderstandings will result.

Field studies and nature centers offer many educational opportunities. These serve as excellent culminating activities, help motivate the children, and provide one means by which they obtain information.

Every elementary teacher doesn't need to be a science specialist, but she should be aware of what good science teaching is and should always be adding to her scientific knowledge. This can be accomplished through school sponsored in-service education activities, university courses, reading of magazine articles, and the utilization of resource people.

Many school systems have science consultants who help the teachers broaden their understanding of science and improve the teaching methods. While the duties of the science consultant vary, the important point for the teacher to remember is that: The consultant provides the leadership but it's the teacher's job to make maximum use of this leadership.

Reading is an important method of teaching science as not everything can be learned directly or by using audio-visual aids. A skillful teacher will attempt to maintain a balance between reading and other learning activities and will see that all activities have a purpose for the pupil.

In general there has been a change from primary dependence on reading as a procedure for teaching science. The trend is toward programs which stress the creative thinking and the problem-solving aspects of science. The principal emphasis is on the processes whereby discoveries are made, not entirely the products of the discoveries.