Alphoretta S. Fish

A state department plans for

Science Curriculum Development

TODAY, more than ever before, professional persons at the state level are aware of the need to meet the growing demands of thousands of elementary school teachers, administrators and supervisors for a science curriculum that emphasizes the processes of scientific inquiry. To promote and formulate a description of science as an inquiry process, a State Advisory Committee on Science in the Elementary School was appointed in August 1961, by Roy E. Simpson, Superintendent of Public Instruction in the State of California. The committee was composed of scientists, supervisors, classroom teachers, administrators and college professors. Special consultants from outside the state also met with the committee to assist in the identification and discussion of problems in science education. Staff members of the Bureau of Elementary Education also participated in the meetings with Helen Heffernan, Chief of the Bureau of Elementary Education, acting as chairman.

The committee decided at its first session to "cut the bonds which tie us to the science curriculum we have had in the past." Today, teachers are not only concerned about teaching science in ways that will provide pupils with a realistic orientation toward a rapidly increasing fund of scientific knowledge. They are equally impressed with the urgency to present this area in ways that will develop the concept of science as a process of inquiry.

Questions Identified

The task identified by the committee at the first meeting was that of describing a curriculum that would provide the most effective science education for the children of California. The committee recognized that this task would evolve around the following questions:

1. What is the nature of science?
2. How should science be taught to achieve the goals of science education?
3. How can children learn science?
4. How should the curriculum be organized?

Alphoretta S. Fish, *formerly with the California State Department of Education, is Assistant Professor of Education, University of Arizona, Tucson.*

5. What criteria should be used in selecting content?

6. How can pupil progress be evaluated?

7. How does the teacher equip himself for evaluating behavioral outcomes?

Position papers on each of these questions were prepared and presented at the second meeting of the Science Advisory Committee. Discussion centered around a consideration of the nature and structure of science and around the identification of the processes of rational thinking and the skills of scientific inquiry.

The committee operated on the premise that the organization for science instruction beginning in the elementary school would become more effective if a thematic approach were employed.

During the third and fourth meetings the *themes* or *strands* of science, useful at the elementary school level, were identified along with the concepts relating to each strand. Concepts were selected with regard to the abilities and interests of the elementary school child.

Prior to the final preparation of the manuscript, committee members included sample lessons which would illustrate, in a specific way, how the strands and concepts could be implemented by the classroom teacher. Since the strands and techniques for implementing the lessons were new to most elementary school teachers, it was necessary to acquaint teachers with the underlying philosophy and techniques for teaching, using a thematic approach. Teachers in four California communities who volunteered to cooperate chose topics of interest to their children, planned and taught a lesson based on the strands. These teaching-learning experiences were observed by members of the Bureau of Elementary Education and were described in the bulletin which was subsequently published.

Suggested Answers

The content and the structure of the completed bulletin reflect a concerted effort to answer the questions posed by the committee at the initial meeting. The answers to the questions may be summarized as follows:

1. What is the nature of science?

"Science is a process of rational inquiry used by man in his search for understanding." [1]

2. How should science be taught to achieve the goals of science education?

"Science should be taught to emphasize both the processes of scientific inquiry and the product or content knowledges that result from the inquiry."

3. How can children learn science?

"Children learn science by active participation. Active participation by children in the process of inquiry in science means 'children in action to solve problems.'" [2]

Why active participation? Active participation is essential to understanding: "Discovery of relationship occurs when the knowledge gained by experience is sufficient for the development of concepts to which rational thinking can be applied." [3]

4. How should the curriculum be organized?

Science instruction should be planned to develop the scientific concepts related to certain broad significant themes

[1] *Science Curriculum Development in the Elementary School.* Sacramento: California State Department of Education, 1963. p. 7.

[2] *Ibid.*, p. 19.

[3] *Ibid.*, p. 18.

or strands which permeate the structure and scope of science. The strands considered basic to the curriculum at the elementary school level were identified as follows: [4]

a. *Variety and Pattern.* Many likenesses and differences occur among the variety and patterns of living and nonliving things.

A variety of function, size, shape and structure exists in plants and stars, rocks and animals, processes and people. However, there are sufficient similarities among material objects to permit man to classify them into orderly patterns. These classifications enhance man's understanding of the universe; conversely, increased understanding often modifies man's scheme of classification. Living organisms share common metabolic function; plants and animals differ in other basic ways.

b. *Continuity and Change.* Continual change occurs with living and nonliving things.

Exchanges of matter and transfer of energy occur among living organisms, among nonliving things and between living and nonliving things. Some changes seem to occur in cycles and some do not. Throughout all these changes run patterns of continuity and constancy. Identities often continue in spite of changes; a living organism maintains its individuality in spite of growth, maturation and ultimate death.

c. *Interaction and interdependence.* Interaction and interdependence occur among living organisms and nonliving things.

Interaction occurs among living and nonliving things due to their relationships in time, position and energy. Interactions cause the exchange of matter and transfer of energy among living organisms, among nonliving material, among all things and their environment. Green plants use radiant energy to convert materials from air, soil and water to produce compounds for plant functions.

[4] *Ibid.*, p. 24-25.

d. *Evolutionary Development.* Long-range developments have occurred and continue to occur among living and nonliving things.

Such processes include the development of galaxies and planetary systems, the evolution of the planet Earth and the development of life.

These developments occur slowly as compared to the life span of organisms. Organisms modify and are modified by their environment; heredity preserves elements of continuity. Groups of animals and plants have evolved continuously since life began; all objects of the earth and universe continue to be subjected to modification.

5. What criteria should be used in selecting content?

Science content should be selected within a framework that is closely associated with the growth and development patterns of the child. Experiences in the area of Living Things, The Earth, The Universe, and Matter and Energy are recommended for selection within this framework. Random selection of topics is not recommended: "To prepare curriculum material or plan science lessons on the basis that 'science is everywhere' and that the responsibility of the teacher is to assist children in the exploration of 'anything' is wasteful of teacher's and pupils' time." [5]

6. How can pupil progress be evaluated?

Evaluation of pupil progress must occur in a multidimensional field:

In order to evaluate concept development, problem-solving behavior and scientific attitudes, situations must be identified where the elements of problem-solving behavior may be expected to operate. Teacher-pupil planning, research activity, and directed evaluation periods are situations where concept development and the various elements of problem-solving behavior and

[5] *Ibid.*, p. 23.

7. How does the teacher equip himself for evaluating behavioral outcomes?

The teacher must be competent, not only in knowledge of science content, but also in an understanding of how children learn:

> The teacher who is cognizant of the purposes of science education and the growth development pattern of children will plan situations in which girls and boys will have experiences that will help them grow in the understandings, skills, and attitudes that are inherent in the objectives of science education. If the outcomes are to come through discovery for the individual, the teacher's purposes will function in the planning of situations that will yield science learnings. The dynamics for moving through the learning situations will come from the purposes of the children.[7]

These answers, greatly enlarged and illustrated, represent the convictions and beliefs of some of the top scientists and educators, not only of California, but of the nation.

The publication, *Science Curriculum Development in the Elementary School*, was to have been distributed to the school districts of California in the fall of 1963. At present the State Department of Education is investigating the possibility of communicating and demonstrating the implementation of the processes of scientific inquiry through the medium of television. The size of the state indicates that this method is probably the most effective means of demonstrating the applicability of the program to the classroom experience and the most efficient means of meeting the insistent needs of the pupils and teachers in California.

[6] *Ibid.*, p. 56.
[7] *Ibid.*, p. 56.