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Development of a Tentative Science Program for Hebeler Elementary School

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DEVELOPMENT OF A TENTATIVE SCIENCE PROGRAM FOR HEBELER ELEMENTARY SCHOOL

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Science has gained an important place in the modern elementary school. The change from the jet age, to the atomic age, and then to the space age in the past twenty years has placed science in a position of great importance as the key to much of our advancement. These changes not only have increased the importance of science as a part of the school curriculum, but the scientific progress has brought an almost insurmountable array of new content into the various areas of science. The importance of science in our lives and the huge amount of scientific data available make it imperative that elementary schools have modern up-to-date science programs.

I. THE PROBLEM

Statement of the problem. The purpose of this study is to (1) develop a group of science topics and subtopics used and accepted for elementary science; and (2) list certain criteria concerning Hebeler Elementary School (H.E.S.) which can be used in determining appropriate content for the science program; and (3) select topics and subtopics for developing the H.E.S. science program using the listed criteria for selection.

Importance of the study. That science has played a significant role in the development of our culture is obvious; that it will play an increasingly important role in our future development is, in light of present progress, taken for granted (25:1). Changes and new developments in the field of science are constantly effecting nearly every person in our society. As a consequence of the effects of science, there is almost continual change in our lives and needs. Most needs and interests of children grow out of their culture and their nature as living human organisms. Science teaching should help children meet their personal and cultural needs (25:112). Elementary science programs should be constructed to provide a place for the new and important changes in the field of science in order to help fulfill students' needs.

In the past several years there have been various revisions of secondary school science curricula in keeping pace with the progress in the discipline of science. Such programs as the Biological Science Curriculum Study, the Physical Science Curriculum Study, the Earth Science Curriculum Project, have been developed. These are now being used in various classrooms. To progress with the changing secondary school science curricula, it is necessary to build contemporary elementary science programs. Fischler recently indicated that some efforts have been started in

developing up-to-date units for elementary science programs. These new units should be examined for placement in the curriculum (13:351). Other content that has commonly been considered fundamental is, in reality, merely traditional and should be examined for placement or elimination (25:333).

Although there is agreement among most textbooks, sourcebooks, and curriculum guides concerning the appropriate topics or areas to be taught in elementary science, the selection of subtopics or units for a particular school will vary. Criteria must be developed to aid in the selection of the more appropriate content materials (37:28).

Hebeler Elementary School, which functions partly as an experimental school, has the role of providing leadership in the development of programs for elementary education. The purpose of this paper is to develop a modern science program which will help facilitate part of that role.

II. DEFINITIONS OF TERMS USED

In this study, the following meanings are used:

Elementary Science. Science as part of the school curriculum in grades kindergarten through six.

Elementary Science Curriculum, Program. The content and activities which occur during the planned and flexible teaching periods in the elementary school.

Intermediate Level. Grade levels 4, 5, and 6 of the elementary school.

Role and Function of H.E.S. The role at Hebeler Elementary School is to provide each child with an up-to-date instructional program which is process-orientated and stimulates each child to proceed at his best learning rate. This program is showcased for college students through individual and group observations and demonstrations. The school is engaged in responsible experimentation on content and methods, cooperates with the college and other agencies in appropriate research, offers consulting services for schools in central Washington, and provides limited opportunities for student teaching assignments (14:4-5).

Science Areas. The major categories of science; the biological sciences, the earth, the universe, and matter and energy.

Science Content. The concepts, generalizations, materials and activities included in the science curriculum.

Subtopic. A specific part of a topic which can be developed into a teaching unit or part of a unit for a certain level.

Topic. A major section of science content which should be taught in some part (subtopic) in two or more grade levels.

III. PLAN OF THE STUDY

The plan for this study is:

1. Review selected literature pertaining to science education and curriculum development to establish a basic overview of elementary science.

2. Review selected elementary science resource texts, textbooks, and curriculum guides of various state departments and school districts to identify science topics and subtopics.

3. Develop specific criteria for selecting appropriate science topics and subtopics from the literature reviewed and the role statement of Hebeler Elementary School.

4. Select appropriate science topics and subtopics for the H.E.S. science program.

5. Recommend further development of the science program.

IV. LIMITATIONS OF THE STUDY

The study is limited to the following aspects:

1. The consideration of certain science topics and subtopics for elementary grades kindergarten through six.

2. Development of appropriate criteria for selecting science content for the specific role and function of H.E.S.

3. The establishment of suggested topics and subtopics for the Hebeler Elementary School science program.

CHAPTER II

REVIEW OF THE LITERATURE

The development of an up-to-date elementary science program should be undertaken with an understanding of its purpose. In order to function professionally within the current ferment in science teaching, educators should attain a clear realization of the factors involved in the development of science in elementary schools. This review briefly presents a background of science in the elementary school to help facilitate such an understanding.

I. REVIEW OF THE LITERATURE PERTAINING TO PLACEMENT OF SCIENCE IN THE ELEMENTARY SCHOOL CURRICULUM

The placement of science education in the elementary school must help fulfill the goals or aims of general education as well as the objectives for science teaching (25:115).

Vessel described education in which science can be a part of the curriculum as,

> . . . a developmental process which takes place in an individual as a result of his exposure and interaction with people and other stimuli in his environment. As a result of this interaction, the

> individual acquires a store of knowledge as well as attitudes, appreciations, skills, and thought processes which enable him to utilize his knowledge and prepare him to live in society (37:3).

Science as a part of education can provide the child with much knowledge and understanding of the environment about him as well as help develop thought processes that will enable him to adjust to his surroundings, an essential core of experience in elementary education (37:7).

All subject matter areas should contribute to the broad objectives of elementary education, but each has some unique contributions to make. The aims of science teaching, as presented by Shrader, describe more specifically and concisely the benefits of science education. These aims are:

> 1. Pupils should gain an understanding, commensurate with their abilities, of the biological and physical environments to enable them to behave in an intelligent manner (33:13).
>
> 2. Pupils should gain an understanding and respect for contributions, abilities, and limitations of persons engaged in scientific pursuits (33:14).
>
> 3. Pupils should become familiar and partially skilled with respect to the use of scientific apparatus and material (33:14).
>
> 4. Pupils should become increasingly aware of the vocational opportunities and responsibilities associated with the several fields of science (33:15).
>
> 5. Pupils should have good opportunities to gain a realization of the avocational values associated with the sciences (33:15).

The purpose of science teaching to accomplish these aims is more than a process of imparting subject matter. Science is a process in which observations and their interpretations are used to develop new concepts, to extend an individual's understanding of the world, to suggest new areas for exploration, and to provide some predictions about the future (25:35).

Craig, in emphasizing the tremendous importance of subject matter in the modern curriculum, has described content as the meaning gained from experience, ". . . a necessary means to the development of behavior essential for the preservation and advancement of democracy (9:81)." Zafforoni has concluded that, "it seems abundantly clear that elementary educators, in general, accept the premise that there should be science instruction for children in the elementary grades (41:5)." Vessel, in a review of elementary science stated, "It is, therefore, essential that science experiences begin early in the individual's education and continue throughout his life (37:7)."

II. REVIEW OF THE LITERATURE PERTAINING TO THE HISTORICAL DEVELOPMENT OF ELEMENTARY SCIENCE

Modern science, which began about 300 years ago, has attained an increasingly important role in man's life.

The importance of science in the elementary school was recognized early in our nation's history. Far-seeing historical leaders such as Benjamin Franklin and Thomas Jefferson saw the importance of helping young people understand and interpret the phenomena that occur in their natural environment (19:1).

Elementary science appears to have stemmed from three developments in education. Vessel lists these developments as, ". . . object teaching, nature study, and secondary school science (37:7)." Science was probably introduced into the elementary school curriculum with the advent of object teaching, a method brought to this country from Europe about 1850. Object teaching can be described as an attempt to teach the nature of real things directly by using all of the individual senses instead of formal reading and memorization (37:7). During the second half of the nineteenth century, object teaching concerning science became popular. Children were taught about the objects of nature in order to prepare them for the study of science in the upper grades. Object teaching received severe criticism because it lacked order, entertained without teaching, and required the teacher to be busy while the pupils sat quietly (20:3).

The nature study movement, which slowly replaced object teaching of science, began during the period 1884 to

1890 and became increasingly popular until about 1910. The aim of nature study was to open the pupil's mind by direct observation to a knowledge of and love for the common things in his environment (37:8).

Underhill has described various factors which affected elementary school science following World War I. First was a trend toward teaching the practical aspects of all subjects in the curriculum. Subject matter which concerned the life of man and making a living was selected for the curriculum. A second trend was an attempt to adopt and place subject matter in various grade levels. During this time rapid technological and scientific developments occurred in the physical sciences which the nature study movement could not meet adequately. Also, a reorganization of science teaching in the secondary and junior high schools began to take place which suggested to many educators new science content for elementary grades (36: Ch. 2).

From about 1920 to 1930 many educators joined in a new movement called elementary science. Some of the leaders of this movement tried to combine the features of nature study with new content. A major change was an attempt to place more emphasis upon the physical aspects of science. An effort was also made to adapt the subject matter to the child (37:10-11).

One of the pioneers who developed an elementary science sequence to replace nature study was Gerald S. Craig. By evaluating a list of selected science objectives and comparing them with a list of children's science questions, he developed an elementary course of science study for the Horace Mann Elementary School (8:42).

In 1932 the leaders of the elementary science movement summarized their ideas in the Thirty-first Yearbook of the National Society for the Study of Education titled A Program for Teaching Science. This summary expressed the recognition of the value of elementary science to the high school science program (24: Ch. 1).

Another evaluation of science teaching was made in 1947 by the Forty-sixth Yearbook, titled Science in American Schools. Emphasis was upon the importance of scientific knowledge during World War II and the impact of science on the future of man (26: Ch. 1-4). A recommendation was made that in each year of the elementary school, children should study in each of the broad areas of science (26:75-76).

In 1959 science teaching was again similarly evaluated. Emphasis was placed upon the need to understand science as a continuing process of inquiry, and not as a set of firm answers to specific questions (25: Ch. 1-4). The importance of up-to-date science programs was described as essential.

> The march of science just preceding and following the mid-period of the twentieth century has caused educators to realize that science teaching must differ in emphasis, purpose and kind from that of the pre-atomic and pre-missile eras. During the past twenty years, science has contributed many distinguishing characteristics of our civilization.
>
> . . . The emerging scientific revolution, together with the trend toward world industrialization, demands a program of science education with new dimensions (25:18).

III. REVIEW OF LITERATURE PERTAINING TO DEVELOPMENT OF ELEMENTARY SCIENCE CURRICULUM

Most educators agree that if children are to achieve maximum growth in school, the curriculum must be carefully planned and managed (20:12). The basis used for the development of elementary school science curricula greatly influences the final result. The bases generally accepted for the construction of elementary school science curricula are: needs of society, nature of science, growth and development of children (32:1-5), and total school program (25:122-124).

The needs of society. In the ever-changing world of today with new developments and improvements, the child needs a different type of education than did the child of a few years ago.

> In a democracy each citizen has a responsibility to help solve the problems and decide the public issues that arise in the community . . . Some responsibilities that fall upon the shoulders of our citizens are of considerable magnitude. And the citizens of tomorrow are in our elementary classrooms today. In our modern scientific, technological, industrialized societies, more and more of the problems and issues to be dealt with and resolved involve science . . . (19:17)

The nature of science. Since early in history, man has searched for explanations of the phenomena that occur in the natural environment. Modern man approaches his investigation with the belief that a natural cause exists for everything that happens. He determines cause and effect of any phenomena by collecting appropriate scientific data and attempting to organize and interpret it.

> An understanding of the nature of science is gained by considering how a problem is solved by employing the scientific method. A problem in science exists for a scientist whenever he becomes aware of a cause-and-effect relationship that he is unable to explain on the basis of the information he has. As he studies the problem and formulates an hypothesis as an explanation of the cause-and-effect relationship involved, the scientist is employing scientific method as the means of making the inquiry required to find a solution to the problem (32:4).

The growth and development of children. In order to utilize the needs and interests of children, both the mental and physical growth and development characteristics should be studied. This study should help develop an understanding

of children from the time they are acquiring sensory experiences at very young ages until they are learning as adults (37:14).

> Man's curiosity about and need to control his environment have led to greater understandings of the world. Likewise, children's curiosity leads them to explore widely. The drive to know, to explore, to investigate, which characterizes young children particularly, is so basic that it is tempting to generalize that children are inherently scientific (25:113).

The total school program. There is a variety of curriculum patterns being used in elementary schools that should be considered. The various patterns occurring in the elementary school may be grouped into four main types: subject, broad-fields, core, and experience (1:58).

In the subject pattern each subject usually exists as a reasonably independent teaching unit and a certain predetermined amount of time is given each subject. In this pattern the materials are well organized into curriculum guides, lessons, or textbooks and usually an effort has been made to determine appropriate content for the various grade levels.

The broad-fields pattern was established to reduce the number of subjects by combining those which have similarities into a single group or area. The material or content from the group of subjects is then presented as a whole.

In the core pattern some subjects have been formed into a large group to be taught with major emphasis in the school. The other subjects are then outlined so they support or expand the core subjects (20:12-14).

The experience pattern was defined by Good as:

> A curriculum in which the content, activities, and structures of instruction are designed to provide a series of purposeful experiences growing out of the interests, purposes, and needs of the learners; characterized by exploration, critical inquiry, replanning in terms of new data and understandings, teacher-pupil plannings, and cooperative problem-solving approaches; common learnings are expected results when the curriculum has been properly built on common interests and needs . . . (15:50)

Kambly and Suttle indicated, ". . . that science may be an integral part of the elementary curriculum regardless of the particular pattern followed (20:15)." The H.E.S. curriculum, which is a combination of patterns, should comply with the development of elementary science.

Combined with the various curriculum patterns are numerous approaches used by teachers in presenting elementary science. Such teaching approaches as the developmental, incidental, integrated, problem solving and eclectic are used in elementary science. Although the use of a certain approach will be an influence upon the development of the science curriculum, there seems to be no clear-cut preferential way to teach science on the basis of present research studies (37:78).

> A basic premise underlying the science program is that it should be in harmony with the total program of education. This implies that elementary science is an integral part of the fabric which includes social studies, language arts, music, mathematics, art and health education. Science brings new strength to the elementary school. Its methods, its approach to problem-solving, and its informational content enrich the whole program and give it new scope and depth (25:122-123).

There seems to be widespread agreement that the most vital programs of elementary science are based on:

1. The needs of the growing and developing child in his environment.

2. Programs which are in harmony with the total school program.

3. Mindful of the needs of society.

4. Utilize the nature of science (25:120).

The process of building an up-to-date elementary science program involves the exploration of each of the four bases of curriculum development without undue regard for a single one. The above bases are the data-sources which are one of the three sets of factors in making curriculum decisions for elementary science. The three sets of factors used for making curriculum decisions follow the formula, "Data-sources plus values plus reality equal curriculum decisions (31:1)."

Some of the criteria that are accepted for the development of successful elementary school science programs

should be considered. These factors are the values drawn from elementary science curriculum development, which should help guide in building the science program. Criteria for guiding curriculum development in elementary school science are described throughout the literature and include lists by Jacobson and Tannenbaum (19:25-26), Kambly and Suttle (20:46) and the Fifty-ninth Yearbook of the National Society for the Study of Education (25:133-135).

A synthesis of some of the selected criteria follows:

1. Elementary science should be recognized as an important part of the total elementary school curriculum. The elementary school science program should be regarded as a base for the entire school science program (19:25). Science should be a definite, planned part of the total curriculum (20:46).

2. The science curriculum should be consistent with the developmental characteristics of children (19:25).

3. The elementary science program should provide for each child (25:133). The present and future individual differences of children should be considered.

4. The science curriculum should be flexible enough to allow for new content and cooperative planning and appraisal (20:46).

5. The development of scientific attitudes is basic in elementary science. Many opportunities should be provided for students to analyze and study questions and problems (25:133).

6. Learning experiences should be provided so that children learn to use some of the generalizations of science to interpret events and phenomena in their environment and within their bodies (19:26).

7. Opportunities to use and practice some of the methods and procedures that are characteristic of science should be provided (19:26).

8. Elementary science content and activities should be determined by definite objectives (37:29).

9. An elementary science curriculum should include all the major topics of science. There should be a balanced content in the sciences (25:134). Modern developments in science should be included and the new topics of science should not be overlooked (19:25).

10. Each grade level should have the opportunity to engage in activities drawn from the broad areas of science (20:46).

11. "Children need to have an opportunity to participate in a variety of activities in elementary science (25:134)." Such activities as experiments, demonstrations, field trips, projects and library research should be

included. Students should have opportunities to handle the apparatus, materials, equipment and tools of science (19:25).

12. The major topics of science should be developed in depth. "The major limitations will be the previous experience and maturity of the pupils (19:25)."

13. There should be a sequence in the development of understandings in each of the major topics of science (22:46). A developmental approach should be used to help the student develop more refined concepts (19:25).

14. Repetition of content should be minimized and should only occur when necessary to improve learning (20:46).

15. Adequate materials to carry on the science program must be provided (25:134).

16. Consultants, professional books, and other curriculum materials must be available to those teaching science (25:135).

17. Those who are to implement a science program must have opportunities to gain a clear understanding of the curriculum (19:26).

To move ahead in elementary science, a clear picture of the strategy for curriculum development in schools must be attained and used by the educators involved in the process. They should gain an understanding that the preparation of an elementary science curriculum is a developmental

process which involves much planning together with the careful consideration of the bases of curriculum development (37:96).

The planning of an elementary science curriculum to be a developmental process should follow a schedule. A schedule should contain the sequence as well as the procedures to be used in the developmental process. The literature indicated the following list of curriculum tasks in a sequence is one which can facilitate the development of an up-to-date science curriculum:

1. Study children and youth.

2. Study contemporary society, including problems which endanger international relations and those which endanger interpersonal relations.

3. Study the contributions of the disciplines.

4. Formulate and use a philosophy.

5. Develop a defensible theory of learning.

6. Formulate clear objectives which indicate both behavior and content.

7. Develop creative learning experiences.

8. Select instructional materials.

9. Organize learning experiences to provide for continuity, sequence, and integration.

10. Evaluate the extent to which each individual attains the objectives, with particular emphasis on behavioral change (30:3).

IV. REVIEW OF THE LITERATURE PERTAINING TO THE SELECTION OF ELEMENTARY SCIENCE CONTENT

As educators are studying the issues of elementary science, one of the most difficult problems seems to be the task of selecting content (41:6). Vessel indicated that, "With the vast array of subject matter available, one of the chief problems has been to determine what is suitable for use in the elementary grades (37:75)." In a review of instructional guides and textbook series, Kambly and Suttle found there is little agreement concerning the scope of content for elementary science (20:17). Chinnis (7:23-27) recently analyzed elementary science textbooks and found a very small amount of agreement as to content among the various series, while Piltz (28:368-380) noted that textbooks of certain publishers have changed very little in content from earlier editions.

Burns and Frazier (6:560-568) surveyed the elementary science programs of twenty-one major cities of the United States and found no well-defined patterns of selected content. Dubins, compiling almost five hundred science topics in an analysis of one hundred and ninety-two study

guides and courses of study for elementary science published from 1940 to 1950, noted there was much confusion as to what to teach (12:318-324).

Inbody (16:270-278), working with primary children, concluded that the science curriculum in primary grades is not sufficiently based on a knowledge of science experiments commonly encountered in preschool years. Young (40:535-539) found a significant impact on the understandings of atomic energy gained outside of school by children in the third and sixth grade from television, newspapers and adult conversations. In a six-year study (1957-1963) to determine what science content can be taught efficiently and effectively, the evidence produced overwhelming support for the conclusion that intermediate grade pupils are socially, emotionally, and intellectually ready for a general science program which is normally presented in grades seven, eight, or nine (11:304-308).

Two recent theses concerning elementary science have dealt with the selection of content. In a thesis by Leonelli, concerning the selection of content for elementary science, the method of selection was based on the opinion of teachers (21:36-38). A thesis by Ippolito to select content for an elementary science curriculum did not list or describe any criteria for guiding the selection (17:14-15).

In a review of the research concerning elementary science content selection, many of the studies have been summaries of current practices and weaknesses. The recommendation was made that researchers devote future efforts to how-to-do-it studies (23:245).

The suggestion was put forth by Vessel that,

> Because the science area is so broad and changing so rapidly it is imperative that practicing scientists be invited to aid in planning and revising curricula by suggesting science content materials and procedures for science studies (37:96).

At the present time there are three major groups, in which are included scientists and science educators, focusing on the development of an up-to-date elementary science curricula and having support of National Science Foundation funds: Educational Services, Incorporated (ESI); the University of Illinois Elementary Science Project; and the Elementary School Science Project at the University of California, Berkeley. These groups are rather small and are mainly developing topics or subtopics in the scientists' specific fields of interest without prior selection (13:351).

The American Association for the Advancement of Science has undertaken a project of initiating and sponsoring a program to develop instructional materials in elementary science for the beginning primary grades. The content selected for this project was limited primarily to

that having a high probablity of shaping those behaviors which reflect the underlying process of science (38:296-301). Atkin has criticized this approach by stating, "I would hope that the focus of curriculum is not on these 'process' elements (34:150)."

The need for better selection procedures was strongly emphasized in the Fifty-Ninth Yearbook of the National Society for the Study of Education.

> Much of the content in science courses that has commonly been considered fundamental is, in reality, merely traditional. Much weeding of this content must precede the modernizing of the science courses. Furthermore, the continuing increase in the amount of new knowledge and theory suggests that an appropriate modernizing of science courses will prove to be a continuing problem. The current trend toward teaching fewer concepts but with increased emphasis on depth of understanding accentuates the need for increased care in the selection of learning experiences. Curriculum workers would like to see the scientific societies take more interest in the problem of identifying content for science courses (25:333).

CHAPTER III

CRITERIA FOR SELECTION OF TOPICS AND SUBTOPICS

The bases for the development of an elementary science curriculum are described in Part III of the Review of the Literature. The content for the H.E.S. science curriculum will be selected by using as three sets of screens:

1. Factors from the bases of curriculum development.

2. A screen consisting of selected criteria for guiding the development of the science curriculum.

3. A screen of factors from the role, function and necessary realities of the local school situation.

In essence this procedure follows the formula of data plus values plus realities equals curriculum decisions.

From the total possible content which might appear in an elementary science program, the selection process developed in this study includes the use of the first screen set as one basis for decision making. This set of screens includes criteria from the following sources:

1. The needs of society.
2. The nature of science.
3. The growth and development of children.
4. The total school program.

Values from the operational philosophy of H.E.S. are used as a second set of screens to help determine the topics and subtopics selected. The curriculum of the school is to be developmental and organized in a vertical team approach. In this vertical team approach, selected topics will be taught simultaneously in grades 3, 4, 5, and 6. Subtopics which will be developed for the various levels not only must relate to the general topic but also must help each student gain some understanding of the strands of science underlying the scientific enterprise. A student should learn, among other things, that knowledge is likely to shift in meaning and status in time.

Selected criteria which are helpful in guiding curriculum development as listed in the synthesis in Part III of the Review of the Literature are a part of this screen, and serve to support or guide the selection. The criteria from the synthesis which are determined as consistent with the bases of curriculum development and values at H.E.S. in the selection of content, are as follows:

1. Elementary science should be recognized as an important part of the total elementary school curriculum. The elementary school science program should be regarded as a base for the total school science program (19:25).

2. The science curriculum should be flexible enough to allow for new content and cooperative planning and appraisal (20:46).

3. An elementary science curriculum should include all the major topics of science. There should be balanced content in the sciences (25:134). Modern developments in science should be included and new topics should not be overlooked (19:25).

4. Each grade level should have the opportunity to engage in activities drawn from the broad areas of science (20:46).

5. The major topics of science should be developed in depth. "The major limitations will be the previous experience and maturity of the pupils (19:25)."

6. There should be a sequence in the development of understandings in each of the major topics of science (20:46). A developmental approach should be used to help the student develop more refined concepts (19:25).

7. Repetition of content should be minimized and should only occur when necessary to improve learning (20:46).

8. The elementary science program should provide for each child (25:133). The present and future individual differences of children should be considered.

9. The development of scientific attitudes is basic in elementary science. Many opportunities should be provided

for students to analyze and study questions and problems (25:133).

10. Learning experiences should be provided so that children learn to use some of the generalizations of science to interpret events and phenomena in their environment and within their bodies (19:26).

11. Opportunities to use and practice some of the methods and procedures that are characteristic of science should be provided (19:26).

12. "Children need to have an opportunity to participate in a variety of activities in elementary science (25:134)." Such activities as experiments, demonstrations, field trips, projects and library research should be included. Students should have opportunities to handle the apparatus, materials, equipment and tools of science (19:25).

The third screen consists of realities which were determined as pertinent at the present time concerning the role, function and necessary realities of the local school situation in selecting topics and subtopics for the science curriculum of Hebeler Elementary School. These factors are as follows:

1. The ultimate goal is that of individualizing instruction to provide each child with an up-to-date instructional program that is process-oriented and in which each child is stimulated to proceed at his own best learning rate.

2. Many of the students attending the school at present are inclined to be of higher achievement and ability than normally found in elementary schools, because of their background and home environment. Steps have been taken to attain a more heterogeneous grouping through admission policies for the first grade.

3. In the future most of the students attending H.E.S. will matriculate to the junior high school and the senior high school in the same city.

4. The school curriculum and activities are showcased for college students and other personnel through individual and group observations and demonstrations.

5. The school personnel engage in responsible experimentation on content and method.

6. Opportunities are extended to cooperate with the college and other agencies in appropriate research and projects.

7. Limited opportunities are provided for student teaching assignments and facilitating graduate student preparation (14:4-12).

8. The school building is a two-story structure with a limited amount of flexible space.

9. The school is in the geographic setting of the eastern slope of the Cascade Mountains in a Semi-Arid Transition Zone approximately in the center of Washington

State. The local area consists of Ellensburg, a city of about 10,000 population, and contains Central Washington State College. There is a great deal of irrigation to support the main industry of agriculture, and there are areas of conifer forests on the surrounding hills. The basin is dotted with small lakes and ponds and the Yakima River flows along one end of this basin.

CHAPTER IV

DEVELOPMENT OF TOPICS AND SUBTOPICS FOR SELECTIVE CONSIDERATION

The scope of science topics and subtopics which are listed for consideration of selection are obtained from three types of sources: curriculum guides of elementary science; elementary science textbook series; and teacher resource books concerning elementary science. It is assumed that these sources are developed with an understanding of elementary science and curriculum development because of the bases used in the selection of each source. The choice of each source is made on the basis of:

1. Being used or recommended by teachers, science experts, science educators, and/or curriculum leaders.
2. Being like other sources of its kind.
3. Being recent in date of publication.
4. Being broad enough in scope to include subtopics for grades kindergarten or one through six.

The elementary science curriculum guide. The curriculum guide is usually a framework of the strategy for teaching science. The curriculum guide usually consists of an outline of the broad topics and subdivisions of them which are included in the science program. Many of the

guides include a statement of general objectives for teaching science and specific materials for certain content or activities. Many of the up-to-date curriculum guides are produced as a result of the efforts of a number of experienced teachers with the guidance of science educators or science experts (37:22-23).

The curriculum guides from which topics and subtopics are considered for selection are from: Bellevue, Washington; Washington State Department of Education; and Cincinnati, Ohio.

Elementary science textbook series. Elementary textbooks are planned courses of study containing topics and subtopics in the form of units usually with many specific suggestions for teaching. They usually are attractive, but suffer from the faults inherent in books. There are approximately a dozen series of elementary school science textbooks available. Each represents the best judgments of several persons concerning the content to be included in elementary science.

Because of the variety and organization of science topics and subtopics Kambly and Suttle stated, "Good modern textbooks deserve first place in a list of learning materials (20:47)."

The textbooks from which topics and subtopics are considered for selection are: Today's Basic Science Series, by Ginn and Company; Science Series, by Silver Burdett Company; and Thinking Ahead in Science Series, by American Book Company.

Teacher resource books. Teacher resource books for elementary science usually undertake to help the teacher in understanding science and teaching it to students. Most of these sources contain a wide scope of content and develop the topics and subtopics in depth so they can be used as a continuous source of information by the teacher. The resource books are generally written by prominent science educators in cooperation with experts from the various areas of science.

The teacher resource books from which topics and subtopics are considered for selection are: Science for the Elementary School Teacher by Craig; Elementary School Science and How to Teach It by Blough and Schwartz; and Teaching Elementary School Science: Methods and Resources by Kambly and Suttle.

The sources were reviewed separately. Each topic from a source was placed on a card and the subtopics from that source were listed below the proper topic. After the sources were reviewed all the topic cards were divided into

four categories or areas: the Biological Sciences; the Earth; the Universe; and Matter and Energy (32:19).

The following lists of topics and subtopics for selective consideration from each area were developed by combining like topics and listing the various subtopics for each. Some duplication of subtopics occurs within certain topics because of the levels for which the subtopics were developed. The duplication of several subtopics within two or more topics occurs because of the inter-relationships in the scientific enterprise, and they were evident in the sources reviewed.

THE BIOLOGICAL SCIENCES

TOPIC - ANIMALS

SUBTOPICS -
1. Pets
2. Farm Animals
3. Birds
4. Kinds of Animals (Insects, Bees, Fish, etc.)
5. Differences in Animals
6. Animal Senses
7. Animal Homes
8. The Basic Needs of Animals
9. Man's Need for Animals

10. Characteristics of Animal Groups
11. Life Cycles of Animals
12. Social Animals
13. Animal Reproduction
14. Care of the Young by Animals
15. Productive Adaptions of Animals
16. Migration
17. Hibernation
18. Animal Classification
19. The Anatomy of Some Animals
20. Cells
21. Conservation of Animals

TOPIC - PLANTS

SUBTOPICS - 1. Kinds of Plants
2. Structure of Plants
3. Essentials for Plant Life
4. Groups of Plants
5. Responses of Plants to Stimuli
6. Adaptations of Plants
7. Photosynthesis
8. Function of Plant Parts (Roots, Stems, etc.)
9. Seeds, Flowers, Fruits
10. Growing Seasons
11. How Plants Store Food

12. Man's Need for Plants
13. Classification of Plants
14. Plant Reproduction
15. Life Cycles of Plants
16. Conservation of Plants

TOPIC - ECOLOGY

SUBTOPICS - 1. What it Means to be Alive
2. Aging of Living Things
3. Balance Between Plants and Animals
4. Competition Among Living Things
5. Metamorphosis
6. Variation Among Plants; Animals (Genetics)
7. Renewable Resources
8. The Energy Cycle
9. Symbosis

TOPIC - HISTORICAL ASPECTS

SUBTOPICS - 1. Fossils
2. Paleozoic Era
3. Mesozoic Era
4. Cenozoic Erz

TOPIC - THE HUMAN BODY

SUBTOPICS - 1. Man Among the Animals of the World
2. How Man Studies Himself
3. Growth and Development

4. Nutrition and Body Needs
5. Body Processes (Digestion, Circulation, Excretion, Respiration, Movement, etc.)
6. Body Senses
7. Health and Disease
8. The Body Parts and Their Purpose (Nervous System, Skeleton, Teeth, etc.)
9. First Aid
10. Poisons and Other Harmful Substances
11. Instruments of Medicine and Their Use

TOPIC - CONSERVATION

SUBTOPICS - 1. What Conservation Is
2. Maintaining Soil Fertility
3. Enemies of the Forest
4. Replacement of Forests
5. Conservation of Water, Air, and Wilderness
6. Inter-relationships of Living Things
7. Resources of the Ocean
8. Conservation Methods

THE EARTH

TOPIC - ROCKS

SUBTOPICS - 1. Kinds of Rocks
2. Formation of Rocks
3. Identifying and Collecting Rocks
4. The Rock Cycle
5. Minerals and Crystals
6. Treasures of the Earth

TOPIC - SOIL

SUBTOPICS - 1. Kinds of Soil
2. Composition of Soils
3. Formation of Soil
4. Erosion of Soil
5. Conservation of Soil

TOPIC - SHAPE AND COMPOSITION OF THE EARTH

SUBTOPICS - 1. Areas of the Earth
2. The Earth Supports Life
3. Geophysics
4. Land
5. Air
6. Water
7. Inside the Earth
8. The Earth's Landscape

TOPIC - ATMOSPHERE

SUBTOPICS - 1. Air
2. Layers of the Atmosphere
3. Composition of Air
4. Water Cycle

TOPIC- HISTORY OF THE EARTH

SUBTOPICS - 1. Fossils
2. Age of the Earth
3. The Changing Earth
4. Life History of Mountains
5. Formation of the Earth
6. The Geologic Time Table

TOPIC - OCEANOGRAPHY

SUBTOPICS - 1. Tides
2. Kinds of Life in the Ocean
3. How the Ocean Is Studied
4. Characteristics of the Ocean

TOPIC - GEOGRAPHY AND GEOLOGY

SUBTOPICS - 1. Maps
2. Locating Positions on the Earth

TOPIC - AIR AND WEATHER

SUBTOPICS - 1. Awareness of Weather
2. Seasons
3. Temperature
4. Clouds

5. Clothes For Different Weather
6. Air
7. Weathering
8. Winds and Their Causes
9. Air Masses and Jet Streams
10. High and Low Pressure Areas
11. Forms of Moisture
12. Weather Forecasting and Weather Instruments
13. Weather Phenomena (Hurricanes, Thunderstorms, etc.)
14. Factors Producing Climate
15. Ventilation
16. Air Conditioning
17. Man-Made Weather

TOPIC - PHENOMENA OF THE EARTH

SUBTOPICS - 1. Volcanoes
2. Hotsprings, Geysers and Other Features
3. Forces That Change the Earth
4. Gravity
5. Earthquakes
6. Erosion
7. The International Geophysical Year

THE UNIVERSE

TOPIC - THE SOLAR SYSTEM

SUBTOPICS - 1. The Earth is Our Planet
2. The Sun
3. The Earth's Moon (Phases)
4. Luminous and Nonluminous Bodies
5. Origin of the Planets

TOPIC - EXPLORING SPACE

SUBTOPICS - 1. Gravity and Rockets
2. Man-Made Satellites
3. Putting Satellites Into Orbit
4. What Space is Like
5. Necessities for Space Travel
6. Journeys into Space
7. Life in Space
8. Possibilities of Life Elsewhere in the Universe

TOPIC - BEYOND THE SOLAR SYSTEM

SUBTOPICS - 1. The Stars
2. The Many Natural Objects in the Sky
3. Constellations
4. The Milky Way
5. The Birth of the Universe
6. Celestial Bodies in Motion

TOPIC - MOVEMENTS OF THE EARTH

SUBTOPICS - 1. Shadows
2. Time (Night and Day)
3. Seasons
4. Rotation of the Earth
5. Distance
6. Measuring Distance with Time
7. Measuring Distance in Space
8. Tides
9. How and Where the Earth Moves
10. Eclipse

TOPIC - HISTORY AND INSTRUMENTS OF ASTRONOMY

SUBTOPICS - 1. Use of Telescopes
2. Space Probes
3. How the Universe is Studied
4. Early Astronomy and Astrology
5. Project Ozma

MATTER AND ENERGY

TOPIC - AVIATION

SUBTOPICS - 1. Air
2. Atmosphere
3. Airplanes in Flight
4. Lift and Controls
5. Lighter-Than-Air Craft

6. Jet Propulsion
7. Airplanes and Elementary Aerodynamics
8. Airplane Engines: Jet, Rocket, and Combustion
9. Aerospace
10. Rockets and Satellites

TOPIC - MATERIALS OF THE EARTH

SUBTOPICS - 1. What Matter Is
2. Things that are Matter
3. States of Matter
4. Water
5. Certain Kinds of Matter
6. The Atom and its Structure
7. Combinations of Atoms
8. Elements and Compounds
9. The Importance of Carbon
10. Early Studies in Chemistry

TOPIC - CHANGES IN MATTER

SUBTOPICS - 1. Chemical Changes
2. Physical Changes
3. Chemical Changes and Energy
4. Changes in Atoms and Molecules
5. Radioisotopes
6. New Atoms

TOPIC - ENERGY

SUBTOPICS - 1. Energy from the Sun
2. Energy to do Work
3. Forms of Energy
4. Changing Energy
5. Matter in Action
6. Uses of Energy
7. Obtaining Atomic Energy
8. Food and the Human Body
9. Using Nuclear Energy
10. Atomic Dating

TOPIC - ELECTRICITY

SUBTOPICS - 1. Static Electricity
2. Production of Electricity
3. How Electricity Flows
4. Uses of Electricity (Telephone, Telegraph, etc.)
5. Measuring Electricity
6. The Electric Motor and Transformers
7. Conductors and Insulators
8. Storage Batteries

TOPIC - MAGNETISM AND ELECTRICITY

SUBTOPICS - 1. Magnetism and Uses of Magnets
2. Nature of Magnetism
3. The Electromagnet

TOPIC - HEAT

SUBTOPICS - 1. Sources of Heat
2. Effects of Heat
3. The Need of Heat for Life
4. Thermometer and Measuring Heat
5. Convection Currents (Heating and Cooling Air)
6. Changing Heat to Energy
7. Evaporation
8. Uses of Heat (Heating Homes, Refrigeration, Air Conditioning)

TOPIC - LIGHT

SUBTOPICS - 1. Shadows
2. Nature of Light
3. Properties of Light
4. Effects of Light on Life
5. Sources of Light
6. Ways to Make Light
7. How Light Travels
8. Lenses
9. Eyes and Vision
10. Radiant Energy
11. Effects of Certain Materials on Light
12. Instruments Using Light

13. Colors
14. Intensity and Illumination
15. Light and Communication

TOPIC - FIRE

SUBTOPICS - 1. Burning and the Nature of Fire
2. Kindling Fires
3. Need of Oxygen for Fire
4. Temperature
5. Spontaneous Combustion
6. Kinds of Fuels
7. Safety in Case of Fire
8. Extinguishing Fires
9. Recent Advances in Extinguishing Fires

TOPIC - MACHINES

SUBTOPICS - 1. Simple Machines (Lever, Pulley, Wedge, etc.)
2. Using Simple Machines
3. Friction
4. Work and Energy
5. Inertia
6. Kinetic Energy
7. Power Sources
8. Complex Machines

9. The Conservation of Energy
10. Engines

TOPIC - SOUND

SUBTOPICS - 1. Nature of Sound
2. Production of Sound
3. Hearing
4. Intensity of Sound
5. Speed of Sound
6. Reflection
7. Vibration
8. Sound: A Form of Energy
9. Using and Controlling Sound (Acoustics)
10. Sound and Communication
11. Recording Sounds
12. Musical Sounds
13. Human Speech

CHAPTER V

SELECTION OF TOPICS AND SUBTOPICS FOR H.E.S.

I. PROCEDURES OF SELECTION

In this study the topics and subtopics listed for consideration in Chapter IV are screened with the criteria which are developed in Chapter III. This process follows the formula of data-sources plus values plus realities equals curriculum decisions. In using the formula, the data-sources, values, and realities are the screens which are used to examine the topics and subtopics considered. The topics and subtopics which satisfy the criteria in the screens will be the ones recommended for inclusion in the science curriculum at Hebeler Elementary School.

A sample topic and its subtopics are examined in this chapter to demonstrate the use of the three sets of screens in determining appropriate science content for the H.E.S. science curriculum. The process is then used to determine and order a selected list of topics and subtopics for inclusion in and development of the H.E.S. science curriculum during the next two years.

II. THE PROCESS USED IN SELECTION

The topic and subtopics of aviation are used to demonstrate the process of selection. Aviation and its subtopics are listed in Chapter IV as:

TOPIC - AVIATION

SUBTOPIC - 1. Air
2. Atmosphere
3. Airplanes in Flight
4. Lift and Controls
5. Lighter-Than-Air Craft
6. Jet Propulsion
7. Airplanes and Elementary Aerodynamics
8. Airplane Engines: Jet, Rocket, and Combustion
9. Aerospace
10. Rockets and Satellites

The first set of screens consisted of criteria from the data-sources which included: the needs of society; the nature of science; the growth and development of children; and the total school program. The major factors within this set of screens are:

1. The research in child growth and development.
2. Facts known about our children and how children learn.

3. Social forces and changes at the national and/or world level.

4. Characteristics and needs of the local state, community, and/or neighborhood.

5. New developments in the disciplines (concepts, structure, and ways of knowing).

6. The role of the school in developing the good person and good citizen (31:2-5).

Values from the operational philosophy of H.E.S. and selected criteria which have been helpful in guiding curriculum development make up the second set of screens to be used in the process of selection. The factors constituting this set of screens are fully described in Chapter III (see pages 26-29).

The third set of screens to be used in the process of selection consists of the necessary realities of the local situation as listed in Chapter III (see pages 29-31).

The topic aviation and its subtopics are examined according to the first, second, and third sets of screens focusing on the factors in each set. In the examination, the topics and each subtopic are assessed according to the following assessment criteria: desirability; attainability; feasibility; clarity of meaning; consistency; comprehensiveness; balance; and priority (31:1).

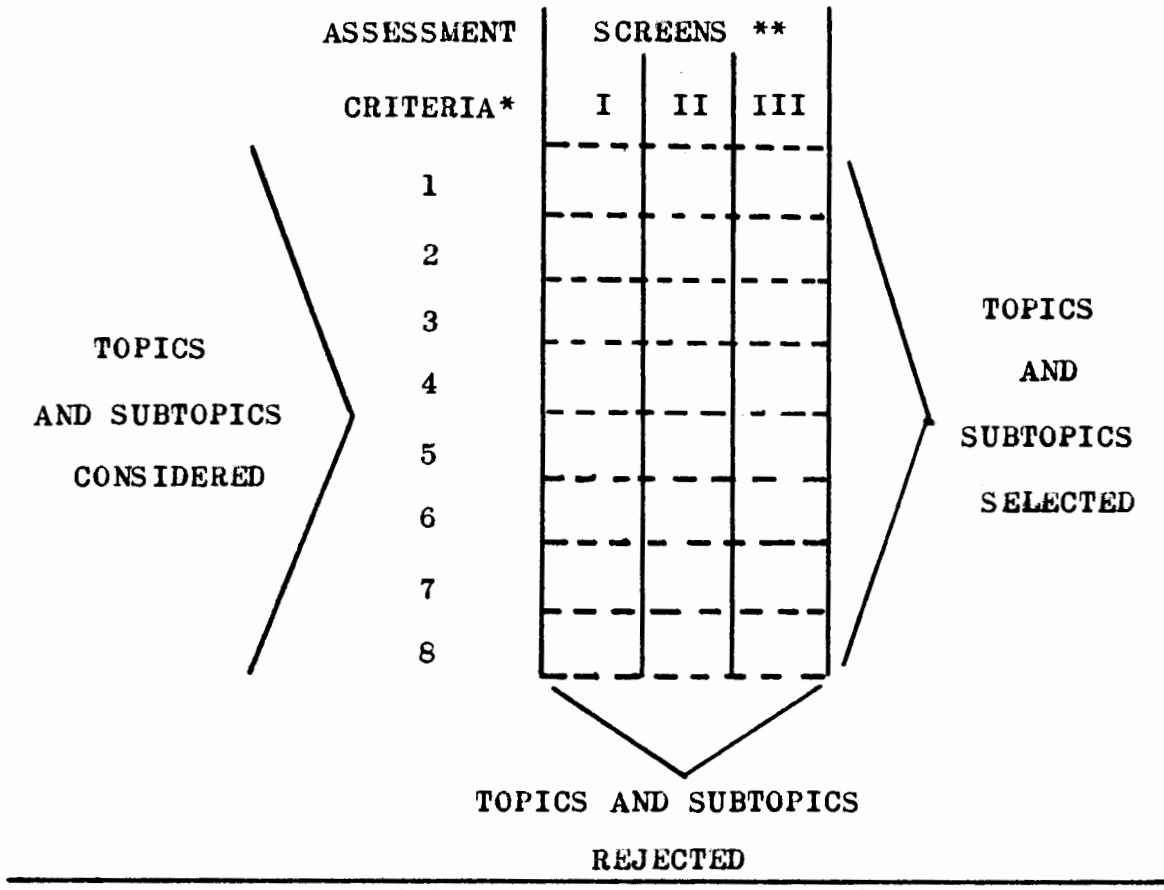
The procedure follows the pattern of comparing the topics of a science area according to how those topics as a group satisfy the above criteria for assessment as evaluated by the factors in the three sets of screens. The selection of topics proceeds by determining, according to the factors in the screens as shown in Table I, which topics are of most significance in elementary science and at H.E.S. In Table I, topics are examined in relation to the factors contained in the vertical columns I, II, and III according to the assessment criteria in the horizontal columns. The topics which satisfy the factors contained in the screens according to the assessment criteria are selected.

All the topics considered are of significance to elementary science, but some, as compared to others, fulfill the criteria in the screens in a way which justifies their development before; or instead of, others. A high priority topic, therefore, should fulfill the needs of the H.E.S. science curriculum as described in the screens to a greater extent than others in that area at the present time.

The subtopics within each topic are similarly assessed. Special consideration to avoid duplication and to attain a balance of content is extended by cross referencing each subtopic among the selected topics.

TABLE I

DIAGRAM OF METHOD FOR SELECTION OF TOPICS AND SUBTOPICS



*ASSESSMENT CRITERIA

1. Desirability
2. Attainability
3. Feasibility
4. Clarity of Meaning
5. Consistency
6. Comprehensiveness
7. Balance
8. Priority

** SCREENS

I. Data Sources
II. Values
III. Realities of the Local Situation

The examination of the topic and subtopics of aviation, according to the factors in the three sets of screens produced the following assessment according to an evaluation using the assessment criterion of desirability.

While some of the assessment criteria are more discriminatory than others in screening topics and subtopics, each has a role in the final determination. Aviation and its subtopics as assessed through the three sets of screens fulfilled the greatest number of factors in a manner which indicated the development of aviation would probably be highly desirable as compared to other topics in the area of matter and energy. A selection of important factors which produced this assessment according to desirability are as follows:

1. Some children at H.E.S. have an interest in building model airplanes as a hobby and the study of aviation may satisfy part of the need for learning to use leisure time for many of the students.

2. Many of the children have parents with the hobby of flying. These children usually have a special interest in aviation which this topic and its subtopics could satisfy now and in the future. The interest of the students at H.E.S. seems to indicate that an introductory subtopic placed in the primary level is highly desirable and probably

help students attain a greater depth of understanding concerning aviation.

3. Certain subtopics of aviation can probably meet the needs of students with special mechanical interests, especially those students with an interest in motors.

4. The topic of aviation can very probably indicate to students an area of technology in which they could develop a saleable skill. The subtopics of aviation to help meet the special needs of certain students would seem most desirable and the placement of aerospace in the late intermediate level in order to help students attain a depth in understanding would probably be most beneficial.

5. Subtopics of aviation might reinforce for the student an understanding of the achievements of man and the motivation of man to learn and explore.

6. An understanding of the way man thinks and works creatively might be developed through the study of aviation in the elementary science program.

7. The use of specialization and atomization in transportation are factors in which the subtopics of aviation could help develop student understanding of the present society.

8. The effects of basic economics on science and effective living probably could be easily delineated in the subtopics of aviation.

9. The need for students to understand the need for and use of some government controls and support in science probably can be satisfied. The subtopics of aviation might have a scope which is not usually found in science units which could make the topic highly desirable for H.E.S.

10. An understanding of aviation might help in the relating of ones self to the cosmos for life adjustment through an understanding of new developments in science.

11. The study of aviation probably will help students develop an understanding of the way science serves the culture.

12. The changes occurring in our culture as a result of science might be explained through the development of the topic aviation.

13. Many books, magazines and television programs are based on aspects of flying and the study of aviation might prepare the students to more fully enjoy and understand them.

14. In order to operate effectively in our democratic society, the good citizen should gain an essential core of knowledge to help him in making personal and group decisions concerning science. Since aviation has become an important part of our lives it probably is a desirable topic for helping students gain a basic understanding for making intelligent decisions when necessary.

15. Subtopics of aviation introduce the students to

many of the current developments and new ideas in science, especially concerning space and space travel. Fulfilling this factor helps attain the need for up-to-date elementary science programs. The subtopic of aerospace at the intermediate level should fulfill this factor and is, therefore, highly desirable.

16. The topic of aviation and its subtopics are important in our culture and have desirability because of their importance.

17. Aviation can possibly provide for many activities including local field trips, projects, experiments, and library reading and research which makes it desirable in the H.E.S. science curriculum.

18. The abilities and interests of the students indicate that the topic of aviation could be developed in depth in the H.E.S. science program and, therefore, is probably very desirable.

19. The topic of aviation possibly is desirable according to the factors indicating that repetition should only occur when necessary to improve learning. Repetition which could occur in the subtopic of air should help the students develop a greater depth and scope in an understanding of the necessary inter-relationships in science. Also, aviation is a topic that is not presented as a part of other subjects at H.E.S.

Above are the factors which indicated the topic of aviation is probably highly desirable for inclusion in the H.E.S. science curriculum. The evaluation in this study using the factors from the three sets of screens produced the assessment that aviation is highly desirable in the H.E.S. science program as compared to other topics in the area of matter and energy. (See Page 43-48)

The examination of aviation continued using the other assessment criteria. As aviation and its subtopics are assessed through the three sets of screens for priority, the final assessment criteria used, aviation seemed to have a high priority placement in the H.E.S. science curriculum because of the following factors:

1. The importance of aviation in the present and future lives of the pupils at H.E.S. is evident. At the local level there is a college department of Air Science and many of the students' parents presently have a high interest in flying as a hobby.

2. To help explain the need and use of aviation.

3. Aviation as a science topic contains many of the new developments and understandings which should be a part of an up-to-date elementary science curriculum.

4. The H.E.S. library contains a large and up-to-date collection of supplementary books concerning aviation.

5. Tentative interest to develop aviation as a topic in the H.E.S. science program is indicated by several college departments and members of the H.E.S. staff.

The examination of aviation using all of the assessment criteria indicated that this topic and its subtopics satisfied the greatest number of the factors from the three sets of screens in a manner which placed it as first to be developed in the area of matter and energy.

Changes were made in the subtopics by combining, eliminating, and/or revising when a change would seem to improve the topic in satisfying the factors in the three sets of screens. As the final result of the screening of aviation and its subtopics, the following subtopics are suggested for the H.E.S. science curriculum:

SUBTOPICS - 1. Airplanes in Flight (Airports, Kinds of Airplanes, etc.)
2. The Properties and Characteristics of Air and the Atmosphere
3. Lighter-Than-Air Craft
4. Lift and Controls
5. Airplanes and Elementary Aerodynamics
6. Airplane Engines: Jet, Rocket, and Combustion
7. Aerospace (Rockets, Satellites, Orbits, Life in Space, etc.)

III. TOPICS AND SUBTOPICS SELECTED

The following list of topics and subtopics are the ones selected for inclusion in and development of the H.E.S. science curriculum. In order to achieve a balance in the

H.E.S. science program, topics from each area should be included and all the topics listed should be developed. Since the construction of the H.E.S. science curriculum is a developmental process over a period of two years, some of the topics and subtopics will be developed for teaching before others. To assist in making the decision about the most appropriate content to be developed, the topics are listed somewhat in order of priority with the first ones in each area having the highest priority for development in the local situation.

The subtopics are listed in an informal sequence of difficulty for placement purposes. Subtopics from certain lower priority topics should be considered for early development in the H.E.S. science curriculum when they contain basic content appropriate for a balanced program. This study does not attempt to delineate such subtopics. It should also be noted that not all the subtopics of a high priority topic are of equal appropriateness or priority.

The topics and subtopics selected are as follows:

BIOLOGICAL SCIENCES

TOPIC - ANIMALS

SUBTOPICS - 1. Kinds of Animals (Pets, Farm Animals, the Zoo, Insects, Bees, Fish, Birds, Sealife, etc.)

2. Animal Homes and Social Animals
3. The Basic Needs of Animals
4. Man's Needs for Animals
5. Conservation of Animals
6. Animal Classification (Evolution, Productive Adaptation, Historical Aspects, Classifying)
7. Life Cycles of Some Animal Groups
8. Animal Reproduction
9. The Anatomy of Some Animals
10. Cells

TOPIC - PLANTS

SUBTOPICS -
1. Kinds of Plants
2. Essentials for Plant Life (Growing Season, Soil, Water, etc.)
3. Man's Need for and Uses of Plants
4. Structure of Plants
5. Function of Plant Parts (Roots, Stems, Leaves, Adaptations of Plants, etc.)
6. Life Cycles of Plants
7. Seeds, Flowers, Fruits
8. Plant Reproduction (Grafting, etc.)
9. Classification of Plants

10. How Plants Make and Store Food
11. Responses of Plants to Stimuli

TOPIC - THE HUMAN BODY

SUBTOPICS - 1. Man Among the Animals of the World
2. Poisons and Other Harmful Substances (Safety)
3. Health and Disease
4. Nutrition and Body Needs
5. Body Processes (Digestion, Circulation, Excretion, Respiration, Movement, Feeling, etc.)
6. The Body Anatomy
7. First Aid
8. Instruments of Medicine and Their Use

TOPIC - ECOLOGY

SUBTOPICS - 1. What it Means to be Alive (Aging, Needs of Organisms, Kinds of Life, etc.)
2. Balance Between and Competition Among Plants and Animals
3. Renewable Resources
4. Variation Among Plants; Animals (Genetics, Metamorphosis, etc.)
5. The Energy Cycle

TOPIC - CONSERVATION

SUBTOPICS - 1. What Conservation Is
2. Resources of the Ocean
3. Maintaining Soil Fertility
4. Enemies of the Forest
5. Methods of Conservation

THE EARTH

TOPIC - ROCKS

SUBTOPICS - 1. Kinds of Rocks
2. Identifying and Collecting Rocks
3. Formation of Rocks
4. Minerals and Crystals
5. The Rock Cycle

TOPIC - WEATHER

SUBTOPICS - 1. Awareness of Weather and Seasons; Temperature
2. Air and Wind
3. Forms of Moisture, Clouds, and the Water Cycle
4. Weathering
5. Weather Forecasting and Weather Instruments
6. Factors Producing Climate

7. Weather Phenomena (Hurricanes, Thunderstorms, etc.)
8. Man-Made Weather

TOPICS - ATMOSPHERE

SUBTOPICS - 1. Properties of Air
2. Layers of the Atmosphere
3. Composition of Air

TOPIC - SHAPE AND COMPOSITION OF THE EARTH

SUBTOPICS - 1. Areas of the Earth (Land, Air, and Water)
2. The Earth Supports Life; Soil
3. Geophysics
4. Inside the Earth
5. The Earth's Landscape (Land Areas, Maps, Locating Positions on the Earth, etc.)

TOPIC - HISTORY OF THE EARTH

SUBTOPICS - 1. Fossils and Age of the Earth
2. The Changing Earth (Life History of a Mountain, River, etc.)
3. Formation of the Earth

TOPIC - PHENOMENA OF THE EARTH

SUBTOPICS - 1. Forces that Change the Earth (Weathering, Gravity, Earthquakes, etc.)

2. Hotsprings, Geysers and Other Earth Features
3. The International Geophysical Year

TOPIC - OCEANOGRAPHY

SUBTOPICS - 1. How the Ocean is Studied
2. Characteristics of the Ocean (Tides, Seashore, Troughs, etc.)

THE UNIVERSE

TOPIC - MOVEMENTS OF THE EARTH

SUBTOPICS - 1. Shadows and Time (Night and Day, Seasons, etc.)
2. How and Where the Earth Moves (Rotation, Distance, and Measure)
3. Effects and Phenomena that Occur as the Earth Moves

TOPIC - THE SOLAR SYSTEM

SUBTOPICS - 1. The Earth is Our Planet
2. The Sun
3. Luminous and Nonluminous Bodies
4. Origin of the Planets, Solar System

TOPIC - BEYOND THE SOLAR SYSTEM

SUBTOPICS - 1. The Stars
2. The Many Natural Objects in the Sky
3. Constellations

4. The Birth of the Universe
5. Possibilities of Life Elsewhere in the Universe

TOPIC - HISTORY AND INSTRUMENTS OF ASTRONOMY

SUBTOPICS - 1. Use of Telescopes
2. Early Astronomy and Astrology
3. Project Ozma

MATTER AND ENERGY

TOPIC - AVIATION

SUBTOPICS - 1. Airplanes in Flight (Airports, Kinds of Airplanes, etc.)
2. The Properties and Characteristics of Air and the Atmosphere
3. Lighter-Than-Air Craft
4. Lift and Controls
5. Airplanes and Elementary Aerodynamics
6. Airplane Engines: Jet, Rocket, and Combustion
7. Aerospace (Rockets, Satellites, Orbits, Life in Space, etc.)

TOPIC - ENERGY

SUBTOPICS - 1. Energy to do Work
2. Matter in Action

3. Forms of Energy
4. Uses of Energy
5. Food and the Human Body
6. Obtaining and Using Nuclear Energy

TOPIC - MAGNETISM AND ELECTRICITY

SUBTOPICS - 1. Magnetism and Uses of Magnets
2. Nature of Magnetism
3. The Electromagnet

TOPIC - MACHINES

SUBTOPICS - 1. Simple Machines (Lever, Pulley, Wedge, etc.)
2. Using Simple Machines (Work and Energy, Friction, Inertia, Power Sources)
3. The Conservation of Energy and Kinetic Energy
4. Engines and Complex Machines

TOPICS - ELECTRICITY

SUBTOPICS - 1. Static Electricity and Conductors; Insulators
2. How Electricity Flows
3. Producing and Measuring Electricity
4. Uses of Electricity (Telephone, Telegraph, Motors, Transformers, etc.)
5. Storage Batteries

TOPICS - HEAT

SUBTOPICS - 1. Effects of Heat (Temperature, Convection Currents, Evaporation)

2. Sources of Heat and Changing Heat to Energy

3. Uses of Heat (Heating Homes, Refrigeration, Air Conditioning, etc.)

TOPIC - LIGHT

SUBTOPICS - 1. Properties and Effects of Light (Shadows, Ways to Make Light, Need for Light, etc.)

2. Sources of Light

3. Light and Communication

4. Effects of Certain Materials on Light (Lenses, Colors, Intensity and Illumination, Eyes and Vision, etc.)

TOPIC - SOUND

SUBTOPICS - 1. Hearing

2. Production of Sound

3. Sound; A Form of Energy

4. Using and Controlling Sound (Communication, Recording Sounds, Musical Sounds, Human Speech, etc.)

TOPIC - FIRE

SUBTOPICS - 1. Safety in Case of Fire

2. Burning and the Nature of Fire (Kindling Fires, Oxygen, Kinds of Fuels, Spontaneous Combustion, etc.)

3. Modern Fire Extinguishing Methods and Equipment

TOPIC - CHANGES IN MATTER

SUBTOPICS - 1. Physical Changes

2. Chemical Changes and Energy

3. Changes in Atoms and Molecules

4. Radioisotopes and New Atoms, Atomic Dating

TOPIC - MATERIALS OF THE EARTH

SUBTOPICS - 1. What Matter Is

2. Kinds and States of Matter

3. The Atom and Its Structure

4. Combinations of Atoms; Elements and Compounds

5. The Importance of Carbon

6. History of Chemistry

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The general purpose of this study was to establish a basis for the selection of topics and subtopics for the Hebeler Elementary School science curriculum and to select appropriate topics and subtopics for further development.

The basis for selection was developed by reviewing the relevent literature concerning curriculum development and elementary school science. The pertinent criteria concerning curriculum development in elementary science became the factors contained in the three sets of screens: the data sources, values, and local realities.

The topics and subtopics considered were assessed by the factors in the three sets of screens according to the formula, data plus values plus realities equals curriculum decisions. Table I, Page 53, outlines the procedures followed in the selection of topics and subtopics and was produced to help readers gain a clear understanding of the selection process used. This process was used to list topics and subtopics recommended for development at H.E.S. during the next two years.

The study was made for a specific situation and not for the purpose of furnishing topics and subtopics for all elementary schools. The usefulness of the content selected is one of providing the H.E.S. staff with a list of recommended topics and subtopics for the scope of the local elementary science curriculum. It is expected that the study will be of value in the future development of elementary science programs by assisting educators in developing criteria for selecting elementary science content, and to use the factors contained in the criteria to systematically determine content for specific elementary school curricula.

II. CONCLUSIONS

The information accumulated during the study suggested the following conclusions and interpretations:

1. Similarities were noted to exist in the content contained in the various topics and subtopics in each of the sources due to the inter-relationships in the scientific enterprise.

2. Differences regarding the levels in which a topic or subtopic should be taught were found.

3. An examination of the content in new elementary science projects, textbooks, curriculum guides, and resource books should be made periodically, especially at the primary level.

4. In further planning for the elementary science curriculum, problems concerning sequence must be considered.

5. The established elementary science curricula of most districts seem to be determined by the textbooks available and the individuals involved in the construction of the curricula.

6. The allocation of time spent in each grade for teaching science should be correlated with the development of new units.

7. Demonstrations, experiments, projects and various other learning and teaching activities should be used in the units developed.

8. The development of elementary school science curricula should consist of careful planning, and criteria should be established and used to select content as outlined in this study.

9. The process for selection as outlined in Table I, Page 53, could be used for curriculum development at other grade levels and in other subject areas.

III. RECOMMENDATIONS

The following recommendations are presented:

1. Emphasis should be placed on attaining a balance of topics from the four science areas during the development of the H.E.S. science curriculum.

2. Teaching units from the suggested topics and subtopics should, to a high degree, help the student develop an understanding of the scientific process.

3. The H.E.S. science curriculum needs attention, and the possibility of a workshop or inservice project should be considered for initiating further development.

4. The units developed should be of sufficient length (15-20 days) to develop several generalizations and understandings in depth.

5. Science units should be taught on consecutive school days.

6. A study should be made to determine the advantages and disadvantages of the program and the research aspects of the H.E.S. science curriculum.

7. A longitudinal study should be made to determine the effectiveness of the process used to select topics and subtopics.

8. An analysis of the method developed and used in selecting topics and subtopics as applied to other situations would also be an appropriate study.

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