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A STUDY OF SELECTED SECOND GRADE SCIENCE PROGRAMS USING AS CRITERIA THE EIGHT AAAS PROCESSES

by

JOANN CHALMERS AMEND

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Head, Major Department

Chairman, Examining Committee

Graduate Dean

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ABSTRACT

The purpose of this study was to survey, in terms of their inclusion of the eight basic processes of science, second grade science programs. Programs selected were published between 1961 and 1969 and were available in the Curriculum Library of the Montana State University Library. The eight basic processes used throughout the study were outlined by the American Association for the Advancement of Science. These processes were Observing, Using Number Relations, Measuring, Using Space/Time Relations, Classifying, Communicating, Inferring, and Predicting. The number of times each of these processes was included in each program was determined. If a process was used in a program once, this was referred to as an "introductory inclusion". If the process was presented two or more times in the program, this was called an "extended inclusion".

It was concluded that second grade science programs do differ in the emphasis placed upon teaching children the processes of science. Two of the programs, the Heath Science Series and The Macmillan Science Life Series, included at least two opportunities to teach each process. In all ten programs children were given at least two opportunities to work with Inferring, Communicating, and Observing. Many of the programs gave little opportunity to develop the skills used in Predicting, Measuring, Classifying, and Using Numbers.

Recommendations based upon the conclusions were made. School systems intending to use the process approach in teaching elementary science should study the programs of various companies and choose the program most closely meeting the objectives of the school, the writer felt. Although the emphasis placed upon the processes of science should be carefully considered, other factors--cost, interest level, and vocabulary level--should also be considered. It was also recommended that teachers become aware of weaknesses in presenting the basic processes in the program used in their district and then supplement the program with special activities. Suggestions for doing this were made in the last chapter of the paper.

CHAPTER I

INTRODUCTION

During the "post-Sputnik" era, many Americans felt that children were not getting a scientific background that was adequate for the future. Therefore, more emphasis was placed upon the teaching of science, and particularly upon the teaching of elementary science, than ever before. The elementary school schedule was crowded with reading, writing, arithmetic, and other subjects, so it was difficult for schools to justify giving additional time to science instruction.[1] The problem for the school was, then, how to make the best use of the time that was devoted to the science curriculum. Gagne' stated:

> The difficulty is that, whatever the content undertaken, a great deal of instruction time must be spent in providing the child with background knowledge about the methods of science. One can't get very far with force and energy without teaching the child how to make systematical observations, measurements, and inferences. And if one proposes to do this in order to teach force and energy, the question naturally arises whether one might try to teach observations, measurements, and inference with reference

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[1] Looking Ahead in Science--A Report of the Production Seminar and Conference on the Improvement of Science Education in the Elementary School, October 5-10, 1959, California State Department of Education, Sacramento, 1960.

to animal digestion, solutions of chemicals, and many other kinds of content.[2]

From beliefs such as Gagne's has developed the philosophy that at the elementary level emphasis should be placed upon learning the processes of science. Once children have established a good background of scientific methods, they can learn the facts of science with greater ease and speed.[3]

In 1962 a Commission on Science Education was appointed by the American Association for the Advancement of Science. It was to outline the behavioral objectives it felt were most important for elementary children to achieve. The Commission included noted public school personnel, university faculty members from several disciplines, and psychologists. After two summers of work, the Commission had compiled a list of the eight processes which they felt were most commonly used in science, and they hypothesized that the behavioral objectives of elementary science should lead children to work easily and naturally with these processes.[4]

The following statement of the Commission on Science Education was directed toward the idea that elementary school children should learn the

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[2]Gagne', Robert M., "Elementary Science: A New Scheme of Instruction", Science, Vol. 151, p. 52.

[3]Ibid., p. 5.

[4]"Science in the Kindergarten and Early Grades", Science Education News, November, 1963, p. 2.

processes of science so they will have a good background of scientific methods for later study.

> Science is much more than a simple encyclopedic collection of facts, and children in the primary grades will derive much benefit from experiences which will enable them to acquire certain basic skills and competencies essential for the learning of science.[5]

In the same article the Commission stated that these basic skills and competencies are Observation, Classification, Communication, Number Relations, Measurement, Space/Time Relations, Prediction, and Inference.

Purpose of the Study

The purpose of this study was to determine if each of the eight processes of science, stated by the AAAS Commission on Science Education as being important to elementary children, was included in second grade science programs. The frequency of inclusion of the eight processes was also determined.

Procedures

In this study, the eight processes identified by the Commission on Science Education--Observation, Classification, Communication, Number

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[5]Ibid., p. 5.

Relations, Measurement, Space/Time Relations, Prediction, and Inference--were used as the criteria to examine science programs for the elementary schools. The writer felt that because the members of the Commission represented many different fields of education and because the processes had been re-evaluated continuously since 1962, the process approach was one of the best criterion available for evaluating elementary science materials.

Selected second grade science programs printed since 1961 were examined to determine the inclusion of each of the eight processes. The selected programs were those in the Curriculum Library in the Montana State University Library. If the inclusion of a process was noted in a program, it was noted whether the process was introduced and taught briefly or whether a planned program for developing the process was presented.

The data for each program was classified by listing the processes included and the frequency of inclusion, introductory or extended.

Conclusions were made based upon the number of processes methodically taught within each program. Since the Commission on Science Education felt that children would learn scientific facts and concepts more quickly and easily if they had learned the eight processes first, the programs methodically covering all of the processes should give children the best background for further study in the scientific field.

Recommendations were then made on the basis of the number of processes included and the degree of inclusion in each of the selected science

programs. These recommendations included programs to consider in textbook selection and the necessity of varied teaching methods and use of additional material with the different programs.

Delimitation

Only programs published between 1961 and 1969 were used in the study. Since 1961 most companies had revised and reprinted their materials in view of recent research in elementary science, so it was unnecessary to review older materials.

Only programs which were available in the Curriculum Library in the Montana State University Library were reviewed.

In the AAAS science curriculum, which was an outcome of the Commission on Science Education's study, the eight processes mentioned earlier were presented by the end of the second grade.[6] Therefore, the programs which were examined were at the second grade level.

Definition of Terms

For the purpose of clarification, two terms are defined. A behavioral objective is an instructional goal defined in terms of an observable change in the student's behavior. In this study, process refers to one of the eight

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[6] Science-A Process Approach--Part C, Xerox Education Division, 1967.

basic skills and competencies which was defined by the Commission on Science Education

Summary

This study was intended to examine recent second grade science programs using as the criteria the eight processes selected by the Commission on Science Education as being the most important outcomes of instruction in elementary science. The study attempted to determine how many of the eight processes were used in each of the selected programs and how frequently each process was encountered by students.

A review of literature, discussing the background of the recent developments in elementary science education, will be presented in Chapter II.

CHAPTER II

REVIEW OF LITERATURE

Since 1920 definite changes have come about in education. Many of these changes have occurred in the elementary school curriculum, and the science program has been affected as much as any of the other programs have been. By the mid-1960's, a philosophy of science education which was quite different from that of 1920 had evolved. The activities of the children in the science program had also changed over the forty year period. Chapter II will review literature which dealt with these changes in philosophy and practice.

Philosophies and Practices of Elementary Science from 1920 to 1960

During the 1920's, the content of the science program was limited, in comparison to the science program of today. Generally, most emphasis was placed upon nature study, because educators realized that nature study was interesting to children and that the field of nature contained many exciting problems for the children to study. Usually the textbooks began with a study of animals, spent some time with the study of astronomy, and then devoted the rest of the book to biographies of great inventors. As would be expected, each progressive book became a little more complex. The science textbook was

often read silently by the children. Because the teachers had been taught mainly from books, and because they had limited opportunities for experimentation in the college science preparation, the children were taught in this manner. Science was mostly a teaching of facts. In spite of this, it was during the 1920's that the need for a systematic elementary science program was first felt. During this period science was assimilated as an integral part of the elementary curriculum.[1]

By the 1930's, science had become an established part of the elementary school curriculum, but little was being done about program development. Even though the need for a systematic elementary science program was felt, teachers often could not actively implement it, because of the lack of material. As the decade progressed, improved materials for use in the elementary program did begin to appear. As a continuation of the science in the 1920's, many of the units had to do with nature study, but units on transportation and weather were also included. There were still few experiments used to support the statements made in the textbook discussions.[2]

By the 1940's, more changes were occurring in science instruction in some elementary schools. World War II influenced the kind of scientific

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[1]Bradley, R. C.: Earp, N. W.: and Sullivan, Troy, "A Review of Fifty Years of Science Teaching and Its Implications", in Science Education, 50:2, March, 1966, p. 152.

[2]Ibid., p. 153.

knowledge that adults were expected to have, and it also influenced the way in which they were to use this knowledge. In the 1940's, science education was aimed at preparing children to live healthful, successful, and responsible lives in their quickly-changing society. Instead of being nature-oriented, the science units were usually correlated with other subjects. Visual aids and experiments became more common in supplementing the science materials. The experiments were usually teacher directed rather than student directed. Studies were made which indicated that teachers still tended to use class discussion, supervised study, and textbook assignments instead of experimental methods.[3]

The real change in elementary science programs came about in the mid-1950's, Stollberg noted.

> The years following World War II were marked by a normal amount of educational adjustment. Science teachers strove to keep their courses abreast of new developments in the field and in line with the evolving needs of a new generation. But it was after nearly a decade had passed that a series of events led to an unprecedented eruption of activity in science education.[4]

During the 1950's American educators, industrialists, government policy-makers and other civic-minded groups became aware that the United States had a serious shortage of technically-educated workers. At the same

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[3]Ibid., p. 153.

[4]Stollberg, Robert, "The Status of Science-Teaching in Elementary and Secondary Schools", in Rethinking Science Education, 59th Yearbook of the National Society for the Study of Education, pt. 1, University of Chicago Press, Chicago, 1960, p. 82.

time, uneasiness became widespread because of the warnings that communist countries were moving ahead more rapidly than the rest of the world in the "race for technical supremacy". As a result, groups which were often financed by industry, philanthropy, and government inaugurated a period of intensive program design, meant to improve American science education. Some of these groups were the National Science Foundation, the Physical Science Study Committee, the Ford Foundation, the American Association for the Advancement of Science, and the Science Manpower Project.[5]

The emphasis now in the elementary science program was to develop in children "science mindedness", to teach them to think scientifically.[6]

The nationwide influence of television was being felt in the classroom. The amount and variety of knowledge available to most children through television gave them a broader background. This caused a change in the elementary science curriculum.[7]

New aids were being developed for the teachers and children. These included science kits, movable science laboratories, and a variety of science books written for children. Much writing was done which changed ideas about

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[5]Ibid., pp. 82-83.

[6]Bradley, Earp, and Sullivan, op. cit., p. 155.

[7]Ibid., p. 155.

what elementary science should consist of and the part it should play in the development of the child at school and at home.[8]

Even though the methods of teaching science had changed greatly between 1930 and 1960, Paul DeH. Hurd felt that the objectives of elementary science hadn't changed much during that time.

> The objectives of science-teaching as they appear in educational literature have changed little in the past twenty-five years. On the other hand there have been changes in the nature of the science taught; for example, the sciences have become more unified and have gained an important position in world affairs. These factors suggest the need to re-think the purposes of teaching science in schools.[9]

By the 1960's, then, educators realized that the purposes of elementary science should be re-considered. Children needed to be better prepared to function in a society where technology was rapidly changing.

Present Philosophy of Elementary Science Education

In the 1960's, the realization grew that changing technology in the United States was rapidly making much of the science content obsolete that children learned in school. Children needed to learn more than the content of

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[8]Ibid., p. 155.

[9]DeH. Hurd, Paul, "Science Education for Changing Times" in Rethinking Science Education, 59th Yearbook of the National Society for the Study of Education, pt. 1, University of Chicago Press, Chicago, 1960, p. 33.

science. They needed to learn scientific methods that would make it possible for them to keep abreast of science, long after their formal education was completed. DeH. Hurd expressed the need for a new concept of elementary science by stating:

> The emerging scientific revolution, together with the trend toward world industrialization, demands a program of science education with new dimensions. More than a casual acquaintance with scientific enterprise is essential for effective citizenship. It is apparent that now is the time to evaluate and redefine the purposes of science-teaching.[10]

Many science educators proposed that elementary children, and particularly those in the primary grades, should first learn the processes of science, so that they can later study science more systematically. Shumsky stated:

> A major contribution of science methodology to the development of the "scientist" in the learner is its emphasis on the process of discovery. In terms of learning, to discover is not mainly to find something new, but to find something for oneself. Inquiry precedes discovery. The teacher who rushes to answer questions rather than guide children to inquire, may be shortcutting the process of discovery.[11]

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[10] Ibid., p. 18.

[11] Shumsky, Abraham, Creative Teaching in the Elementary School, Meredith Publishing Company, New York, 1965, p. 163.

Marshall shared Shumsky's belief that a child should learn the processes of science before he begins to study science in depth.

> In the lower elementary grades children cannot really study science, but they should get ready to study it. One authority has said the science curriculum in the first three grades should be primarily a pre-science in which a child finds out how to learn about his world.
>
> Children in the primary grades need to learn how to use their senses to make careful observations. They may discover some interesting facts, but that is incidental. What is important is that they gain a sense of what careful and systematic observations can do.[12]

Marshall felt that primary children should learn that the five senses bring them different kinds of information and that they should use all of this information in learning; that children must learn to recognize the limitations of their senses; that children must learn that first impressions are not always reliable; that children should learn to manipulate some of the basic tools in science--the ruler or meter stick, a simple balance, and containers to measure volume; that children should learn to use mathematics in making and recording observations; and that while children are doing these things, they should also be learning the vocabulary of science.[13]

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[12]Marshall, J. S., "A Look at the Science Curriculum of Tomorrow", School Briefs (Scott, Foresman's service bulletin for school executives), 32:3, pp. 1-2.

[13]Ibid., 4 pp.

If children learn these processes in the primary grades, Marshall thought that,

> In the upper elementary grades (4-8) emphasis in the science program should change from teaching simple skills needed for science to science itself. If children have had training in observing, measuring, and classifying in the primary grades, they are ready to engage in more serious scientific inquiry.[14]

Even though many science educators agreed that the process approach to elementary science education may be the best one, most schools still were using a content-oriented program in the early 1960's.[15]

The following statement suggested why a content-oriented approach may not be effective in teaching children science.

> The content of successive units is selected from various scientific fields and little effort is made to relate them. There is no logical sequence. The effect is that the child, retaining some facts about isolated phenomena, is apt to consider science to be a bits-and-pieces thing.[16]

Craig had the same criticism of elementary science programs which were completely content-oriented. He stated that, "In the encyclopedic type

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[14] Ibid, 4 pp.

[15] "Science in the Kindergarten and Early Grades", op. cit., p. 2.

[16] Ibid., p. 2

of instruction the purposes of science in elementary education become lost in content of little value and in busywork."[17]

Even though many educators in the 1960's agreed that the process approach to science was the best approach, particularly in the primary grades, teachers still used science materials which were content-oriented. Between 1961 and 1969 many companies did publish new elementary science programs. The question arose, then, whether these programs included opportunities for children to develop a process approach in learning science or whether the programs continued to be content-oriented.

The Basic Processes of Science

Even though educators agreed that the process approach to elementary science might be more desirable than the content approach, there had to be some agreement as to what the basic processes of science were before they could be incorporated into any program.

As mentioned earlier in Chapter II, during the late 1950's and the early 1960's, concern about lagging science education in the United States lead government, industry, and philanthropic groups into the field of science

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[17]Craig, G. S., Science for the Elementary School Teacher, Ginn and Company, New York, 1958, p. 85.

program development. One of these groups was the American Association for the Advancement of Science.

In May, 1962, the Association established a Commission on Science Education. The decision to establish the Commission was made after scientists and leaders in education, who were brought together by the Association, agreed that there definitely was a need for improvement in science education at the elementary and junior high levels. The purpose of the Commission on Science Education was to study the problems of science education.[18]

Original members of the Commission included Paul B. Sears, Chairman, Department of Botany, Yale University; Albert A. Blank, Department of Mathematics, New York University; George B. Brain, Superintendent, Baltimore (Maryland) Public Schools; Margaret W. Efraemson, Principal, Rudolph S. Walton Public School, Philadelphia; Robert M. Gagne', Director of Research, American Institute for Research, Pittsburgh; Reuben G. Gustavson, Office of the President and Department of Chemistry, University of Arizona; Thomas S. Hall, Department of Zoology, Washington University; James G. Harlow, Dean, College of Education, University of Oklahoma; and Illa Podendorf, The Laboratory Schools, University of Chicago.[19]

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[18]"Science in the Kindergarten and Early Grades", op. cit., p. 3.

[19]Ibid., p. 3.

Later in 1962, two conferences were sponsored by the Commission. From the conferences came a recommendation that in the early grades instructional materials should stress the processes of science rather than science content.[20]

During the remaining months of 1962 and during 1963, a panel worked with the conference suggestions. This panel outlined the processes which they felt were the basic processes of science, and they identified the stages of development of skills which children might be expected to achieve at various ages. They also prepared activities to use in teaching the basic processes.[21]

Since 1962, activities used in teaching the processes were modified. In 1965, however, the eight basic processes were still considered to be Observing, Using Numbers, Measuring, Using Space/Time Relationships, Classifying, Communicating, Inferring, and Predicting.[22]

This study will not consider the program developed by the American Association for the Advancement of Science. However, the eight processes

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[20] Ibid., p. 3.

[21] Ibid., p. 3.

[22] Science-A Process Approach--part 3, American Association for the Advancement of Science, 1965.

outlined by the Commission on Science Education will be used as criteria in surveying second grade science programs.

Summary

When science was first assimilated into the elementary curriculum in the 1920's, the emphasis was upon nature study and upon learning facts. The science program consisted mainly of textbooks from which the children read silently and of lectures by the teacher. This approach was modified to some extent by the 1940's. Fields other than nature study were included in the program by then, and some experiments were used to illustrate points. However, most of these experiments were performed by the teacher or at least were directed by the teacher. After World War II the philosophy began to develop that science education should help the children lead more useful and healthful lives and not be merely a study of scientific facts. In the late 1950's, the launching of satellites and the realization that the Unites States needed more technological manpower brought increased publicity to the science program. Government agencies, philanthropies, and industries used their resources to determine what kinds of science programs would best prepare children for their rapidly changing society.

It was agreed by many educators that the content-oriented science program, particularly in the primary grades, was leading to nothing but a

collection of unrelated facts. Many of them agreed that teaching children the processes of science in the primary grades would make it possible for them to be more scientific in their later studies. It would also develop in them a "science-mindedness" which was not developed when the program was content-oriented.

One of the groups that developed a process approach to science was the American Association for the Advancement of Science. This group compiled a list of eight processes which the members felt were basic to the further study of science. They then suggested that children be able to use these eight processes before they work with sophisticated concepts of science. Their feeling was that once children knew the processes of science, they could carry out methodical, worthwhile investigations in the field.

Chapter III includes the results of a survey of second grade science programs.

CHAPTER III

A SURVEY OF SECOND GRADE SCIENCE PROGRAMS

In the late 1950's, the launching of satellites and the realization that the United States needed more technological manpower brought much publicity to the science programs of the elementary schools. Interested groups, such as government agencies, industries, and philanthropic organizations, supported studies that were intended to analyze the science programs being used in elementary schools. If the studies showed a need for improvement, these programs were to be updated or replaced with curriculums that were appropriate for the scientific needs of the 1960's.

As a result of these studies, many educators decided that a purely content approach to science was inadequate, and the process approach gained in popularity. Because much of the content-oriented material in the older editions was now considered to be inappropriate, many book companies revised their elementary science programs in the 1960's.

Definition of the Eight AAAS Processes

One of the organizations that made a study of what elementary children should learn in science was the American Association for the Advancement of Science. In 1962 this organization set up a Commission on Science Education which carefully outlined what they felt the basic processes of science were. The Commentary for Teachers stated:

> Science exercises for the primary grades stress the basic process skills of: Observing, Classifying, Using Space/Time Relationships, Using Numbers, Communicating, Measuring, Inferring, Predicting. These basic processes provide the foundation for the more complex or integrated processes....[1]

The AAAS also discussed what each of these terms implied. The meaning which the AAAS had in mind for each of the eight basic processes is discussed below.

> ...For the process of Observing, any or several or all of the senses--sight, touch, hearing, taste, and smell--may be used. Observing requires that you pick up objects, feel them, shake them, press them, and do all the things which help you obtain information about the object. It does not mean visual inspection alone....

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[1]Science-A Process Approach Commentary for Teachers (AAAS Miscellaneous Publication 68-7), American Association for the Advancement of Science, 1968, p. 8.

> By Observation we mean those characteristics that are directly perceived by the senses.[2]
>
> Classifying is the process scientists use to impose some order on collections of objects or events....
>
> Classification schemes are designed to be useful for identifying objects or events....
>
> Classification systems are designed to be useful, classification systems are arbitrary, and any group of objects or events can be classified in more than one way.
>
> Developing a classification system is a process in which a set of objects is first divided into two or more subsets on the basis of one observable property. Each subset is further subdivided on the basis of a second observable property, and so on, until individual objects can be identified by observing a sufficient number of properties.[3]

Using Space/Time Relationships was the process that considered description of the physical environment in terms of location in space and time. The Commentary for Teachers stated that children should be able to see spatial relationships in their immediate physical environment and how these relationships change with time. The children should learn to name simple two- and three-dimensional shapes, be able to recognize the shadows of three-dimensional objects, have some concept of symmetry about a line or axis, and be able to recognize cross-sections or cuts through objects. They

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[2]Ibid., pp. 36-37.

[3]Ibid., pp. 58-59.

should also learn to draw realistic three-dimensional objects. They should understand concepts of speed and direction of movement in space. They should be able to use the techniques of time-keeping for measuring time intervals.[4]

According to the Commentary for Teachers, Using Numbers was also a process of science. It was different from the other seven basic processes, because the development of this process was the principal goal of another part of the elementary school curriculum, arithmetic. If children had not learned certain skills in arithmetic, however, they should learn them in the science program as the process of Using Numbers. Skills which the children should learn, because these skills are so important in science, include how to use positive and negative portions of the number line, how to find means and rates, how to determine probability, and how to use scientific notation.[5]

The basic process of Measuring in science involves use of the metric system. Children should learn to measure length, mass, and time with the basic units the meter, the kilogram, and the second. They should also learn to measure area and volume. Since it is not always possible or

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[4]Ibid., pp. 40-41.

[5]Ibid., p. 71.

practical to make direct measurements, children should learn to measure objects indirectly and to make estimations.[6]

Communication is important in science, so it was included as one of the basic processes.

> Communicating requires many skills and much practice. In science many kinds of communication are used--for example, the written and spoken word, graphing, diagrams, and a variety of visual aids.... The process of Communicating becomes important to the child as he communicates to others what he has observed, classified, or measured, and the way he has used space/time relationships, and in turn as information is communicated to him by others.[7]

Although Inferring and Predicting are closely related skills, they were considered as two separate processes by the AAAS.

> An inference is an explanation of an observation and results from thinking about the observation. The thought process is frequently strongly conditioned by past experiences, and may take place in a fraction of a second.
>
> In many cases it is possible to make more than one inference to explain an observation or set of observations. It is important to remember this.[8]
>
> ...A prediction is a special kind of inference. An inference that is derived from interpolation or extrapolation from

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[6]Ibid., pp. 103-104.

[7]Ibid., p. 112.

[8]Ibid., p. 145.

> a table of data or from a graph is called a prediction. . . . In identifying the processes of science it is not necessary to make a special process of predicting. However, the choice was made in order to emphasize to children the special kind of inference that is an extension to future events of observations and measurements; that is, inferences that predict what future observations may be.[9]

These, then, are the eight basic processes which will be considered in the survey. The meanings attached to them by the AAAS are the meanings which will be used throughout the study.

Science Programs Surveyed in the Study

Second grade science programs which were published between 1961 and 1969 were used in the study. Programs which were available in the Curriculum Library of the Montana State University Library were included. The programs which were surveyed are listed below.

1. The Basic Science Program, Science Is Learning--2, J. Stanley Marshall, Wilbur L. Beauchamp; Scott, Foresman and Company: Glenview, Ill., 1968.

2. Concepts in Science Series, Concepts in Science 2, Paul F. Brandwein, Elizabeth K. Cooper, Paul E. Blackwood, Elizabeth B. Hone; Harcourt, Brace, and World, Inc.: New York, 1966.

3. Heath Science Series, Science for Here and Now--2, Herman and Nina Schneider; D. C. Heath and Company: Boston, 1968.

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[9] Ibid., p. 134.

4. The Macmillan Science Life Series, Book 2, J. Darrel Barnard, Celia Stendler, Benjamin Spock, Mary W. Moffitt; The Macmillan Company: New York, 1962.

5. Science for You Series, Science for You--2, Gerald S. Craig, Etheleen Daniel; Ginn and Company: Boston, 1965.

6. Singer Science Series, Science All the Year--2, George Willard Frasier, Helen Dolman MacCracken, Donald Gilmore Decker; The L. W. Singer Company: Syracuse, 1962.

7. Steck Science Series, Things Around You--2, Kay L. Ware, Gertrude B. Hoffsten; The Steck Company: Austin, Texas, 1963.

8. Thinking Ahead in Science, Searching in Science--2, Willard J. Jacobson, Cecilia J. Lauby, Richard D. Konicek; American Book Company: New York, 1965.

9. Today's Basic Science, The Scientist Finds Out--2, John Gabriel Navarra, Joseph Zaffaroni; Harper and Row, Publishers: New York, 1967.

10. The World of Science Series, The Exciting World of Science--2 Joseph Novak, Morris Meister, Warren W. Know, Dorothy W. Sullivan; The Bobbs-Merrill Company, Inc.: Indianapolis, 1966.

Emphasis upon Each Process in Each Program

Although many of the programs may have included the teaching of a process, the process may not have been given the same amount of emphasis in each of the programs. For this reason it seemed advisable to differentiate between the programs which merely introduced a process and those which contained a series of process-building exercises.

If the children were introduced to a process in a program but were given no further chance to build upon the introduction, this was called an introductory inclusion. If the children were given two or more opportunities to work with a given process, this was called an extended inclusion. If a process was included in a program, a differentiation was made, calling the inclusion either introductory or extended.

Results of the Study

In order to make the results of the study as concise as possible, the findings were summarized in Table 1. It can be concluded from this table that there were differences in the processes presented among the ten programs.

The Basic Science Program (Scott, Foresman and Company), gave opportunities for extended learning with the processes of Observing, Using Space/Time Relationships, Classifying, Communicating, Predicting, and Inferring. The process of Measuring was introduced. There were no opportunities for development of Using Numbers.

Concepts in Science Series (Harcourt, Brace, and World, Inc.), included extended opportunities to study the processes of Observing, Using Space/Time Relationships, Classifying, Using Numbers, Communicating, and Inferring. Introductory inclusions of Measuring and Predicting were made.

TABLE 1. INCLUSION OF THE EIGHT BASIC PROCESSES OF SCIENCE IN SELECTED SECOND GRADE SCIENCE PROGRAMS

	Observing	Using Space/Time Relationships	Classifying	Using Numbers	Measuring	Communicating	Predicting	Inferring
The Basic Science Program	**	**	**	o	*	**	**	**
Concepts in Science Series	**	**	**	**	*	**	*	**
Heath Science Series	**	**	**	**	**	**	**	**
The Macmillan Science Life Series	**	**	**	**	**	**	**	**
Science for You Series	**	**	**	*	**	**	**	**
Singer Science Series	**	**	**	**	**	**	o	**
Steck Science Series	**	**	*	**	o	**	o	**
Thinking Ahead in Science	**	*	**	*	o	**	*	**
Today's Basic Science	**	**	*	**	**	**	**	**
The World of Science Series	**	**	*	**	**	**	**	**

* indicates an introductory inclusion of a process.
** indicates an extended inclusion of a process.
o indicates no inclusion of a process.

The Heath Science Series (D. C. Heath and Company), gave opportunities for extended development of all eight processes. The Heath Series was unique, because three process blocks were included within the book. These were called "Investigating Sizes", "Investigating Objects", and "Observing and Predicting". Although development of the basic processes was included throughout the program, these process blocks gave special emphasis to specific processes.

The Macmillan Science Life Series (The Macmillan Company), also gave opportunities for extended development of all eight processes. This program was different from the others included in the study, because the processes taught in each unit and the page numbers indicating where they were taught appeared at the beginning of the unit. However, the processes listed differed from those suggested by the AAAS.

Science for You Series (Ginn and Company), gave opportunities for extended learning with the processes of Observing, Using Space/Time Relationships, Classifying, Measuring, Communicating, Predicting, and Inferring. An introductory inclusion of Using Numbers was made.

Singer Science Series (The L. W. Singer Company), offered extended inclusion of all processes except Predicting. There were no opportunities given for the development of this basic process in the Singer Series.

Steck Science Series (The Steck Company), gave opportunities for extended development of Observing, Using Space/Time Relationships, Using Numbers, Communicating, and Inferring. An introductory inclusion was made for Classifying, and there were no opportunities for development of Measuring or Predicting.

Thinking Ahead in Science (American Book Company), presented extended inclusions of the processes Observing, Classifying, Communicating, and Inferring. Introductory inclusions of Using Space/Time Relationships, Using Numbers, and Predicting were made. There was no inclusion of Measuring in the second grade Thinking Ahead in Science program.

Today's Basic Science (Harper and Row, Publishers), contained extended inclusions of the processes Observing, Using Space/Time Relationships, Using Numbers, Measuring, Communicating, Predicting, and Inferring. An introductory inclusion of the process Classifying was made.

The World of Science Series (The Bobbs-Merrill Company, Inc.), gave opportunities for extended development for Observing, Using Space/Time Relationships, Using Numbers, Measuring, Communicating, Predicting, and Inferring. An introductory inclusion of Classifying was made.

Table 2 shows the percentage of surveyed programs which contained one inclusion of each process, two or more inclusions of each process, and no inclusions of each process.

TABLE 2. PERCENTAGE OF PROGRAMS INCLUDING EACH OF THE EIGHT PROCESSES

Process	Percentage of programs		
	Introductory inclusion	Extended inclusion	No inclusion
Observing	0	100	0
Using Space/Time Relationships	10	90	0
Classifying	30	70	0
Using Numbers	20	70	10
Measuring	20	60	20
Communicating	0	100	0
Predicting	20	60	20
Inferring	0	100	0

It can be determined from Table 2 that some processes were given extended inclusion in 100 percent of the programs while other processes were given extended inclusion in only 60 percent of the surveyed programs. Up to 20 percent of the programs offered no opportunities to develop skill in some of the basic processes.

Some general comments concerning the programs can be made. All of the programs gave at least two opportunities for the children to develop skill in Inferring, Communicating, and Observing. In the case of Observing, the programs leaned heavily toward observing by sight. Examples of opportunities for children to use the other senses--hearing, smell, taste, and touch--were not common.

Opportunities to develop skill in Using Space/Time Relationships were given in all of the programs. Most of these exercises were contained in units dealing with Earth, the sun, and the moon. The children were urged to talk about the shape of these bodies, their relative sizes, and the time of rotation and revolution of the bodies.

As a whole, the programs gave little opportunity for children to gain skill in Using Numbers, Measuring, Classifying, and Predicting. This is particularly true of Predicting, since only six of the ten programs in the study gave two or more opportunities for the children to use this process.

In all cases, if a program in the study used a system of measurement, it was the English system, rather than the metric system suggested by AAAS. The children were given opportunities to measure weight, time, and length.

Summary

The results of this study indicated that second grade science programs published in the 1960's did differ in the number of opportunities they gave children to develop skill in using the eight basic processes of science. Some processes were included in all of the surveyed programs, and some of the processes were included in only 80 percent of the surveyed programs.

Chapter IV summarizes the study more fully. Conclusions from the results of the study are also made in the following chapter.

CHAPTER IV

SUMMARY AND CONCLUSIONS

From the 1920's, when a science curriculum was first included in the elementary school program, until the late 1950's, few changes were made in the practices of teaching science to young children. During that time the curriculum was oriented toward the content of science. In the 1950's, increased concern was expressed about the "content-oriented" elementary science programs. It seemed that the vast amount of scientific knowledge could not be taught by a completely "content" approach, and so the United States was beginning to experience a shortage of technically-educated workers. It appeared at this time, too, that other countries were rapidly moving ahead of the United States in scientific knowledge. This lag of scientific knowledge in the United States seemed to be even more apparent when the Soviet Union launched the first satellite.

Because of this concern, different groups began to study science programs in the schools. The intent was to determine why the programs were not meeting the needs of the scientific community. Many educators decided that much of the problem was due to orienting the elementary science programs toward content. They felt that young children should first learn the processes

of science so that they could think and work more scientifically as they grew older.

One of the groups which developed a "process-approach" philosophy to elementary science education was the American Association for the Advancement of Science. This Association concluded that there were eight basic processes which primary school children should learn before they begin a concentrated study in the content areas of science.

Summary

In this study, second grade science programs were surveyed, using as criteria the eight basic processes of science which were outlined by the AAAS. These processes were Observing, Using Space/Time Relationships, Classifying, Using Numbers, Measuring, Communicating, Predicting, and Inferring. The definition given to each process by the AAAS is found at the beginning of Chapter III.

Second grade programs which were published between 1961 and 1969 were included in the study. No program older than this was used, because it apparently was not until the 1960's that educators seriously started to think in terms of "process" rather than "content". The programs used were available in the Curriculum Library at the Montana State University Library.

The emphasis upon each process in each of the programs was noted. If a process was included in the program once, this was referred to as an introductory inclusion. If the process was presented two or more times in the program, this was referred to as an extended inclusion.

It was found that second grade science programs do differ in the emphasis placed upon the eight basic processes of science. The Heath Science Series and The Macmillan Science Life Series were the two programs surveyed which gave at least two opportunities to develop each of the eight processes. The Heath Science Series was unique, because it included three process blocks which gave special emphasis to the basic processes. Listed at the beginning of each unit in The Macmillan Science Life Series were the processes taught in that unit and the pages on which they were discussed.

Four of the programs presented all of the processes as either an introductory or an extended inclusion. They were the Concepts in Science Series, Science for You Series, Today's Basic Science, and The World of Science Series.

Four of the programs did not give any opportunities for development of one or more of the basic processes. These programs were The Basic Science Program, Singer Science Series, Steck Science Series, and Thinking Ahead in Science.

The programs all gave opportunities for extended development of Inferring, Communicating, and Observing. However, these opportunities to observe were often limited to the sense of sight. Many of the programs gave little opportunity to develop the skills for Predicting, Measuring, Classifying, and Using Numbers.

In all cases, if any system of measurement was used by a program, the English system was used rather than the metric system.

Conclusions

Several conclusions can be drawn from the results of this study. These conclusions are discussed below.

Even though many leading educators believed that a process approach to elementary science would better equip children to think scientifically in their later work, it appeared to the writer that in second grade materials, many science programs published during the 1960's did not give children enough experiences in working with the basic processes to become skilled in using them. Whether the programs were published early or late in the decade seemed to make no difference in the number of opportunities children had to develop process skills.

It can also be concluded that elementary science programs varied in the amount of emphasis placed upon the process approach. Heath Science Series

and The Macmillan Science Life Series placed special emphasis upon the basic processes of science in their programs, either by including blocks of work specifically directed toward the processes or by pointing out to the teacher the processes included in each unit. The other eight programs gave less emphasis to the basic processes.

Even though the metric system was used as the system of measurement in the scientific field, it was not introduced in any of these programs. Many educators may feel that young children should first become acquainted with the English system, since it is commonly used in the United States.

Perhaps the most important conclusion drawn from this study concerns the teacher who agrees with the philosophy of using a process approach to teaching science. She must, in most cases, give children opportunities outside the structured science program to develop skill in using the eight basic processes. The writer felt that most of these opportunities can easily be worked into the science program, even though the opportunities may not be inherent in most of them.

Chapter V includes recommendations that were an outcome of the study.

CHAPTER V

RECOMMENDATIONS

After considering the results and conclusions of the study, several recommendations can be made. These recommendations are concerned with the selection of an appropriate science series for use in a school district and with the implementation of the process approach in an elementary science program.

The philosophy of a school district determines to a large extent the type of series that district will purchase for its use. If the district feels that young children should learn the content of science, they will probably look for a series that is content-oriented. On the other hand, if the district agrees that the process approach to science is most beneficial to young children, they will probably look for a series that is process-oriented. The two series in the study that appeared to the writer to be most process-oriented were the Heath Science Series and The Macmillan Science Life Series. Both of these series gave children at the second grade level at least two opportunities to develop skill in each of the eight basic processes. Of course, other factors would probably be considered when a series is chosen for use by a school district. The cost of the program is important. The appeal of the textbooks

and other materials, the level of the vocabulary used, and the interest level should all be considered in relation to the needs of each school district.

The other series surveyed in the study could also be used as the basis of an elementary science program. If the teacher is aware of the weaknesses of a program in teaching the processes, she could make provisions for these deficiencies. Below are listed methods that a teacher might use to provide learning opportunities for specific process deficiencies.

Although all of the surveyed programs gave ample opportunities for Observing, the opportunities were usually limited to using the sense of sight. For this reason the teacher may wish to give additional experiences in Observing and have children use hearing, smell, touch, and taste. Many of these experiences could be extensions of activities suggested in the science manual. For example, when children go on a field trip to observe changes of season, they could use touch, smell, and hearing in addition to sight. The use of taste in Observing has been controversial because of the possible danger in tasting unknown substances. Therefore, the teacher should use discretion in having children use this sense, and she should caution them about the dangers of using taste in observation.

If a program does not give enough chances for children to develop skill in Using Space/Time Relationships, the teacher could give additional opportunities to measure time and to compare times. She might ask questions such as, "How long is recess in comparison to lunch break?". Most of the

programs contained few exercises which discussed the shape and symmetry of objects. The class could examine the shape of objects and name them--a sphere, a cylinder, a cube, and so on. The teacher could show cross-sectional cuts of these same objects and have the children decide which object had been cut and in which direction it had been cut. The class could also discuss the symmetry of these objects around a point or a line. The moon, sun, and Earth could be studied in the same way.

Children could be given practice in Classifying. They could group objects according to shape, then subdivide the groups according to color, and divide them once again according to size. This could be done with blocks, with leaves that had been brought and used for other purposes, or with many other objects.

Since Using Numbers is an important process in science, the teacher should make children aware of the relationship between mathematics and science. Children could use a number line to help determine answers to problems in science. While using a thermometer to measure temperatures, the relationship between the number line and the thermometer could be established. This would also be a good opportunity to discuss the negative side of the number line. Some simple exercises using probability might be developed. For example, the teacher could put two red marbles and one blue marble in a box and ask, "What is the probability (chance) that you will pick out a blue marble?".

Children should be given opportunities to practice Measuring. Almost any object they work with could be measured to find the length, the volume, or the weight. The teacher may wish to introduce the metric system. If not, she should at least make children aware that there is another system of measurement that is used by scientists.

Although the programs appeared to give ample opportunities for Communicating, the teacher should help the children become as accurate and concise in communication as possible. Because the use of graphs is important in communication, children should become familiar with their uses. Children might construct graphs showing the weights of everyone in the room or showing the growth rate of plants.

Most of the programs seemed to offer opportunities for Inferring, but few of them extended this process into Predicting. If the children have kept records of plant growth or of their weights, they could use this material to predict what would happen next. They could then continue recording to see if their prediction was correct.

In summary, if a school system accepts the idea that young children should use a process approach to science, they should look for a series that agrees with this philosophy. Of course, considerations such as expense, appeal, and vocabulary used in the series must also be weighed.

If a teacher subscribes to the process-approach philosophy, she should become aware of the weaknesses in the program she is using. She should then incorporate into the program exercises which will give the children skill in using all eight basic processes of science.

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