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ABSTRACT

A description of needs and specifications for research and development activities in elementary school science are presented in this paper. Serving as a report from the Project on Prototypic Instructional Systems in Elementary Science, it considers the current and future needs of the child and the society of which he is a member. An overview of deficiencies in current practice is given, followed by a plan for development and related-research activities which will provide an environmental education for elementary school children. Several alternatives for developing materials in this area of environmental education are described and the strengths and weaknesses of each are indicated. A developmental sequence is detailed for one alternative - Ecological Readers. Throughout the report, the necessity of cooperative arrangements among school personnel, universities, governmental agencies and private industry is indicated. (Author/BL)

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Working Paper No. 40

Environmental Education in the Elementary School: Needs and Specifications

Report from the Project on Prototypic Instructional Systems: Elementary Science

EXPERIMENTAL MATERIALS

RESEARCH
LEARNING

Wisconsin Research and Development
CENTER FOR COGNITIVE LEARNING

THE UNIVERSITY OF WISCONSIN
Madison, Wisconsin

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Working Paper No. 40

ENVIRONMENTAL EDUCATION IN THE ELEMENTARY SCHOOL: NEEDS AND SPECIFICATIONS

By Alan M. Voelker

Report from the Project on Prototypic
Instructional Systems in Elementary Science
Alan M. Voelker, Principal Investigator

Wisconsin Research and Development
Center for Cognitive Learning
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July 1970

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The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practices.

The priority objective of Project 203, Prototypic Instructional Systems--Elementary Science, is to develop curricular materials and conduct related research to insure that these materials are effective in improving educational practice. More specific objectives embodied in this broad objective are (1) to determine which science concepts are appropriate for inclusion in the K-6 science program that should be learned and could be learned, (2) to develop an evaluation system and corresponding assessment materials for measuring the attainment of the aforementioned concepts, (3) to develop instructional materials associated with the concepts, (4) to determine, through related research, how well children of specified characteristics can learn the concepts under specified instructional conditions, and (5) to determine the relationship between science concept learning and concept learning in other subject-matter areas. The development of instructional materials focuses on preparing materials for use by children.

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CONTENTS

ABSTRACT

This paper presents a description of needs and specifications for research and development activities in elementary school science. Consideration is given to the current and future needs of the child and the society of which he is a member. An overview of deficiencies in current practice is followed by a plan for development and related-research activities which will provide an environmental education for elementary school children. Several alternatives for developing materials in this area of environmental education are described; strengths and weaknesses of each are indicated. A developmental sequence is detailed for one alternative--Ecological Readers.

The necessity of cooperative arrangements among school personnel, universities, governmental agencies and private industry is indicated.

I

INTRODUCTION

A CURRICULAR NEED

Our greatest curricular need--a perennial one--is the development of programs which meet the needs of the individual learner, a program which considers his nature and development. This curriculum and related instructional procedures must also be constructed to fulfill societal needs. The only type of science program that can effectively contribute to the attainment of these goals is one which has as its central theme the production of a scientifically literate citizenry.

A scientifically literate citizen has been characterized by the National Science Teachers Association as one who

> knows something of the role of science in society and appreciates the cultural conditions under which science thrives. He also understands its conceptual inventions and its investigative procedures (NSTA, 1964).

Another science education group published a research report in which it was stated

> The scientifically literate individual presently is characterized as one with an understanding of the (1) basic concepts in science, (2) nature of science, (3) ethics that control the scientist in his work, (4) interrelationships of science and society, (5) interrelationships of science and humanities, and (6) differences between science and technology (Pella, et al., 1966).

The data presented in the latter report indicated that the most important characteristic was understanding the interrelationships between science and society. Both of these statements indicate that the major goal of science education in the elementary school should be to provide a background in science as a part of the general education of an individual for effective citizenship. Other components of the science program in the elementary school, such as the conceptual knowledge and the investigative nature, should be present for their own sake but also heavily utilized to promote an understanding of the science-societal interrelationship. Existing science curricula for the elementary school are not meeting this need for they focus heavily on science as a discipline, an organized body of knowledge, and methods of inquiry, at the expense of the needs of the child and his society.

Since the emergence of science programs in the curriculum of the elementary school, a consistently stated purpose has been to assist children to understand their environment, primarily directed at appreciation (NSSE, 1932, 1947, 1960; Underhill, 1941). Our society has changed from an agrarian society to one heavily influenced by science and technology but the elementary school science program has not responded (Roth, et al., 1970).. It does not consider that a major societal need is to understand the environment for the sake of preserving it rather than merely appreciating nature's beauty. Children have a definite need to understand themselves and their relationship to the environment so they can more ably solve their problems as well as contribute to solving societal problems. They need to understand their

environment and the interactions between the universe and self; science programs must be organized to promote these understandings. Children need to learn how to use scientific knowledge to help them make personal and societal decisions concerning their interaction with their environment. To do this they need to learn to consider the social, political, and economic aspects of their society in conjunction with their understanding of the physical and biological world.

At no time in the history of our country has there been a more pressing need for a science curriculum which points toward an understanding of the interrelationships between science and society to preserve our environment. A program which emphasizes this aspect of scientific literacy for effective citizenship can best fulfill the needs of the individual and our society. This need will persist into the future of society. It is the current group of elementary school children who will be most affected by these problems; it is they who will be required to make most demanding decisions affecting their lives and the destiny of our world.

DEFICIENCIES IN CURRENT PRACTICE

Current practice in developing science curricula for elementary school children has been of two major types:

1. Textbook series published by commercial publishing firms and
2. Programs sponsored and supported by the National Science Foundation and various foundations--the outputs from which are ultimately published by commercial firms.

Examination of the textbook-oriented materials in conjunction with the six referents for scientific literacy indicates that the texts deal primarily with the referent, conceptual knowledge. The materials strive to present the conceptual knowledge of science which has been accumulated over a period of years. Only a series published or revised recently is apt to consider the interrelationships between science and society and man's interaction with his environment and, then, only in an isolated chapter or two.

At best the available textbook materials provide an opportunity for developing one aspect of scientific literacy--conceptual knowledge, treat science as divorced from society and lack evidence of a research base for organization. These materials appear to be usable with children having a high reading ability in particular geographical locations. They do not permit much flexibility for adaptation to a local situation.

Recently, major input into science curriculum development in the elementary school has come from the work of programs supported by the National Science Foundation. The result of these programs has been an emphasis on two aspects of scientific literacy--conceptual knowledge and the nature of science, its investigative nature. The NSF programs do stress that science is investigative, science is experimental, and that the conceptual knowledge of science develops largely from employing this investigative, experimental approach to learn about nature. Generally these programs have contributed to increasing scientific literacy by extending science curricula beyond the scope of conceptual knowledge. However, they also neglect the interrelationships between science and society and man's interaction with his environment.

In addition to textbooks and kits of materials, there have been prepared curriculum guides and instructional guides for teachers. Some of these do give considerable emphasis to the interrelationships between science and society, but their potential benefit for children is severely hindered because teachers have not had the necessary preparation to be able to convert these conceptual ideas into practice. Also, there are little or no materials for children.

In summary, the present status of science programs for the elementary school is characterized by

1. Programs which provide, at best, minimal opportunities to promote the education of a scientifically literate citizenry; especially dealing with the aspect of the interrelationships between science and society and man's interaction with his environment.
2. Textbook-oriented curricula not necessarily appropriate for a local situation, not developed for the local environment; programs which depend very heavily on the ability of children to read.
3. Programs which lack materials that can be utilized by children without a large amount of teacher guidance.
4. Programs which lack a research foundation and sufficient evaluation related to external criteria, consisting of materials which lack sufficient and appropriate quality verification.
5. Programs which lack the flexibility to provide individually guided education.

A program of development activities to meet the needs for science instruction in the elementary school, K-6, and alleviate the current deficiencies in instruction would concentrate on the development of materials for use by children. They would focus around having children use their knowledge of science and social studies to understand the role of science and technology in society, particularly as related to man's interaction with his environment. Teacher's guides and evaluation materials would need to be prepared to accompany these student materials.

II

SPECIFIC NEEDS IN ELEMENTARY SCHOOL SCIENCE

STUDENTS

A major problem confronting those persons and groups responsible for developing curricular materials for use by elementary school children is selecting topics that are consonant with children's interests and development. Questions that adults feel should concern the child as "What is my role in society?" and "What are my responsibilities in helping to preserve the environment?" may be of little importance in the early and personal lives of children. However, the influence of the mass media and the increasing societal awareness of children indicate that concerns of adults and children regarding the environment may not be as separated as they once were. Even so, care must be taken that materials development is compatible with children's interests and development.

The unfortunate fact is that little, if any, curricular materials are available to help a child learn about his role in society, to help him answer the aforementioned questions at a time when he is psychologically and socially receptive. There are no materials that make a direct connection between the investigative nature, the conceptual knowledge, and the technological dimension of science and the making of societal, political, and economic decisions concerning the present and future destiny of society and the environment.

For example, does the child relate the findings of science and technology with social problems such as population growth and mobility? When he hears via television that it is possible to cut down the amount of pollutant per automobile, does he state that this may not alleviate pollution problems in Dallas, or any given city, because its population is growing exponentially? Probably not, because his science instruction has come devoid of any connection with the production and alleviation of social problems. This kind of science instruction produces adults who believe that, given a billion dollars, scientists can cure all of Lake Erie's ills; these same adults will also blame science and technology for creating the devices that pollute the environment and yet do not realize that it is the general populace which does or does not purchase these products. Curricular materials are certainly needed to help children understand these aspects of the interrelationships between science and society: to see where as an individual, the child, fits into the total scheme.

Thus, from the perspective of the child, the preparation of curricular materials should be concerned with problems that are a part of a child's world, that are interesting to children, and that involve them in their solution. Consideration must be given to what a child might want to do as well as what he will do. A major criterion in materials development must be the nature and development of the child.

TEACHERS

Teachers and other instructional personnel in our schools also need assistance in learning how to deal with curricular and instructional

problems in the area of science and society. Practicing teachers have had little or no prior preparation in this area. Their preparation programs have been devoid of work in the history, philosophy, and sociology of science; work is not done in political science and economics. Certainly as critical is the the lack of interaction between science teachers and social studies teachers and the misconception on the part of many of our science teachers that it is unethical to relate the subject area to social, political, and economic issues.

Instructional personnel need to consider the interrelationships between science and society as individuals and in conjunction with other teachers. They need to be provided with guidelines for means of integrating science and social studies instruction. They need assistance to identify those science and social studies concepts directly related to societal and environmental problems.

They need moral support for launching into the study of controversial issues and making decisions for eliminating much superfluous material from their current curricula.

INDIVIDUALLY GUIDED EDUCATION

In preparation of curricular materials for the elementary school, consideration must be given to formulating and carrying out instructional programs for individual students in particular schools. Such a system has been developed by the Wisconsin Research and Development Center for Cognitive Learning and school people (Klausmeier, et al., 1968). Planned variations in instruction make provisions for

differences in students' rates and modes of learning and what students learn. These variations are based on knowledge of the characteristics of each student and the educational objectives and programs of the school.

To achieve the previously stated objectives the interrelationships of all structural components of an instructional system require careful attention. Five components relevant to the proposed science material development are:

1. an organization of instruction,
2. instructional materials,
3. teaching-learning activities,
4. measurement tools and evaluation procedures, and
5. a management system.

The organization for instruction is provided for by the instructional and research unit--developed to replace the self-contained classroom (Klausmeier, 1970). Instructional personnel guide each child through a carefully designed sequence of learning activities in order to achieve specified instructional objectives. Each child normally engages in one-to-one relations with a teacher or aide; in one-to-one interactions with instructional materials, including independent study; and in small-group activities, class-size activities, and large-group activities. The amount and relative proportion of each kind of activity for each child are dependent upon the characteristics of the child, the objectives to be attained, the nature and quality of the instructional materials, and the cost of instruction. Instructional materials for most curriculum areas are selected that enable the students to learn the same subject

matter through independent study of printed instructional material or through some combination of audiovisual instructional material and group activity led by a teacher.

Instructional materials must be prepared to take into account at least two modes of children's learning. Printed materials are required and helpful to children who learn easily and well through independent reading. Audiovisual materials are helpful for all children but are essential for those who do not learn well independently through reading. Thus, any set of curricular materials in science should include these two types of materials at a minimum and desirably include other kinds of materials and activities.

Children also learn through interacting with skillful instructional personnel, other adults, and their peers. This necessitates the development of materials that can serve as the basis for one-to-one, small-group, and/or large-group instruction. Film loops, sound motion pictures, and other audiovisual materials and activities are required.

Measurement tools and evaluation procedures are required to assess children's characteristics and behaviors prior to instruction, to assess their progress, to assess their final achievement, to provide feedback for program improvement, and for conducting research related to the program.

Teachers need assistance in guiding an individual student through an instructional program by means of criterion-referenced tests and identification of appropriate instructional activities based on the results of careful assessment, following the progress of students and continuous modification of the instructional program and student

placement. A science program of instruction should be developed to fit into a school management design with the previously discussed features.

RESEARCH

To fulfill the child's learning needs requires that it be experimentally determined which concepts an individual child can learn and under what conditions he does learn them. These kinds of data are necessary to develop a learner-oriented curriculum which has a sufficient research base that learning expectations for the child are within the range of his abilities and limitations. Consideration needs to be given to the child's personal characteristics, the nature of the instructional personnel, the nature of the instructional media, the nature of the instructional format, and the location and design of the learning facilities.

Our current curricular materials do not give evidence of a consideration of the inconsistencies between a logical structure of the discipline and the development of the learner. It is true that our present research base is limited but it is not being utilized. Also, existing curricular materials have not been evaluated or, in those instances where they have, are too dependent on internal criteria for judging success.

III

ALTERNATIVES FOR DEVELOPMENT

There are several viable alternatives for meeting the need of developing and quality-verifying materials that assist children to acquire an environmental education. Each of five will be discussed briefly and a general appraisal of potential impact given.

AN INTEGRATED SCIENCE-SOCIAL STUDIES CURRICULUM

One means of fulfilling the needs of children to understand the interrelationships between science and society would be to develop a completely integrated science-social studies curriculum. It would consist of all necessary student materials and related teacher guidelines and in-service suggestions for a K-6 program. The subject-matter content would consist of those science and social studies concepts which children need to understand in order to make decisions concerning science, society, and themselves, related to preserving their environment. Such a program would have a tremendous impact on those schools where their staffs are inclined to be curriculum adopters rather than curriculum producers; as most school systems currently fit this description, a huge number of children could be served by this program.

However, such a curriculum would require at least 5 years to complete and cost millions of dollars. In 5 years more schools will

wish to develop their own curricula which will cause "complete" science programs to be nonsaleable and useless.

KEYING EXISTING MATERIALS

Another development project could be the identification of the relevant concepts present in existing materials. The product outcome of this project would be strategies for using the identified science and social studies concepts to develop an understanding of the interrelationships between science and society. These strategies would illustrate how to integrate science and social studies concepts to facilitate environmental education in these and other subject-matter areas of the elementary school curriculum.

This approach has the advantages of producing materials at a faster rate than the development of a new integrated curriculum, at less cost, and having more potential for flexibility of use at the local level. However, it does not produce materials for students; it depends on teachers with a lack of preparation in the area of environmental education; and it lacks the potential for acquiring much needed data on what children can learn.

ECOLOGICAL READERS

Ecological readers could be developed. Each reader would focus on a major environmental problem such as air pollution, water pollution, or population. These would focus on developing the necessary concepts related to the problem at two levels--primary and intermediate. The primary level materials could consist of pictorial readers and associated visuals while the intermediate level reader could consist

of a basic book and associated visuals. A set of these readers and associated visuals and tests could be prepared to deal with each of the high priority social problems resulting from the interaction of man and his environment.

Materials of this type have the advantage of being usable by children without major dependence on the teacher's knowledge of concepts related to the problems. Also, because of their topical nature and differing conceptual levels they would be very flexible in meeting local needs at the system, building, or classroom level. They are less expensive than an entire curriculum, can be developed and revised rapidly, and new ones can be easily added as new problems arise. They could be readily quality-verified and could be evaluated, formative and summative, in a relatively short period of time.

A series of ecological readers also has the potential of alleviating a lack of interest in reading because of a lack of interesting materials. Many children are reluctant readers because the materials available to them are not related to their interests and concerns. For those children who are more socially aware, readers dealing with the problems of science and society could serve as a motivational device; they would give these children "more" to read so they could become more fluent readers. They might become stimulated to pursue additional reading as well as other instructional activities.

INSTRUCTIONAL PACKAGES

A fourth development project that could be undertaken to meet the pressing need for environmental education would be the preparation of

self-contained instructional packages.[1] Each package would be designed to concentrate on developing in children an understanding of one particular aspect of environmental education such as water pollution, air pollution, or solid waste disposal; all children should have certain common knowledge. The structure would be such that all children, K-6, would have an opportunity to learn how to use their understandings of concepts from the biological and physical sciences. They would learn to use these conceptual understandings, together with their understandings of social, economic, and political concepts, to make decisions concerning personal and societal responsibilities regarding the future of society and the environment. Each package could be integrated into the existing science curriculum or be a supplement to it. A spiraling approach to concept learning would be employed.

There are several advantages to adopting this approach. The bulk of the materials developed would be for children and less dependence would be placed on teachers who may not have a background in environmental education. Several packages focusing on the most prominent social problems of environmental education could be developed in a relatively short period of time; quality verification through formative and summative evaluation could be readily attained. The materials would possess the flexibility of being usable in a variety of school-community environments and under various

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[1] A self-contained instructional package contains all materials necessary for instruction with a group of approximately 30 students, teacher's manual, student manual, laboratory equipment, tests, visuals, and any other appropriate materials.

school management systems; local systems could select those which best fit their situation.

INSTRUCTIONAL UNITS

This alternative is similar to the previously described project in that it consists of the preparation of instructional units for children. It differs in the lessening of content to be covered. Each unit would be designed to assist children understand one very small problem related to environmental education, focusing on developing the related science and social studies concepts. It would be designed primarily for children of one age level but would be sufficiently open-ended to be used with children in more than one situation.

Materials developed in such a project have the advantage of being easily quality-verified and would be flexible enough to be adaptable to many different local situations.

Although each of the suggested programs for development has its relative merits, it appears that concentrating development efforts on one or more of the latter three alternatives would be most appropriate at this time. Each could be pursued separately, but the degree of commonality is so great that it would be reasonable and feasible to conduct two of these activities simultaneously, reader development and one other. These judgments are based on the immediate need for making materials available, projected changes in school management procedures, and the increasing emphasis on developing local curricula.

IV

A STRATEGY FOR DEVELOPMENT--ECOLOGICAL READERS

The following consists of a description of procedures for developing, testing, and revising Ecological Readers and related audiovisual materials. This project has been selected for description because so many of the development procedures are quite similar to requirements for developing other student materials such as instructional packages or instructional units.

It is recognized that two types of materials should be prepared: printed materials for children who can learn well through independent reading and audiovisual materials for those who learn best through seeing, hearing, and discussing. (See the section on Individually Guided Education, p. 9.) This has been considered in preparing the developmental plan such that one or the other of these two types of material could be prepared or both types of materials could be prepared simultaneously, each in lesser amounts than if all efforts were developed to preparing a single type of product.

SPECIFIC OBJECTIVES

The major objective of these readers is to make available to children a vehicle for learning those science concepts, and related concepts from social studies, economics, politics, aesthetics, etc.,

that all children should understand to acquire an environmental education. Attainment of these concepts will better enable the children to understand how knowledge of these concepts can be employed to make decisions concerning the environmental problems confronting society. They will illustrate how various subject-matter areas of the curriculum are interrelated.

Teachers who lack preparation in the area of environmental education will be able to use materials of this nature without a major in-service program. They will have materials to utilize and, thus, can provide instruction in environmental education. By starting with available materials, they will become more adept at integrating subject matter within the curriculum, devote more time to science-related social problems, and be more able to help children deal with, and solve, problems of a controversial nature. Also, they will be able to provide more individually guided education.

CONSTRAINTS

Readers developed for use at the intermediate level would be restricted to use by children who possess, at a minimum, the reading skills of a fourth grader; however, because the reader will be designed for use by an individual, they can be utilized at a time when the child acquires sufficient reading ability to comprehend the material. Also, they have the flexibility of use under any school management system. Concurrent development of audiovisual materials to assist children in learning these same concepts would alleviate much of this limitation. The readers

prepared for use at the primary level will be usable by all children regardless of their ability to read prose.

Initial estimates indicate that it will be necessary to develop eight to ten readers, each at two levels, in order to adequately cover the priority areas needed to give an elementary school child an environmental education.

DEVELOPMENTAL SEQUENCE

Step 1:

Recently completed (Roth, et al., 1970) and ongoing studies at the Center have produced and are producing lists of basic environmental schemes considered appropriate for inclusion in the K-12 or K-16 curriculum by national panels of scholars in science and science-related disciplines. These lists will provide the basis for selecting the content of the materials for the K-6 environmental education-science curriculum.

Those conceptual schemes related to environmental education, appropriate for inclusion in the elementary school program, would be selected. A group of experts from science, social studies, concept learning, child development, and curriculum and instruction would be assembled at the Center to assist in making these decision. Also, this group would be asked to make their best judgments concerning the scope and sequence of these schemes for elementary school children. The Center's Task Force for Science and Social Studies would be an integral part of this Committee of Experts.

Step 2:

The tentative organizational framework established by the Committee of Experts would be critiqued by consumers and practitioners including teachers, science supervisors and curriculum coordinators, and administrative personnel. The results of the efforts of these two groups would be utilized in preparing the working framework for initiating development activities. This framework and its procedures for development would be published as a Center report.

Step 3:

The process (observation, model-building, etc.) and product (matter, animal, change, etc.) concepts, and principles, embodied in each of the conceptual schemes--science, social studies, etc.--would be identified and selected for inclusion in the development activities. These also would be presented in a Center publication.

Step 4:

Each basic concept would be analyzed according to attributes and nonattributes, examples and nonexamples, to be used in teaching and testing, relationship to other concepts, etc. Materials developed from this base would have a high probability of success because they can be systematically tried out with children and modified until the desired achievements are attained.

Step 5:

Behavioral objectives will be developed for each individual concept and sets of related concepts. These objectives will serve

as guidelines for preparation of the instructional materials and the related pre-assessment and achievement tests. The actual degree of relationship and understanding of the environmental education concepts and schemes will be determined later on the basis of hard data collection.

All work completed to this point would be necessary and prerequisite to facilitate other appropriate development activities.

Step 6:

Concurrent with the previous steps a model will be developed for preparing and quality-verifying instructional readers.

Step 7:

Reader prototypes will be developed. The first of these prototypes will be prepared for the intermediate grades and will provide the vehicle for testing the model for developing the actual reader and associated supplementary materials. Each reader prototype will consist of the following materials.

1. A reader approximately 75-125 pages in length.
2. Student activities and focusing problems.
3. Associated visuals.
4. A teacher's manual and in-service suggestions.
5. Tests.

The reader and related materials will have the flexibility of use for independent study and focusing small-group discussions. The visual materials will be geared to providing information for large groups. The teacher's manual and accompanying in-service suggestions should be

adequate to permit inexperienced teachers to use these materials effectively. With the regular and increasing efforts currently being devoted to environmental education pre-service and in-service programs, teachers will be able to increase the impact of these materials.

Step 8:

Formative evaluation and modification will proceed through a series of limited tryouts and a small-scale field test in the State of Wisconsin

1) pilot test with a limited number of children--revision if necessary
2) pilot test with a limited number of classes--revision if necessary
3) expanded test with several hundred children--revision if necessary
4) small-scale field test with children in self-contained classrooms and multiunit schools in a variety of school-community environments.

Step 9:

The quality-verified prototype will be let out for bids. Sufficient copies will be prepared to conduct a large-scale field test and pursue summative evaluation activities. These activities would probably be directed by the Center but would be conducted by other agencies such as the Regional Laboratories or a university research group.

V

RELATED RESEARCH

Research activities should be centered around helping the child to be a more productive learner and having him learn those things which will fulfill his needs. They should be pertinent to the local school scene and have potential for assisting school personnel deal with their more pressing problems such as teaching children with low reading ability. Also, they should produce results that a variety of instructional personnel working in several learning environments--self-contained classrooms, multiunit schools, teaching teams, individually guided instruction, etc.--improve on the outcomes of instruction. Major contribution to these ends can be made through an integrated program of evaluating developmental products and basic research.

The major area of needed research is the determination of the interaction of (1) the level of attainment of a concept (possible and/or intended), (2) the characteristics of the learner, (3) the characteristics of the instructional personnel, (4) the nature of the learning environment, and (5) the nature of the instructional media. For example, consider that the intended outcome of instruction was a child's ability to perform certain selected tasks adjudged to demonstrate mastery of a concept. Data would need to be collected

related to the nature of the learning environment in which children were successful or unsuccessful.

Personal Characteristics of Children:

- IQ
- Age
- Achievement
- Self-concept
- Perceptive abilities
- Values
- Other

Location and Design of the Learning Facilities:

- Suburban or core school
- Self-contained classrooms
- Individually guided education
- Other

Nature of the Instructional Personnel:

- Single teacher
- Differentiated staff
- Educational set
- Cultural attitude
- Personality
- Empathy
- Content background
- Teacher behaviors
- Other

Nature of the Instructional Media:

- Printed
- Film--Instructional, Evaluative
- Laboratory
- Verbal presentation
- Other

Nature of the Instructional Situation:

- Independent study
- Tutoring
- Small group
- Large group
- Other

The key question under investigation would be "How do children learn concepts in environmental education, science, and social studies?" Examples of specific questions are:

1. What is the nature of those children who "can learn" from printed materials? From other materials?

2. What is the nature of those children who can learn on a 1:1 basis with a teacher, instructional aide, peer? Under what conditions did learning occur?

3. What is the nature of those children who can learn in small groups that are teacher-directed, aide-directed, peer-directed? Under what conditions did learning occur?

4. What is the nature of those children who can learn in large groups under various conditions?

5. What is the nature of those concepts that children can learn under various conditions?

6. What levels (possible and/or intended) of concept mastery can children attain under various conditions?

7. At what rate can children learn various science concepts? Under what conditions?

8. For those students who read "well," can they direct their own learning from printed directions? Can "poor" readers use audio and video directions to direct their own learning? What is the nature of those children who can guide their own learning?

9. What effect do self-evaluation techniques have on what children learn, how children learn, the rate of learning?

10. Can certain of the concepts of the products and processes of science be acquired equally as well with laboratory activities presented on film rather than having children perform these activities with actual materials? By whom? Under what conditions? Research on this problem is necessary to enable the utilization of specific laboratory activities that are too difficult or impossible for children and/or teachers to perform. Such would be necessary to facilitate programs of individually guided education.

11. Can elementary school children learn to make data-based decisions regarding science-related social issues? What

prerequisite "knowledge" do the successful students possess? Under what conditions is success obtained? What is the personality and value structure of the child? What are those factors which affect the ability of children to make decisions? Can children learn to deal with a concept of "RISK?"

12. What is the nature of the situation in which children acquire an understanding of the nature of the scientific enterprise? What effect do factors such as the child's self-concept have on such acquisition?

13. What learning outcomes would be considered sufficient evidence that a concept had been mastered? (Singles and combinations.)

14. Do students learn more effectively when they are given a list of instructional objectives prior to starting an instructional program? What is the nature of those students who are successful? Not successful? What effect does the nature of the instructional program have on student success?

V

RELATIONSHIP TO OTHER CENTER PROJECTS

This project is closely related to several other projects and programs of the Center. It contributes in some degree to attainment of each of the general objectives of PROGRAM 2: PROCESSES AND PROGRAMS OF INSTRUCTION. These are:

1. To establish a rationale and strategy for developing instructional systems in the cognitive domain.
2. To identify by careful synthesis and further research sequences of concepts and cognitive skills within and across disciplines.
3. To develop assessment procedures and materials for the concepts and skills identified above.
4. To identify existing materials or develop new instructional materials associated with the concepts and cognitive skills.
5. To generate new knowledge through research about instructional procedures including motivation, individualization, classroom management, and organization of instruction.

In addition to contributing directly toward achieving these objectives, the analyses of concepts and development of related assessment materials helps to facilitate the work of Project 111: A Structure of Concept Attainment Abilities. Development of materials and related

assessment procedures contributes to a better understanding of individually guided education and the operation of related school management systems; a major Center focus.

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