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A comprehensive review and survey of elementary science and environmental education in Iowa

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Abstract

The author wishes to acknowledge friends and family members whose support and assistance were greatly appreciated throughout this research project. Dr. Greg Stefanich gave guidance, time and research assistance patiently and enthusiastically. Dr. Cheryl Budlong receives the author's appreciation for her meticulous guidance through the literature review and making the impossible seem attainable. The author's principal, Wm. Nettleton, North Cedar Elementary School, and fellow staff members have provided support and personal time. Duane Toomsen, Environmental Education Consultant, Iowa Department of Education gave encouragement, time and economical support.

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CHAPTER 1

INTRODUCTION

Introduction

Planet Earth's social and political problems and the state of the earth's environment today should prompt educators to give science and environmental education (SEE) a critical position in school programs (Rachel Carson, 1962). There is a relationship between modern (inquiry approach) science training and the development of the belief that one can in some measure, determine one's own destiny. Science is a vital part of general education; it provides innumerable opportunities for noting cause and effect relationships, using critical thinking, using problem solving techniques and developing a concept of causality. We can control our own destinies (Rowe, 1978).

The National Science Foundation and Physics Study Committee headed the development of materials and science curriculum projects for science education in the sixties. These include PSSC Physics, Science-A Process Approach (S-APA), Science Curriculum Improvement Study (SCIS), and Elementary Science Study (ESS) (Piltz and Sund, 1974). During the 1970s and early 1980s many other local, state and national groups and foundations such as the Natural Heritage Foundation, National Wildlife, and United States Conservation Department joined in the funding of SEE materials and programs. These include MINNEMAST (Minnesota Mathematics and Science Teaching Project), and more specifically directed environmental education materials: Project Learning Tree and Project Wild (Western Regional Environmental Education Council), OUTLOOK (Environmental Education Enrichment), IDEAS (Iowa Developed Energy Activity Sampler), ECAPS (Energy Conservation Activities Packets), Ding Darling Program (4-H Extension Service), Investigating Your Environment (US Forest Service), CLASS (Conservation Learning Activities for Science and Social Studies - National Wildlife Federation) and OBIS (Outdoor Biological Investigation Strategies). Recently "hands-on", inquiry based programs such as these have also been developed in the fields of social science.

The main thrust of the programs listed is the development of inquiry, critical thinking and problem solving skills through the use of science materials and activities. The emphasis varies but the "hands-on", discovery approach theme is constant. The advent of the open classroom approach and concerns following the launching of the Russian satellite, Sputnik, in 1957 nurtured the use of the programs which had been developed earlier (Piltz and Sund, 1974).

The late 1970s and early 1980s brought the detailed reports such as A Nation at Risk (1983) Holmes Group Report (1984) and Carnegie Task Forum Report (1980). Statements in these reports recommend that significant classroom time should be devoted to learning the "new basics" (Nation at Risk, 1983). These statements caused a return to basics with a greater emphasis on time on task and mastery learning which are not supportive of the inquiry approach to learning.

The comparison of the tests scores of students of the United States with scores from nations such as Japan (Walberg, 1984) has prompted additional emphasis on the basics. These comparisons have gained strength through media coverage. Other factors involving lack of confidence and training of educators has also negated our practice of a "hands-on" inquiry approach. Statements calling for a back to the basics movement have been made by government leaders such as Bennett (1986) and by fundamentalist religious groups. Fundamentalist groups oppose the fostering and teaching of critical thinking and inquiry-based discussion skills (NEA Today, 1987).

In the late 1970s and early 1980s there was a return to the use of basal science texts and to the practice of skipping science instruction altogether. The reasons for this change were the strength of the opposition to inquiry-based science, the lack of teacher training, and the lack of confidence in strategies of inquiry and SEE. Educators and researchers need to seek a workable balance between directed instruction and independent learning activities. We must work our way back towards openness and not allow authoritarianism, permissiveness or confusion to cloud our ideal (Walberg, 1984).

The search for "excellence in education" has brought a new emphasis on critical thinking, inquiry, co-operative goal structures, wait time and problem-solving (Johnson and Johnson, 1986). This gives us a new hope that modern inquiry-based science programs will become a regular part of education.

Statement of Problem

The purpose of the study was to present a summary of the status of elementary school science and to determine the level of science texts and programs in elementary schools (Grades 1-6) in Iowa. The study focused on texts and programs used in science classes, total time spent in science, time spent on "hands-on" activities, outdoor and environmental programs, and supplemental materials.

This study also formulated various comparisons with data from a survey of elementary school science done by Jan Anderson in 1980. Brief comparisons were made with data from a national survey by Weiss in 1970.

Need for the Study

There is a need to up-date the data from the Anderson (1980) survey of science practices in the elementary schools of Iowa. There is also a need to determine whether or not the discovery materials published in the 1970s as well as those recently produced were being used by teachers.

Questions to be Answered

1. What elementary science textbooks are currently in use in Iowa schools?

2. Are copyright dates of textbook adoptions current?

3. How often are schools adopting new textbooks and/or science programs?

4. To what degree are textbooks used at the various grade levels?

5. What SEE programs and materials are being used in elementary schools in Iowa? How many class periods are those programs and materials used?

6. How does the use of ESS, SCIS and S-APA compare with this level of use eight years ago?

7. What is the average number of minutes per week and number of hours per year spent on science at each grade level in Iowa?

8. How does the amount of time spent on science today compare with the time spent eight years ago in Iowa?

9. What percentage of time in Iowa elementary schools is spent on "hands-on" type of activities at grade levels 1-6?

10. How does this compare with time spent on "hands-on" activities in Iowa eight years ago?

11. What percentage of the elementary classrooms in Iowa use outdoor experiences as part of their science education program?

12. To what degree have Iowa elementary teacher's received training in SEE?

The Procedure

The literature review consists of the historical and developmental background of SEE and its implications on SEE texts, programs, materials and strategies emphasized today.

A survey was written to ascertain specific SEE information and sent to 302 elementary schools in Iowa on March 16, 1987. Duane Toomsen, Environmental Education Consultant, Iowa Department of Education, provided address labels, mailers, postage and receiving personnel for the surveys. From the complete set of Iowa elementary school address labels provided, every third label was used to form a randomly selected sample.

A set of seven survey forms were sent to each selected elementary administrator. The administrators were asked to select one teacher at each grade level to complete a survey form and return it to him/her for return to the Department of Education, Des Moines, by May 1, 1987.

Between May 1 and June 20 results from the survey were compiled and recorded in tables. The data were recorded in raw scores and percentages.

The survey covers a time period ranging from 1980 to 1987 with comparisons to earlier surveys of a time period ranging from 1961-1977. Lack of recent surveys by other researchers limits the number of comparisons that can be made.

Delimitations

1. The review of the literature was limited to materials available at the University of Northern Iowa, Cedar Falls, Iowa.

2. The study was limited to 302 randomly-selected Iowa elementary schools.

3. The study surveyed only one instructor at each grade level of a selected school in grades one through six.

4. National comparisons were limited because of unavailability of the recent research materials.

Definition of Terms

The terms defined in this section are terms used in the paper that may require further clarification for the reader. The first 14 titles refer to SEE programs and materials used in the survey instrument of this study.

ESS (1978) - activity-based, by Education Service, independent units for K-9 designed to create a natural curiosity in children concerning their environment and to develop in inquiry area.

S-APA (1976) - activity-based, hierarchical development of process skills, K-6, developed by American Association for the Advancement of Science.

SCIS (1975) - activity-based, to develop science literacy through scientific concepts.

MINNEMAST (1976) - investigative, based on integration of mathematics and science in the classroom.

Project Learning Tree (1977) - an interdisciplinary program with student interaction with natural and social environment.

OUTLOOK (1983) - interdisciplinary environmental education program of K-12, based on learning cycle.

Project Wild (1985) - interdisciplinary environmental and wildlife program emphasizing wildlife.

IDEAS (1986) - energy conservation activities and inquiry based discussion, decision-making skills emphasized.

<u>ECAPS</u> (1977) - similar to above, revised and combined in new IDEAS.

<u>Ding Darling Program</u> (1983) - cartoon-based conservation activity-based program based on work of cartoonist Ding Darling.

<u>Sharing Nature With Children</u> (1979) - this is a book of activities and discussion ideas based on ecological concepts.

<u>Examining Your Environment</u> (1977) - woodland-based investigative environmental education activities.

<u>CLASS</u> (1981) - activity based ecological program from National Wildlife Federation.

<u>OBIS</u> (1979) - learning activities for use at common outdoor sites to help students gain a better understanding and appreciation of the ecological relationship in their local environment.

<u>Inquiry Approach</u> - science approach based on questions to students that ask: What do we know? How did we learn it? What does it mean? - and invites continuous inquiry (Rowe, 1978).

Environmental Education - the study of interdependencies of our ecological system resulting in an understanding of the need for conservation and protection of species and resources (McCollough, 1983).

Conception of Causality - control you have of your own destiny gained through confidence in concept - conflict situations of inquiry, fate control (Rowe, 1978).

SEE - An acronym composed for this paper representing science and environmental education.

Wait Time - time a teacher waits after asking or responding to a reply, three or more seconds recommended (Rowe, 1978).

Summary

A comprehensive literature review of the historical and developmental aspects of SEE in the United States was compiled. SEE needs were determined based on problems faced in our nation today, survey results, and current status of classroom curriculum and climate.

How these needs are currently being met in Iowa was determined by a survey of 302 randomly-selected schools. Requests were made through the survey for time, texts, programs and strategies in reference to

SEE. Information regarding teacher training and environmental interests was also requested.

The objectives of this study were: a) to compile a literature review summarizing the development of SEE, b) to determine and compare texts, copyrights, time spent on materials and programs, c) to determine materials and programs currently being used in Iowa elementary classrooms, d) to determine environmental interests and time, strategies and materials used in SEE.

A comparison was made of Iowa's elementary SEE practices to a similar study completed in 1980, and a brief comparison was made to national practices, surveyed in 1977.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Introduction

There is a need for student involvement in process, inquiry-based, exploration in science and interdisciplinary environmental education. The basis for this need lies in the projected positive effect of critical thinking and problem solving skills and their future application. This literature review reports on the historical, developmental and current trends in elementary school science and environmental education.

A brief overview of the set of assumptions derived from the studies of educational theorists is provided. This overview provides a basis for understanding the science and environmental education philosophies and programs of the 1960s and 1970s. It also helps define current practices and trends. From 1955 to 1975 there was more activity in science education than during any other two decades. (Helgeson, Blosser and Howe, 1977). Thus to understand the current practices and projected trends this time period must be carefully reviewed. The actual state of the earth's environment is the real test of validity for science and environmental eduation.

Fifty percent of the elementary teachers surveyed in the United States feel they do not have enough time to teach science (Maben, 1980). In New Hampshire, surveys conducted in 1970 and 1978, found that science was rarely being taught as a major part of the curriculum. This was also projected to be a national trend (Andrew, 1980).

Two terms need to be clearly defined before this literature review can be understood. Cognitive developmentalists and behaviorists are the terms commonly applied to the two conflicting schools of thought regarding science and environmental education.

Cognitive developmentalists believe the brain acts on the environment and makes it meaningful. Everything should have meaning. Students should respond by forming a reality to learn, to create a model from reality, and to be able to test that model against reality. To the cognitive developmentalist everything should have meaning. The teacher becomes the support person who helps the child give meaning to the things in the environment.

Behaviorists believe that the mind is a passive receiver of what the senses give it. Reductionism, breaking down into smaller parts, is necessary for learning. The more frequently an act takes place the easier it becomes. Behaviorists believe answers and outcomes are very important. Connectionism, conditioning and habituation are important aspects. Behaviorists consider discovery learning academically inefficient (Knapp, 1985).

This paper is basically composed of five parts. Chapter 1 is an introduction and preface. Chapter 2 relates the studies and conclusions of early educational theorists in a brief overview of those works important to current science and environmental education. This chapter reviews theorists and science education strategies present in United States education from the early romantic period of the 1930s, the "camping" approach of the 1940s, through Sputnik's impact in the 1960s, the influence of the energy crisis of the 1970s, to present trends of the 1980s.

Chapter 2 also discusses the teacher's role in science and interdisciplinary environmental education curriculum, the actual resulting current SEE theories, and instructional models, materials and education programs being used in science education today. This discussion was based on the work in current science and environmental education journal articles. Results of a survey of SEE in Iowa's elementary schools concludes the study in Chapters 3, 4 and 5.

Education Theorists and Science and Environmental Education

The writers of the 1930s finally left the religion-based texts and behaviorism and explored nature from a more scientific and romantic viewpoint (Guilford, 1956). Theories from the school of Gustac soon became the basis for cognitive developmentalists in science education. Free thought and good questioning techniques were encouraged in classrooms (Botsford, 1939). Gustac believed that true understanding of the whole comes from breaking the whole into parts. This philosophy formed the beginnings of the belief in the need to recognize cognitive development. It was also attributed to being the bridge from behaviorism to cognitive developmentalism. These combined philosophies have formed the real basis of environmental education in the present day.

Herman Epstein studied brain spurts and plateaus in students, ages 11 to 15, and determined a need to laterize and connect knowledge, later known as formal reasoning or application (Glasser, 1984).

Piaget (1982), although not a learning theorist, wrote on his detailed study of how the mind works. Through his study of Epstein's writing and his work with Bennett on the construction of tests for the human mind, Piaget concluded that children conceived reality differently from adults and at different stages. He worked from the simple premise, "How do children know?" He developed the terminology for the four basic stages he recognized in a child's development: (a) sensori-motor, (b) pre-operational, (c) concrete operational, and (d) formal operations.

Kuhn (1979) built on Piaget's work especially in the area of formal reasoning. He wrote of students' needs for building operations on operations (abstractions on abstractions). He believed in the mind's ability to build mental models from concrete reasoning.

Kohlberg (1975) molded the work of Piaget and Kuhn to his detailed theory of cultural morality or culturally imposed values. He wrote of strict moral codes that must guide humans, regardless of the outcome, the rule must be followed, specific rules derived from specific cultural morality. The stages he wrote of were: (a) preconventional - comfort-oriented,

(b) conventional - peer group imposed, concern for the rule, (c) post conventional - social contact, concern about effect of rules as well as the rule itself, and (d) level of freedom - free to make choices, to make decisions on own morality, following the needs of humanity as opposed to following the rules of the majority's feelings. At this level "majority rules" is not a final decision. You use your own approach to decision making.

Bruner (1958) researched and wrote of the process of education and especially science education. He stressed the need for teacher-understanding and organization of materials to be learned. However, he stated that the discovery method should be used to motivate the learner with minimum information and maximum references available. The goal, to Bruner (1958), was for the student to leap the learning-thinking barrier--to want to learn, to think and to apply learning.

Ausubel (1961), Gagne (1962), Skinner (1949), and Bloom (1959) wrote more from the behaviorist's point of view. Gagne was a leader who emphasized the hierarchy of learning. He wrote of his belief in structure, the need for details first and then breaking tasks into parts. He also researched memory and comprehension.

Ausubel (1961) was concerned with speed and efficiency in learning. He advocated teacher-formed frameworks, not student-formed. Developing concepts with meaningful verbal learning was important to Ausubel. Although he built his work somewhat on Gagne's, (1962) he advocated an overview (as opposed to Gagne's details first) as an end result to the understanding of knowledge integrated into a whole. The advanced organizers of Ausubel became especially important in the 60's after the impact of Sputnik.

Skinner's (1949) research and studies centered on the mastery of learning through conditional responses. He advocated manipulated reinforcements. Skinner's (1954) mastery learning was built on the taxonomy developed by Benjamin Bloom's (1959) research and writing. This taxonomy organizes levels of learning in all knowledges as being: (a) knowledge, (b) comprehension, (c) application, (d) analysis, (e) synthesis, and (f) evaluation.

Dewey earlier wrote of "learning by doing," functionalism, the WHOLE being vital and equal opportunities for all (learners) groups (Dewey, 1930, 1945). Glasser (1984) followed with his work in strong, positive decision making based on a student's understanding with (1) defining, (2) personalizing, and (3) challenging both academic and physical-action problems on a personal and/or far reaching level.

Development of Environmental Education

The thirties brought the freedom of questioning and individualization (Botsford, 1939). War in the late 1930s and 1940s led us to a tighter, less romantic philosophy to one with a more sound scientific basis. The 1940s introduced the "camping" plus basic outdoor knowledge plan. The new freedom of the 1950s and early 1960s produced the "open-classroom" theories, but Sputnik brought educators back to hard realities (and basics) in the late 1960s (Iozzi, 1983).

Environmental education in the 1970s was greatly influenced by an energy crisis and new environmental fears (Knapp, 1985). This new influence, plus the work of the early theorists, forms the basis for the present-day philosophies and programs.

In a study of 270 schools in 22 states in 1972, it was revealed that the average 10th and 12th grader possessed a limited amount of cognitive environmental information (Knapp, 1985). Knapp continues that although research had supported the teaching of responsible environmental decision making through effective inquiry and valuing skills. Unfortunately, educators and citizens have not supported environmental education to the degree that is necessary. This is especially true at the secondary level.

Knapp (1985) offers further proof in a study of environmental education of the 1970s that revealed that high school students ranked an environmental curriculum objective as the most important among eleven other educational objectives. In the same study parents ranked the environmental objective fourth, teachers ranked it tenth and administrators ranked it eleventh. It is evident from this study why environmental education has not been given the highest priority in the curriculum despite the preferences of high school students (Knapp, 1985).

In striving for further implementation of environmental education in school systems across the nation, environmental leaders and groups, and interested educators formulated and/or recognized declarations and codes in the 1970s. Examples of these are: The Declaration of the Dependence of the Land, A Bioethical Creed for Individuals and A Trail Users'

Code of Ethics (Knapp). Many declarations connected needed values to basic philosophies of native Americans. New centers for studies of environmental issues such as the Sigurd Olson Environmental Institute of Ashland Wisconsin developed across the nation.

Another such center, the Northwest Environmental Education Center submitted a position paper to the 1971 Session of the Washington State Legislature. The position taken was:

> Human survival depends upon a major change in the way we view our relationship to the world. Pathogenic premises within which we now operate have been identified by experts as the major cause of our environmental crisis. These premises must be challenged by our educational institutions through reform from within that includes the adoption of transdisciplinary, problem-solving curriculum. We must offer students environmentally sound alternatives to the uncertain future they face, in an educational environment that is humanized. A model for a regional academic plan as well as for a program is proposed (Northwest Environmental Education Center, 1971, p. 3).

The Pathogenic Premises identified by the Educational Policy Research Center, Stanford Research Institute were used in the position paper mentioned above. These premises were prepared for the Bureau of Research, U.S. Office of Education in 1970, and have been widely used across the United States. The premises have been identified as the major cause of our environmental crisis and environmental education programs must offer alternatives (in decision-making and for life style).

These premises are:

1. The premise that the pride of families, the power of nations, and the survival of the human species all are to be furthered (as in the past) by population increase.

2. The "technological imperative," that any technology that can be developed, and any knowledge that can be applied, should be.

3. The premise that the summed knowledge of experts constitutes wisdom.

4. The reductionist view of man, a premise associated with the development of contemporary science and which lends sanction to dehumanizing ways of thinking about and treating men.

5. The premise that men are essentially separate, so that little intrinsic responsibility is felt for the effects of presentations on remote individuals or future generations.

6. The premise that man is separate from nature, and hence that nature is to be exploited and "controlled" rather than worked with cooperatively.

7. The "economic man" image, leading to an economics based on ever-increasing GNP, consumption, and expenditure of irreplaceable resources.

8. The premise that the future of the planet can safely be left to autonomous nation-states, operating essentially independently.

9. The disbelief that "what ought to be" is a meaningful concept and is achievable (Educational Policy Research Center, 1970).

From the work of the centers described in this paper and many other groups and individuals emerged the Environmental Policy Act of 1969. It officially established the practice of evaluating the effects of man's changes on the environment. An environmental impact statement (E.I.S.) is a report which examines a proposed project in detail. Environmental impact considers how much the project will affect different parts of the environment. With the passage of this policy act and the consequential studies and environmental impact statement that followed, the need and importance of environmental education became more evident and profound (Knapp, 1985).

Hungerford (1980) conducted a study to determine if the attitude of sixth grade students would be positively changed after participation in a series of outdoor education investigations conducted on the school site and in the community. A control group of an equal number of sixth graders having no outdoor education experiences was used. The pre-test and post-test comparisons showed that the mean score of the experimental group was significantly higher, at the .05 level, than the mean score of the control group. It was concluded that a significant effect had resulted in the subjects of the experimental group due to the weekly outdoor education experience.

He further concluded that there were two major implications of his research. First, programs of school site and community outdoor education could achieve positive attitudinal changes. Second, such a program could be successfully implemented by a classroom teacher. Hungerford (1980) recommended that school boards introduce their teachers to the outdoor education method and that further study should be done in the area of effects produced on on-site outdoor education programs. In further studies, Hungerford (1980) suggested that environmental education does not have to take place in the "out-of-doors" or "in the woods or country," but can take place anywhere you are.

The National Commission on Environmental Education Research (NCEER) was established in 1980 when a need was perceived for researchers in the field of environmental education to gather and examine the rapidly growing body of environmental education research. The purpose of the commission was to organize and synthesize that information and to make suggestions and recommendations to help guide future research.

Through the work of the (NCEER) commission, Iozzi (1983), synthesized more than four hundred environmental education research abstracts. A conclusion of this comprehensive study was that traditional lecture and discussion, self-instructional simulation, advanced organizers, and combined indoor-outdoor instructional approaches can be effective in the development of ecological knowledge and future application in formal (education) settings.

In a study by Stapp (1973) a conclusion was reached that schools should design instructional programs to help develop skills, such as critical thinking, problem solving and social change strategies. "Such schools assist students to function more effectively in achieving goals arising from their attitudes of concern for the environment," Stapp projected (1973, p. 82). In a study by the Northwest Environmental Education Center (1971) it was recommended that there was a great need for quality curriculum design, program revision, content improvement, and the development of a composite environmental education curriculum content plan. Iozzi (1983) concluded that government regulations was believed by many to be the most effective and desirable way of solving environmental problems.

In the late 1970s the North American Association for Environmental Education was formed. The guiding principles stated that:

1. Environmental education should consider the environment in its totality - natural and built; biological and physical phenomena and their interrelations with social economic, political, technological, cultural, historical, moral, and aesthetic aspects.

2. Environmental education needs to integrate knowledge from the disciplines across the natural sciences, social sciences and humanities.

3. Environmental education must examine the scope and complexity of environmental problems and thus there

is a need to develop critical thinking and problem-solving skills and the ability to synthesize data from many fields.

4. It should develop awareness and understanding of global problems, issues, and interdependence - helping people to think globally and act locally.

5. Consideration both short and long term futures on matters of local, national, regional and international importance should be part of environmental education.

6. Environmental education should relate environmental knowledge, problem-solving values, and sensitivity at every level.

7. Environmental education should emphasize the role of values, morality and ethics in shaping attitudes and actions affecting the environment.

8. It should stress the need for active citizen participation in solving environmental problems and preventing new ones.

9. It needs to enable learners to play a role in planning their learning experiences and providing an opportunity for making decisions and accepting their consequences.

10. Environmental education should be a life-long process - should begin at a preschool level, continue throughout formal elementary, secondary, and post secondary levels, and utilize non-formal modes for all age and educational levels.

These guiding principles later became a guide for the National Association for Environmental Education (Iozzi, 1983). Environmental education research and studies resulted in the actualization of the value of ecological knowledge and the value of environmental education as a vehicle to promote the development of inquiry, critical thinking and problem-solving skills.

Development of Current Science and Environmental Education Theories, Practice, and Trends and the Teacher's Role

Teachers have a significant, vital role in science and interdisciplinary environmental education and in models, materials and programs being implemented in the classroom today. Yager's (1986) conclusion after studying school science is:

> We need a new focus for school science. We need teachers who see their primary role to be preparing future citizens - all people - to live more effectively in a scientific/technological society. We need teachers with different philosophical orientation, and the new orientation needs to be so engrained that it affects curriculum design, instructional strategies,

> evaluation techniques and the day-to-day experiences that students have with their school science (p. 145).

In other studies he concludes:

> By getting students outside, by using the community as a classroom and laboratory, their teachers allow the students full opportunity to do, to learn, to appreciate, and to feel a part of their own communities. At the same time, community leaders become involved in the school science program, increasing its richness and its value. By every definition, this is science-learning at its finest (Penick & Yager, 1986, p. 147).

These conclusions are supported by Dewey's (1916) philosophy of student-involvement and community responsibility.

Studies of the role of writing in science lead to similar conclusions. Writing is efficient; it works as learning. In laboratories, science teachers give students opportunities to learn science by experimenting with procedures and instruments. Writing can also let students experiment with concepts and processes. As they manipulate and test factual data on paper - as they write - they actively learn science (Strenski, 1984). Time for observation and pair-peer discussions followed by writing is emphasized by Blake (1985).

Partner and small group interactions are emphasized in other writings and studies. In a project called PLUS (Partner-Learning in Understanding Science), DiSibio and DeReu (1986) conclude that partner-learning in science combines the process and product approaches to science investigations and productive student interaction.

Teacher-student and class interaction is advocated for across-the-curriculum environmental education strategies to develop thinking, problem solving and strong decision making skills by Glasser (1973). Small peer groups solving mathematics problems together, enhance and promote skills for problem solving in all areas (Charles, 1985). This philosophy has been adopted by many Cedar Falls teachers and is currently being tested (Dotseth, 1986).

Small centers for providing remedial work, individualization, enrichment challenge and expansion are advocated for science education in studies conducted by curriculum writers (DiSibio and DeReu, 1986). If in total class instruction, small groups or centers, it is currently advocated that the ideas of the theorists such as Ausubel and Bruner should be respected (Yeany, Yap, and Padilla, 1986). Advance-organizers and carefully organized and prepared lessons are important (Ausubel, 1961) (Bruner, 1961).

Current studies indicate that process-skill-based curriculum activities need to be developed and presented with a structure which reflects the super and subordinate relationships of the skills. An assessment of students' needs to be carried out on a very systematic and individual basis. The entry level as well as the progress of students in relation to the skills must be measured regularly to determine the status of an individual and prescribe instruction which is responsive to task-related prerequisite skills lacking in the student (Yeany, Yap & Padilla, 1986).

Aside from the attention that should be given to these suggestions by school science personnel, science education researchers need to pick up on the task of establishing hierarchical relationships which exist among the set of concepts and skills identified as those to be attained by a scientifically literate person. Application capabilities need to be studied. The measurement and statistical procedures are in place to support such an effort. The job is mammoth. It will require the efforts of many people and a major commitment of time and money. But until this type of effort is made and a stable concept/skill hierarchy is established on an empirical basis, no effort to construct a theory of discipline will be entirely successful (Yeany, Yap & Padilla, 1986). There may need to be a whole field developed known as the science of application (Rowe, 1978).

The effort to integrate Piagetian cognitive modes with science process skills is strong but reveals frustration as in the Yeany, Yap & Padilla (1986) study and in the Tobin (1986) study. Tobin highlighted some implications for planning and teaching activity-oriented science in middle school grades. Teachers tended to implement the planning and processing components of science activities in whole class interactive settings. As a consequence, engagements for most students was covert in these parts of the lesson.

Teachers might plan and implement science activities so that more opportunities are provided for overt student engagement in learning tasks. The results of the studies do reaffirm the relationship between formal reasoning ability and process skill achievement. Tobin (1986) believes further research is needed to seek answers to questions concerning differential involvement of students in learning tasks and the role of the teacher in initiating and maintaining student engagement.

The role of the teacher is further debated and discussed by researchers and writers. Teachers take a vital role in textbook selections - although the bitter textbook wars of 1960s and 1970s are over, new political battles may be taking shape. Clashes between special interest groups over what children should read are likely to be far more complex than the battles of the past (Bernstein, 1985).

The past histories of gender, class and ethnic relations, and actual local political economy of publishing set the boundaries within which these decisions are made and in large part determine who makes the decisions (Apple, 1985). Besides textbook and resource selection, teachers must acknowledge the censorship movement across the curriculum and especially in science. Public education has often become the scapegoat (Griffin, 1986).

Teachers must decide on how time is spent in classrooms. About 58% of the school day is allocated to academic activities. During time allocated for academics, students spent about 16 minutes per hour not actually engaged in the academic task. On the average, students were engaged about 73% of the allocated time in reading and math (Rosenshine, 1986).

With limited time for science and environmental education, the teacher's goal must be to use the most practical, sensible and possible way to enhance environmental science in our schools. A recommended approach is the infusion of environmental education across the curriculum. This has the potential of providing a significant contribution to the educational enterprise and to environmental quality (Disinger, 1985).

Teachers must acknowledge wait time importance for promoting inquiry. Riley (1986) concluded that after an analysis of achievement results, there were significant differences attributable to teacher wait time and questioning level. McNergney and Haberman (1986) conducted research on wait time after questioning and concluded that people want schools to teach more than facts. Society needs thinking graduates who can solve adult problems. Preparing students to be critical thinkers isn't easy but providing appropriate wait time is an important step in the right direction (Rowe, 1978).

Teachers must acknowledge factors pointed out in such reports as The Nation at Risk: The Imperative for Education Reform (1983), The Paideia Proposal; An Educational Manifesto (Macmillan, 1982), Goals for Holmes Group Standards (1985) and What Works: Research About Teaching and Learning (Bennett, 1986). Bennett (1986, p. 7), United States Department of Education, describes an effective school from research findings, as follows, "The most important characteristics of effective schools are strong instructional leadership, a safe and orderly climate, school-wide emphasis on basic skills, high teacher expectations for student achievement, and continuous assessment of pupil progress."

Walberg's (1984) research is cited in Figure 1. Curriculum development and implementation is a role of the teacher. Walberg (1985, p. 23) wrote from research:

> Sharing power over curriculum development can involve risks. The political context in which vital curriculum decisions will be made must be a context in which all parties concerned with school improvement are involved and working cooperatively. Curriculum leadership can be measured by the degree of competence of teachers.

After nationwide, state-wide and/or school-wide science curriculum decisions are made, the teacher decides the specific instructional models and programs

Method	Effect	Size
Reinforcement	1.17	XXXXXXXXXXXX
Acceleration	1.00	XXXXXXXXXX
Reading Training	.97	XXXXXXXXXX
Cues and Feedback	.97	XXXXXXXXXX
Science Mastery Learning	.81	XXXXXXXX
Cooperative Learning	.76	XXXXXXXX
Reading Experiments	.60	XXXXXX
Personalized Instruction	.57	XXXXXX
Adaptive Instruction	.45	XXXXX
Tutoring	.40	XXXX
Individualized Science	.35	XXXX
Higher-Order Questions	.34	XXX
Diagnostic Prescriptive Methods	.33	XXX
Individualized Instruction	.32	XXX
Individualized Mathematics	.32	XXX
New Science Curricula	.31	XXX
Teacher Expectations	.28	XX
Computer Assisted Instruction	.24	XX
Sequenced Lessons	.24	XX
Advance Organizers	.23	XX
New Mathematics Curricula	.18	XX
Inquiry Biology	.16	XX
Homogeneous Groups	.10	X
Class Size	.09	X
Programmed Instruction	-.03	-.
Mainstreaming	-.12	-X
Instructional Time	.38	XXXX

Note: The X symbols represent the sizes of effects in tenths of standard deviations.

Home, Peer, Class Morale, and Media Effects

Method	Effect	Size
Graded Homework	.79	XXXXXXXX
Class Morale	.60	XXXXXX
Home Interventions	.50	XXXXX
Home Environment	.37	XXXX
Assigned Homework	.28	XXX
Socioeconomic Status	.25	XXX
Peer Group	.24	XX
Television	-.05	X.

Note: The X symbols represent the sizes of effects in tenths of standard deviations or correlations.

Figure 1. Instructional Quality and Time Effects on Learning.

to be used in his/her classroom. Many lists of programs and activities are currently available. These publications have recognized the complexities of the expectations for science and environmental education in the 1980s. They are prepared on the background research and studies of the accepted theorists as related to science education reported.

Before choosing programs, teachers must make the decisions to include or exclude outdoor education. Priest (1986) writes a definition for outdoor education founded upon six major points: (1) method for learning, (2) experiential, (3) takes place outdoors, (4) requires uses of all senses and domains, (5) based upon interdisciplinary, and (6) is a matter of relationships involving people and natural resources. An approach is outlined in Figure 2. Priest maintains that this approach properly integrated, achieves objectives for all four relationships, and in the process, create a truly functional outdoor education experience.

In contrast to Priest's (1986) opinion that the outdoors is a necessary setting for environmental education, Lutts (1986) concludes that personal experience of "place" is a fundamental step toward

The Outdoor Setting

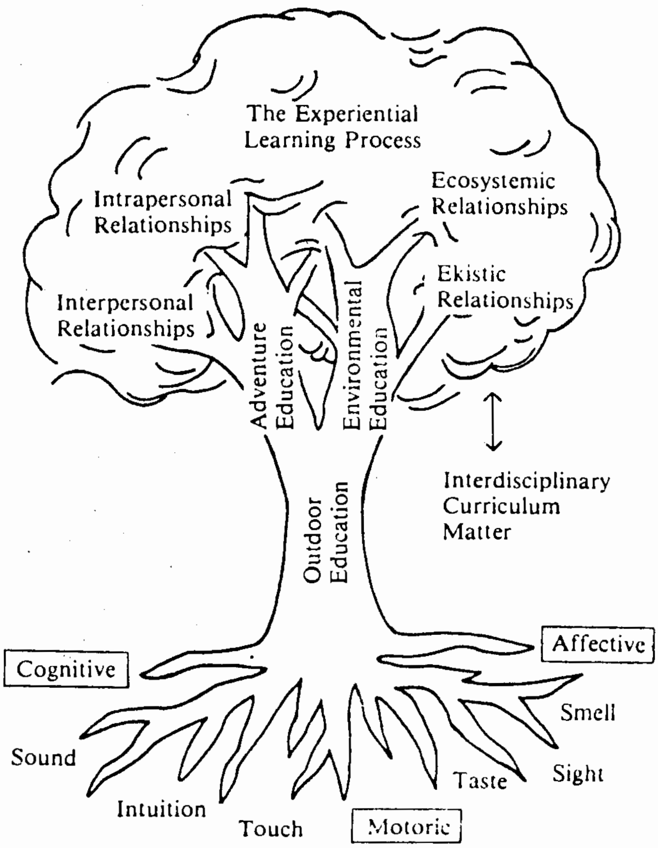

Figure 2.

understanding our environment. Environmental education needs to take place everywhere at all times. Environmental educators should make good use of place, home and story in their teaching.

After place and definition, choice of instructional models and programs remain. The curriculum choice of the 1980s based on the work of educational theorists and current environmental education researchers and writers is supportive of student involvement in exploration, critical thinking and decision making. Pre-organizers (Ausubel, 1961) and an accepted hierarchy of learning (Bloom, 1959) are also generally agreed upon as being a good basis for an effective environmental education program.

Multi-disciplinary approaches are deemed most beneficial (Thompson, 1986). In Thompson's studies, he developed the schema depicted in Figure 3. It was not meant to be a model for curriculum development but rather a holistic and hierarchical organization of factors which should be incorporated in an environmental aesthetics curriculum and the related processes of learning.

The choice of the educator is broad. Models and programs available seem to build on the complexity of the demands of a meaningful SEE curriculum as seen in Figure 3. Many science and environmental process, activity, inquiry-based programs are now available. The following brief overview of just a few of these programs makes this evident:

1. <u>USMES</u>, Unified Science and Mathematics for Elementary Schools (1977) challenges students to solve real problems. Solving real problems is

Science and Environmental Education Model

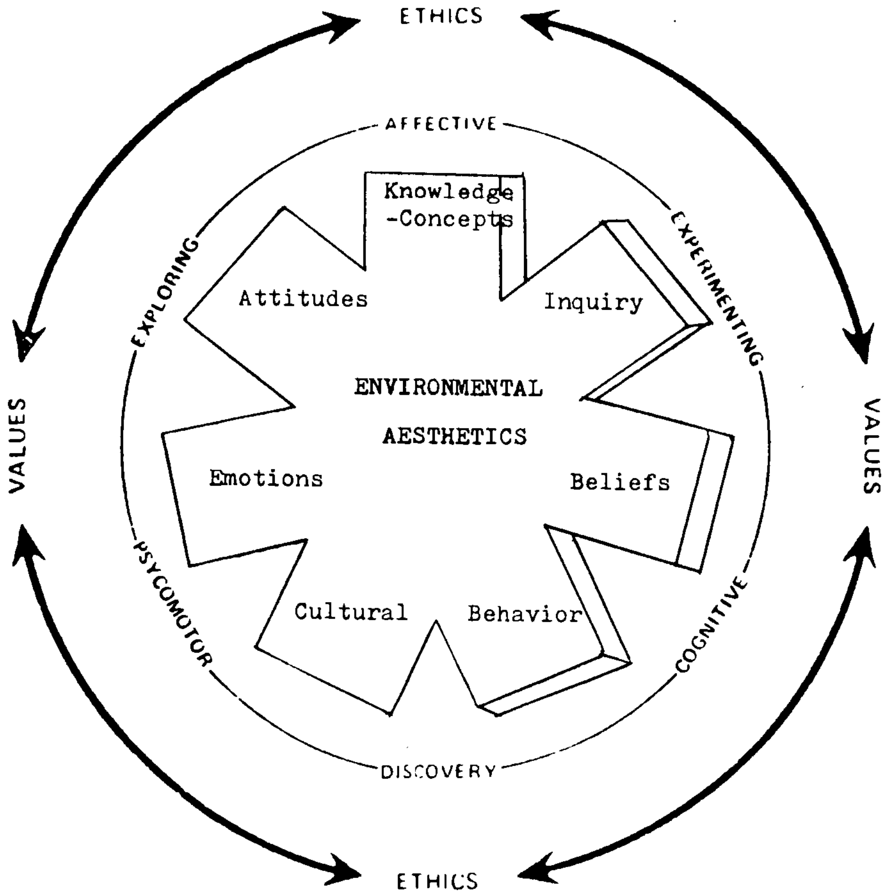

Figure 3.

interdisciplinary; skills, processes, and concepts from science, mathematics, social science and language arts all play a part. Students make decisions, work productively in small groups, and develop and clarify values.

2. MINNEMAST Minnesota Mathematics and Science Teaching Project (1976) is based on integration of mathematics and science in the classroom; investigative process is used.

3. Project Learning Tree (1977) is an interdisciplinary program with student interaction with natural and social environment.

4. Project Wild (1985) is an interdisciplinary, environmental and conservation education program emphasizing wildlife. It is to assist learners of an age in developing awareness, knowledge, skills and commitment to result in informed decision-making responsible behavior, and constructive actions concerning wildlife and the environment upon which all life depends.

5. The Learning Cycle (Cooney, 1986) is based on a theory that if one follows Piaget's theory of learning, a precise pattern can be established to assist students in their mental development. Students can be provided with conditions in which disequilibration, assimilation, accommodation, and equilibration will occur. In other words, if instructional strategies are based upon Piaget's theory, the necessary components for concept

development will place your students in disequilibration with regard to a specific concept and then provide opportunities for them to assimilate and accommodate the new concept.

6. OUTLOOK (UNI, 1983) is a completely interdisciplinary program for grades K-12. It is based on 11 environmental topic/issue spheres, six themes and a developmental scheme which focuses upon the cognitive abilities of the student curriculum matrix as shown in Figure 4. Activities of OUTLOOK are presented in a three-part learning cycle: (a) exploration, (b) invention, and (c) application (Piaget).

7. Project CLASS (National Wildlife Federation, (1981) is a program directly based upon the theories of Bloom (1959) (Knowledge, Comprehension, Application, Analysis) and Kuhn (1979) (Receiving, Responding, Valuing, Organization). The investigation is outlined and specific integration methods are suggested for various concept investigations in the areas of science, social studies and math or social studies, language and art. Relationships between cognitive and affective domains are recognized and utilized in these lessons.

Outlook Curriculum Matrix

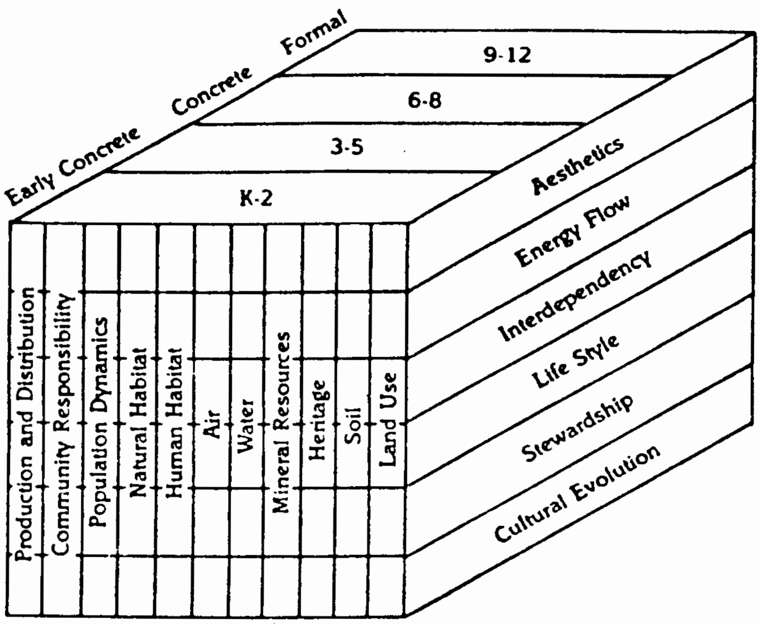

Figure 4.

8. IDEAS (1986) and ECAPS (1977) are two energy conservation programs that provide conservation activities and inquiry-based discussion ideas.

9. Other programs available and discussed further in the Definition of Terms of this study are: Ding Darling Program (1983), Examining Your Environment (1971), and OBIS (1979).

Human behavior can rarely be neatly compartmentalized in terms of cognition and affect. It is easier to divide educational objectives and intended behaviors into the two domains of cognitive and affective domains. However, even the separation of objectives into these two groups is somewhat artificial in that no teacher or curriculum worker really intends one entirely without the other. There is a great deal of research which demonstrates that cognition and affect can never be completely separated. But even more interesting are the possibilities that one exists partly because of the effect of the other.

There have been many who take the view that interest will arise from increased information about some area of knowledge and that if teachers forget all about the affective objectives, they will "naturally" arise from the development of the cognitive objectives. (Bruner, 1958) felt that it is the process of problem solving and discovery in learning that will bring about increased motivation for the subject and all the appropriate interests and attitudes. He believed that it is not so much what is learned, but how it is learned, which will determine the affect that will be attained at the same time as the cognitive objectives are attained.

There is a need for research and for educators to understand more thoroughly students conceptual knowledge. Elementary teachers need to have a command of: (a) the reasoning patterns and preinstructional conceptions students have, (b) the scientists' view and, (c) the appropriate goal for the children, given their age (Riley, 1986).

There are also some educators who believe that the primary problem is one of motivating students. If the students develop appropriate affective behaviors, then the learning of the subject matter (and cognitive objectives) will take place at a very rapid rate and at a high level of complexity. Recent research proves wait time valuable for learning in science (Rowe, 1986).

The writers of Project CLASS, (1986) are convinced that, although there may be various relationships between cognitive and affective objectives, the particular relationships in any situation are determined by the learning experiences the students have had. Thus one set of learning experiences may produce a high level of cognitive achievement at the same time that it produces an actual distaste for the subject. Another set of learning experiences may produce a high level of cognitive achievement as well as great interest and liking for the subject. Still a third set of learning experiences may produce relatively low levels of cognitive achievement but a high degree of interest and liking for the subject.

All three situations are not only theoretically but actually possible. What is true in any given situation has rarely been investigated because researchers have not had the necessary instruments to study both cognitive and affective outcomes simultaneously. It is to be hoped that an increased emphasis on affective objectives and the development of appropriate instruments and research designs will enable educational research workers to resolve some of these issues in both theoretical and more practical and specific educational situations.

In some instances it it impossible to tell whether the affective goal is being used as a means to a cognitive goal or vice versa. Perhaps it is fairest to say they are both being sought simultaneously (CLASS, 1981).

Research supports the notion that affective goals can be reached through discovery learning and that positive attitudes toward an intellectual activity (as well as skill in it) can be developed through the development of the child's inquiry abilities (Suchman, 1962).

In some instances the joint seeking of affective and cognitive goals results in curricula which uses one domain as the means to the other on a closely-knit alternating basis. Thus a cognitive skill is built and then used in rewarding situations so that affective interest in the task suggests persistence towards the next cognitive task to be achieved, and so on. Through alternating between affective and cognitive domains, one may seek a cognitive goal using the attainment of a cognitive goal to raise interest (an affective goal). This permits achievement of a higher cognitive goal, and so on (Project CLASS, 1986).

Project CLASS writers concluded that educators must decide against the negative approach, (Project CLASS, 1986). Reported findings concluded that children and adults develop a hopeless attitude from negative presentations, and when values are imposed.

Computer education has become an important aspect of many classrooms. Wallace states that all teachers must decide on, the computer's place and the place of their class, in the computer curriculum (Wallace, 1983). He continues that computers link classroom skills to the real contemporary world. Wallace stresses the importance of software selection. Science software materials are being developed on sound environmental education theories.

The unprecedented pace of scientific and technological innovations of the past several decades have made great demands on science education. Steps must be taken to meet these demands through development of centers for collaboration in science education. How such centers can be funded, and how to create forums at national conferences to develop action plans are future needs (Linn, 1987).

Summary

The literature provides a solid base of sound research for inquiry based science and environmental education. Activity and research in environmental education in the 1970s led to new awarenesses and goals for the 1980s in SEE.

The interdisciplinary approach supported by educators offers opportunities for excellent SEE instructional programs. These will allow for future application of knowledge and skills in environmental issues and problem-solving situations.

However, there are many factors influencing the classroom teacher's decisions that do not contribute to the implementation of exploratory science and/or interdisciplinary environmental education in the curriculum. These factors render a significant discrepancy between sound research data and actual classroom practice in elementary science.

CHAPTER 3

PROCEDURES

Introduction

The sample population is defined and sampling procedures are outlined. Specific procedures for designing and distributing the survey form and the collecting of data are discussed. Procedures for computing, summarizing and reporting the data are reported.

Population Description

The sample was drawn from the population consisting of Iowa elementary teachers of grades 1 through 6. The sampling was randomly drawn by the use of every third address label from a computer - printed current address label packet containing all Iowa elementary schools by buildings, totaling 926. The addresses were organized in this packet by zip code so a wide geographic sampling was allowed. This was obtained from the Science Curriculum Department, Iowa Department of Education. One teacher from each grade level, grades 1 through 6, of selected school buildings was surveyed.

The use of every third address label yielded 302 schools or approximately one-third of the elementary schools in Iowa. Time and cost consideration made a survey of the total population impractical. Many sixth grades are now a part of middle schools, so although a survey was included for each sixth grade, it was projected the return would not be as high as for grades Kindergarten through fifth. The Kindergarten results will not be a part of the study.

Design of the Survey Form

An appropriate survey (appendix A) was designed in February of 1987 to determine time spent on various strategies, materials utilized, and teacher interest and educational background as related to SEE in elementary schools in Iowa. The survey collected SEE information pertaining to time spent on: (a) "hands-on process activities (b) outdoor exploration experiences, (c) inquiry-problem-solving skills, (d) direct teaching of ecological-interdependency facts and under, (e) science texts and, (f) selected SEE programs. The text, including publisher and copyright date, and special program and materials being used were surveyed. Information regarding teacher's personal interest in and educational background in SEE and the inquiry approach was surveyed.

Total hours spent on outdoor exploration experiences was surveyed. The total hours were to be sub-divided into percentage of time spent in a nature center park, outdoor habitat and identification of "other."

Each teacher was asked to indicate major science text, secondary science texts, social studies text and secondary text. The copyright date and publisher for each text was surveyed. Chapters of social studies texts that were taught and had a environmental education relationship were requested. The percent of time spent in science texts, social studies texts, and/or activities which have a social studies - science connection were surveyed.

The list of specific special materials and programs to be surveyed in the field of SEE was compiled by an investigation of UNI Library and Curriculum Laboratory materials. This list was reviewed and revisions suggested for relevancy and accuracy, by Duane Toomson, Environmental Education Consultant, Iowa Department of Education and Dr. Greg Stefanich. Additional categories of "locally-developed" and other materials were added to this list.

Approximate number of class periods per year that special program were taught was requested.

Teachers were asked, "If given a choice of activities to engage in in your personal time would an investigative nature - type activity (i.e. a prairie walk) be among your top 3 priorities?" This question was to survey personal interest. They were requested to indicate approximate graduate and workshop hours in the field of ecology and/or environmental education to survey educational background in SEE. Comments and the sharing of additional information were welcomed.

The form was designed to take teachers about 15 minutes to complete. It covered three sides of two pages and contained boxes of percentage or time ranges for ease in answering and tabulating the survey. Teachers were asked to consider health as a separate subject from SEE in their computations of requested information.

The survey went through seven revisions with the assistance of Dr. Greg Stefanich. The author's staff peers were requested to attempt to respond to surveys at various revision stages. A final revision was accepted when understanding by test - participants was deemed at a maximum. Face validity was established through review by the writer, Dr. Greg Stefanich, Duane Toomsen and Ms. Jan Anderson, author of a similar survey in 1980.

Method of Dispersal and Collection of Data

The 302 surveys were folded in groups of seven with a cover letter (appendix B) for each building administrator attached and placed in the addressed envelopes. They were then taken to the Science Curriculum Department, Iowa Department of Education (Des Moines), where stamped and self-addressed envelopes were added for the return of the surveys. It was requested that they be returned to the Iowa Department of Education as it was ascertained that the return rate might be higher. The postage was funded by the Iowa Department of Education as the projected results will be of value to them. Seven surveys were sent to each elementary school in the belief that Kindergarten science and environmental information should also be compiled and studied in conjunction with but in a separate paper.

A cover letter was prepared for each Iowa elementary school building sent for the attention of the building administrator (appendix B). The cover letter requested that the administrator distribute the surveys, one to a teacher at each grade level. Surveys were to be collected and returned to the Iowa Department of Education in an enclosed correctly addressed stamped envelope.

Approximately 2,114 copies of the survey were then duplicated and sent to the 302 randomly selected Iowa elementary school buildings. A bright color (yellow) was used at the suggestion of the UNI Print Shop director; the director indicated that more research reports were returned when yellow survey papers were used. School building surveys returned were checked off on a list of the 302 to which surveys were sent as they were received.

Method of Organization and Summarization of Data

The survey forms were checked in, counted, and organized by grade level as they were received. The results were tabulated using about four sets of a three page summary sheet for each grade level. This information was then tabulated into totals by grade levels where percentages were computed. There was one set of three pages of this final tally sheet for each grade level, grades 1 to 6.

Tabulations were made in minutes spent for science per week in categories of: a) zero, b) 1-30, c) 31-90,

d) 91-180, and e) 181+. Percent of total time spent per week on text in science was tabulated in categories of: a) 0%, b) 1-20%, c) 21-50%, d) 51-80%, e) 81-99%, and f) 100%. Hands-on process time spent, time spent in outdoor explorations, time spent on inquiry, problem solving approaches, and time spent in the teaching of ecological and interdependency facts were also tabulated using the same percentage range as in the previous statement. The information obtained from the survey regarding areas of outdoor exploration used such as nature, center, park or schools outdoor education habitat was not useful in this study. Only three teachers of the 1148 returns reported having outdoor education habitats. Percentages were computed for each topic surveyed with N = number of surveys received at a grade level.

Science text books were tabulated by both publisher and copyright date; copyright dates were categorized in five year ranges of a) zero, b) 68-72, c) 73-77, d) 78-82, and e) 83-87. Information was tabulated and percentages computed for both publisher and copyright dates, again using N=number of surveys received at a grade level. Teachers reported the use of fourteen different publishers in science texts with a copyright date range of 1969 to 1987.

The information surveyed concerning a social studies and science-environment education connection was deemed invalid. Only seven teachers on the 1,148 returned surveys answered the request to enumerate lessons from social studies text used concerning SEE. The author concluded the question was not clear or the connection not generally present in subjects surveyed.

SEE programs and materials surveyed were listed and tabulated by title and number of class periods each was presented in grade levels. Percentages were computed in the same manner as stated previously.

Comparisons were made using prairie interest, total credit hours surveyed, versus special programs utilized, time spent on: a) process, b) inquiry, outdoor explorations, and c) teaching ecological-interdependency facts as criterion. An attempt was made to report a relationship between and/or among this surveyed information in respect to a teacher's choices in the classroom regarding SEE. Tabulations were made by grade level.

Much information from the survey was reported in both raw scores and percentages. This information is represented in the tables in the next chapter.

Summary

Chapter 3 outlines the procedures used in collecting data gained from the surveying of time spent and materials utilized in teaching elementary science in Iowa. The procedure to survey individual teacher's decisions and their relationships to various factors are also described in this chapter. The population sample was comprised of elementary schools of Iowa, grades 1 to 6. Three hundred and two Iowa elementary school buildings were randomly selected. One teacher was surveyed at each grade level in each school selected.

SEE information, centering on time spent, was surveyed concerning the following: a) hands on process, b) outdoor exploration experiences, c) inquiry problem solving skills, d) direct teaching of ecological-interdependency facts, e) special programs used, and f) text used.

Also surveyed for this study were the publishers and copyright dates of texts and teacher's personal interest and education credits earned in SEE. Statics realized from the survey, were recorded, predominately in percentages, in categories relating to grade level.

CHAPTER 4

RESULTS OF THE STUDY

Introduction

This chapter reports and discusses the results compiled with a survey instrument used to collect data concerning SEE in elementary schools of Iowa. Responses were received from 164 schools of the 302 randomly selected sample population of Iowa's 926 elementary school buildings or 54.30%. Surveys received were evenly distributed across grade levels except from the sixth grade. This can be attributed to two factors: many sixth grades are now a part of a middle school and many teachers indicated a fifth-sixth grade position and these were all assigned to the fifth grade.

Time Spent in Teaching Science in Iowa Elementary Schools in Iowa

This section will report and compare data from Tables 1 to 10. It incorporates total time spent teaching science in hours per week, and time spent on other specific lessons and activities of science, in percentages as follows: 1) dominant science text time, 2) "hands-on" process time, 3) outdoor exploration time, 4) problem-solving inquiry time and, 5) ecological-interdependency fact time.

Table 1

Percentage Distribution of Iowa Classrooms in Which Science is Taught for a Certain Number of Hours Per Week

		Hours Spent in Science Per Week				
Grade	N	0	0-1/2	1/2-1 1/2	1 1/2-3	3+
1	150	1.33	12.67	67.33	18	.66
2	158	1.27	12.66	56.33	27.22	2.53
3	147	0	6.8	35.37	53.74	4.08
4	148	0	4.73	14.19	77.03	4.05
5	136	0	1.47	9.56	44.85	44.12
6	86	1.16	1.16	4.65	40.70	52.33

Dominant Science Text Time

Table 1 indicates the number of hours per week spent in teaching science. Health and science were separated for the purpose of this study. This table does not give a yearly assessment of total science time as only weekly allotments are recorded. Table 2 is a record of time spent in hours per year in Iowa elementary schools.

Table 2

Percentage Distribution of Iowa Classrooms in Which Science is Taught for a Certain Number of Hours Per Year

		Hours Spent in Science Per Year				
Grade	N	0	0-18	18-54	54/108	108+
1	150	1.33	12.67	63.33	18.00	.66
2	158	1.27	12.66	56.33	27.22	2.53
3	147	0	6.80	35.37	53.74	4.08
4	148	0	4.73	14.19	77.03	4.05
5	136	0	1.47	9.56	44.85	44.12
6	86	1.16	1.16	4.65	40.70	52.33

Note! Time spent in science was computed in hours per week in Table 1 to hours per year for clarity in comparison to other surveys.

The time spent teaching science increases a great deal from first grades to sixth grades. First and second grades most often spent 1/2 to 1 1/2 hours per week. Third grades most often spent 1 1/2 to 3 hours per week. Fourth grades had the highest percentage correlation of 77.03, at 1 1/2 to 3 hours per week. Fifth and sixth grades most often spent 3 or more hours per week in science.

Time ranges in all grades were from zero minutes to 360 minutes per week. Tables 1 and 2 show comparisons of the amount of time by minutes per week spent teaching science with surveys taken by Blackwood (1961-62), Weiss (1978), Anderson (1979-80), and Heller (1987). The Blackwood and Weiss figures are from national surveys and the Anderson and Heller information comes from Iowa surveys. Specific comparisons are not possible as the survey of this study was done in time ranges rather than exact minutes. An approximate comparison yields data that points towards more time now being spent in science than stated in Blackwoods (1962), or Anderson (1980) especially at grades 3, 4 and 5 and 6. In a national survey (Weiss, 1978) showed more time given to science but still not as high as the current survey indicates especially in upper elementary grades. In another 1980 New Hampshire survey (Andrew, 1980) it was shown that time spent on science varied a great deal from classroom to classroom but was somewhat higher than the

Iowa survey ranging from 30 to 90 more minutes per grade level per week.

When a comparison is made with a recent Iowa survey of all subjects taught in elementary schools (Heller, 1987) it is found that science is allotted the least time of all academic subjects at each grade level except sixth. At the sixth grade level, science is given 245 minutes per week, while arithmetic is given 204 and language arts 200. Sixth grade is allotted 45 to 100 more minutes for science than all other grade levels.

In a comparison with Anderson (1980) it is found that science is being given quite different time allotments in Iowa elementary schools in 1987 than in 1980. Comparisons are made in Tables 3 and 4. These comparisons also suggest that currently more science time per week is being allotted. Time is concentrated in the 1 to 1 1/2 hour range in grades 1 and 2, the 1 1/2 to 3 hour range in grades 3 and 4 and divided between the 1 1/2 and 3 hour range and 3 hour plus range in both grades 5 and 6.

The most similar time allotments comparing the 1979-80 and 1986-87 surveys occurs at the fifth and sixth grade levels where more science time is

Table 3

Comparison of Number of Minutes Per Week Spent in Teaching Science in Elementary Schools*

	Grade Level					
	1	2	3	4	5	6
Blackwood (1961-62)	57	59	72	85	100	110
Weiss (1977-78)		(--------85------)			(------140------)	
Anderson (1979-80)	44	51	66	101	106	115
Heller (1987)	80	92	110	109	120	210
Iowa (1986-87)	30<-90	30->90	90<-180	90-180	90->180	180+

* Blackwood (1965, p. 180) Weiss (1978, p. 51) Anderson (1980, p. 54) Heller (1987)

scheduled than indicated in national, Iowa, and 1960s and 1970s surveys. However, allotted science time has increased in grades 1 through 4 in a comparison to both national and state surveys.

The results of the survey's collection of time spent on a dominant text are recorded in Table 5. First and second grades spend the least time in any

Table 4

Comparison of Science Time Allotments in Iowa Elementary Classrooms Using 1979-80 and Current Surveys

		Number of Hours Per Week				
Grade	Year	0-1/2	1/2-1	1-1 1/2	1 1/2-3	3+
1	1979-80	14.88	42.15	19.01	22.57	.008
	1986-87	1.33	12.67	67.33	18.00	.660
2	1979-80	15.00	31.43	20.71	28.86	2.14
	1986-87	1.27	12.66	56.33	27.22	2.53
3	1979-80	7.38	24.16	24.16	39.08	5.36
	1986-87	0	6.80	35.37	53.74	4.08
4	1979-80	1.90	16.46	19.62	44.49	15.80
	1986-87	0	4.73	14.19	77.03	4.05
5	1979-80	2.68	11.41	8.05	43.88	34.08
	1986-87	0	1.47	9.56	44.85	44.12
6	1979-80	2.38	11.11	3.17	40.32	42.22
	1986-87	1.16	1.16	4.65	40.70	52.33

dominant text, both reporting about 25% of science time spent without dominant text usage. Ten to fifteen percent of the third through sixth grades reported spending zero time in a dominant science text. Although fifth and sixth graders spend more time in science, about 40% of the teachers surveyed spend 80% to 100% of that time using a dominant science text.

Over 15% of sixth grade teachers reported using a dominant text 100% of their allotted science time.

Table 5

Percentage Distribution of Iowa Classrooms in Which Time is Spent on a Dominant Science Text for a Certain Percentage of Science Time Per Week

		Percentage of Science Time Spent on Dominant Text Week					
Grade	N	0	1-20	21-50	51-80	81-99	100
1	150	25.33	19.33	18.00	21.33	10.00	6.00
2	158	22.15	17.09	15.82	20.25	17.72	6.96
3	147	14.92	11.56	14.29	17.69	24.49	17.69
4	148	12.16	8.78	15.54	20.27	27.03	16.22
5	136	10.29	13.97	13.24	26.47	30.15	5.88
6	86	11.63	5.81	18.60	19.77	29.07	15.12

Over 40% of teachers in grades 3 and 4 reported the use of dominant texts 80% to 100% of the time. Specific times spent in dominant science texts were not available for comparison at this time.

Hands-on Process Time

Science time spent in "hands-on" process time is listed in Table 6. The percentage of science time spent on "hands-on" process activities is listed on Table 6 the most frequent indication being in the 1% to

Table 6

Percentage Distribution of Iowa Classrooms in Which Time is Spent on "Hands-On" Process Oriented Activities for a Certain Percentage of Time Per Week

		Percentage of Science Time Spent on "Hands-On Process" Oriented Activities					
Grade	N	0	1-20	21-50	51-80	81-99	100
1	150	18.67	36.67	26.67	12.00	5.33	.67
2	158	13.29	43.03	28.48	12.65	1.26	1.26
3	147	4.46	44.22	36.73	7.48	4.76	2.04
4	148	8.11	55.41	26.35	5.41	3.38	1.35
5	136	11.03	41.91	27.21	13.24	5.15	1.47
6	86	5.80	46.51	34.88	11.62	1.16	0

20% time span, with 36.67% at the first grade level and increasing to 55.41% at the fourth grade, then decreasing to 46.51% at the sixth grade. At the sixth grade 5.8% of all teachers spend "no time on hands-on" process activities. This increases to 18.67% at the first grade.

In a comparison shown in Table 7, with Anderson's (1980) Iowa survey the data indicates more teachers

Table 7

Comparison of "Hand-On" Percentage of Science Time Allotments Using Iowa 1979-80 and Current Survey

		Percentage of Time				
Grades		0-21	21-50	51-80		81-100
1	Anderson	25.53	27.66	21.28	···12.77···	12.77
	Current	55.34	26.67	12.00		6.00
2	Anderson	25.17	33.11	15.89	···15.23···	10.60
	Current	56.32	28.48	12.65		2.52
3	Anderson	23.35	38.92	15.57	···11.98···	10.18
	Current	48.68	36.73	7.48		6.80
4	Anderson	18.24	34.71	20.00	···13.53···	13.53
	Current	63.52	26.35	5.41		4.73
5	Anderson	21.94	29.68	20.00	···16.13···	12.26
	Current	52.94	27.21	13.24		6.62
6	Anderson	20.45	25.76	23.48	···18.18···	12.12
	Current	52.31	34.88	11.62		1.16

devoted a greater percentage of time to "hands-on" science in 1980 than presently.

In a 1978 national survey Helgeson (1977) indicated 7% of grades K to grade 3 used "hands-on" activities daily and 11% used them in grades 4 to 6.

Assuming daily means 81% to 100% of allotted science time, Anderson's 1980 Iowa study indicated about 12% usage in grades 1 to 3 and 14% in grades 4 to 6. However, the current Iowa survey shows lower figures in the 81% to 100% category with grades 1 to 3 averaging about 5% and grades 4 to 6 about 4% in time spent on "hands-on" activities.

<u>Outdoor Exploration Time and Teacher Participation</u>

In the Iowa elementary grades surveyed and recorded on Table 8, the greatest concentration of percentage of science time spent in outdoor exploration experiences was in the 1% to 20% category. Third graders were least likely to spend time outdoors (with 53.07% reporting no outdoor activity) while sixth graders were most likely to spend time outdoors with only 24.42% not going outside. Also 75.58% of all sixth grade teachers reported spending time in an outdoor experience while only 46.93% of third grade teachers indicated an outdoor experience.

Anderson (1980) reported 43.86% of teachers used outdoor experiences at the first grade level, 37.84% at the second grade, 40.25 at the third grade, 52.69% at the fourth grade, 46.36% at the fifth grade at 66.15 at the sixth grade level.

Comparison of the Anderson (1980) survey with this current study, shows that about 20% more teachers are, now, involving students in outdoor science experiences at the first and second grade level. The percentages

Table 8

Percentage Distribution of Iowa Classrooms in Which Time is Spent on Outdoor Exploration Experiences for a Certain Percentage of Time Per Week and Teacher Participation Percentage

		Percentage of Science Time Spent on Outdoor Exploration Experiences Per Week						
Grade	N	0	1-20	21-50	51-80	81-99	100	Teacher Participation Percentage
1	150	38.00	57.30	5.37	0	0	0	62.00
2	158	47.67	43.91	8.42	0	0	0	52.33
3	147	53.07	42.59	4.34	0	0	0	46.93
4	148	41.22	51.78	4.71	2.29	0	0	58.78
5	136	47.08	45.99	5.55	1.38	0	0	52.92
6	86	24.42	67.88	3.09	4.61	0	0	75.58

(all about 50%) for third, fourth, and fifth grades. According to the survey about 10% more sixth grade teachers involve classes in outdoor experiences than reported by Anderson in 1980, with an increase from 66.15% to 75.58%.

Problem Solving-Inquiry Skills

The results of the survey of Iowa elementary teachers concerning science time spent on problem solving and inquiry skills are recorded in Table 9. There is a concentration of all grades with percentages ranging from 50.34% to 73.65% in the 1% to 20% range. Sixth grade teachers spend the biggest percentage of science time in problem-solving inquiry with about 75% listed in the 21% to 50% range.

Elementary teachers of Iowa were surveyed regarding the percentage of science time spent in the teaching of ecological and interdependency facts. This data is recorded in Table 10. The highest percentage, with an average of 56.35% for all grades 1 to 6, is recorded in the 1% to 20% of science time range. First grade teachers report doing no ecological interdependency fact teaching for 49.00% of science time allotted. This percentage decreases to a report of 12.17% at the sixth grade level.

Anderson (1980) surveyed Iowa teachers for information concerning percentage of classrooms

Table 9

Percentage Distribution of Iowa Classrooms in Which Time is Spent in Experiences of Inquiry and/or Problem Solving Skills for a Certain Percentage of Time Per Week

		Percentage of Science Time Spent in Experiences of Inquiry and/or Problem Solving					
Grade	N	0	1-20	21-50	51-80	81-99	100
1	150	28.67	63.33	6.67	1.33	0	0
2	158	29.11	56.32	13.92	.63	0	0
3	147	33.33	50.34	14.96	1.36	0	0
4	148	16.89	73.65	6.76	2.70	0	0
5	136	27.94	59.55	11.76	.74	0	0
6	86	12.79	63.95	17.44	4.65	1.16	0

involved in "environmental education." The teaching of ecological-interdependency facts will be equated with the terminology "environmental education" for the purpose of comparison of the current Iowa survey and Anderson's 1980 survey. Grades 1 and 2 had about a 20% decrease in environmental education lessons being taught; grades 3 and 4, a 10% decrease; and grade 5, a 5% decrease. Grade 6 remained the same at 88%.

Science Text Adoption in Iowa Elementary Schools

This part of the report of the survey results is recorded in percentages of dominant science texts used

Table 10

Percentage Distribution of Iowa Classrooms in Which Time is Spent on the Teaching of Ecological and Interdependency Facts for a Certain Percentage of Time Per Week

		Percentage of Science Time Spent on Teaching of Ecological and Interdependency Facts					
Grade	N	0	1-20	21-50	51-80	81-99	100
1	150	49.00	47.33	3.33	3.33	0	0
2	158	42.40	48.73	7.59	.63	.6329	0
3	147	36.65	50.34	16.32	.68	0	0
4	148	18.24	68.24	6.76	5.41	1.35	0
5	136	27.94	59.55	11.76	.74	0	0
6	86	12.79	63.95	17.44	4.65	1.16	0

and copyrights of the dominant science texts. Comparisons are made to state and national surveys, as available at this time. This information is recorded in Tables 11 through 14.

Table 11 lists the use of dominant science texts by percentage of use in the elementary classrooms in

Iowa as tabulated from information gained from the current survey. The texts are listed alphabetically by publishers. Grade level categories, with an all-grade total, are listed in Table 11. Science texts used are recorded by percentage in rank order on Table 12.

Dominant textbooks tabulated by percentage and totaled to an all-grade percentage are as follows: 1) Merrill at 24.05%, 2) Silver Burdette at 17.22%, 3) Heath at 15.72), 4) Holt at 9.59%, 5) McGraw Hill at 7.26%, 6) Ginn at 4.01%, 7) Scott Foresman at 3.86%, 8) Harcourt, Brace at 3.22%, 9) Addison-Wesley at 2.25%, 10) Laidlaw at 1.75%, 11) Houghton Mifflin at 1.32%, and 12) Modern Curriculum Press at 8.05%. As most school buildings have a building-wide science text adoption, this grade percentage tabulation should present an accurate report. A "no text" total grade percentage of 7.93% was reported with 22.67% of first grade teachers reporting "no text" and grades 2 through 4 having 4% to 5% of "no text" adoptions and grades 5 and 6 at about 6%.

Merrill leads dominant text selection, as rank-ordered in Table 12 with 15.33% use in first grades, 18.99% in second grades, 25.85% in third grades, 27.03% in fourth grades, 25.74 in fifth grades and a 31.40%

Table 11

Percentage Distribution of Science Textbooks Used Most Often in Elementary Classrooms of Iowa, Grades 1-6

Textbook by Publisher's	Grade 1	2	3	4	5	6	All Grades
Addison-Wesley	2.67	1.90	4.08	3.38	1.47	0	2.25
Ginn	4.11	3.80	5.44	4.73	3.68	2.33	4.01
Harcourt, Brace	4.00	3.16	2.72	2.70	4.41	2.33	3.22
Heath	16.00	19.62	12.93	14.19	16.91	13.95	15.72
Holt	8.67	10.13	12.54	11.49	6.62	8.14	9.59
Houghton, Mifflin	1.33	1.27	1.36	1.35	1.47	1.16	1.32
Laidlaw	.67	.63	2.72	2.70	1.47	2.33	1.75
Merrill	15.33	18.99	25.85	27.03	25.74	31.40	24.05
McGraw, Hill	6.00	8.23	6.12	7.43	8.82	6.98	7.26
Modern Curriculum Press	0	.63	.68	.68	1.47	1.16	.805
Scott Foresman	2.67	5.06	3.40	4.05	2.21	5.81	3.86
Silver Burdette	16.00	20.89	14.97	14.19	19.85	17.44	17.22
No Text	22.67	4.43	4.08	4.73	5.88	5.81	7.93

Table 12

Percentage Distribution and Rank Order of Science Textbooks Used in Iowa Elementary Classrooms.

Rank	Textbook Order by Publisher	Grade 1	2	3	4	5	6	All Grades
1	Merrill	15.33	18.99	25.85	27.03	25.74	31.40	24.05
2	Silver Burdette	16.00	20.89	14.97	14.19	19.85	17.44	17.22
3	Heath	16.00	19.62	12.93	14.19	16.91	13.95	15.72
4	Holt	8.67	10.13	12.54	11.49	6.62	8.14	9.59
5	McGraw Hill	6.00	8.23	6.12	7.43	8.82	6.98	7.26
6	Ginn	4.11	3.80	5.44	4.73	3.68	2.33	4.01
7	Scott Foresman	2.67	5.06	3.40	4.05	2.21	5.81	3.86
8	Harcourt, Brace	4.00	3.16	2.72	2.70	4.41	2.33	3.22
9	Addison-Wesley	2.67	1.90	4.08	3.38	1.47	0	2.25
10	Laidlaw	.67	.63	2.72	2.70	1.47	2.33	1.75
11	Houghton, Mifflin	1.33	1.27	1.36	1.35	1.47	1.16	1.32
12	Modern Curriculum Press	0	.63	.68	.68	1.47	1.16	.80

* No "text usage" received a 7.93 total grade percentages and would rank fifth if listed on this table.

use in sixth grades. Silver Burdette is second with 17.22% total grade average, Heath third with 15.72% and Holt fourth with 9.95% usage. Silver-Burdette, Heath, and Holt all have a grade level distribution similar to Merrill's (see Table 12).

Anderson (1980) and Weiss (1978) reported percentages of textbook preference quite similar on both the Iowa and national level respectively. Comparisons are made in Table 13. Weiss (1978) stated from results of a national survey, that the top three science textbooks were: 1) Harcourt, Brace with a 12% usage at K to grade 3 and a 16% usage for grades 4 to grade 6; 2) Silver Burdette was second with 5% usage for K to grade 3 and 10% usage for grades 4 to grade 6; 3) Laidlaw was third with 5% usage at K to grade 3 and 7% at grade 4 to grade 6; and 4) Heath was fourth. In Anderson's (1980) Iowa survey, Harcourt, Brace remained first with a 12.55% total usage; Silver Burdette was second at 12.34%, Heath was third with a 9.72%, Laidlaw fourth with a 9.06% usage.

There was not a report of "dominant" usage in the Anderson (1980) or Weiss (1978) reports. Anderson reported the highest usage of ESS at 13.21% and usage of that program as a single program at 3.68%. In the current study "no text" usage received a 7.93% total grade average, indicating more schools did not select a dominant text, especially in first grades with a 22.67 "no text" percentage.

Table 13

<u>Percentage Comparisons of Science Textbook Usage Survey</u>

	Texts and Percentages					
Rank Order	Weiss (1978)		Anderson (1980)		Current (1987)	
1	Harcourt, Brace	14.00	Harcourt, Brace	12.55	Merrill	24.05
2	Silver Burdette	7.50	Silver Burdette	12.55	Silver Burdette	17.22
3	Laidlaw	6.00	Heath	9.72	Heath	15.72
4	Heath	5.05	Laidlaw	9.06	Holt	9.59

Silver Burdette and Heath ranked in the top four in all three surveys compared; Harcourt, Brace and Laidlaw were both dominant in the 1978 and 1980 surveys but dropped to eighth and tenth places respectively in the 1987 survey. Merrill, although not significant enough by usage to be ranked in the 1978 and 1980 survey, was reported to have a total grade average percentage distribution of 24.05%, 10% higher than any science textbook had received in available survey studies. Silver Burdette also showed a 5% gain in usage over the 1980 Iowa survey (Anderson (1980). Heath increased by 6% from 1980 usage. Holt, in fourth place in the current survey, had also not been reported in the 1978 or 1980 surveys as having significant usage. Dominant science textbook usage has made significant changes in publisher chosen and percentage of usage in the past seven years.

The range of copyright dates adoptions made in Iowa in the 1986-87 school year recorded in Table 14. Those classrooms making adoptions in the 1983-87 were as follows: 1) first grade classrooms listed at 36%, 2) second grades listed at 44.94%, 3) third grades listed at 43.54%, 4) fourth grades listed at 41.89%, 5) fifth grades listed at 48.53%, and 6) sixth grades listed at 43.02%.

This compares with the Anderson (1980) survey: 1) first grades listed at 56%, 2) second grades listed at 59%, 3) third grades listed at 60%, 4) fourth grades listed at 56%, 5) fifth grades listed at 60%, and 6) 54% of sixth grade classrooms. Overall adoptions made from the previous five years to the current year were

Table 14

Percentage Distributions and Raw Scores of Science Textbook Copyright Dates Used in Iowa Elementary Schools During the 1986-1987 School Year

Grades	No Text %	Raw	1968-72 %	Raw	73-77 %	Raw	78-82 %	Raw	83-87 %	Raw	Grade Totals
1 N=150	22.67	34	2.67	4	.67	1	38.00	57	36.00	54	77.34
2 N=158	5.70	9	3.16	5	1.90	3	44.30	70	44.94	71	94.30
3 N=147	4.08	6	0	0	2.72	4	48.69	73	43.54	64	95.92
4 N=148	4.05	6	1.35	2	1.35	2	51.35	76	41.89	62	95.94
5 N=136	5.88	8	.74	1	1.47	2	43.38	59	48.53	66	94.12
6 N=86	5.81	5	1.16	1	2.33	2	47.67	41	43.02	37	94.18

about 5% to 12% less in 1987 than in 1980. The first grade shows a larger percentage decrease of 21% from 1980 to 1987.

Less than 5% textbook adoptions were made before 1978 for grade 3 to grade 6 and less than 7% for grade 1 and grade 2 in this survey. The Weiss (1978) survey reported 19% for K to grade 3 with copyright dates over ten years old and 24% at grade 3 to grade 6. Anderson's (1980) Iowa survey reported grade 1 to grade 3 at 20% over 10 years old and grade 4 to grade 6 at 15% over 10 years old.

Selected Programs and Materials Used in the Elementary Schools of Iowa

The survey gathered information regarding selected programs and materials used in place of science texts or to supplement or augment them. These survey results are recorded in Table 15. Seventeen programs and materials including "locally developed" and "other" were listed in the survey. SCIS, ESS, SAPA and Minnemast are considered "programs" and all other listed items are "materials."

The data recorded in rank order in Table 15 shows CLASS to be first, used by 21.65% of teachers surveyed in Iowa elementary classrooms. Usage was highest in

Table 15

Percentage Distribution of Selected Programs and Materials Used in Iowa Elementary Classrooms by Rank Order

Programs and Materials		Grade						
Rank Order		1	2	3	4	5	6	All Grades
1.	CLASS	12.00	15.19	19.04	27.70	19.85	18.60	21.65
2.	ESS	16.00	26.66	9.52	21.08	26.47	20.93	20.11
3.	Learning Tree	11.33	8.86	14.28	20.27	15.44	18.60	14.79
4.	Local	20.00	13.92	8.84	18.24	15.44	10.46	14.48
5.	Other	10.66	8.23	10.20	8.10	17.64	31.39	14.37
6.	OUTLOOK	8.00	6.96	10.88	17.56	16.17	19.76	13.22

Rank Order	Programs and Materials	Grade 1	2	3	4	5	6	All Grades
7.	Wild	6.66	6.33	12.92	9.45	11.76	17.44	10.76
8.	IDEAS	3.33	15.52	4.76	14.86	11.76	11.62	10.30
9.	ECAPS	3.33	9.49	7.48	12.16	11.02	15.11	9.76
10.	SCIS	6.00	10.11	6.80	6.08	7.35	4.65	6.83
11.	Ding Darling	.66	1.90	.68	8.10	10.29	17.44	6.51
12.	S-APA	4.66	10.76	6.80	6.08	2.20	2.32	5.47
13.	Sharing Nature	2.66	8.62	2.04	7.43	1.11	8.13	4.99
14.	OBIS	1.3/3	1.90	6.12	4.05	8.08	8.13	4.93
15.	Examining Your Environment	3.33	3.80	6.12	6.08	2.20	2.32	3.97

Rank Order	Programs and Materials	Grade 1	2	3	4	5	6	All Grades
16.	MINNEMAST	3.33	3.16	.68	0	1.11	5.81	1.79
	No programs	----	----	----	----	----	----	17.33

Note: 1) Other is explained as the use of Weekly Reader science section at about 50 percent of "other"
2) Explanation for each abbreviation in Definition of Terms.

the fourth grade with 27.70%, but it was used across all grades in a range from 12.00% to 19.85%, outside of the high of 27.70%.

ESS ranks second overall but first of the three programs at 20.11%. The Anderson (1980) survey listed ESS as having a 13.21% usage in grades 1-6 in Iowa. Weiss' (1978) national survey reported ESS to be used in 5% of the time in K-3 programs and 9% in grades 4 to 6. Iowa's use of ESS was higher than the national average in 1980. It has increased by about 7%; it still ranks first in programs used in science. Eleven teachers indicated ESS was the dominant science adoption of their schools.

Learning Tree had evenly distributed overall usage in a range of 8.00% to 19.76% from grade 1 to grade 6, with a grade average of 14.79%. Locally developed materials rank fourth at 14.48% and "other" programs and materials rank at 14.37%. If "other" materials were identified, approximately 50% listed the use of <u>My Weekly Reader's</u> science section for selected material for science.

OUTLOOK is sixth overall and third in materials at 13.22% usage, is higher at sixth grade with a range of 8.00% to 19.76% from grade 1 to grade 6.

SCIS had 6.83% usage in Iowa elementary schools and ranked tenth in selected materials and programs but second in programs. SCIS usage is again highest in second, third, and fourth grades. Weiss (1978) found SCIS to be at 11.50% usage for grade K to grade 6. Anderson (1980) reported SCIS to be ranked third among programs used at a 8.62% usage. MINNEMAST ranks fourth in programs used and sixteenth in materials used. It has a 5.81% usage at the sixth grade level and a zero to 3.16% usage range in grades 1 to 5.

S-APA ranks twelfth, in materials and programs but third in programs listed at 5.47%, having a higher percentage of usage in first through fourth grades. Anderson's (1980) survey revealed a higher use of S-APA at 8% and Weiss (1978) listed it at 4% usage at the K to grade 3 level and 9% in grade 4 to grade 6. Iowa's usage has been higher than the national average. S-APA usage in Iowa schools remains higher in first grade through fourth grade than in the fifth grade and sixth grade.

A survey of number of class periods spent on individual selected programs and materials as shown in Table 16 resulted in the following information: 1) ESS and SCIS lessons are used mostly in 1 to 11 class

Table 16

Percentage Distribution of Class Periods That Selected Programs and Materials are Used in Iowa Elementary Classrooms

Materials	N	1-5	6-11	12-15	16-21	22-27	28+
ESS	147	34.69	18.37	6.80	7.48	1.36	31.97
SCIS	64	31.25	10.93	7.81	10.93	1.56	37.50
SAPA	41	60.97	7.31	--	12.20	--	19.51
MINNEMAST	11	90.90	--	9.09	--	--	--
Learning Tree	121	83.47	10.74	4.96	--	--	.83
OUTLOOK	111	58.56	24.32	9.91	4.50	--	2.70
Wild	78	64.10	19.23	7.69	2.56	1.28	5.12
IDEAS	90	77.77	12.22	2.22	4.44	--	3.33
ECAPS	70	78.57	10.00	7.14	1.43	1.43	1.43
Ding Darling	52	84.62	11.54	3.85	--	--	--
Sharing Nature	36	83.33	16.66	--	--	--	--

Materials	N	1-5	6-11	12-15	16-21	22-27	28+
Examining Your Environment	37	89.19	5.41	--	2.70	--	2.70
CLASS	156	85.90	7.69	3.85	--	--	2.56
OBIS	47	93.62	4.26	--	2.13	--	--
Local	145	68.28	7.59	4.14	3.45	1.38	15.17
Other	99	58.59	20.20	5.05	5.05	1.01	10.10

periods a year, then skips to heavy usage in over 28 class periods a year; and 2) in all other selected programs and materials surveyed usage concentrates in one to five class periods a year.

Usage of ESS continues to be high in Iowa. CLASS, Learning Tree, OUTLOOK and locally developed materials comprise about 20% of science time in Iowa elementary schools.

SEE Credits of Iowa Elementary Teachers

Teachers surveyed indicated post-graduate hours of credit earned and personal preferences in free time choices in regard to an environment-type activity. Data is recorded in Table 17.

Approximately 50% of Iowa elementary teachers surveyed indicated post-graduate credits had been earned in science and/or environmental education. About 23% of credits earned were in the 1 credit to 10 credit hour range. About 8% earned were in the 11 hour to 15 hour range, 1% in the 21 hour to 25 hour range, and 1.5% in the over 25 category. More teachers of grade 4 to grade 6 earned post graduate credit than grade 1 to grade 3.

Surveyed teachers were asked the question, "If given a choice of activities in your personal time

Table 17

Percentage Distribution of Post Graduate Science and Environmental Credit Hours Earned by Iowa Elementary Teachers and Free Time Choice

		Credit Hours							Free Time Choice		
Grade	N	0	1-5	6-10	11-15	16-21	21-25	26+	All Grades	No Credits	With Credits
1	150	58.00	23.33	22.66	7.33	1.33	1.33	0	42.00	53.00	63.08
2	158	46.20	20.89	23.42	6.96	1.27	.63	.63	53.80	53.00	62.00
3	147	48.30	14.97	23.13	10.20	.68	2.04	.68	51.70	50.63	71.50
4	148	54.06	14.86	14.86	12.10	.67	0	2.70	45.94	62.16	89.70
5	136	41.91	25.73	20.58	6.61	.73	0	4.41	58.08	53.33	90.70
6	86	32.55	21.99	22.09	6.97	2.32	0	1.16	60.46	61.33	94.23

* Free time choice was, "When given a choice of activities to engage in your personal time would an investigative nature type activity be among your top three priorities?"

would an investigative nature type activity (i.e. a prairie walk) be among your top three priorities?" Of the teachers having post-graduate credits, 78.53% answered "yes." Teachers with no post-graduate science or environmental credits answered "yes," at 53%. The "yes" choice was higher with grade 4 to grade 6, with teachers at 90%. The majority of teachers surveyed did not separate workshop and graduate credits as requested so only total credit hour data is listed in Table 16.

Summary of Survey Findings

A survey instrument was sent to a sampling of 302 randomly selected elementary school buildings from a population of 926 elementary schools in Iowa. Seven surveys were sent to each building for distribution to teachers of grades K-6. There was a return from 164 buildings (54.30%).

Data was compiled and listed concerning environmental education and science for hours per week and percentage of time spent on specific lessons and activities such as: dominant text time, "hands-on" process time, outdoor exploration time, problem-solving inquiry time, and ecological-interdependency teaching time.

Time spent teaching science increased a great deal from grade 1 to grade 6. First and second graders most often spent 1 to 1 1/2 hours per week, third and fourth grades most often indicated 1 1/2 to 3 hours. Nearly 50% of the classroom teachers in grades 5 and 6 reported that they spent three or more hours per week teaching science. Time spent in science varies a great deal from school to school. More time is currently being spent on science in Iowa classrooms than indicated on state and national surveys completed in 1978 (Weiss) and 1980 (Anderson).

In the survey results of time spent in a dominant science text, first and second grades spent the least time in texts, reporting a 25% "no text" time. Approximately 40% of fifth and sixth grades spend 80% to 100% of science time using the science text. Selected programs such as ESS, SCIS, S-APA comprised about 30% of science time in grade 4 through grade 6 in Anderson's 1980 survey. Times spent in dominant science texts from other surveys was not available at this time.

The percentage of time spent on "hands-on" process activities was most often noted as being 1% to 20%. Teachers that spend no time in "hands-on" process activities were at 5.8% at sixth grade level increasing to 18.67% at the first grade. In a comparison with a 1980 Iowa survey (Anderson), more teachers spent more science time in "hands-on" activities than currently do so.

Comparing this 1987 survey with Anderson's (1980) Iowa survey, data compiled shows that about 20% more teachers involved students in outdoor science experiences at the first grade and second grade levels. Percentages remain about the same at 50% for fourth grade and fifth grade. About 10% more sixth grade teachers involve students in outdoor experiences with an increase from 66.15% to 75.58%.

The results of the survey of Iowa elementary teachers concerning science time spent on problem-solving and inquiry skills indicate percentages ranging from 50.34 to 73.65% at the 1% to 20% range.

The survey indicates that a great majority of Iowa teachers spend less than 20% of their science time addressing ecological-interdependency facts. In comparison with Anderson's 1980 survey, there has been an approximate 10% to 20% decrease in the numbers of classrooms presenting lessons dealing with environmental education in grades 1 to grade 5; grade 6 remained the same at 88%.

Percentage comparisons of dominant science textbook usage were compiled in this survey. Results are as follows: 1) Merrill with 24.05%, 2) Silver Burdette with 17.22%, 3) Heath with 15.72%, and 4) Holt with 9.59%. "No dominant" textbook usage was 7.93% by all grades. Anderson's 1980 survey listed Harcourt, Brace with a 12.55% usage, Silver Burdette with a 12.55% usage, Heath with a 9.72% usage, and Laidlaw with 90.6% usage . Merrill was not listed by any teachers in 1980 as a science text but surveyed at 24.05% usage in Iowa elementary schools by 1987. In a survey of textbook copyright adoptions, data suggests that over 90% of science textbooks are newer than a 1978 copyright and over 40% have a 1983-1987 copyright date.

Selected programs and materials used in science curricula in Iowa that were surveyed ranked as follows: 1) CLASS with a 21.65% usage, 2) ESS with 20.11%, 3) Learning Tree with 14.79%, 4) locally developed materials with 14.48%, 5) "other" with 14.37, 6) OUTLOOK at 13.22%, and 7) Project Wild at 10.76%. IDEAS and ECAPS ranked next with percentages of 10.30

and 9.76, respectively. "Other" was explained as <u>My Weekly Reader</u> science section in about 50% of "other," thus <u>My Weekly Reader</u> received about a 7.18% usage.

ESS, SCIS, S-APA and MINNEMAST are considered programs in this survey and all other titles listed are materials. ESS continued to rank highest of the three programs with a 20.11% usage. This compares with a 13.21% reported usage in Anderson's 1980 survey.

Selected Iowa elementary teachers were surveyed for post-graduate credit hour in SEE and personal free time interest in the environment. Over 50% of all teachers indicate credits earned. Of these 50%, about 79% would choose a prairie investigation as a priority for a free time activity. Most teachers had earned between 1 and 10 credits in science and environmental education.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The authors intent was to provide a thorough review of literature and current status of SEE that would direct educators towards alternative solutions in this field. Educators must see the need for and the projected positive effects of having students involved in process, inquiry, and exploration strategies, both in science and interdisciplinary environmental education. Guiding our students to develop an interest and understanding in science and a global ethic must be a goal.

This paper explored research, reviews and writings of early science theorists. Their work was the basis for the present combination of the structure of behaviorism in the hierarchy of knowledge and materials plus the inquiry, exploration, and process strategies of the cognitive developmentalists. Current SEE curriculum instruction models and programs were reviewed and their use surveyed. Attention was given to their basic philosophical connections to the earlier theorists and current trends.

The teachers vital roll in the classroom was discussed. The connections between students' needs, classroom climate, "hands-on" process experiences, inquiry and problem solving instructions, "whole" language and/or interdisciplinary integration approaches and the classroom teacher were considered. The decisions the teacher makes in individual classroom settings concerning sensitivity to individual students, time, strategies, and materials was the essence of this research. Successful SEE alternatives could not be separated from these classroom teacher decisions.

The body of this study came from the research and writings of others and data gathered through use of the survey instrument. Three hundred and two randomly selected Iowa elementary schools from a population of 926 schools were surveyed with a 168 or 53.30% return. A summary of information surveyed follows.

1. Time spent on teaching science increased a great deal from a grade 1 to grade 6 and varies a great deal from school to school. More time is currently being spent in Iowa classrooms than in national and state surveys of 1978 and 1980.

2. A survey of time spent in dominant texts revealed data stating that about 40% of fifth and sixth

grade teachers use a science text 80%-100% of all science time.

3. The current survey instrument revealed that "hands-on" process time has greatly decreased from Anderson's 1980 survey. "Hands-on" process activities were now at 5.8% for all grades. Teachers selected Merrill the science text most often, 25%.

4. Survey results show that 20% more teachers of grade 1 to grade 3 involved their students in outdoor exploration activities. Fifth grades and sixth grades remained at approximately the same percentage as a 1980 survey.

5. Time spent on problem-solving and inquiry experience is minimal with most classes falling in the 1% to 20% range. Sixth graders spend 21% to 50% of science time in inquiry and problem solving.

6. The teaching of ecological facts is concentrated for all grades at 56.35% in the 1% to 20% range. There has been a decrease in time spent in environmental education in grade 1 to grade 5 since 1980 (Anderson).

7. Dominant science textbooks are Merrill, Silver Burdette, Heath and Holt. Over 50% of text adoptions

are less than 10 years old; 98% are less than 20 years old.

8. The survey instrument gathered information concerning selected programs and materials in SEE. CLASS, ESS, Project Learning Tree, and locally developed or chosen "other" materials led the percentage rating. About 20% of all elementary teachers choose CLASS and ESS. Fifteen percent developed or chose their own materials for SEE. ESS usage is high in Iowa and higher than in the 1980 Anderson survey. There were 14 programs and sets of materials noted by respondents.

9. Over 50% of teachers surveyed have post-graduate credits in SEE. Over 50% would choose a nature investigative-type activity in their free time.

Conclusions

Sound research substantiates the theory that any science program is profoundly dependent on the beliefs and sensitivity of individual teachers; on the strategies, materials and management skills implemented (Walberg, 1984). Accepting this premise, the author's intent was to relate the compiled results of the literature review and survey conducted to ways in which a class climate becomes a positive atmosphere of inquiry, leading to critical thinking and problem solving. Self confidence and fate control are the esoteric results of becoming skilled in inquiry. Students with self confidence and fate control become critical thinkers and problem solvers. Following are conclusions made from this study:

1. Students have the right, the need, to be trained in inquiry.

2. Teachers have the power and the responsibility to make the right decisions class climate conducive to inquiry based SEE and interdisciplinary strategies in their individual classrooms.

3. Educators should learn about past education theorists, past and present SEE programs and mentors to understand and appreciate trends today.

4. Time spent in teaching science in Iowa's elementary schools has greatly increased in the past 10 years, especially in grades 1-4.

5. From 50% to 80% of time in science is spent in one textbook for upper elementary grades.

6. "Hands-on" process time spent in science classes has decreased by 10% to 20% in the past ten years.

7. Twenty percent more teachers of grade 1 to grade 3 involved their students in outdoor exploration experiences than in 1980 (Anderson). Percentage of outdoor experiences for grade 5 and grade 6 have remained the same.

8. Supplemental materials and programs were ranked as follows: 1) CLASS, 2) ESS, 3) Project Learning Tree, 4) locally developed materials, 5) "other" such as My Weekly Reader, and 6) OUTLOOK.

9. Over 50% of Iowa teachers surveyed had post graduate credit hours in science and/or environmental education and would choose a nature investigation activity as a free time activity.

10. Environmental education time as decreased in the past seven years.

11. There is a need for all teachers to be made aware of SEE and materials available. Thirty two teachers requested information on programs and materials listed on the survey.

12. Complete and extended use of textbooks such as Merrill and programs such as ESS need to be understood by educators.

13. Teachers need to be trained in inquiry and in such skills as wait time (Rowe, 1978) and cooperative goal structures (Johnson and Johnson, 1986).

14. Most textbook adoptions are current, ESS Programs have increased and outdoor trips taken more often for some grades indicating money and support are there for SEE programs.

15. There is a need for an understanding of the need for, and concept of, interdisciplinary environmental education.

Recommendations

Recommendations were based on the review of literature, surveyed information, and the teacher-power and class climate connection to inquiry and "hands-on" process theories. The researcher proposes the following:

1. Science education leaders must make educators aware of the need for and benefits of training in inquiry skills and "hands-on" process strategies. Programs and classes should be established to do so.

2. Classes, programs and/or support groups should be made available for educators to become more knowledgeable and aware of education theorists, trends and issues.

3. Educators should be offered and perhaps given released time and compensation for presenting or receiving classes in "hands-on" process, inquiry, and problem solving skills.

4. Programs, materials and textbooks should be thoroughly in-serviced and "made special" to new users. Support groups should continue to meet and discuss process materials.

5. Teachers and their students should be offered well-developed programs by local tax-funded nature centers and area personnel enabling both the students and the teachers to grow in environmental knowledge and inquiry skills.

6. A funded week for all educators at Spring Brook, Iowa's Conservation Camp, of appreciation, awareness and personal growth in SEE would benefit our students for a long time.

7. Teachers should make themselves more aware of programs, materials, needs and alternative strategies in SEE through classes, conferences, journal reading and discussions. Administrators must be supportive, distribute information, and provide released time.

8. Schools should develop outdoor education habitats to involve students in the process of re-

establishing native environments and habitats. A 3 x 3 foot plot can be enough.

9. Educators must become open and accepting of students as individuals to be able to promote inquiry and critical thinking as an integral part of class climate.

10. The "schema theory" in the teaching of reading must be given support, for as confidence in one's own schema as a reader grows so does confidence in fate control. More classes integrating reading and science should be offered to pre-service and practicing teachers.

11. Teachers must become confident in conducting science investigations and maintaining atmospheres of inquiry through training in college or in-service programs. Teachers have to understand what scientists are and what science is.

12. Helping students to construct a conceptual framework through "hands-on" process based science that permits them to perceive the phenomena in a meaningful way and to integrate their inferences into generalizations should be the main objective in elementary science curriculum. This can be done through teacher education as outlined in number 11.

13. Because of continued heavy dependency on science texts, these texts must be revised to include more of the teaching strategies and learning approaches that promote scientific literacy and inquiry.

14. Centers for collaboration in science education must be funded and created to promote the last two recommendations.

15. State legislation to establish laws to mandate environmental education may be necessary.

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APPENDIX A

ELEMENTARY SCIENCE SURVEY

Elementary Science and Environmental Education

Science and environmental education are constantly changing to meet the vital technical and ecological needs of our habitat - EARTH. These changes need to be recorded and studied to provide present and future positive decision-making alternatives.

This survey is being conducted to obtain this information for a master's research paper at the University of Northern Iowa and for use by Iowa's Department of Education. It should be of use to science educators and those interested in environmental education. I believe it should only take about 15 minutes to complete.

State ______________ Date ______________

School System ______________ School ______________

City ______________ Zip Code ______________

Grade Level ______________ ☐ Survey results requested.

Please answer each of the following questions:

1. Do you treat science and health as separate subjects (time period and curriculum-wise) in your classroom? YES ☐ NO ☐

   Even if you do not separate science and health in your curriculum, please do so as much as possible for the purposes of this survey. This survey is only concerned with the science aspect.

2. Enter minutes per week spent on teaching science and social studies using choices from the chart below. (If you are departmentalized, enter time one class would spend per week.)

0	1-30	31-90	91-180	181+

   A. Science ☐

   B. Social Studies ☐

3. In the following section please list dominant Science and Social Studies texts and programs. Record publishers and copyright dates for texts.

   Indicate estimated percentage of total science time spent per week on this material using choices from the chart below.

0	1-20	21-50	51-80	81-99	100

   % of total science time spent per week

   A. Science text (dominant) ______________ . . . . . . ☐

   Publisher ______________

   Copyright date ______________

   List chapter numbers used related to ecological facts or environmental education.

   ____

   ____

% of total science time spent per week

Science texts (others used - include publisher and copyright dates for all) . . . . ☐

____

____

B. Social Studies (dominant) ______________________ . . ☐

Publisher ______________________

Copyright date ______________________

List chapter numbers used related to ecological facts or environmental education.

____

____

Social Studies (others used - include publisher and copyright dates for all) . . . . ☐

____

Other Science-Social Studies Connections . . . . ☐

C. Indicate YES or NO as to your use of each of the following science programs. If the answer is YES, record the approximate number of your science periods per year you use.

Science and Environmental Education Programs:	APPROXIMATE number of class periods used per year ↓ YES	NO
ESS (Elementary Science Study)	______	______
SCIS (Science Curriculum Improvement Study)	______	______
SAPA (Science and Process Approach)	______	______
MINNEMAST (Minnesota Mathematics & Science Teaching Project). .	______	______
Project Learning Tree (Western Regional Environmental Ed. Council)	______	______
OUTLOOK (Environmental Education Enrichment, Dept. of Ed., UNI).	______	______
Project WILD (Western Regional Environmental Education Council Department of Education)	______	______
IDEAS (Iowa Developed Energy Activity Sampler)	______	______
ECAPS (Energy Conservation Activity Packets)	______	______
Ding Darling Program (4-H Extension Service)	______	______
Sharing Nature With Children (Joseph Cornell)	______	______
Investigating Your Environment (US Forest Service)	______	______
Conservation Learning Activities for Science and Social Studies (National Wildlife Federation)	______	______
OBIS (Outdoor Biological Investigation Strategies)	______	______
Locally Developed Science or Environmental Education Curriculum Programs:	______	______
Name of Program ______________________ . . .	______	______
Name of Program ______________________ . . .	______	______
Others: ______________________ . . .	______	______

If your answer is YES on the following, indicate percentage of total science time spent per week from the choices on the chart below.

0	1-20-	21-50	51-80	81-99	100

% total science time spent per week

YES NO

4. Is time spent in a hands-on process approach in science?

% time spent . . . . ______ ___

5. Is time spent in cognitive experiences (such as discussion of current environmental issues in the news media) as a provision for the development of further application of knowledge in problem-solving skills?

% of time spent . . . . ______ ___

6. Is time spent on the direct teaching of ecological facts (such as direct teaching of interdependencies)?

% of time spent. . . . . ______ ___

7. Is time spent in an outdoor habitat experience? ______ ___
Approximately how many total hours per year—[ ]
What % of those total outdoor hours per year are spent :

a. nature center. . . . . ______
b. park . . . . ______
c. school's outdoor habitat . . . . ______
d. other ______________________ . . . ______

8. If given a choice of activities to engage in your personal time would an investigative nature type activity (ie. a prairie walk) be among your top 3 priorities? . . . . ______ ___

9. Please indicate approximate number of hours you have earned in the fields of ecology and/or environmental education. . . . . Undergraduate or graduate: ______
Workshop: ______

10. Are there any comments or additional information you would care to share?

____

____

____

____

____

Thank you so much for your cooperation and sharing your valuable time. I greatly appreciate your assistance. If you would be interested in information regarding the results of this research, please check the box next to your grade level indication on page 1. Please return this survey to your principal.

Mary Norton

APPENDIX B

COVER LETTER TO BUILDING ADMINISTRATOR

March 16, 1987

Dear Principal,

I am requesting your support and cooperation in the completion and return of the enclosed surveys. They are a vital part of a study concerning Science and Environmental Education in the curriculum of Iowa's elementary schools. The results will be used by the Department of Education and in a masters research project.

Please have one teacher at each grade level in your building complete a survey and return it to you. They should be returned to the Department of Education in the enclosed envelope by May 1st. I feel it should take only about 15 minutes for a teacher to complete a survey.

If there are any questions or comments please feel free to contact me using the information on the attached card.

Mary Norton