EFFECTS OF A RESIDENTIAL ENVIRONMENTAL SCIENCE ACADEMY ON THE ENVIRONMENTAL LITERACY OF 11TH AND 12TH GRADE STUDENTS

By

CHRISTINE ALLEN MOSELEY

Bachelor of Science
Texas Tech University
Lubbock, Texas
1974

Master of Arts in Teaching
Angelo State University
San Angelo, Texas
1982

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
July, 1993

OKLAHOMA STATE UNIVERSITY

EFFECTS OF A RESIDENTIAL ENVIRONMENTAL SCIENCE ACADEMY ON THE ENVIRONMENTAL LITERACY OF 11TH AND 12TH GRADE STUDENTS

Thesis Approved:

Ted Miller
Thesis Adviser

Ramon DSouza

Steve Anderson

John D. Foster

Thomas C. Collins
Dean of the Graduate College

ACKNOWLEDGEMENTS

I would not have been able to pursue this degree program without the help, advice, and support of several special people.

I express my sincere appreciation and thanks to my committee: to Dr. Russell Dobson who helped keep me focused on what teaching is really about--the child; to Dr. Steve Anderson for his scientific objectiveness and natural resources expertise; to Dr. Jack Vitek for planting the seed of the research topic and continually believing in my ability; and most of all to Dr. Ted Mills, chairman of my committee, who has served not only as my advisor, teacher, mentor, and confidante but also as my friend.

I am forever indebted to my parents, Jim and Bette Allen, and the late Mary Jane Allen, who instilled in me the love of learning, emphasized the importance of education and never expected less from me. Also, thanks to my brother, J.H., and my sisters, Nancy and Carol, for their infallible belief in their big sister.

Lastly, and most importantly, I am grateful to my two sons, Matt and Will, and my husband and best friend, Mark, for their endless love, patience, and ability to help me keep things in perspective. This degree would not have been completed without their constant moral support, their ability to adjust to their mom's, and wife's, erratic moods and schedules, and their endurance of four years of cold cereal for dinner, take-out pizza, and store-bought cookies. To all of you, thank you!

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

The lack of knowledge, egocentricity, and materialistic value constructs of humans have caused isolated environmental problems to fuse into ones of global proportions. Global climate change, hazardous and solid waste management, pesticide and fertilizer usage, and population dynamics, for example, have created world-wide socio-economic, political, and technological disruption in recent years. The Tbilisi Declaration, adopted and issued by the UNESCO Conference on Environmental Education in 1977, recognized the urgency of pending eco-catastrophe by setting forth guidelines for creating public awareness of the environment. A portion of this statement reads (Tbilisi Declaration, 1978):

> In the long run, nothing significant will happen to reduce local and international threats to the environment unless widespread public awareness is aroused concerning the essential links between environmental quality and the continued satisfaction of human needs (p. 70).

With the drafting of this UNESCO document, the importance of the field of environmental education was established.

Environmental education evolved as a direct outgrowth of a growing public awareness and concern for environmental issues. Prior to the 1960's, a small number of conservation-minded writers (Muir, 1901; Leopold, 1949) attempted to arouse public awareness concerning environmental conditions. Although these individuals did not meet with

widespread success, their works did set the stage for future public awakening. Therefore, in 1963, when Rachel Carson's Silent Spring appeared, citizens responded. On March 29, 1969, President Richard Nixon, arising to political and public pressure, signed Executive Order No. 11472, establishing the Environmental Quality Council. This growing public awareness can further be exemplified in the following recommendation made by this Council on Environmental Quality in 1981 (Marcinkowski, 1991):

> Public awareness and better understanding of complex world population, resource, and environmental problems can help build the necessary public climate for responsive citizen and government action to address the problems. The public must also take an active part in the process of finding solutions. Such is an essential part of maintaining the level of public interest and support necessary for the far-reaching, long-term actions needed to alter present trends (p. 7).

It becomes apparent that the educational community has an important role in providing the public with the necessary knowledge and skills to participate in a responsible and effective way in solving environmental issues. It is generally accepted that before an individual participates in behavior towards the remediation of an environmental issue, he/she should be knowledgeable of all aspects of that issue.

The earliest form of education required for human survival must have been some form of environmental education. Survival depended upon knowledge, interpretation, and understanding of the physical environment. Later, as society became more complex, and the transmission of knowledge became more systematic and formal, education moved indoors, and it became easier to read and write and concentrate on the abstract. Presently educators are becoming more aware of the

importance of their role in environmental education. The continued existence of many species, including possibly the human species, depends upon an ability to make conscious changes in cultural attitudes toward nature and place in the biosphere (Hart and McClaren, 1978).

Today, environmental education provides a change in focus for education. It is a shift from education as a teaching process (with the principal activity carried on by the teacher) to education as a learning process (with the principal activity carried on by the student). According to Roth (1991), it attempts to bring learners to focus on the following four issues:

1. The interrelationships between natural and social systems.
2. The unity of humankind with nature.
3. The impacts of technology and the making of choices.
4. Developmental learning throughout the human life cycle.

Environmental education is an integrated process involving experience, investigation, and problem solving in natural and man-made surroundings. It is the study of people and how they shape the total natural and cultural surroundings for good or ill. Humans cannot be separated from the ecosystems of the earth.

Ultimately, environmental education is oriented toward development of values that are translated into action. Each student must acquire an environmental ethic, a concern for and moral commitment to his/her responsibility to the environment. Furthermore, the student must have the competency and motivation to make choices between alternatives and to act on his/her choices. Environmental education should result in the knowledge, desire, and ability necessary to direct one's conduct toward improving the quality of life.

Environmental education is all learning, and the environment encompasses all of where people live, how they live, and why they live. Environmental education programs should seek to develop a commitment both toward the environment and toward learning that will last beyond the years of schooling and form a lifelong concern. The vision made by Lyndon Baines Johnson 25 years ago on the schools of tomorrow could be the vision of today for the future of environmental education (from an address delivered at the annual convention of the American Association of School Administrators, February 16, 1966. Reprinted in Hawkins and Vinton, 1973):

> Tomorrow's school will be a school without walls--a school built of doors which open to the community.
>
> Tomorrow's school will reach out to the places that enrich the human spirit--to the museums, the theaters, the art galleries, to the parks and rivers and mountains.
>
> It will ally itself with the city, its busy streets and factories, its assembly lines and laboratories--so that the world of work does not seem an alien place for the student.
>
> Tomorrow's school will be the center of community life, for grown-ups as well as children--a shopping center of human services. It might have a community health clinic or a public library, a theater and recreation facilities.
>
> It will provide formal education for all citizens--and it will not close its doors any more at three o'clock. It will employ its building round the clock and its teachers round the year (p. 186).

Statement of the Problem

The field of environmental education has grown rapidly in the 23 years since it first began to gain public awareness and concern. In 1969, the Environmental Quality Council was created. On January 1, 1970, funding for this council was established and the National

Environmental Policy Act was signed into law, creating the present Council on Environmental Quality (CEQ). Earth Day, April 22, 1970, caused a flurry of increased public awareness of the quality of life and the prospects for improving that quality. In July, 1970, the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) were created.

The educational community soon joined the movement and "environmental education" became a familiar term. In December, 1970, the First National Conference on Environmental Education, focusing on elementary and secondary education, was held at the University of Wisconsin-Green Bay. This University was also the first higher education institution to focus its total curriculum upon environmental themes. Other conferences followed, with each trying to define environmental education, to establish objectives, and to develop strategies for implementation. Influenced by conservationists, educators, public officials, and concerned citizens, Congress passed the Environmental Education Act of 1970. One important aspect of the bill was a recognition that through cooperative ventures among educators, governmental agencies, private organizations, business and industry, and concerned citizens individual interests could be enhanced. Congress also included in the Act moderate provisions for the funding of grants and contracts specifically for the development and dissemination of curricular materials.

However, even though the early 1970's brought about an increased public awareness of environmental issues and federal enactments, Congress did not invent environmental education. As Thomas Marcinkowski stated before Congress in 1990 (Lewis and Zeldin, 1991):

> The educational and environmental roots of environmental education may be traced back a century or more. They are traceable to the creation of our first national park, our first attempts to grapple with how to manage our nation's bounteous natural resources, and the nature study movement. They are traceable to those working at the turn of the century on the preservation of the vast tracts of land which now comprise much of our natural forests and wilderness system.
>
> They are traceable to the creation of federal level resource management agencies, and to the involvement of those agencies in conservation education. They are traceable to the youth camping and outdoor education movements, and to the development of ecology as a science. They are traceable to the initial monitorings of environmental impacts, and to the international conferences of the 1960's. By 1969, the date many cite as the beginning of environmental education, a century of groundwork had been laid (p. 7).

The decade of the 1970's was important in developing objectives for environmental education (EE) and in recognizing the need for definitive research studies of EE programs. Unfortunately, little evaluation of the effectiveness of the many environmental educational programs--assessments of curriculum materials, gains in student knowledge, attitude shifts, behavioral changes, teacher effectiveness--has actually taken place. A review of literature and research in the field of environmental education done by Hendee (1972) revealed a lack of rigorous empirical research. A survey done by Lucko, Disinger, and Roth (1982) of 284 EE programs revealed only seven percent included formal evaluation. O'Hearn (1982) strongly suggests that the main reason the Environmental Education Act of 1970 was repealed in 1981 was because of a lack of formal evaluation of new EE programs. In times of budgetary restraints, programs must have evaluation to gain needed enthusiastic political support.

This lack of formal evaluation could be attributed to several characteristics of environmental education. By nature, environmental

education is interdisciplinary and a part of every curriculum area. Programs in EE place emphasis on the processes of learning, problem solving skills, and use of the community as a learning resource. All of these factors have caused educational researchers not to make sufficient efforts to determine the degrees of effectiveness in achieving cognitive, affective, or behavioral gain. According to Donaldson (1982), research appears to have been done on those things easiest to grasp rather than in terms of what is needed to be known. Previous research has also been criticized for inadequate research design and/or population size studied.

Lucko et al. (1982) identified program evaluation in environmental education as an area needing serious, immediate attention, as well as a potentially fruitful field for the educational researcher. Roth (1979) also stated a need for research efforts in environmental education that relate to documentation of program effectiveness, goal attainment, concept acquisition, belief and attitude shift, and skill acquisitions. Moreover, Childress (1975) found that research data describing the general characteristics of public school environmental education curricula are generally not available. At the time of his study, no available research provided a comprehensive description of the environmental education programs or project curricula developed and implemented in the elementary and secondary schools of the United States. According to Roth (1979) and Jeter (1982), too much emphasis is being placed on program development rather than researching program effectiveness. Consequently, Roth (1979) and Lucko et al. (1982) feel that a primary force requiring systematic evaluation of all educational programs, including EE, is accountability--to the community, to funding

agencies, and to students. Information as to whether a student achieves cognitive or noncognitive objectives is needed to justify programs and to assure that students are being prepared to become primary decision makers.

As O'Hearn (1982) states:

> ...evaluation must establish credible evidence of the value of the activity...to convince sponsors and decision makers, some of whom may be indifferent and even hostile to the notion of some aspects of environmental education (p. 1).

Consequently, the Alliance for Environmental Education (1982) developed a set of guidelines for the development of EE programs. In regard to evaluation, the guidelines state:

> The value of programs and materials is determined by their effectiveness with users. Evaluation is, therefore, a key program element and should provide for field testing and evaluation of programs and materials in terms of stated goals and objectives by users prior to wide-scale implementation and continuous feedback and modification needed, once a program is underway (p. 2).

The National Environmental Education Act was reinstated in December, 1990, by Congress. The stated policy of the new law is (Lewis and Zeldin, 1991):

> ...to establish and support a program of education on the environment, for students and personnel working with students, through activities in schools, institutions of higher education, and related educational activities, and to encourage post secondary students to pursue careers related to the environment (p. 7).

This law requires the establishment of an Office of Environmental Education within the Environmental Protection Agency and, in addition, authorized expenditures of $12-14 million per year to fund a task force, training programs, internships, research projects, and an awards program (Renew America, 1992). The re-establishment of this law brings forth a stronger emphasis on the importance of effective environmental education

program evaluation. Today, in the political and social climate of financial accountability, it is imperative to the survival of programs that a systematic method of evaluation be established.

Purpose of the Study

The overall purpose of this study was to investigate the immediate, intermediate, and enduring effect that a three-week long environmental education academy would have on the environmental literacy levels of high school students. More specifically, the study investigated environmental awareness, environmental knowledge, and environmental action--three major components of environmental literacy--of a select group of high school juniors and seniors before attending the residential environmental youth academy, immediately afterwards, and then three months later. The results of this study can assist the OSU environmental science academy staff members to discover the strengths and/or weaknesses of the program and to determine what changes should be made in the techniques used and the attitudes, content, and action models stressed in the curriculum. Moreover, this study of the program will help in the establishment of other similar environmental education programs and to serve as a model for the implementation of its various components into a regular standard public school curriculum. Finally, this research study sought to identify those components that define environmental literacy and to investigate ways on how to create environmental literate students.

This research study was developed and conducted to strengthen evaluation methods and to strengthen an environmental education program that has merit and value in environmental education curricula. After,

conducting an extensive search of literature relating to the field of environmental literacy, it was discovered how little research has been completed. This study is unique in that it includes a longitudinal research of the environmental literacy components and incorporates a specific action component. This research study will make a contribution to the needed knowledge base for determining value of an environmental education program. For as Charles Roth (1979) stated:

> In order for an environmental education program to provide maximum contribution to the achievement of educational goals, reliable and valid evaluation is needed. This will require researchers to strengthen evaluation in the areas of student changes in attitudes, knowledge and concepts, and problem-solving and decision-making skills to reflect the current goals of environmental education (p. 7).

Objectives of the Study

The OSU Summer Academy for Environmental Science in Stillwater, Oklahoma was initially funded by several contributing sponsors in 1990. An informal evaluation was done by means of a subjective open-ended questionnaire distributed to participants and parents at the conclusion of the first academy. This current formal study was done during the second year of the program, in 1991. It sought to objectively assess the impact of the academy on the environmental literacy levels of the eleventh and twelfth grade students who spent three weeks at the academy held on the Oklahoma State University campus. This formal study has established a precedent for an objective evaluation of the OSU environmental education program and its related materials for feedback, program modification, and future funding requests from sponsors.

The major objectives of this study were to determine:

1. How successful the academy was in promoting positive environmental growth in the cognitive and affective domain of program participants.
2. Whether any cognitive and/or affective changes resulting from participation in the academy continued to exist after three months.

More specifically, the research objectives of this study were:

1. To determine if students who participated in the Environmental Science Academy exhibited a change in environmental literacy.
2. To determine if students who participated in the Aerospace Academy (a comparative group) exhibited a change in environmental literacy.
3. To determine if students who participated in the Environmental Science Academy exhibited the same levels of environmental literacy as students who participated in the Aerospace Academy.
4. To determine if correlations existed between the three components of environmental literacy--attitude (affect), knowledge, and action (verbal and actual commitment).
5. To determine if correlations existed between personal characteristics (gender, ethnicity, and community size background) and environmental literacy.
6. To determine if students who participated in the Environmental Science Academy sustained a positive change in environmental responsible action after a delayed period of time.

It is hypothesized that the levels of environmental literacy--affect, knowledge, verbal and actual commitment--will change for

participants in the Environmental Science Academy but not change for the Aerospace Academy participants. It is further hypothesized that the environmental responsible action behaviors of the Environmental Science Academy participants will be influenced by the academy and will be (three months).

Research Questions and Hypotheses

The research questions directing the study lead to an investigation which proposes to test the following null hypotheses. The major objectives of this study were to determine the effectiveness of an intensive academy format and content in promoting positive change in environmental literacy among high school students in the cognitive and affective domain, and to determine if any changes induced in the participants were enduring. The Ecology Attitude Inventory, including four subscales, designed by Maloney and Ward (1975), was the instrument utilized as a pre, post, and delayed post test.

Stated in the null hypothesis format:

As a result of participating in the Environmental Science Academy...

I. No significant change in the cognitive and affective growth regarding the environment (pre, post, and delayed post test mean scores of the combined subscales of the Ecology Attitude Inventory) will occur

A. At the conclusion of the three week academy

B. Three months after completing the academy

II. No significant change in affect (emotionality) regarding environmental problems (pre, post, and delayed post test mean scores of the Affect subscale of the Ecology Attitude Inventory) will occur

A. At the conclusion of the three week academy

B. Three months after completing the academy

III. No significant change in verbal commitment regarding efforts to improve environmental quality (pre, post, and delayed post test mean scores of the Verbal Commitment subscale of the Ecology Attitude Inventory) will occur

A. At the conclusion of the three week academy

B. Three months after completing the academy

IV. No significant change in actual commitment (behavior) to improving environmental quality (pre, post, and delayed post test mean scores of the Actual Commitment subscale of the Ecology Attitude Inventory) will occur

A. At the conclusion of the three week academy

B. Three months after completing the academy

V. No significant growth in knowledge about environmental issues (pre, post, and delayed post test mean scores of the Knowledge subscale of the Ecology Attitude Inventory) will occur

A. At the conclusion of the three week academy

B. Three months after completing the academy

As a result of participating in the Aerospace Academy...

VI. No significant change in the cognitive and affective growth regarding the environment (pre and post test mean scores of the combined subscales of the Ecology Attitude Inventory) will occur at the conclusion of the three week academy.

VII. No significant change in affect (emotionality) regarding environmental problems (pre and post test mean scores of the Affect

subscale of the Ecology Attitude Inventory) will occur at the conclusion of the three week academy.

VIII. No significant change in verbal commitment regarding efforts to improve environmental quality (pre and post test mean scores of the Verbal Commitment subscale of the Ecology Attitude Inventory) will occur at the conclusion of the three week academy.

IX. No significant change in actual commitment (behavior) to improving environmental quality (pre and post test mean scores of the Actual Commitment subscale of the Ecology Attitude Inventory) will occur at the conclusion of the three week academy.

X. No significant growth in knowledge about environmental issues (pre and post test mean scores of the Knowledge subscale of the Ecology Attitude Inventory) will occur at the conclusion of the three week academy.

A secondary objective of this study was to identify any relationships which might exist between and/or among knowledge of environmental issues, affect (the degree to which the subjects were emotional about environmental issues), verbal commitment (what did the subjects say they were willing to do for environmental quality), and actual commitment (what did the subjects do to improve environmental quality), as well as the relationships of several personal characteristics of the academy participants (gender, ethnic background, and community size background). Again, the Ecology Attitude Inventory was the instrument used as a pre, post, and delayed posttest. Stated in null hypothesis format:

As a result of participating in the Environmental Science Academy...

XI. No significant relationships exist between and/or among the Affect subscales of the Ecology Attitude Inventory and the following subscales:

A. Actual Commitment
   1. Prior to attending the academy (pre test mean scores)
   2. At the conclusion of the academy (post test mean scores)
   3. Three months after completion of the academy (delayed post test mean scores)

B. Verbal Commitment
   1. Prior to attending the academy (pre test mean scores)
   2. At the conclusion of the academy (post test mean scores)
   3. Three months after completion of the academy (delayed post test mean scores)

C. Knowledge
   1. Prior to attending the academy (pre test mean scores)
   2. At the conclusion of the academy (post test mean scores)
   3. Three months after completion of the academy (delayed post test mean scores)

XII. No significant relationships exist between and/or among the Actual Commitment subscale of the Ecology Attitude Inventory and the following subscales:

A. Verbal Commitment

1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

B. Knowledge

1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

C. Affect

1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

XIII. No significant relationships exist between and/or among the Verbal Commitment subscale of the Ecology Attitude Inventory and the following subscales:

A. Knowledge

1. Prior to attending the academy (pre test mean scores)

2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

B. Affect
1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

C. Actual Commitment
1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

XIV. No significant relationships exist between gender and each of the following subscales of the Ecology Attitude Inventory:

A. Affect
1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

B. Actual Commitment

1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

C. Verbal Commitment

1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

D. Knowledge

1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

XV. No significant relationships exist between ethnicity and each of the following subscales of the Ecology Attitude Inventory:

A. Affect

1. Prior to attending the academy (pre test mean scores)

2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

B. Actual Commitment
1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

C. Verbal Commitment
1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

D. Knowledge
1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

XVI. No significant relationships exist between community size background and each of the following subscales of the Ecology Attitude Inventory:

A. Affect
   1. Prior to attending the academy (pre test mean scores)
   2. At the conclusion of the academy (post test mean scores)
   3. Three months after completion of the academy (delayed post test mean scores)

B. Actual Commitment
   1. Prior to attending the academy (pre test mean scores)
   2. At the conclusion of the academy (post test mean scores)
   3. Three months after completion of the academy (delayed post test mean scores)

C. Verbal Commitment
   1. Prior to attending the academy (pre test mean scores)
   2. At the conclusion of the academy (post test mean scores)
   3. Three months after completion of the academy (delayed post test mean scores)

D. Knowledge
   1. Prior to attending the academy (pre test mean scores)

2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

A comparable study group was also utilized to further investigate the effectiveness of the Environmental Science Academy format and content. Using the Aerospace Academy as the comparable group and the Ecology Attitude Inventory as the instrument, the following null hypotheses were made:

XVII. In regard to affect, no significant differences will occur...

A. In the treatment from which the sample means were drawn (pre x post test)
B. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)
C. In the interaction between group and treatment from which sample means were drawn.

XVIII. In regard to knowledge, no significant differences will occur...

A. In the treatment from which the sample means were drawn (pre x post test)
B. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)
C. In the interaction between group and treatment from which sample means were drawn.

XIX. In regard to actual commitment, no significant differences will occur...

A. In the treatment from which the sample means were drawn (pre x post test)

B. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)

C. In the interaction between group and treatment from which sample means were drawn.

XX. In regard to verbal commitment, no significant differences will occur...

A. In the treatment from which the sample means were drawn (pre x post test)

B. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)

C. In the interaction between group and treatment from which sample means were drawn.

XXI. In regard to the combined scores of the Ecology Attitude Inventory, no significant differences will occur...

A. In the treatment from which the sample means were drawn (pre x post test)

B. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)

C. In the interaction between group and treatment from which sample means were drawn.

Greater insight into the effect the Environmental Science Academy had on environmental action behavior skills, the major component of environmental literacy, was desired. Therefore, the Environmental Knowledge and Personal Environmental Action Assessment instrument was administered as a pre and delayed post test.

Stated in null hypothesis format:

XXII. No significant difference exists between the mean pre and delayed post test scores of the number of appropriate knowledge responses on Item I (personal knowledge) of the Environmental Action Assessment.

XXIII. No significant difference exists between the mean pre and delayed post test scores of the number of appropriate knowledge response categories on Item I (personal knowledge) of the Environmental Action Assessment.

XXIV. No significant difference exists between the mean pre and delayed post test scores of the number of appropriate action responses on Item II (action skills) of the Environmental Action Assessment.

XXV. No significant difference exists between the mean pre and delayed post test scores of the number of appropriate action response categories on Item II (action skills) of the Environmental Action Assessment.

Definition of Terms

Environment - The sum total of the physical, chemical, biological, social, economic, political, aesthetic, and structural surroundings for organisms (Willard, 1976).

Ecology - The scientific study of human and nonhuman organisms, their relationship to their physical environment (air, water, land, sun, etc.) and to each other. The discipline presupposes a "holistic" view of the universe and its intricate interrelationships (Willard, 1976).

Ecosystems - Homogeneous, recognizable units of the biosphere that include human beings, their activities and products, together with

physical factors, other organisms, and processes operating among these components (Willard, 1976).

Environmental ethics - Concerns for natural resources when dealing with the balance between individual freedoms and social controls for the benefit of the human community (Katz, 1960).

Environmental education - That aspect of man's education that deals with culturally imposed, ecologically related issues in the environment. It is the development of concepts and attitudes in humans as reflected in their behavior toward their physical environment (Hungerford and Litherland, 1970).

Literacy - A tool for knowledge construction and learning; reasoning or problem-solving to generate new knowledge (Roth, 1992).

Environmental literacy - In 1990, the United Nations stated that environmental literacy (Roth, 1991):

> ...is a basic functional education for all people, which provides them with the elementary knowledge, skills, and motives to cope with environmental needs and contribute to sustainable development (p. 44).

Attitudes - Generally, Katz (1960) and Knapp (1972) defined an attitude as the predisposition of an individual to evaluate some psychological object in a favorable or unfavorable manner. Specifically, it is defined as the mean score on the 10-item Affect subscale of the Ecology Attitude Inventory, developed by Mahoney and Ward (1973).

Value - A guiding force that determines the choices people make in living their life (Knapp, 1972).

Environmental action - That behavior initiated by an individual intended to remediate an identified environmental problem.

Environmental actions are classified as (a) persuasion, (b) consumerism, (c) political, (d) legal, and (e) ecomanagement. Environmental action may also be a combination of the actions listed above (Ramsey, 1979).

Knowledge - Roth (1979) defined knowledge as a familiarity, awareness, or understanding of the environment through experience or study. For this research study it is specifically defined as the mean score on the 15-item Knowledge subscale of the Ecology Attitude Inventory, developed by Mahoney and Ward (1973).

Environmental Science Academy - The 1991 Oklahoma State University High School Summer Academy for Environmental Science: Science, Technology, and Societal Interaction is the model program, the experimental group, for this research. This academy is a multidisciplinary program that integrates environmental science concepts with societal issues such as economics, politics, wise use management principles, and social and cultural beliefs; and with problem solving skills and personal behavior. A detailed description may be found in Appendix A.

Aerospace Academy - The 1991 Oklahoma State University Aerospace Education Academy served as a comparison group for this study. The Aerospace Academy is a multidisciplinary program that integrates science into aerospace education. A detailed description may be found in Appendix B.

Majority student - Any student who is classified as of White, Anglo ethnicity background.

Minority student - Any student who is not classified as of White, Anglo ethnicity background, i.e. African-American, Native American, Asian American, and Hispanic. Because of the small population sample

size the minority student population could not be statistically identified by race.

Community size background - Population size of the community from which the academy participants came. The students were grouped according to the following population breakdowns: < 10,000; 10,000-25,000; 25,000 - 100,000; > 100,000.

Rural student - Any student who lives in a community with a population size < 25,000.

Urban student - Any student who lives in a community with a population size > 25,000.

Assumptions

During the study, the following assumptions were made:

1. The participants responded to the pre and post tests honestly.
2. Variations in the time and location that the pre and post tests were administered to the experimental group and the control group was not a factor.
3. The Aerospace Academy emphasized a study of technological achievements (human/technology model) whereas the Environmental Science Academy emphasized a study of technological impacts (human/earth model).
4. Each dependent variable--affect, knowledge, actual commitment, and verbal commitment--is normally distributed in the populations from which the samples are derived.
5. Each group and the respective population has the same variability.

Limitations

Several limitations in this research project include:

1. A relatively small sample size participated in the experimental group (24) and the control group (29).
2. The instrument used may not be sensitive to the full range of student perceptions.
3. The same instrument was administered three times (pre-test treatment interaction).
4. Selection of the experimental sample and the comparative sample was by evaluation of voluntary academy application and was not random (lack of randomization).
5. The study was conducted over a three month period of time. Therefore, mortality of subjects occurred.
6. All subjects were not delayed post tested at the same time. Mail out post tests were administered and caused additional delay.

Organization of the Study

Chapter I established the need for the field of environmental education in society and emphasized the importance of research for evaluation of EE programs. A historical background of the development of environmental education and environmental literacy is reviewed in greater depth in Chapter II. Changes in ways of thinking in environmental education and shifts in EE goals and objectives will be reviewed as well as prior research. The research design, description of the subjects and instruments, and research procedures and methods are

discussed in Chapter III. Data generated from pre and post test instruments are tabulated, analyzed and reported in Chapter IV. Conclusions and suggestions for further research are presented in Chapter V. Several appendices are attached which include detailed descriptions of the curriculum and program design of the OSU Summer Academy for Environmental Science and the OSU Summer Academy for Aerospace Education. Copies of the instruments used in the research are also included in the appendices.

CHAPTER II

REVIEW OF LITERATURE

Introduction

The literature related to the description and usage of the term "environmental literacy" is sparse. The concept of environmental literacy and its definition is still being debated and developed. In fact, the literature related to environmental education research is also sparse. This research peaked between the mid-70's and early 80's. After 1980, the amount of research available and related to this topic decreased. However, since 1990, a slight increase in environmental education research, and particularly, research involving the term "environmental literacy" has been noted. ERIC, Dissertation Abstracts, and Government Documents were among the computer sources examined to conduct this review. Various descriptors such as "environmental literacy", "environmental education", environmental ethics", "environmental philosophy," "environmental education research", "environmental attitudes", "environmental behavior", and "environmental awareness" were identified to acquire current sources.

The field of environmental education has struggled with a "definitional problem" for some time (Marcinkowski, 1991). According to Marcinkowski, in the past, individuals have used the term "environmental education" to represent an array of activities that do not reflect

generally accepted principles and characteristics of environmental education. This "definitional" problem was recognized as early as 1970 by Schoenfeld who noted that there is no clearly defined structure for environmental education. Schmieder (1975, in Hungerford, Peyton, and Wilke, 1980) reported that:

> Although some problems are widely apparent, some general goals clear, there is still little consensus as to what the domain of environmental education is or what an environmental educator should know or do (p. 42).

Environmental education often appeared to be an "umbrella" discipline, with many and diverse approaches claiming to be environmental education. This situation prompted Tanner (1974, p. 23) to ask "Is EE anything and everything? Is it 'all education' as has frequently been stated? How should EE be defined?"

As time passed, the term "environmental literacy" began to be used more and more in the jargon of environmental educators (Roth, 1991). It became common to state that environmental literacy is the ultimate goal of environmental education. However, almost as many definitions and perceptions of the nature of environmental literacy exist as do perceptions of the nature of environmental education. This chapter reviews and discusses the historical background and development of the field of environmental education and its relationship to the establishment of a standard definition for environmental literacy, as well as review what research has been done in the area of environmental literacy and its components.

Environmental Education

> It sustains us all - whatever our race, creed, nationality, political persuasion, or even our species. Also Leopold called it 'the land'; James Lovelock and the early Greeks refer to it as Gaia; Native Americans knew it as Mother Earth; many scientists describe it as the biosphere. By whatever term it is known, it provides all the conditions for life and we are all living integral parts of life itself. It is the 'environment' we refer to in the term 'environmental education' (Roth, 1990, p. 3).

Environmental education began to emerge as a separate field during the mid 1960's. It has its roots in a variety of related fields--conservation education, nature education, resource-use education, outdoor education, geographic education, science education, and ecology. A study done by Roth (1970) identified 112 environmnental education concepts derived from these related fields. Roth interviewed 80 University of Wisconsin scholars, representing 40 disciplines, who were interested, or actively engaged in, conservation and/or environmental management education. The concepts that were finally identified were then rated for relevancy to environmental education by a national panel of 699 scholars corresponding to the same 40 disciplines as the University of Wisconsin scholars and representing 24 universities across the country. Archbald and Gundlach (1970) further classified the above concepts by the frequency key words were used and subsequently, developed a diagram to represent these words (Figure 1). This diagram indicates the diversity of the areas of study that contribute to environmental education - the study of man and his total relationship to his environment. Likewise, according to Roth (1991), environmental

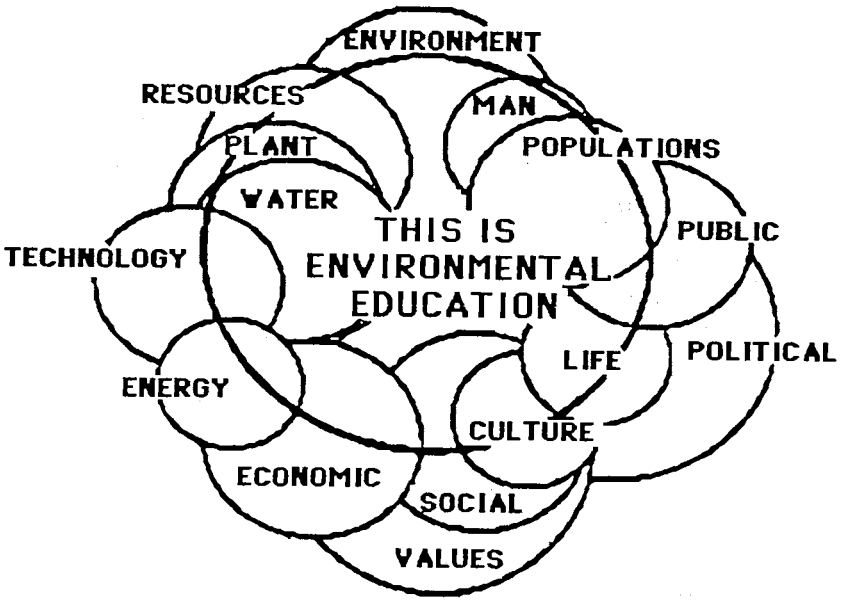


Figure 1. Components of Environmental Education

education draws its strengths from all of the above areas as well as the traditional disciplines but derives its focus from the following basic issues:

1. The interrelationships between natural and social systems.
2. The unity of humankind with nature.
3. The impacts of technology and the making of choices.
4. Developmental learning throughout the human life cycle.

Growing public awareness of environmental issues has led to the implementation of environmentally oriented curricula in some schools. In the last two decades, educators have developed a new area of study emphasizing distinctly different objectives than those found in the earlier studies of ecology and conservation education. Environmental education studies are international, interdisciplinary, field oriented, for public consumption, and designed to prepare citizens to take action.

The need for environmental education was recognized by the international community at the United Nations Conference on the Human Environment held in Stockholm in June, 1972. Participants at this conference recommended that (UNESCO, 1980):

> The organizations of the United Nations system, especially the United Nations Educational, Scientific, and Cultural Organization, and the other international agencies concerned, should after consultation and agreement, take the necessary steps to establish an international programme in environmental education, interdisciplinary in approach, in school and out of school, encompassing all levels of education and directed towards the general public, in particular the ordinary citizen living in rural and urban areas, youth and adult alike, with a view to educating him as to the simple steps he might take, within his means, to manage and control his environment (p. 19).

UNESCO's implementation of the above recommended program led to the Tbilisi Intergovernmental Conference in October, 1977. The Tbilisi

Declaration, issued by this conference, declared that environmental education, utilizing findings of science and technology, should play the leading role in creating environmental awareness, fostering positive national patterns of resource use, and providing education for citizens of all ages and levels (Ramsey, 1979). The UNESCO conference also adopted the following definition of environmental education (Disinger and Schoenfeld, 1970):

> Environmental education is a life-long, multidisciplinary approach to teaching, mass communication, community participation or some other activity aimed at the development of a world population that is aware of, and concerned about, the environment and its associated problems and that has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones (p. 29).

As interpreted from the above definition, environmental education is a "life-long" process encompassing all ages. Its audience is the broadest range of individuals, in continuous learning situations throughout their lives. It is "multidisciplinary", concerned with the interrelationships among the fields of knowledge (biophysical and sociocultural). Environmental education uses many sources, ranging from mass communication, governmental agencies and educational institutions to acquire and apply knowledge and skills in problem-solving activities. Finally, environmental education motivates the learner to act responsibly toward understanding, analyzing, and solving current environmental problems and links learning to life situations.

The Declaration of the United Nations Conference on the Human Environment and the Tbilisi Declaration were reaffirmed at the United Nations Conference on Environment and Development, held in Rio de Janeiro in June, 1992. This environmental summit met to establish new

global partnerships and cooperation among states, people, and societies. In regard to environmental education, participants adopted the following principle (New York Times, 1992):

> The creativity, ideas, and courage of the youth of the world should be subsidized to forge a global partnership in order to achieve sustainable development and insure a better future for all (p. 10).

Environmental Literacy

Environmental education in the United States in the last two decades has experienced a multi-directional proliferation of curricular guidelines, methodologies, instructional materials, and program applications across a variety of academic disciplines. The net effect, according to Tanner (1974, p. 24), is that the term "environmental education" has been attached to such a variety of programs that environmental education "has been lost in a sea of insignificance and irrelevance". Without national direction, environmental education will become a curricular glut--unfocused, multi-faceted, unorganized, and ineffective (Ramsey, 1979). Cummings (1974) maintained that many environmental education guidelines are contradictory; other guidelines have adopted new titles and been applied to traditional courses.

Consequently, as environmental education has emerged since the Tbilisi conference, a number of subsets have come forward claiming to be "environmental education", each with its own list of goals and objectives (Roth, 1991). However, the fundamental goal of all the various EE programs, despite the many differences, is to create an environmental literate citizenry. Questions now arise as to what

constitutes environmental literacy and what skills and knowledge the environmentally literate person should possess.

Initially, much of the focus of environmental education was on environmental knowledge and awareness. According to a National Education Association survey (1970), a majority of environmental education programs were intended either to give pupils a general acquaintance with the outdoors and nature, or to provide them with a general awareness of the relationship between man and his environment. As the field of environmental education developed, however, there emerged a number of leaders who stressed not only awareness, but also attitudes, skill development, and citizenship development in environmental problem solving (Hungerford, 1975; Stapp, 1970).

Hawkins and Vinton (1973) emphasized the idea of a citizenry trained beyond the knowledge and awareness level when they stated:

> Mankind is beginning to awaken to learn from past errors in his use of the environment. Awareness, reason, and rational action offer a viable alternative to continued misuse of the environment...the solution to the environmental crisis... rests neither with the scientists nor with government officials but with a citizenry educated in environmental problem solving (p. 108).

Thus, a critical component in solutions to environmental problems is an environmental literate citizenry. As Volk (1983) describes:

> Such a citizenry is one which possesses the knowledge and awareness of environmental problems, appreciation of the environment and its problems, attitudes supportive of taking action toward the remediation of those problems, and skills requisite to that action-taking (p. 7).

Harvey (1976), in providing a definition of the superordinate goal of environmental education, described the task of environmental educators as:

> ...aiding citizens in becoming environmentally knowledgeable, and above all, skilled and dedicated citizens who are willing to work, individually and collectively toward achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment (p. 1).

Three significant contributions to environmental education are re-directing the future development of environmental education curricula and assisting in the establishment of a national definition for environmental literacy. These three contributions include: (1) the Expected Outcomes of Environmental Education (Harvey, 1976); (2) the Tbilisi Declaration Environmental Education Objectives (1978); and (3) the "Goals for Curriculum Development in Environmental Education" (Hungerford, Peyton, and Wilke, 1980). Together, these objectives and goals are serving to focus the development and evaluation of environmental education curricula and methodologies. They are also currently being analyzed and synthesized in the establishment of a national standard for environmental literacy. Because of their importance, these three contributions warrant individual attention.

(1) Expected Outcomes of Environmental Education

Harvey (1976) attempted to discover whether there existed a generally accepted definition of environmental education and a generally accepted substantive structure for environmental education. In order to accomplish this, he conducted an exhaustive search of the literature. He concluded neither a generally accepted definition nor a structure for EE existed. Thus, he attempted to synthesize a definition of EE from the existing definitions found in the literature. His methodology involved identifying and tallying key words and phrases found in

existing definitions. From these words and phrases, Harvey (1976) developed the following definition for environmental education:

> The process of developing an environmentally literate, competent, and dedicated citizenry which actively strives to resolve values conflicts in the man-environment relationship, in a manner which is ecologically and humanistically sound, in order to reach the superordinate goal of a homeostasis between quality of life and quality of environment (p. 189).

Harvey (1976) also attempted to construct a generic substantive structure of EE by utilizing three major components: philosophy, precept, and expected outcome. The philosophical base of EE was described as a melding of "Spaceship Earth" and "Lifeboat". As described by Harvey (1976):

> The "Spaceship Earth" philosophy deals with what is perceived to be a desirable homeostatic relationship between the earth and its inhabitants. The "lifeboat" concept takes this general premise and...applies human values to the man-environment relationship (p. 189).

The two major philosophical components described above; i.e., the man-environment relationship and a values context, lead to the second component of EE structure, the precept. In order for a topic to be EE, all three components of the precept; i.e., man, environment and relationship, and a human values component must be present.

The third major component of a generic substantive structure of EE was expected outcome. According to the literature, the expected outcome of EE was generally regarded as "environmental literacy" or "the development of an environmental literate citizenry." Harvey (1976) suggested an expansion of the concept of environmental literacy to include environmental competency and environmental dedication. All three outcome levels as defined by Harvey (1976) as they relate to the psychomotor, cognitive, and affective domains are listed below:

> Environmentally literate person - one who possesses basic skills, understandings, and feelings for the man-environment relationship.
>
> Environmentally competent person - one who is environmentally literate, and in addition, has the ability to apply, analyze, synthesize, and evaluate knowledge.
>
> Environmentally dedicated person - one who is environmentally literate and environmentally competent...and in addition, is characterized by a values system in which one acts consistently in a manner compatible with homeostasis between quality of life and quality of environment (p. 200).

(2) The Tbilisi Declaration Environmental Education Objectives

The Tbilisi Declaration issued a statement on environmental literacy that is broadly accepted in today's environmental education community. It states that an environmentally literate person has:

1. An awareness and sensitivity to the total environment;
2. A variety of experiences in and a basic understanding of environmentally associated problems;
3. Acquired a set of values and feelings of concern for the environment, and the motivation for actively participating in environmental improvement and protection;
4. Acquired the skills for identifying and solving environmental problems; and,
5. Opportunities to be actively involved at all levels in working toward resolution of environmental problems (Ramsey, 1979).

(3) Goals for Curriculum Development in Environmental Education

Using the five Tbilisi objectives as a basis for content validity, and Harvey's (1976) definition of EE, Hungerford, Peyton, and Wilke (1978) generated curriculum development goals in environmental education. Organized under a superordinate goal that encompasses both

the definition and structure developed by Harvey (1976), four subordinate goal levels were established. This Hungerford, Peyton, and Wilke (HPW) model is as follows (Ramsey, 1979):

> Superordinate Goal: to aid citizens in becoming environmentally knowledgeable and, above all, skilled and dedicated citizens who are willing to work, individually and collectively, toward achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment.
>
> Level I. Ecological Foundation Level: to provide the receiver with sufficient ecological foundation knowledge to permit him/her eventually to make ecologically sound decisions with respect to environmental issues.
>
> Level II. Conceptual Awareness Level (Issues and Values): to guide the development of a conceptual awareness of how individual and collective actions may influence the relationship between quality of life and the quality of the environment...also, how these actions result in environmental issues which must be resolved through investigation, evaluation, value clarification, decision making, and finally, citizenship action.
>
> Level III. Investigation and Evaluation: to provide for the development of the knowledge and skills necessary to permit receivers to investigate environmental issues and evaluate alternative solutions for remediating these issues. Similarly, values are clarified with respect to these issues and alternative solutions.
>
> Level IV. Environmental Action Skills Level--Training and Application: to guide the development of those skills necessary for receivers to take positive environmental action for the purpose of achieving and/or maintaining a dynamic equilibrium between quality of life and the quality of the environment (p. 4).

The Tbilisi objectives were developed and approved by a consortium of international environmental educators. The "Goals for Curriculum Development in Environmental Education" were derived from the Tbilisi objectives and validated by a panel of environmental educators. Although the Tbilisi objectives were generated subsequent to Harvey's (1976) research and concurrent to the development of the Goals for

Curriculum Development (Hungerford et al, 1980), there is a considerable degree of consistency among the three documents, and they lend mutual support to one another. Together, these objectives and goals represent a comprehensive theoretical model for the development and evaluation of environmental education curricula and methodologies.

However, there has been concern as to what extent established curricular programs have adhered to the Tbilisi objectives and/or the Hungerford et al. goals. A review of the literature finds that most instructional techniques have been based on environmental awareness models. The Childress National Profile of Environmental Education Curriculum (1978) found that 80 percent of the environmental programs at that time had as their primary objective the acquisition of environmental knowledge and an appreciation of environmental resources. Furthermore, a survey done by Hungerford, Tomera, and Wilson (1983) discovered 60 percent of the environmental educational research conducted between 1971-1981 dealt with affect or issue awareness. Research focusing on the investigation and/or evaluation of issues or some aspect of citizenship action accounted for only 8.3 percent of the total environmental education research. Childress (1978) concluded:

> There was a clear indication that objectives focused on helping students become knowledgeable about their environment and its associated problems, and developing an appreciation of environmental resources, were considered of more importance in a majority of programs and projects than were those objectives focused on helping students actually solve environmental problems or develop problem-solving skills (p. 10).

According to Hungerford and Volk (1990, p. 8), the "ultimate aim of education is shaping human behavior." Consequently, responsible environmental behavior has been cited as the ultimate goal of

environmental education (Hungerford and Peyton, 1976; Roth, 1970; Stapp, 1969). However, existing empirical studies indicate that this goal is not being met in schools across America (Childress, 1978; Volk, 1983). Emphases instead have been directed towards the awareness and analysis of environmental problems, while environmental problem-solving skills and citizen participation has been neglected (Volk, 1983).

The traditional thinking in the field of environmental education has been that change in behavior can be done by making human beings more knowledgeable about the environment and its associated issues. An early and widely accepted model for EE is described in the following way: "Increasing knowledge leads to favorable attitudes...which in turn leads to action promoting better environmental quality" (Ramsey, 1981, p. 24). This model is illustrated below in Figure 2: (Hungerford and Volk, 1990, p. 9).

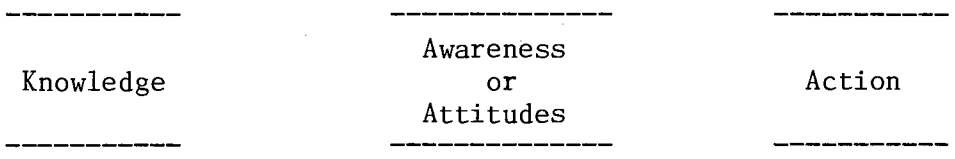


Figure 2. Behavioral Change System

Research into environmental behavior does not bear out the validity of the above linear model for changing behavior (Hungerford and Volk, 1990). In 1986-87, Hines published a meta-analysis of the behavior research literature in EE. That research analyzed 128 studies...

> which has been reported since 1971...which assessed variables in association with responsible environmental behavior and which reported empirical data on this relationship.... An analysis of data resulted in the emergence of a number of makor categories of variables which had been investigated in association with responsible environmental behavior.... In the end, fifteen separate variables were meta-analyzed in an effort to determine the strength of their association with environmental behavior (p. 3).

From this analysis, a model of responsible environmental behavior emerged. This model is displayed in Figure 3 (Hungerford and Volk, 1990, p. 10). In discussing this model, Hines (1986-87) made the following inferences:

> An individual who expresses an intention to take action will be more likely to engage in the action than will an individual who expresses no such intention... However, ...it appears that intention to act is merely an artifact of a number of other variables acting in combination (e.g. cognitive knowledge, cognitive skills, and personality factors).
>
> Before an individual can intentionally act on a particular environmental problem, that individual must be cognizant of the existence of the [issue]. Thus, knowledge of the [issue] appears to be a prerequisite to action.
>
> [A]n individual must also possess knowledge of those courses of action which are available and which will be most effective in a given situation.
>
> Another critical component...is skill in appropriately applying this knowledge [i.e. knowledge of action strategies] to a given [issue].
>
> In addition, an individual must possess a desire to act. One's desire to act appears to be affected by a host of personality factors...locus of control, attitudes [toward the environment and toward taking action], and personal responsibility [toward the environment].
>
> Situational factors, such as economic constraints, social pressures and opportunities to choose different actions may...serve to either counteract or to strengthen the variables in the model.

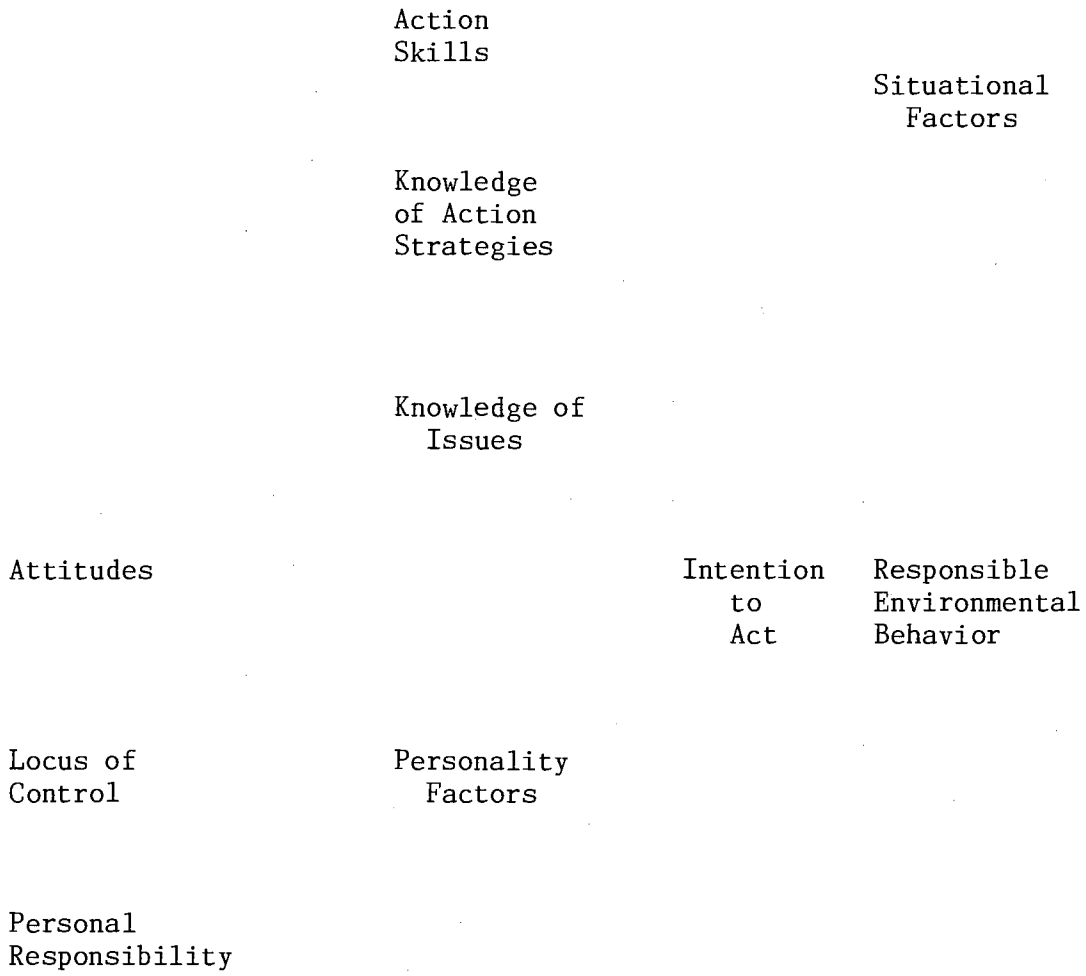


Figure 3. The Hines Model of Responsible Environmental Behavior

Hungerford and Volk (1990), using the study done by Hines (1986-87) and other studies (Borden, 1984-85; Ramsey, 1981; Marcinkowski, 1989; Sia et al. 1985-86) developed a third environmental behavior model, based on three categories of variables that contribute to behavior. The variable categories (entry - level variables, ownership variables, and empowerment variables) are hypothesized by Hungerford and Volk (1990) to act in more or less of a linear fashion, although a complex one. These variables are displayed in Figure 4 (Hungerford and Volk, 1990, p. 13).

Entry level variables are good predictors of behavior. These appear to be prerequisite variables that enhances a person's decision-making once an action is undertaken. Ownership variables are those that make environmental issues personal. The individual "owns" the issues, i.e., the issues are important at a personal level. According to Hungerford and Volk (1990), ownership variables appear to be critical to responsible environmental behavior. Empowerment variables give human beings a sense that they can make changes and help resolve environmental issues. "Empowerment", as related to the research, seems to be a cornerstone of environmental education, yet it is a step often neglected in educational practice (Hungerford and Volk, 1990).

Entry-level Variables	Ownership Variables	Empowerment Variables	
Major Variable →	Major Variables →	Major Variables →	CITIZENSHIP
Environmental Sensitivity	In-Depth Knowledge About Issues	Knowledge of and Skill in Using Environmental Action Strategies	
	Personal Investment in Issues and the Environment	Locus of Control (Expectancy of Reinforcement)	
		Intention to Act	
Minor Variable	Minor Variables	Minor Variable	BEHAVIOR
Knowledge of Ecology	Knowledge of the Consequences of Behavior--both Positive and Negative	In-Depth Knowledge About Issues	
Androgyny			
Attitudes Toward Pollution, Technology and Economics	Personal Commitment to Issue Resolution		

Figure 4. Behavior Flow Chart: Major and Minor Variables Involved in Environmental Citizenship Behavior

Knowledge of a problem is a prerequisite to appropriate action. However, knowledge of the problem is only part of the catalyst required; a person must also know what he can do to help. Jordan et al. (1986) found that high school students participating in environmental education workshops that stressed both issues and action strategies reported participating in a greater number of environmentally appropriate behaviors than did students receiving only issue-awareness instruction.

The study done by Jordan et al. (1886) involved six residential outdoor environmental education programs (lasting six days each) for a total of 62 Illinois high school students, conducted by the Environmental Workshop staff at the Touch of Nature Environmental Center, Southern Illinois University - Carbondale, during the summer of 1982. Three of the programs received instruction at the awareness level in environmental issues while the other three programs received instruction in both environmental issues and action strategies, also at the awareness level. The following environmental action categories were covered and are listed in the order of the amount of instruction time given to each (most to least): encouragement, persuasion, consumerism, organizational membership, political action, and legal action.

All groups were pretested and posttested with the same instrument, the Environmental Knowledge and Personal Environmental Action Assessment, which assessed the participants' knowledge of environmental action and the environmental actions reportedly participated in for the two-month time period prior to the workshop. A delayed posttest was mailed to the participants two months after the program ended. It assessed those environmental actions the students reportedly participated in for the two-month period following workshop completion.

A demographic sheet plus two instruments were used to collect data. Instrument I was used at both the pre- and posttest to collect data on the criterion variables: the student's knowledge of environmental action, and personal environmental actions taken for the two month period prior tot he workshop. Instrument II was used as the delayed posttest which collected data on the criterion variable: student's personal self-reported environmental behavior for the two-month period following the workshop.

Open-ended questions were used to measure both the participant's knowledge of environmental action strategies and the participants' personal environmental behavior. Content validity of the instruments was established by submitting a copy of the instruments to a jury of three environmental educators for review.

Jordan et al. (1986) used identical procedures to administer the instruments to all six groups. The pretest was administered during the evening of the first day of each program. The posttest was administered before the concluding activity of each program. Instrument II (delayed posttest) was a mailed questionnaire sent to the subjects two months after they completed the workshop.

The participants who received instruction in environmental action demonstrated a higher level of knowledge concerning environmental action after instruction when compared to the level shown before instruction and when compared with a group who did not receive instruction in environmental action. Also, participants who received instruction in environmental action reported participating in a statistically significantly greater number of environmental actions following the workshop when compared to the number reported before instruction and

when compared to the number reported by the group who did not receive instruction in environmental action. Consequently, Jordan et al. (1986) concluded that those students receiving instruction in both environmental issues and action strategies did demonstrate an increased level of knowledge of environmental action and reported participating in a greater number of environmental behaviors.

However, even though statistically significant increases were recorded for the issue and action awareness group, "the amount of change observed was less than hoped for" (Jordan et al., 1986, p. 20). These authors observed that most of the types of environmental actions reported undertaken by participants were conservation-related behaviors, easy to fulfill, requiring neither substantial effort nor special skills. Consequently, the authors inferred that the program motivated students to participate in those actions with which they were familiar and which did not require much effort to complete. Also, it was inferred that either students were not willing to undertake other actions covered during the program that required more effort (consumerism and legal action), or they did not master the necessary skills underlying the actions. Therefore, Jordan et al. (1986) concluded that instruction concerning more complex environmental actions must receive more time in order that the students develop the knowledge, skills, and motivation to participate in them.

Borden and Scheltino (1979) found that environmental knowledge had a positive effect on actual commitment but a relatively small effect on willingness to adopt responsible activities in the future. Their study indicated that both affective and cognitive experiences are involved in developing the highest level of environmentally responsible action.

Roth (1972) and Hendee (1972), on the other hand, have argued that educators should teach facts and concepts about the environment. As Southern (1972) also states:

> If the child acquires particular broad environmental understandings (knowledge) he will develop social conscience (attitude) that will affect his behavior (actions) toward the total environment (p. 14).

However, Borden and Scheltino's (1979) investigation, consistent with previous research done by Bohl (1976) and Richmond (1976), found little relationship between affective and cognitive domains. Their research supports the conclusions of Tanner (1974, p. 40) that argues that "until we know more, it seems prudent to attempt a judicious mix of the cognitive and affective domains."

The purpose of the study done by Borden and Schettino (1979) was to test the assumption that factual knowledge and feelings about environmental issues are independent variables and to examine the contribution of each of these variables in producing environmentally responsible action. Furthermore, the study was to test whether environmental concern and ecological knowledge combine additively or interactively to produce current environmental action, as well as a willingness to adopt future environmentally responsible commitments.

The subjects in the sample were 203 male and 327 female undergraduates enrolled in introductory psychology courses at Purdue University in the fall of 1976. Each subject was administered the Ecology Attitude Inventory, developed by Maloney, Ward, and Braucht (1975). This 45-item instrument is composed of four subscales. Two of the subscales (Affect scale and Knowledge scale) correspond to the factors of affect and knowledge. The last two subscales measure

respective behavioral variables. The Actual Commitment scale assesses behaviors in which the individual is currently engaged. Futuristic items that the person states he/she would be willing to do in reference to environmental issues is listed in the Verbal Commitment Scale.

The study utilized a 2 (affect) x 2 (knowledge) ANOVA design with subject's actual commitment and verbal commitment scores as dependent measures. Environmental knowledge had a positive effect on actual commitment. Subjects' actual commitment was also significantly influenced by their environmental affect. However, the analysis of variance showed no interaction of affect and knowledge in determining actual commitment.

The analysis also showed that subjects high in environmental affect significantly influenced verbal commitment. However, verbal commitment was only slightly influenced by environmental knowledge.

The study done by Borden and Schettino (1979) revealed several conclusions. First, it suggested that increased concern about the environment does not lead to the seeking of knowledge; or conversely, the acquisition of environmental facts does not result in increased affective reactions. The study further found that the level of affect appears to be a somewhat more important determinant of actual commitment than level of knowledge. Furthermore, these two factors were observed to combine additively in producing the current level of environmental responsible action taken by an individual.

In contrast, verbal commitment was found to be almost exclusively a function of environmental affect. Increased levels of environmental knowledge had only a slight influence on future commitment. Thus, as Borden and Schettino (1979 concludes:

> It seems that what a person says he or she would be willing to do in the future is based almost entirely on their emotional reactions, whereas a high degree of actual current commitment involved a blend of high knowledge and emotional development (p. 38).

A study done by Edwards and Iozzi (1983) also concluded that growth in knowledge alone resulted in short-lived gains, while an increase in emotionality existed over a long period of time (two years). Furthermore, this study showed that the increase in emotionality had a significant impact on the changes in actual environmental behavior skills of the subjects involved.

Edwards and Iozzi (1983) conducted their research at a summer institute/workshop for in-service teachers at Cook College, Rutgers University of New Jersey, in 1979. The intensive four-week Environmental Education Institute was designed to expose teachers to a wide variety of environmental problems. Activities were designed to promote cognitive and affective growth related to environmental issues and to introduce new methodologies for translating those experiences into classroom applications. Twenty-nine teachers participated in the study. The short form of the Ecology Attitude Inventory (Maloney and Ward, 1973) was utilized in the study as a (1) pre-test, on the first day of the institute, (2) post-test, on the last day of the institute, and (3) mailed delayed post-test, one year after, and again two years after the institute.

Edwards and Iozzi (1983) utilized the four subscales of the Ecology Attitude Inventory: Affect, Knowledge, Actual Commitment, and Verbal Commitment. Results achieved by analysis of variance demonstrated that there was significant increase in emotionality (affect) regarding environmental problems and in actual commitment at

the conclusion of the institute. Those increases also remained significant after one year and two years following the institute. Also, there was significant positive growth in knowledge after participating in the institute and that growth remained significant after one year. However, after two years the amount of knowledge gained was no longer significant. In addition, participation in the institute resulted in no significant positive change in verbal commitment.

The Pearson Product Moment Correlation ratios were computed to determine if any relationships existed among affect, actual commitment, verbal commitment, and knowledge. In contrast to the study done by Borden and Schettino (1979), Edwards and Iozzi (1983) reported no relationship between knowledge and actual commitment. However, their findings did agree with Borden and Schettino (1979) in that actual commitment was significantly influenced by affect; affect significantly influenced verbal commitment; no relationship existed between affect and knowledge; and knowledge had little, or no significant relationship, to verbal commitment. Edwards and Iozzi (1983) also found a significant relationship between actual commitment and verbal commitment; those who said they would do more reported they actually did more. Based upon their findings, Edwards and Iozzi (1983) concluded that positive cognitive and affective changes can be induced as a result of participating in a intensive institute/workshop program.

Responsible environmental behavior is a learned response/action. As the ultimate goal of environmental education, it is synonymous with environmental literacy. Therefore, the variables that support environmental literacy are the same variables that predict responsible environmental behavior. Such variables are identified by Sia,

Hungerford, and Tomera (1985-86) as: (1) knowledge of issues, (2) beliefs concerning issues, (3) individual values, (4) individual attitudes, (5) locus of control, (6) environmental sensitivity, (7) knowledge of and skill in the use of environmental action strategies, and (8) ecological concepts. Further, these variables interact with each other. Research done by Sia et al. (1985-86) indicated that all of the above variables were significant predictors of environmental behavior.

Sia et al. (1985-86) examined the relative contribution of the above eight theoretical variables as well as variables which specific research studies suggest have predictive power. Scores on a validated behavior instrument served as the criterion. High and low behavior groups were selected from midwestern Sierra Club members (105 subjects) and Illinois Elderhostel program participants (66 subjects). Multilinear regression analyses were used to determine the performance of each predictor variable and to determine the best set of variables which predicts environmental behavior. Seven of eight variables were found to be statistically significant. They were: (1) level of environmental sensitivity, (2) perceived knowledge of environmental action strategies, (3) perceived skill in using environmental action strategies (4) psychological sex role classification, (5) individual locus of control, (6) group locus of control, and (7) attitude toward pollution. The one nonsignificant variable was (8) belief in technology.

Likewise, in Sia et al. (1985-86), stepwise regression showed that the best predictors for all respondents were the aforementioned variables (1) level of environmental sensitivity, (2) perceived

knowledge of environmental action strategies, and (3) perceived skill in using environmental action strategies. Their investigation concluded that both knowledge of and skill in using environmental action strategies are strong predictors of responsible environmental behavior. Therefore Sia et al. (1985-86) state that:

> ...if professionals are to meet the major goal of environmental education, which is to produce environmental responsible citizens who can work for a balance between quality of life and quality of the environment, it becomes imperative that these predictors be addressed in EE curriculum development and instructional practice (p. 39).

The study done by Sia et al. (1985-86) also inferred that instruction should include experiences that would foster environmental sensitivity. Sia et al. (1985-86) concluded that students need to be exposed to those factors that promote environmental sensitivity, e.g., participation in outdoor experiences on a continuous basis, time spent in pristine environments, and the influence of role models. Sia et al. (1985-86) also concluded that both knowledge of and skill in using environmental action strategies as predictor variables add further validity to Ramsey's (1979) research regarding the need of training students in environmental action problem-solving skills. This environmental action training needs to be promoted into EE instructional practice.

Ramsey's (1979) study involved three intact classes of eighth grade students in southwestern Illinois. One class (sample size = 26) received environmental action instruction using the program Process Modules for Investigating Environmental Problems (Hungerford and Litherland, 1975); one class (sample size = 21) received instruction utilizing environmental case studies; and one class (sample size = 20)

received instruction only in physical science. The research instruction extended over a period of 36 academic days from January to March, 1978. All groups were pre and posttested using analysis of variance and t-test comparisons made between groups.

The results of Ramsey's study (1979) showed that EE instruction providing training directed at environmental action strategies significantly increased eighth grade students' knowledge of environmental action and significantly altered and increased eighth grade students' overt environmental behavior. After receiving environmental action training, the action group mean was more than twice as large as the case study group and four times larger than the control group mean with respect to overt environmental actions taken by students. The results of this study, as well as the results of the research done by Sia et al. (1985-86) substantiate the need for using EE curricula which educate students to be knowledgeable of and skillful in the use of environmental action strategies.

However, Monroe and Kaplan (1990) conclude that there is more to teaching problem solving than action and experience. These authors infer from their study that using examples of successful solutions to environmental problems and encouraging discussions of actual problem-solving experiences are critical in encouraging students to become problem solvers. They do agree with the research done by Ramsey (1979) that indicates an action project is the most effective teaching strategy for environmental problem solving. However, they acknowledge that the limitation of exploring fewer major issues, the unknown degree of project success, and potential classroom and community constraints tend to decrease the benefits of an action project.

Monroe and Kaplan's (1990) study involved surveying members of Michigan Science Teachers Association who believed they helped students develop environmental problem-solving skills. This survey was done to determine which teaching strategies were used in developing these skills. Fifty-one surveys were used. The more successful teachers were defined as those who had more students that showed an interest in or who participated in environmental problem-solving activities. It was determined that the most successful teachers used five teaching strategies significantly more often than less successful teachers. The chi-square statistic indicated that there is a significant relationship between success and the following five teaching strategies:

1. "Case studies" about solutions to environmental problems.
2. "Trying to solve problems."
3. "Case studies" about what students can do to help solve a problem.
4. "Talking about what others do" to help solve a problem.
5. "Becoming aware of others' beliefs"

Therefore, Monroe and Kaplan (1990) conclude that:

> ...in the process of solving environmental problems, students should be exposed to (1) background knowledge about the issue; (2) knowledge of the variety of ways in which environmental problems have been solved; and (3) specific information about the types of actions that have been used to resolve similar cases (p. 40).

Students should not only be involved in an action project, but also involved in reading and discussing a wider variety of case studies and experiences because this combination increases students' familiarity with solving environmental problems.

From all of the previously stated research, Hungerford and Volk (1990) identified a number of critical components of a total educational program for EE if changes in learner behavior are desired. These components are listed below:

> It appears that we can maximize opportunities to change learner behavior in the environmental dimension if educational agencies will:
>
> 1. Teach environmentally significant ecological concepts and the environmental interrelationships that exist within and between these concepts;
>
> 2. Provide carefully designed and in-depth opportunities for learners to achieve some level of environmental sensitivity that will promote a desire to behave in appropriate ways;
>
> 3. Provide a curriculum that will result in an in-depth knowledge of issues;
>
> 4. Provide a curriculum that will teach learners the skills of issue analysis and investigation as well as provide the time needed for the application of these skills;
>
> 5. Provide a curriculum that will teach learners the citizenship skills needed for issue remediation as well as the time needed for the application of these skills; and
>
> 6. Provide an instructional setting that increases learners' expectancy of reinforcement for acting in responsible ways, i.e., attempt to develop an internal locus of control in learners (p. 14).

There is no clear method of implementing the above critical components. However, Hungerford and Volk (1990) suggest several major strategies that they consider critical in implementing these components:

1. The need for reinforcement strategy.

Three years after Ramsey (1979) measured the effects of three different treatments on the environmental behavior of eighth grade students, he completed an unpublished investigation (Hungerford and

Volk, 1990). Ramsey trained graduate students as interviewers to assess the extent of student involvement in environmental issues and environmental appropriate behavior. These interviewers were taken to the secondary schools where the original subjects were students. The interviewers were not told which students had been in the experimental group, yet they could identify each of these students because the students were involved in more environmental appropriate behaviors than their counterparts. However, the behaviors observed by the interviewers were not as strong as the original behavior observed three years earlier. There had been no educational reinforcement following treatment for the students during the three-year period. Thus, Hungerford and Volk (1990) concluded that it is imperative that learners receive in-depth educational experiences over a substantial amount of time for reinforcement.

2. Development of environmental sensitivity.

"Environmental sensitivity" is a function of an individual's contact with the outdoors in relatively pristine environments (Hungerford and Volk, 1990). Environmental sensitive individuals report that hunting, fishing, or other outdoor activities, over long periods of time, increased their environmental sensitivity. Increased sensitivity was also reported when individuals experienced some severe environmental degradation. Teachers and/or parents also play a part as sensitive role models. Few individuals report education courses or books as variables of raising environmental sensitivity.

Therefore, Hungerford and Volk (1990 conclude that learners must have environmental positive experiences in nonformal outdoor settings

over long periods of time. Also, learners must have teachers who are sensitive and willing to act as positive environmental role models.

3. Two curricular strategies: the issue investigation and action model and the extended case study model.

Hungerford and Volk (1990) acknowledges that research into both strategies reveal that behavior changed positively as a consequence of instruction. The major difference cited between the two strategies is that in the issue and action investigation, students learn and participate in the problem solving steps involved in taking action on an environmental issue. In the case study model, students learn many of the same skills, except they are focused on a predetermined issue. Hungerford and Volk (1990) conclude, somewhat in contrast to Kaplan and Monroe (1990), that although successful, the case study model is not as powerful an instructional model as the issue investigation and action model.

In 1990, UNESCO further expanded the Tbilisi Declaration to state that (Roth, 1991):

> Environmental literacy is a basic functional education for all people, which provides them with the elementary knowledge, skills, and motives to cope with environmental needs and contribute to sustainable development (p. 44).

However, according to Roth (1991), this broad definition still needs to be refined and clarified in order that it may be used in goal and objective planning and in assessment of programs developed to promote environmental literacy.

Dictionaries generally define literacy as (1) the ability to read or write, and (2) being well-educated, having or showing extensive knowledge, learning or culture. The absence or existence of literacy

can best be determined by observed behavior. Likewise, the degree of environmental literacy can be defined in terms of observable behavior.

McClaren (1989) identifies eight elements of environmental literacy. He recommends blending the thematic approach with special events and programs over the 12 to 13 year course of public schooling to graduate students who are environmental literate in these elements:

1. The ability to think about systems
2. The ability to think in time: to forecast, to think ahead, and to plan
3. The ability to think critically about value issues
4. The ability to separate number, quantity, quality, and value
5. The ability to distinguish between the map and the territory
6. The capacity to move from awareness to knowledge to action
7. A basic set of concepts and facts plus the ability to learn new ones and to unlearn the old
8. The ability to work cooperatively with other people.

Roth (1991) identifies three major cluster areas of a proficiency continuum that individuals progress along in degrees towards acquisition of environmental literacy. These areas are:

1. Nominal environmental literacy--ability to recognize many of the basic terms used in communicating about the environment, yet have little or no depth of actual understanding of them (awareness and knowledge level).
2. Functional environmental literacy--capacity to use fundamental environmental knowledge, concepts, and thinking skills to communicate positions on environmental issues (attitudes and skill level).

3. Operational environmental literacy--capacity to regularly perceive environmental issues, gather and evaluate information, examine and choose alternatives, and take action (action level).

A person who is environmentally aware is not necessarily environmentally literate; nor is a person who possesses broad environmental understanding and/or concern; nor is a person who takes action. A person is deemed operational environmental literate only when all the components come together in actions taken. Achievement of operational environmental literacy in individuals is the ultimate goal of environmental education (Roth, 1991). Thus, environmental education can now be defined as education that develops environmental literacy at one or more levels.

Refining and clarifying a working definition of environmental literacy is currently underway by a number of organizations, including the National Science Teachers Assn. (NSTA), the Association for Supervision and Curriculum Development (ASCD), the North American Association for Environmental Education (NAAEE), and the United Nations Educational, Scientific, and Cultural Organization (UNESCO). These organizations are not only working to create standards for program evaluation and guidelines for curriculum development that are currently being analyzed and synthesized by the American Society for Testing and Materials (ASTM) Committee on Environmental Education. For as Roth (1991), a member of the ASTM Committee on Environmental Education stated:

> Whereas science literacy, for many people, seems to be built on a mechanistic paradigm, environmental literacy builds on an ecological paradigm. Environmental literacy is the capacity to perceive and interpret the relative health of

> environmental systems and to take appropriate action to maintain, restore, or improve the health of those systems... Environmental literacy extends beyond aspects of scientific literacy; environmentally literate people have aspects of economic literacy, geographic literacy and have or seek historical understanding of how various environmental issues came to be...People seldom think of literacy beyond certain cognitive skills. However, in the more modern sense of literacy as multiple discourses literacy involves particular ways of thinking, acting, and valuing. Environmental literacy is being defined in all these ways and may be somewhat unique among current definitions of particular literacies in doing this so overtly (p. 45).

The investigation done by this researcher was developed to use the emerging definition of environmental literacy being developed by Roth and the ASTM committee and apply it to an environmental education program involving high school students. The study focuses on the environmental literacy continuum levels, as defined by Roth (1991), of students who participate in a resident environmental science academy as compared to a similar control group of students who do not participate. The study also investigates continuation and retention along the proficiency continuum over a period of three months.

Summary of the Literature

Creation of an environmental literate citizenry is the ultimate goal of environmental education. Questions now arise as to what constitutes environmental literacy and as to what skills and knowledge the environmental literate person must possess.

A review of the literature finds that most instructional techniques in the past have been based on environmental awareness and knowledge models. Knowledge and awareness of the environment and environmental problems are certainly prerequisites to appropriate action, however, some research demonstrated that knowledge and awareness

of action skills are also prerequisites for taking action. Furthermore, students need to be specifically trained in environmental action problem-solving skills, and that this training needs to be incorporated into the instructional practice of environmental education. Affective and cognitive skills and experiences are involved in developing the highest level of environmental responsible action.

Environmental responsible action is synonymous to environmental literacy. In 1990, UNESCO defined environmental literacy as a (Roth, 1991):

> Basic functional education for all people which provides them with the elementary knowledge, skills, and motives to cope with environmental needs and contribute to sustainable development (p. 44).

This definition is still being refined and clarified in order that it may be used in goal and objective planning and in assessment of programs developed to promote environmental literacy.

This study investigated the three major components of environmental literacy--awareness, knowledge, and action--and to identify and analyze its nature and growth as affected by an environmental education program involving high school students. Existing environmental literacy levels of students were investigated as was the effect of an environmental education program on those literacy levels. The procedures used in this study to evaluate environmental literacy and to collect data for analysis are reported in Chapter III.

CHAPTER III

METHODS AND PROCEDURES

Introduction

Chapter III contains a description of the sample and comparative populations and an overview of the Environmental Science Academy. The instruments used, which include the Ecology Attitude Scale and the Environmental Knowledge and Personal Environmental Action Assessment, are described and the processes for their administration and statistical analysis is presented. Also, the informal evaluation surveys and interviews conducted with participants and parents are discussed.

Description of the Sample

The quasi-experimental population sample consisted of 24 junior and senior high school students recruited from high schools across the state of Oklahoma to attend the 1991 OSU Summer Academy of Environmental Science. The overall goal of the academy program was to assist a select group of high school students to become environmentally literate (Mills and Moseley, 1991). At the end of the academy experience students were:

1. To be aware of major environmental issues and problems
2. To be knowledgeable about the ecological concepts that connect the issues, problems, and solutions

3. To be able to identify and willing to take action and make personal commitment to environmental issues

The brochures and application forms for the academy were initially mailed in February, 1991 by the Oklahoma Board of Higher Regents office to 3,000 Oklahoma high school principals, counselors, and science teachers. Another mailout, by the OSU Education Extension office to 600 high school counselors, followed in March of the same year. The brochures were also sent to previous academy participants to solicit their involvement in recruitment in their home areas.

Applications were reviewed by a panel of academy staff in May, 1991. Selection criteria included:

1. Academic potential as measured by an acceptable grade point average (GPA). A balance between high GPA's and lower GPA's was desired, rather than recruiting only those with above average GPA.
2. Documented member of an under-represented minority group.
3. Leadership potential.
4. Two letters of reference.
5. Maintenance of a multicultural balance consistent with the population of the state of Oklahoma.
6. Maintenance of a balance between rural and urban high schools and geographic regions of Oklahoma.

Based on the selection criteria, 25 participants were selected from 40 applicants. Because one of the selected students cancelled at a late date, 24 students attended. Table I is a breakdown of the characteristics of these 24 students comprising the experimental group studied.

TABLE I

DESCRIPTION OF THE EXPERIMENTAL POPULATION

	Age				School Classification	
	15	16	17	18	Junior	Senior
Male	3	4	3	1	6	5
Female	7	4	2	0	10	3

	Ethnic Origin				
	Anglo	Hispanic	Oriental	Native American	Black
Male	7	1	1	0	2
Female	10	1	0	1	1
TOTAL	17	2	1	1	3

	Community Population			
	<10,000	10,000-25,000	25,000-100,000	>100,000
Male	4	4	3	0
Female	5	1	6	1

The Environmental Science Academy faculty consisted of nine staff members who were either OSU graduate students pursuing degrees in either environmental science or secondary science education, or doctoral graduates of the OSU Environmental Science Program. Fifty percent of the staff members actually had degrees and experience in environmental science and science education. The staff also consisted of two OSU professors who served as faculty advisors and two OSU undergraduate students interested in pursuing an environmental science graduate degree

and who served as staff members in an internship capacity. In the recruitment of staff, maintenance of a multicultural and gender balance was desired, as was expertise in environmental science and secondary science education. Table II is a breakdown of the staff.

TABLE II

DESCRIPTION OF THE ENVIRONMENTAL SCIENCE ACADEMY STAFF

	Anglo		Hispanic		Asian		Native American		Black	
	M	F	M	F	M	F	M	F	M	F
Undergraduate student	1	1	0	0	0	0	0	0	0	0
Graduate student										
Masters	1	3	0	0	0	0	1	0	0	0
Ph.D.	0	1	0	0	0	0	1	0	1	0
Doctoral graduates	0	0	0	0	0	0	1	0	1	0
Faculty advisors	2									

Description of the Comparable Population

The Summer Academy for Aerospace Education served as the comparable population in this study. The objectives of the Aerospace Education Summer Academy (Marks, 1992) were to:

1. Nurture the interest of students in biology, chemistry, physics, earth science and mathematics, and demonstrate how they can be integrated into aerospace education studies.
2. Interest females and under-represented minority groups in the sciences.
3. Conduct an evaluation of the summer academy for future research purposes.

The academy was offered June 9 - 28, 1991. The first two weeks were devoted to curricular matters in aerospace education studies by means of lectures and hands-on laboratory experiences. The third week was devoted to field experiences.

This comparable population sample consisted of 30 junior and senior high school students recruited from Oklahoma high schools to attend the OSU Summer Academy for Aerospace Education. Information pertaining to application to this academy was also mailed by the Oklahoma Board of Higher Regents in February, 1991 to 3,000 recipients in Oklahoma public high schools. Females and under-represented minority groups were targeted and 30 participants were selected from 130 applicants. Table III indicates the background of this control group.

TABLE III

DESCRIPTION OF THE COMPARATIVE POPULATION

	Ethnic Origin				
	Anglo	Hispanic	Asian	Native American	Black
Male	0	0	3	6	1
Female	10	0	3	7	0
TOTAL	10	0	6	13	1

	High School Status			Age			
	Junior	Senior	Total	15	16	17	18
Male	5	5	10	0	7	2	1
Female	11	9	20	3	14	3	0
TOTAL	16	14	30	3	21	5	1

	Community Size			
	<10,000	10,000-25,000	25,000-100,000	>100,000
Male	5	1	3	1
Female	13	1	4	1

Specific Treatment

The Oklahoma State University Summer Academy for Environmental Science (the experimental group) was an intensive three-week program of study with follow-up activities for 24 high school students (11th

and 12th grades) interested in and studying the application of scientific knowledge to social/economic issues as addressed in environmental science. The academy was designed to expose students to a wide variety of environmental problems ranging in scope from local and state issues to international problems.

The Summer Academy had two phases. Phase One involved classroom and laboratory activities on the OSU campus and field instruction in Oklahoma. Phase Two involved student activities in home towns that extended and enhanced the objectives of Phase One.

On-Campus Activities: Phase One

Phase One began June 8, 1991 and ended June 29, 1991. Students worked together in research teams for a significant portion of the time during the three-week program. Research done by Slavin (1980, 1981, 1983) has demonstrated that heterogeneous teams made up of males and females of different racial or ethnic backgrounds can be especially successful. This research also indicated that cooperative learning methods using small groups of students contribute significantly to student achievement at all grade levels in different subject matter areas and in different geographic locations.

A balance between the abstract and the concrete was included to accommodate a variety of learning styles. To achieve this goal, lectures, seminars, research teams, discussion groups, laboratories, and field trips were planned around the study of the physical and cultural environment. Urban and rural human interaction with natural resources were considered as they relate to world, national, state, and community environmental issues. Each team collected significant field data from

across the state and developed a visual report which demonstrated the nature of the program and accomplishments.

Activities were designed to promote cognitive and affective growth related to environmental issues. This was accomplished by utilizing an extensive variety of resources that included:

1. Field trips to environments typical throughout the nation (woodland, grassland, forest) but also to areas unique to Oklahoma (salt plains, tall grass prairie).
2. Field trips to corporations involved in environmental issues (local landfill and recycling center, hydroelectric power plant, coal-fired power plant, toxic waste disposal plant, Phillips Petroleum, waste water treatment plant, Weyerhaeuser Timber Co., Tyson Poultry Industry).
3. Field trips to state and federal agencies involved in environmental issues (Oklahoma Attorney General, Oklahoma Department of Wildlife Conservation, U.S. Soil Conservation Service, Oklahoma Department of Health)
4. Field trips and speakers representing local citizen action groups
5. Panel/debate discussions
6. Role-playing situations
7. Audio visual and computer technology materials
8. Development and presentation of a comprehensive slide program
9. Participation in activities from several environmental education curricula, particularly Project Wild and Project Learning Tree

10. Faculty, staff and speakers comprised of graduate students and professors of Oklahoma State University

Critical to the program, however, were two major ingredients: (1) throughout the academy, participants were engaged in extensive interactions with staff and each other. All staff traveled with students on each field trip and stayed with them in the same lodging facilities on overnight trips; and (2) informal get-togethers, i.e. cookouts, games, sports, and after-hour discussions and pizza parties, were extensively utilized. The above activities were possible because of the many field trips and because all students were housed together on campus. These factors created camaraderie and feelings of mutual concern and support among students and staff.

Follow-Up Activities: Phase Two

The emphasis of the academy was on environmental awareness, acquisition of knowledge, and potential environmental action. The follow-up activities emphasized environmental action. One major follow-up activity involved students conducting analysis of use patterns for energy, water, toxins, solid waste, and transportation in their home. Another activity involved selection and participation in one or more environmental action projects appropriate for their community, home, or school. Students brought their results from both activities back to the OSU campus for the Fall Equinox weekend, September 21-22, 1991. Their results were discussed and analyzed.

Instrumentation

This study investigated the environmental literacy levels of a designated sample population before and after treatment of an intensive environmental science experience. A search through the literature did not reveal any one validated instrument specifically designed to measure environmental literacy. Therefore, other instruments and research were investigated. An instrument was needed that addressed all three major components of environmental literacy--attitudes, knowledge, and action. The Ecology Attitude Inventory was finally chosen because it addressed the three components and had been tested for reliability and validity and, consequently, used in other research (Appendix C). Because a study of environmental literacy involves a strong emphasis on action and environmental behavior, a second instrument, the Environmental Knowledge and Personal Environmental Action Assessment was also chosen (Appendix D). This validated instrument has been used in research involving reported environmental action skills and also in longitudinal research studies. A description of each instrument follows.

Demographic Data

Demographic data were obtained from a survey (Appendix E) to accurately describe the samples by age, grade, gender, academic background, rural or urban community, and ethnicity. Students were identified by a code to assure anonymity.

Ecology Attitude Inventory (EAI)

Maloney and Ward (1973) originally developed a 128-item ecological attitude-knowledge scale. This scale was tested for known-group validity by administering it to members of two Sierra Club chapters, an undergraduate college group, and a non-college adult group. Items having the highest item-total correlation were selected for the revised 45-item short form. The revised scale consists of four subscales: verbal commitment (VC), which measures what a person states he is willing to do in reference to pollution-environment issues (10 items); actual commitment (AC), which measures what a person actually does in reference to pollution-environment issues (10 items); affect (A), which measures the degree of emotionality related to such issues (10 items); and knowledge (K), which measures specific factual knowledge related to ecological issues (15 items) (Maloney, et al. 1975). The indirect internal consistency index of reliability was used throughout the development of both the longer original version (Maloney and Ward, 1973) as well as the revised shorter version (Maloney, Ward, and Braucht, 1975). Content validity was established by three independent judges who assessed the appropriateness of each item in its subscale. Reliability on the longer version was estimated separately for such subscale by use of the split-half technique. The following Pearson reliability coefficients were obtained: VC, .91; AC, .93; A, .92; and K, .89 (Maloney and Ward, 1973).

The revised scale is recommended by Gray et al. (1985) in their survey of ecological attitude research. The scale was also reported by Edwards and Iozzi (1983) to be used in the only long term environmental

action longitudinal study, a two year one, reported in the environmental education literature. The EAI was utilized as a pre and post test administered at a two week summer institute for teachers, again administered to the group after one year, and then two years after the institute. Borden and Schettino (1979) also successfully used the EAI instrument in research conducted with 530 undergraduates at Purdue University in the fall of 1976.

Despite the strengths of the Ecology Attitude Inventory design and its usage in research, there are several limitations that must be noted. The instrument was written in 1973 and revised in 1975. Several of the questions do not reflect current environmental issues or concerns. Word usage and terminology are also outdated in some instances. The instrument needs to be revised and updated in order to better assess the environmental attitudes, knowledge, and action skills in the society of today. This revision is discussed as a recommendation for further research in Chapter V.

Environmental Knowledge and Personal Environmental Action Assessment (Environmental Action Assessment)

This assessment instrument was developed by Jordan, Hungerford, and Tomera in 1982 to assess the effect of a residential environmental education workshop on responsible environmental behaviors of high school students. Open-ended questions were used to measure both the participants' knowledge of environmental action strategies and the participant's personal environmental behavior. Content validity was established by submitting a copy of the instrument to a jury of three

environmental educators for review (Jordan et al. 1986). The final instrument was administered to six treatment groups as a pre-test on the first day of the workshop and as a post-test to all six groups on the sixth and final day of the workshop. It was also administered as a delayed post-test by mailout two months after the workshop. The final questions used on the Environmental Knowledge and Personal Environmental Action Assessment, as developed by Jordan et al. (1982), are modifications of instruments developed by Ramsey (1979) and Klingler (1981) whose studies were similar but were conducted in a classroom setting with eighth grade students.

The instrument used in this study consisted of an open ended questionnaire containing two items measuring the students' knowledge of the types of environmental actions (Item I) and students' personal environmental actions (Item II). The items read as follows:

I. Environmental problems are problems because they have not been solved as yet. This means that citizens must work toward solving these issues. As a citizen, what kind of actions do you think you could use in helping solve environmental problems? Please list below as many different kinds of environmental actions as you can.

II. Have you ever taken any of these environmental actions before? If so, list the actions and the problems that action was directed toward. If you have taken no actions, please write none.

Data collected from Item I were utilized to determine the relative extent to which the environmental science academy altered students' knowledge of types of environmental actions. Data obtained from Item II

were utilized to determine the relative extent to which the environmental science academy altered the types and number of independent environmental actions taken by students.

The Environmental Action Assessment (Items I and II) was administered as a pretest on the first day of students' attendance at the environmental science academy. The same instrument was administered again as a posttest three months later to those students attending the academy reunion. Twenty-four students received the pretest. At the reunion, 18 students attended and completed the post test. The questionnaire was mailed to the remaining six students. Three of these six eventually responded for a total of 21 post tests which constituted a 87.5 percent return.

Informal Evaluation

In addition to the validated instruments, several informal evaluation surveys and an informal interview were also administered to the Environmental Science Academy participants (experimental group) and their parents. The interview consisted of open-ended questions, regarding the effects of the academy on their personal lives, and was administered during the weekend reunion three months after the academy (Appendix F). One evaluation survey was administered to the students on the last day of the three week program Appendix G). This survey was designed using open-ended questions, to solicit their opinions of various academy activities, speakers, and field trips, and also to gain their suggestions for changes and improvement. After the reunion, parents of the students were mailed a questionnaire soliciting their opinions of the academy, of noticed behavior changes of their child

attributable to the academy, and of comments expressed by the child about the academy while at home (Appendix H).

Throughout the academy, participants were required to keep a written journal. In their journals, they were asked to describe their reactions, opinions, perceptions, and evaluations of events. These journals were also used to evaluate the program. Writings by participants were read with the intent of identifying changes in environmental awareness, knowledge and responsibility as anecdotal evidence supporting data from the objective instruments.

Summary of Research Instruments

The Ecology Attitude Inventory served as the pre-test, post-test, and delayed post-test for attitude, knowledge, and action. The Environmental Action Assessment instrument was administered with the Ecology Attitude Inventory pre-test and delayed post-test to further assess action skills the students participated in as a direct result of the academy experience.

Research Design

Both the quasi-experimental group and the comparable group were pre-tested and post-tested with the Ecology Attitude Inventory, which assessed environmental attitude, knowledge, and action. The Environmental Science group was also delayed post tested with the Ecology Attitude Inventory. Also, the Environmental Science group was pre tested and delayed post tested with the Environmental Action Assessment to assess changes in environmental actions prior to the treatment and environmental actions reportedly participated in for the

three month time period after the academy. A demographic sheet was also administered to both groups along with the pre test. A diagram of the research format follows in Table IV.

This research design is similar to one designed by Jordan et al. (1986) in assessing the effects of two residential environmental workshops on high school students. Participants in their study were pre tested, post tested, and delayed post tested with the same instrument, the Environmental Action Assessment. Pre test and post test were administered on the first day and last day of the week-long workshop. The delayed post test was mailed to participants two months after the study. This design can be diagrammed as follows:

$O_1\ X_1\ O_2\ O_2$

$O_2\ X_2\ O_2\ O_3$

TABLE IV

DIAGRAM OF THE RESEARCH FORMAT

	Pre-Test		Post-Test		Delayed Post-Test		
Group 1 (ESA)	O_1	P_1	X_1	O_2	O_3	P_2	S_1
Group 2 (AA)	O_1		X_2	O_2			

P_1 Environmental Action Assessment pretest
P_2 Environmental Action Assessment posttest
O_1 Ecology Attitude Inventory pretest
O_2 Ecology Attitude Inventory posttest
O_3 Ecology Attitude Inventory delayed posttest
X_1 Treatment - Environmental Science Academy
X_2 Control - Aerospace Academy
S_1 Student Interview

Edwards and Iozzi (1983) also employed a similar design that they described as a pre-experimental longitudinal time design. Participants in their study were pretested the first day of an Environmental Education Institute and posttested on the last day of the four week workshop. Additional posttests were administered one year and again two years after completing the Institute. This design can be diagrammed as follows:

$O_1\ X_1\ O_2\ O_3\ O_4$

The same instrument, the Ecology Attitude Inventory, was employed for pretesting and all posttesting. No comparable group was used in their study.

This current study of the Environmental Science Academy students modeled the research design done by Edwards and Iozzi (1983), but goes beyond their research by utilizing a high school sample for comparison. Therefore, this study also modeled the design done by Jordan et al. (1986) utilizing two groups. This design is also discussed by Gay (1987) as an example of a quasi-experimental design, known as a non-equivalent control group design because random assignment of subjects to groups was not done. Two existing groups were pretested, administered a treatment, and posttested.

Procedures

A written objective test was given to the experimental and comparable groups the first day participants in each academy arrived on campus. The programs actually ran concurrently. The Environmental Science Academy was June 8-29, 1991 and the Aerospace Academy was June 9-28, 1991. However, the academy participants never intermingled. Dorm

accommodations were separate as were classroom facilities, field trips, and recreational activities.

Students in both the experimental group (Environmental Science Academy) and the comparable group (Aerospace Academy) were administered a demographic survey and the Ecology Attitude Inventory pretest (O_1) the first day of each program. The Environmental Science group was also administered the Environmental Action Assessment (P_1) the first day. The same students were administered the Ecology Attitude Inventory posttest (O_2) which was identical to O_1, on the last day of each program, concluding three weeks of attendance at the respective academy. Students in the experimental group were again administered the Ecology Attitude Inventory Delayed posttest (O_3) and the Environmental Action Assessment posttest (P_2) on the first day of the reunion, three months after attendance at the academy. O_3 delayed posttest was identical to O_1 pretest and O_2 posttest for attitude, knowledge, and action, as was P_2 delayed posttest was identical to P_1 pretest for action. The ES students were also administered a short interview during the reunion using the student evaluation survey (S_1). All pre and post tests were administered to all students each time by this researcher. The interviews (S_1) were conducted by this researcher and four other academy staff members.

Data Analysis

Ecology Attitude Inventory

Mean scores and standard deviations were computed for the total inventory (combined subscales) and for the individual subscales--affect,

verbal commitment, actual commitment and knowledge. One-way analyses of variance (alpha level = .05) were used to compare the pre, post, and delayed posttest mean scores of the Environmental Science group to determine if the increases in scores were significant. Bartz (1988) suggests that an alpha level of .05 is adequate and most commonly used in research that involves the behavioral sciences. Analysis of variance (ANOVA) was used because it statistically analyzes the amount of variation in the scores between groups against the variation among members of the same group yielding an F value. This F value is compared to values in a statistical table for statistical significance. If a significant F value resulted, the Tukey t-test was employed to determine where the significant increase occurred (pre post, pre delayed post, post delayed post). The above one-way ANOVA was used for the combined scores as well as for the mean scores of the individual subscales.

An attempt was made to determine where, if any, relationship existed among affect, actual commitment, verbal commitment, and knowledge of the Environmental Science students. Pearson Product Moment Correlation ratios were computed for each comparison at pre test, post test, and delayed post test times. The Pearson r, a popular and universal measure of correlation, measures the amount of linear relationships between two distributions. After the correlation coefficient (r) is calculated, it is compared to a statistical table to test for significance (Bartz, 1988). A correlation matrix was also completed comparing affect, actual commitment, verbal commitment, and knowledge scores of the Environmental Science subjects with their personal variables of gender, ethnic background, and community size background.

Lastly, two-way analyses of variance were employed to compare mean scores (pre and post tests) for participants in the Environmental Science group to the mean scores (pre and post tests) for students in the comparison group, the Aerospace Academy. Two-way analysis of variance was used because it evaluates two groups of subjects, each group receiving a different treatment. Comparisons were made for the combined scores and for each of the four individual subscales: affect, actual commitment, verbal commitment, and knowledge.

Environmental Knowledge and Personal Environmental Action Assessment (Environmental Action Assessment)

Scoring criteria and data interpretation procedures used in this research with the Environmental Action Assessment instrument were those developed by Ramsey (1979), modified by Jordan et al. (1986), and again slightly expanded by this researcher. Each subject received a numerical raw score for responses on each instrument item. Data for Item I (knowledge of environmental action skills) and Item II (personal environmental actions) were interpreted and classified into three different levels of response; (1) number of appropriate discrete responses, (2) number of categories represented by the discrete responses, and (3) number of responses within each category.

Criteria for assessing appropriate responses and categories, as determined by Ramsey (1979, p. 61) were based on the following classification of types of environmental problem-solving skills:

1. Persuasion - the act of trying to convince others to take a more positive environmental position, e.g., letter-writing, letter-to-editor, persuasive discussion.
2. Ecomanagement - any physical action aimed at maintaining or improving natural systems, e.g., litter pick-up, recycling, water conservation.
3. Consumerism - any action relying on a monetary effect which exerts persuasive pressure, e.g., direct and indirect boycotting, discriminating purchase of goods and services.
4. Political action - any physical action relying on the persuasion of a legislator, electorate, or governmental agency to conform to values and actions which are more environmentally positive, e.g., persuasive letters, petition signing and circulation, lobbying, voting.
5. Legal action - any legal/judicial action directed at some aspect of environmental law enforcement, e.g., lawsuits, injunction.
6. Organizational memberships - any membership and/or participation in organizations whose major focus is to increase environmental awareness, concern, and to promote environmental action.
7. Personal education - the act of self-education of environmental issues and problems to be more responsibly knowledgeable.

Jordan et al. (1986) added the sixth category to their interpretation of the data--organizational membership. This would include organizing and/or belonging to an environmental group, e.g.,

high school environmental club, local community clubs, and/or state or national organizations such as the Sierra Club, Defenders of Wildlife, National Wildlife Federation, etc. This researcher, in reviewing the responses given by the subjects in this study, added a seventh category--education. This category relates to self-education of the respondent, the acquisition of more knowledge related to environmental issues. Education as it relates to the respondents teaching others is recorded under the category of persuasion.

Each discrete response was interpreted for "category" classification and assigned a numerical value of "1" if it met the criteria. Raw scores were calculated by this researcher for the total number of environmental action skill categories, total number of appropriate responses, and total number of responses per categories. Credit was given for each response with the exception of redundant or overlapping responses. These occurred when general responses were included with specific responses in the same skill area. Table V provides data interpretation examples.

The correlated t-test was utilized on the pretest and posttest data of the Environmental Action Assessment instrument to indicate statistically significant differences in means of the total number of responses and the total number of categories of both Item I (knowledge of environmental action skills) and Item II (environmental action skills). The correlated t-test was chosen because significant differences between the means of correlated samples, in this case, repeated measurements of the same subject was desired. A one-tailed t-test was also used because of the use of a directional hypothesis.

This researcher predicted that there would be a significant difference between means and that difference would be positive.

TABLE V

SAMPLE RESPONSES WITH SCORING AND DATA INTERPRETATION

Sample Responses	No. Responses	Category	No. Categories
1. "I would write the newspaper editor	1	Persuasion	1
"I will take shorter showers"	1	Ecomanagement	1
"I recycle cans"	1	Ecomanagement	-
TOTAL	3		2
2. "I save energy	-	--	-
"I lower the thermostat"	1	Ecomanagement	1
"I buy recycled paper products"	1	Consumerism	1
TOTAL	2		2

Summary of the Methodology

The subjects used in this study were eleventh and twelfth grade students attending two different summer in-residence academies at Oklahoma State University. A total of 54 students participated in the

study. There were 24 students in the Environmental Science Academy (the experimental group) and 30 students in the Aerospace Academy (the comparative group). The Ecology Attitude Inventory was given as a pretest and posttest to both groups to measure and compare environmental knowledge, attitudes, and actions--components of environmental literacy--of the students. The Ecology Attitude Inventory was also administered as a delayed posttest to the Environmental Science participants to determine what long-term effect the academy had on environmental literacy and the relationships between and/or among the literacy components and with the personal variables of gender, ethnicity, and community background. The Environmental Knowledge and Personal Environmental Action Assessment was administered as a pretest and a delayed posttest to the Environmental Science participants to determine further what effect the academy had on changes in environmental behavior skills. In addition, informal evaluation of the Environmental Science Academy was obtained from the administration of a parental evaluation survey, a student questionnaire, and student journals and interviews.

CHAPTER IV

INTRODUCTION

The major objectives of this study were to determine the effectiveness of an intensive academy format and content in promoting positive change in environmental literacy among eleventh and twelfth grade students in the cognitive and affective domains, and to determine if any changes induced in the participants were enduring. A secondary objective of this study was to identify any relationships which might exist between and/or among knowledge of environmental issues, affect (the degree to which the subjects were emotional about environmental issues), verbal commitment (what did the subjects say they were willing to do for environmental quality), and actual commitment (what did the subjects to do improve environmental quality), as well as several personal characteristics of the academy participants (gender, ethnic background, and community size background). A comparable group was utilized to further investigate the effectiveness of the treatment.

Pre, post, and delayed post test results were analyzed at the Oklahoma State University Computer Center using the Statistical Analysis System (SAS) computer program. The analysis of variance and the Pearson Product Moment correlation were the primary tools utilized.

Mean scores and standard deviations were computed for the total Ecology Attitude Inventory (combined subscales) and for the individual subscales--Affect (A), Verbal Commitment (VC), Actual Commitment (AC),

and Knowledge (K) for both the Environmental Science Academy group (ES) and the Aerospace Academy group (AS). Tables VI, VII, and VIII illustrate the descriptive comparison of means for both groups, while Figures 5 and 6 graphically compares the means of the four subscales of each group.

TABLE VI

PRE AND POST TEST MEAN SCORES AND STANDARD DEVIATIONS ACHIEVED BY ENVIRONMENTAL SCIENCE SUBJECTS IN ECOLOGY ATTITUDE INVENTORY (COMBINED AND SUBSCALES)

	Pre test	Post Test	Delayed Post Test
Combined			
x	24.54	26.50	28.67
sd	7.76	7.29	7.68
Affect (A)			
x	6.88	7.23	7.29
sd	2.77	1.99	1.95
Verbal Commitment			
x	7.58	7.86	8.05
sd	2.39	2.53	2.48
Actual Commitment (AC)			
x	4.63	4.77	6.48
sd	2.37	2.51	2.32
Knowledge (K)			
x	5.46	6.63	6.86
sd	2.55	3.04	3.14

TABLE VII

PRE AND POST TEST MEAN SCORES AND STANDARD DEVIATIONS ACHIEVED BY AEROSPACE SUBJECTS ON ECOLOGY ATTITUDE INVENTORY (COMBINED AND SUBSCALES)

	Pre Test	Post Test
Combined		
x	20.34	20.57
sd	6.93	6.90
Affect (A)		
x	5.69	5.92
sd	2.59	2.21
Verbal Commitment (VC)		
x	5.76	5.93
sd	2.79	2.79
Actual Commitment (AC)		
x	4.21	3.96
sd	2.51	2.44
Knowledge (K)		
x	4.69	4.75
sd	2.11	2.17

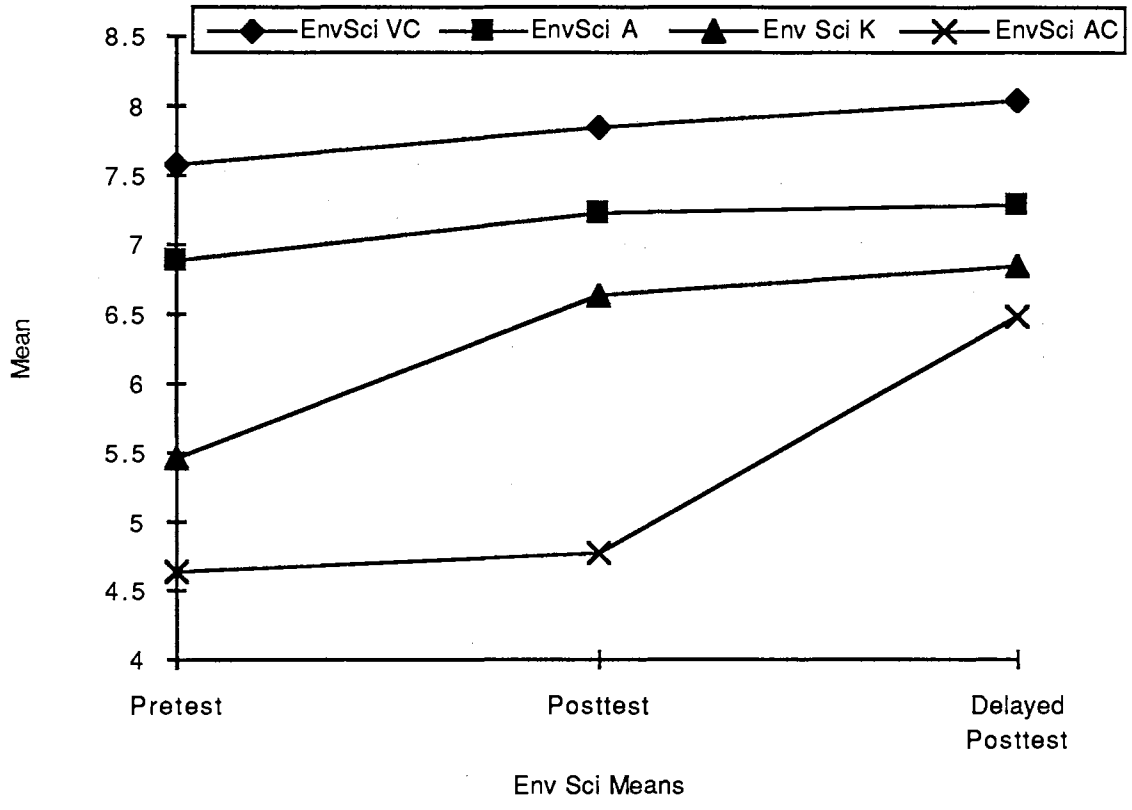


Figure 5. Pre Test, Post Test and Delayed Post Test Mean Score of Participants in the Treatment (EnvSci) on the Ecology Attitude Inventory

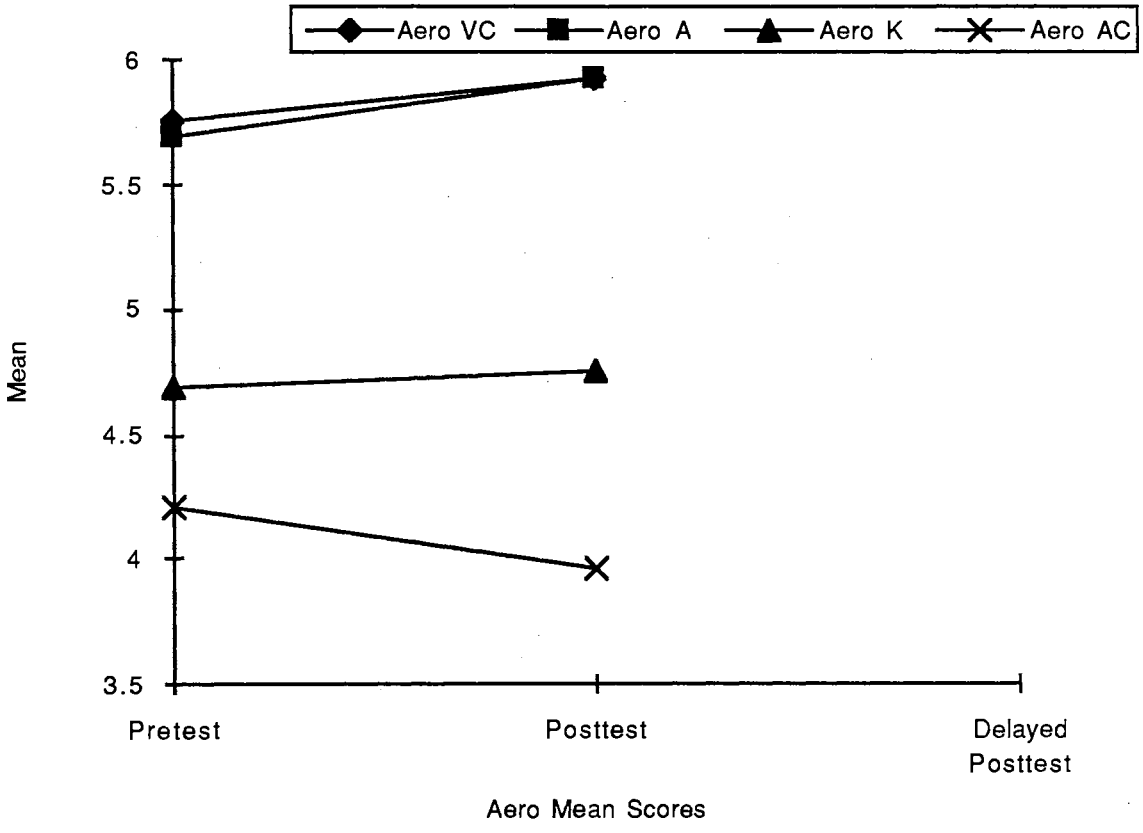


Figure 6. Pre Test and Post Test Mean Score of Participants in the Comparision (Aero) Group on the Ecology Attitude Inventory

TABLE VIII

PRE AND POST TEST MEAN SCORES AND STANDARD DEVIATIONS ACHIEVED BY ALL SUBJECTS ON ECOLOGY ATTITUDE INVENTORY (COMBINED AND SUBSCALES)

	Pre Test		Post Test		Delayed Post-Test	
	ES	AS	ES	AS	ES	AS
Combined						
x	24.54	20.34	26.50	20.57	28.67	-
sd	7.76	6.93	7.29	6.90	7.68	-
range	8-36	7-31	4-38	9-36	12-38	
Affect (A)						
x	6.88	5.69	7.23	5.92	7.29	-
sd	2.77	2.54	1.99	2.21	1.95	-
range	1-10	1-10	2-10	1-10	1-10	
Verbal Commitment (VC)						
x	7.58	5.76	7.86	5.93	8.05	-
sd	2.39	2.79	2.53	2.79	2.48	-
range	2-10	0-10	2-10	0-9	0-10	
Actual Commitment (AC)						
x	4.63	4.21	4.77	3.96	6.48	-
sd	2.37	2.51	2.51	2.44	2.32	-
range	1-10	0-10	2-10	0-9	0-10	
Knowledge (K)						
x	5.46	4.69	6.63	4.75	6.86	-
sd	2.55	2.11	3.04	2.17	3.14	-
range	2-10	1-10	1-13	1-9	1-13	

In addition to the analysis of the data collected using the Ecology Attitude Inventory, data were further collected by using the Environmental Knowledge and Personal Action Assessment instrument. This data were collected in hopes of gaining a greater insight into the effect the Environmental Science Academy had on environmental action behavior skills, the major component of environmental literacy. The results of this instrument were tabulated by this researcher utilizing one-tailed correlated t-tests. The data analysis of the two instruments--the Ecology Attitude Inventory and the Environmental Action Assessment--will be discussed separately.

Furthermore, personal data of subjects in both groups were collected by using a demographic questionnaire administered at the time the pretests were given. The information from the questionnaire is summarized in the following categories by means of frequency distributions:

1. Age (15 - 19)
2. Gender (male and female)
3. Grade (freshman, sophomore, and junior)
4. Ethnic background (majority - Anglo; minority - all others)
5. Community size background (rural - < 25,000; urban - > 25,000)

In addition to the above quantitative data analyses, several methods were employed to collect qualitative data. This descriptive data were used to substantiate the quantitative data and strengthen the research. These quantitative methods included personal interviews and journal writings of the Environmental Science students. Chapter IV will be separated into the two major categories of quantitative and qualitative data for explanation and discussion.

Quantitative Data

Demographic Questionnaire

A demographic questionnaire was administered the first day of each academy (ES and AS), along with the pretests, to acquire information about the personal variables that were used in the statistical analyses. These variables included participants' age, gender, grade, ethnic background, and community size background. Frequency distributions were completed for each variable in order to compare the two groups. Several similarities between groups existed:

1. Age - Both groups had a majority of students in the younger age brackets (15 and 16). The ES academy reported 42 percent fifteen year olds plus 33 percent sixteen year olds totaling 75 percent ages fifteen and sixteen. Likewise, the AS academy had fewer fifteen year olds (10 percent), but more 16 year olds (65 percent) for a total of 76 percent of 15 and 16 year olds (see Table IX).

TABLE IX

FREQUENCY DISTRIBUTION OF GROUP BY AGE

Group Frequency Percent Row Pct Col Pct	Age 15	16	17	18	19	Total
Env. Sci.						
	10	8	5	1	0	24
	18.87	15.09	9.43	1.89	0.00	45.28
	41.67	33.33	20.83	4.17	0.00	
	76.92	29.63	45.45	100.00	0.00	
Aerospace						
	3	19	6	0	1	29
	5.66	35.85	11.32	0.00	1.89	54.72
	10.32	65.52	20.69	0.00	3.45	
	23.08	70.37	54.55	0.00	100.00	
Total	13	27	11	1	1	53
	24.53	50.94	20.75	1.89	1.89	100.00

2. Grade - Both groups were similar in the distribution of the grade levels. A higher percentage existed in both groups of students who had just completed the sophomore grade (ES = 62 percent, AS = 56 percent) (Table X).

TABLE X

FREQUENCY DISTRIBUTION OF GROUP BY GRADE

Group Frequency Percent Row Pct Col Pct	Grade		
	Sophomore	Junior	Total
Env. Sci	15 28.80 62.50 48.38	9 16.98 37.50 40.91	24 45.28
Aerospace	16 30.19 55.17 57.14	13 24.53 44.83 59.09	29 54.72
Total	31 58.49	22 41.51	53 100.00

3. Gender - The Aerospace Academy had a slightly higher percentage of females (63 percent) than the ES Academy (54 percent) (Table XI).

TABLE XI

FREQUENCY DISTRIBUTION OF GROUP BY GENDER

Group Frequency Percent Row Pct Col Pct	Gender		
	Male	Female	Total
Env. Sci	11	13	24
	20.75	24.53	45.28
	45.83	54.17	
	50.00	41.94	
Aerospace	11	19	29
	20.75	33.96	54.72
	37.93	62.07	
	50.00	58.06	
Total	22	31	53
	41.51	58.49	100.00

4. Ethnic Background - In this category, the two groups varied more. The AS academy had a much higher percentage of students with a minority background (55 percent) than the ES academy (29 percent). Another interesting observation was that the AS academy was more evenly distributed in ethnicity (majority = 45 percent; minority = 55 percent) than the ES academy (majority = 71 percent; minority = 29 percent) (Table XII).

TABLE XII

FREQUENCY OF DISTRIBUTION OF GROUP BY ETHNIC

Group Frequency Percent Row Pct Col Pct	Ethnic		
	Majority	Minority	Total
Env. Sci	17	7	24
	32.08	13.21	45.28
	70.83	29.17	
	56.67	30.43	
Aerospace	13	16	29
	24.53	30.19	54.72
	44.83	55.17	
	43.33	69.57	
Total	30	23	53
	56.60	43.40	100.00

5. Community Size Background - Both groups had approximately twice as many students from a rural background than from an urban (ES = 63 percent rural, 38 percent urban; AS = 69 percent rural, 31 percent urban) (Table XIII).

Figures 7 through 11 graphically compare the variable numbers of each category between the two groups.

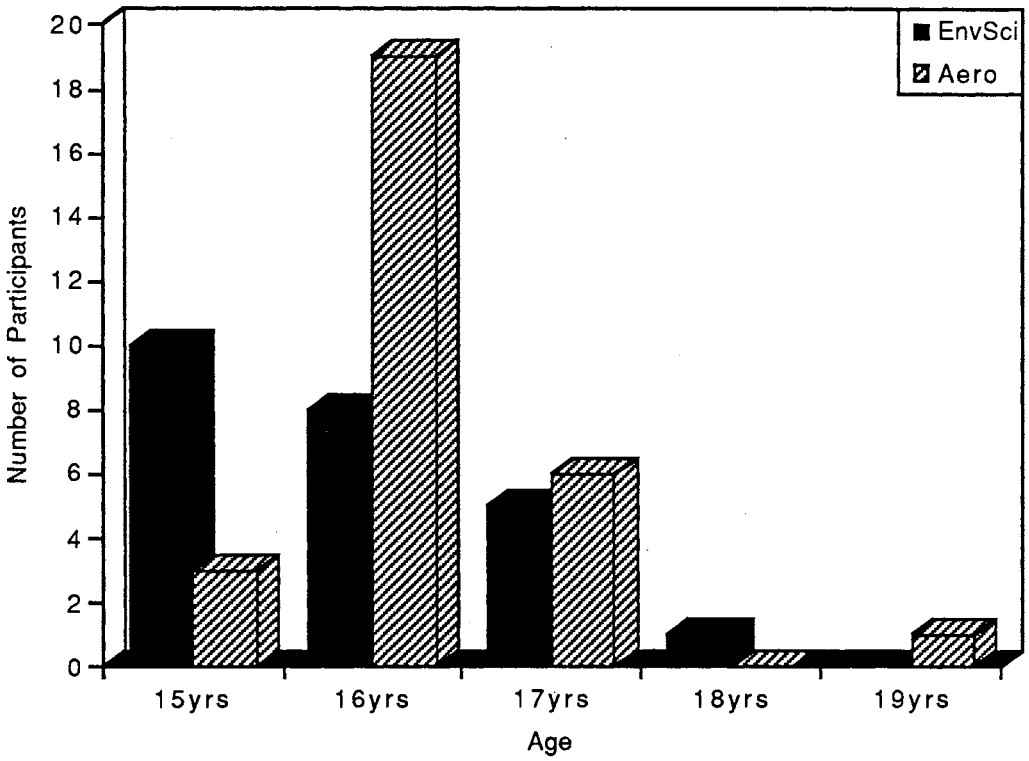


Figure 7. Age of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups

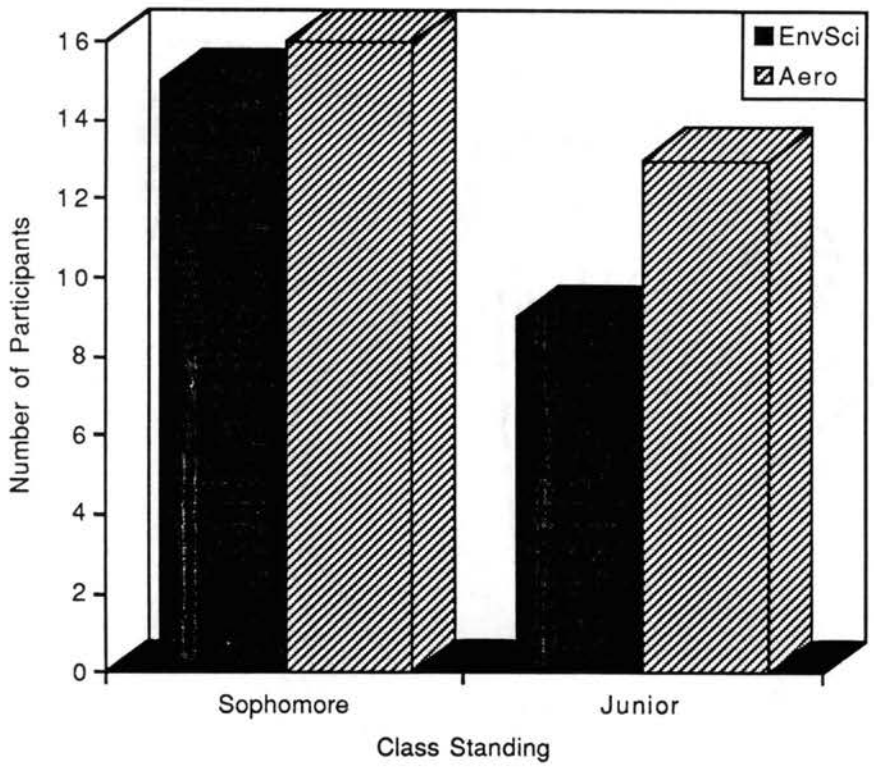


Figure 8. Class Standings of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups

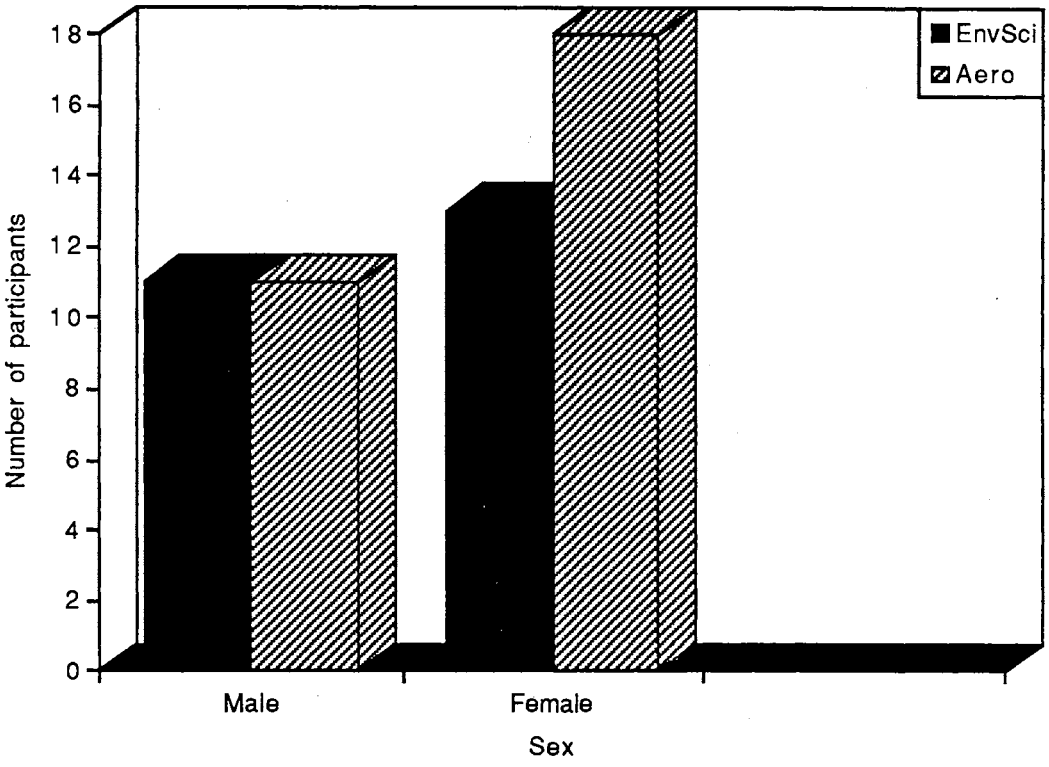


Figure 9. Sex of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups

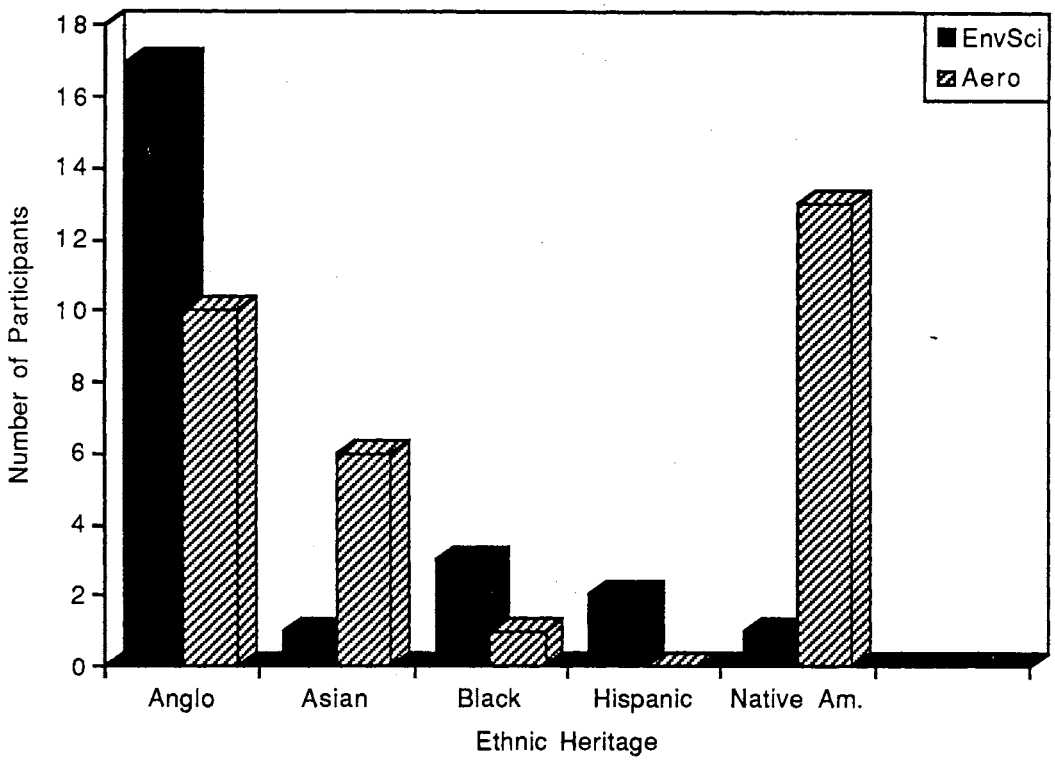


Figure 10. Ethnic Heritage of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups

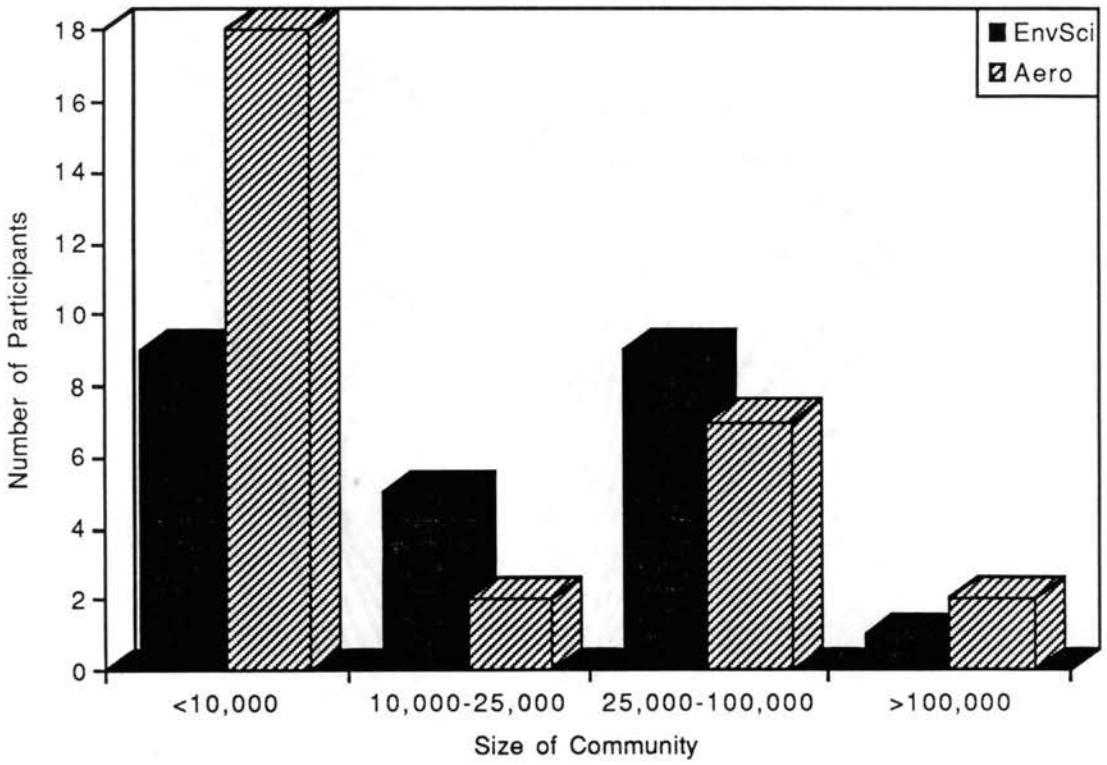


Figure 11. Approximate Size of Home Community for Participants in the Treatment (EnvSci) and Comparison (Aero) Groups

TABLE XIII

FREQUENCY DISTRIBUTION OF GROUP BY COMMUNITY

Group Frequency Percent Row Pct Col Pct	Community		
	Rural	Urban	Total
Env. Sci	15	9	24
	28.30	16.98	45.28
	62.50	37.50	
	42.86	50.00	
Aerospace	20	9	29
	37.74	16.98	54.72
	68.97	31.03	
	57.14	50.00	
Total	35	18	53
	66.04	33.96	100.00

Ecology Attitude Inventory

Comparison of the pre test mean scores with the post test and delayed post test mean scores of the Environmental Science group (Table VI) reveals that in all cases post test scores exceeded pre test scores and delayed post test scores exceeded post test scores. This occurred in the total combined scores and with each subscale.

Comparison of the pre test mean scores with the post test mean scores of the Aerospace group (Table VII) reveals that the Combined total scores, the Affect subscale, Verbal Commitment subscale, and the Knowledge subscale show slight increases after the academy. However,

the Actual Commitment subscale shows a slight decrease from the pre test mean score to the post test mean score.

Table VIII reveals a comparison of the pre and post test mean scores of both the Environmental Science and the Aerospace groups. In all cases the ES mean scores are greater than the comparative mean scores of the AS group. This data are graphed to indicate these changes more clearly in Figures 12 through 16.

In order to determine if the increases in the Environmental Science mean scores achieved from the pre test to post test were significant, and moreover, to determine whether such growth was enduring, the data were compared using a one-way analysis of variance (ANOVA). Analysis of variance was utilized with the Combined scores are well as with each subscale mean scores. If the corresponding F value obtained was significant, the Tukey t-test was utilized to determine where the actual significant increase occurred (pre - post, pre - delayed post, or post - delayed post). For comparison purposes, a t-test analysis was also utilized on the pre and post test mean scores of all four subscales of the Aerospace Academy participants to determine if the increases in those scores were significant.

Also, an attempt was made to determine what, if any, relationship existed among affect, actual commitment, verbal commitment, and knowledge subscales. Pearson Product Moment Correlation ratios were computed for each comparison at pre test, post test, and delayed post test times for the mean scores of the Environmental Science group. A correlation matrix was also completed comparing affect, actual commitment, verbal commitment, and knowledge with personal variables of gender, ethnic background, and community size background.

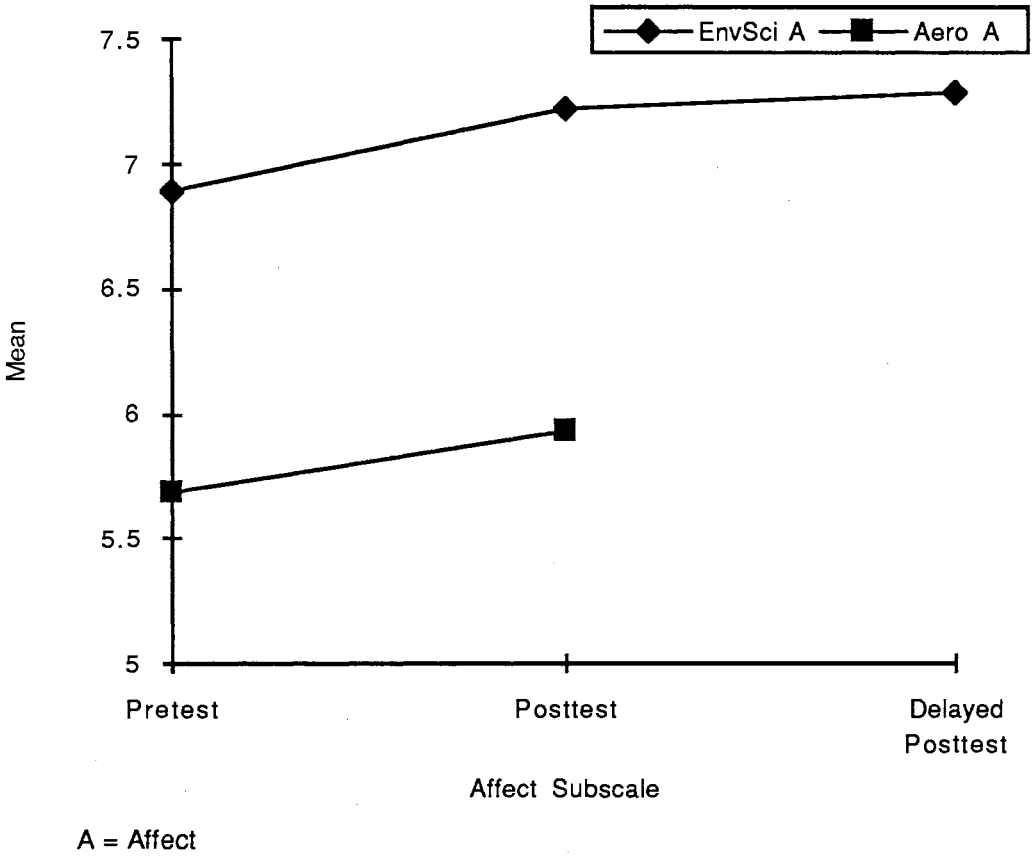


Figure 12. Pre Test, Post Test and Delayed Post Test Mean Score of Attitude of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups on the Ecology Attitude Inventory

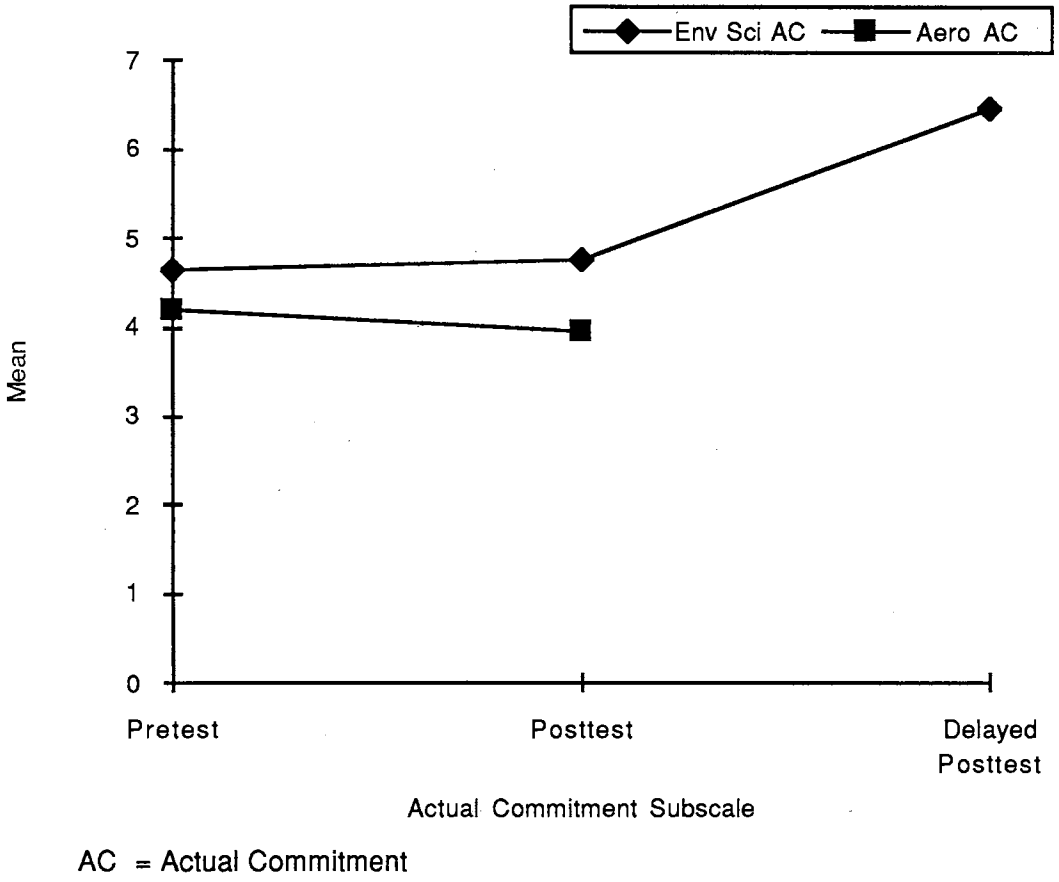


Figure 13. Pre Test, Post Test and Delayed Post Test Mean Score of Actual Commitment of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups on the Ecology Attitude Inventory

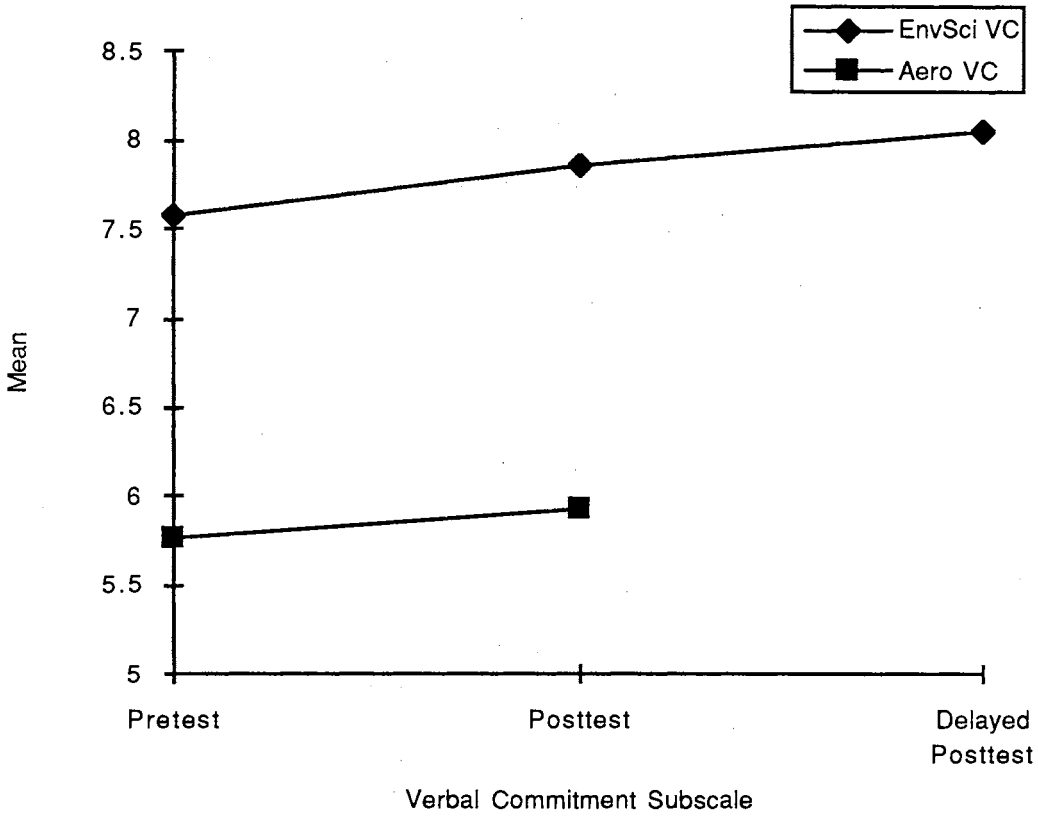


Figure 14. Pre Test, Post Test and Delayed Post Test Mean Score of Verbal Commitment of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups on the Ecology Attitude Inventory

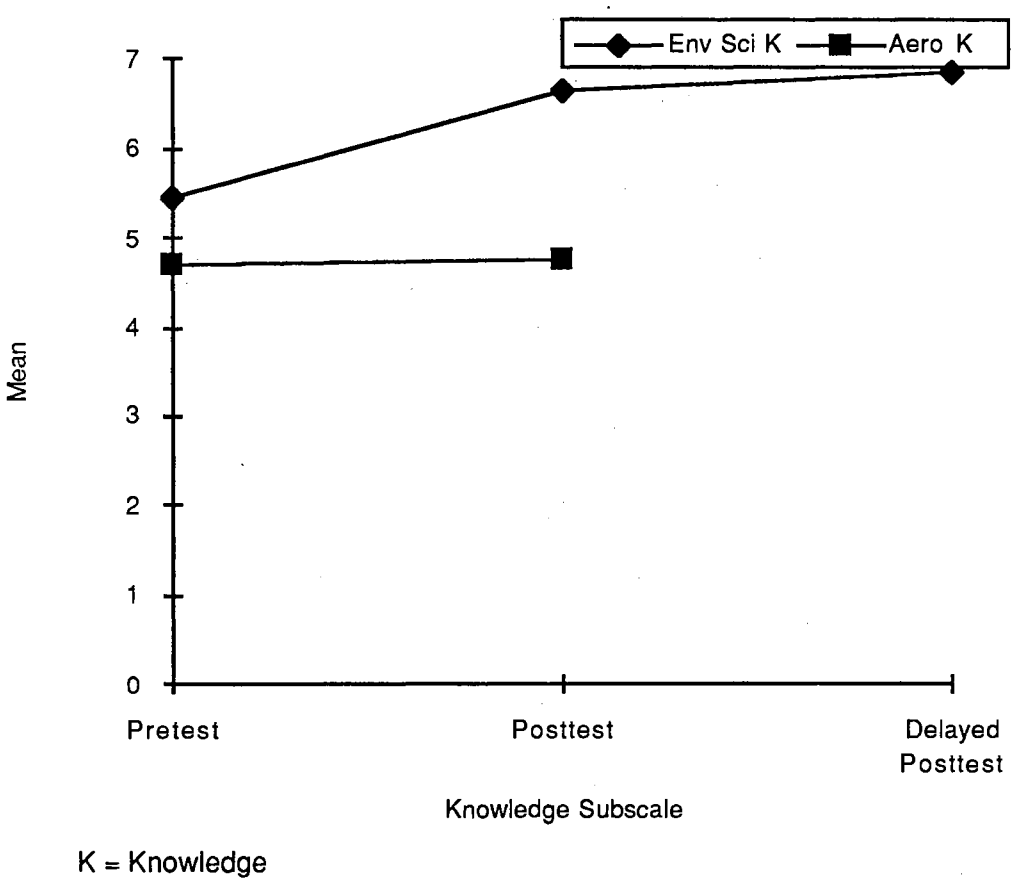


Figure 15. Pre Test, Post Test and Delayed Post Test Mean Score of Knowledge of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups on the Ecology Attitude Inventory

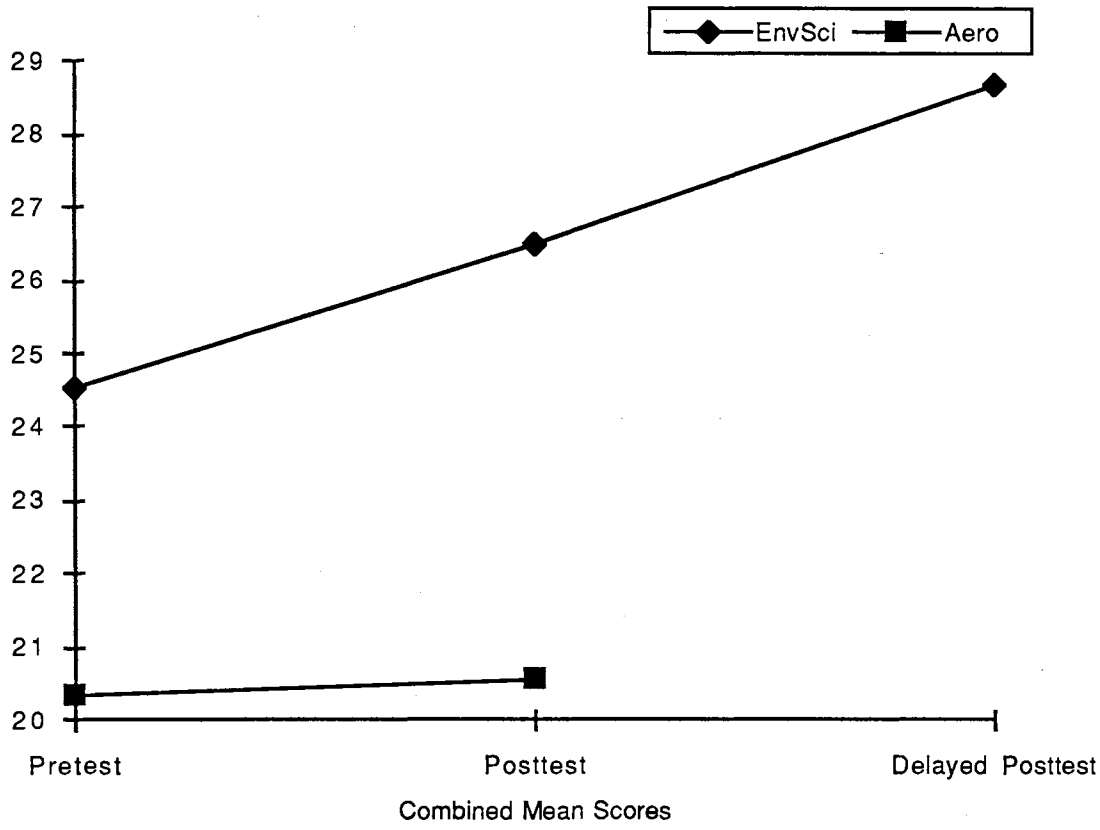


Figure 16. Combined Mean Score of Participants in the Treatment (EnvSci) and Comparison (Aero) Groups

In studying the mean scores of the ES and AS groups, it was discovered all of the ES scores were higher in value in each test to the corresponding AS scores. In order to determine if this relationship was significant, a two-way analysis of variance was used to investigate the effects of two variables simultaneously and their interaction effect. The two variables involved were type of group (Environmental Science academy and Aerospace Academy) and treatment (pre and post tests). The two-way ANOVA was conducted on the Combined mean scores as well as on each of the four subscale mean scores--affect, actual commitment, verbal commitment, and knowledge. A 2 (group) x 2 (treatment) factorial design was utilized.

Hypothesis I

As a result of participating in the Environmental Science Academy, there will be no significant change occurred in the cognitive and affective growth regarding the environment (pre, post, and delayed post mean scores of the Combined subscales of the Ecology Attitude Inventory)...

a. At the conclusion of the three week academy

b. Three months after completing the academy

The mean scores achieved on the pre, post, and delayed post tests were compared. Delayed post test mean (x - 28.67) exceeded post test mean (x - 26.50), which in turn exceeded pre test mean score (x - 24.54). However, the results of the one-way analysis of variance did not result in a significant F value ($F = 1.66$, $p > .1986$) (Table XIV). Therefore, null hypotheses Ia and Ib were not rejected.

TABLE XIV

ANOVA FOR PRE, POST, AND DELAYED POST TEST FOR COMBINED MEAN SCORES (ES)

Source	DF	SS	MS	F	Pr>F
Between	2	190.59	95.29	1.66	0.1986
Within	64	3678.13	51.47		
Total	66	3868.72			

Hypothesis II

As a result of participating in the Environmental Science Academy, no significant change occurred in affect (emotionality) regarding environmental problems (pre, post, and delayed post test mean scores of the Affect subscale of the Ecology Attitude Inventory)...

a. At the conclusion of the three week academy

b. Three months after completing the academy

The means achieved on the pre test, post test, and delayed post test were compared. Post test mean score ($x = 7.23$) exceeded pre test mean score ($x = 6.88$). Delayed post test mean score ($x = 7.29$) exceed both prior scores. However, when a one-way ANOVA was conducted, the F value that resulted was not significant ($F = .22$, $p > .8065$) (Table XV). Therefore, Hypotheses IIa and IIb were not rejected.

TABLE XV

ANOVA FOR PRE, POST, AND DELAYED POST TEST FOR AFFECT MEAN SCORES (ES)

Source	DF	SS	MS	F	Pr>F
Between	2	2.28	1.14	0.22	0.8065
Within	64	336.71	5.26		
Total	66	339.04			

Hypotheses III

As a result of participating in the Environmental Science Academy, there will be no significant change occurred in verbal commitment regarding efforts to improve environmental quality (pre, post, and delayed post test mean scores of the Verbal Commitment subscale of teh Ecology Attitude Inventory)...

a. At the conclusion of the three week academy

b. Three months after completing the academy

Mean scores from the pre, post, and delayed post tests of the Verbal Commitment subscale were compared. The scores slightly increased with each test (pre $x = 7.58$, post $x = 7.86$, delayed post $x = 8.05$). However, when the one-way ANOVA was done, the F value ($F = .20$, $p > .8163$) computed was not significant (Table XVI). Therefore, Hypotheses IIIa and IIIb were not rejected.

TABLE XVI

ANOVA FOR PRE, POST, AND DELAYED POST TEST FOR VERBAL COMMITMENT MEAN SCORES (ES)

Source	DF	SS	MS	F	Pr>F
Between	2	2.47	1.24	.20	0.8163
Within	64	389.38	6.08		
Total	66	391.85			

Hypothesis IV

As a result of participating in the Environmental Science Academy, there will be no significant change occurred in actual commitment (behavior) to improving environmental quality) pre, post, and delayed post test mean scores of the Actual Commitment subscale of the Ecology Attitude Inventory)...

a. At the conclusion of the three week academy

b. Three months after completing the academy

Mean scores from the pre, post, and delayed post tests of the Actual Commitment subscale were compared. With each test, an increase occurred in mean scores (pre $x = 4.63$, post $x = 4.77$, delayed post $x = 6.49$). The one-way ANOVA yielded a significant F value ($F = 3.9$, $p < .0233$) (Table XVII). In order to determine where the significant increase occurred (pre-post, pre-delayed post or post-delayed post), the Tukey t-test was computed (Table XVIII). This test yielded a

significant increase in mean scores of pre test to delayed post test ($P < .05$). Therefore, Hypothesis IVa was not rejected, but Hypothesis IVb was rejected. A statistical significant change in actual commitment occurred three months after completing the academy.

TABLE XVII

ANOVA FOR PRE, POST, AND DELAYED POST TEST FOR ACTUAL COMMITMENT MEAN SCORES (ES)

Source	DF	SS	MS	F	Pr>F
Between	2	45.95	22.98	3.99*	0.0233
Within	14	368.73	5.76		
Total	66	414.69			

*$p < .05$

TABLE XVIII

TUKEY T-TEST AFTER SIGNIFICANT ANOVA COMPARING PRE, POST, AND DELAYED POST TESTS FOR ACTUAL COMMITMENT MEAN SCORES (ES)

	N_1	X	N_2	X_2	q
Pre vs. Post	24	4.63	22	4.77	.28
Pre vs Delayed Post	22	4.63	21	6.48	3.63*
Post vs Delayed Post	22	4.77	21	6.48	2.37

*$p < .05$

Hypothesis V

As a result of participating in the Environmental Science Academy, no significant growth occurred in knowledge about environmental issues (pre, post, and delayed post test mean scores of the Knowledge subscale of the Ecology Attitude Inventory)...

a. At the conclusion of the three week academy

b. Three months after completing the academy

When comparing the mean scores of the pre, post, and delayed post tests of the Knowledge subscale, it was found that with each subsequent test, a slight increase in scores occurred (pre $\bar{x} = 5.46$, post $\bar{x} = 6.64$, delayed post $\bar{x} = 6.86$). However, the one-way ANOVA did not yield a significant F value ($F = 1.54$, $p > .2232$) (Table XIX). Therefore, Hypotheses Va and Vb were not rejected.

TABLE XIX

ANOVA FOR PRE, POST, AND DELAYED POST TEST FOR KNOWLEDGE MEAN SCORES (ES)

Source	DF	SS	MS	F	Pr>F
Between	2	25.99	12.99	1.54	0.2232
Within	64	541.62	8.46		
Total	66	567.61			

Hypothesis VI

As a result of participating in the Aerospace Academy, no significant change occurred in the cognitive and affective growth regarding the environment (pre and post mean scores of the combined subscales of the Ecology Attitude Inventory) at the conclusion of the three week academy.

The pre and post test mean scores of the AS group showed only a slight increase on the total combined scales (pre $x = 20.34$; post $x = 20.57$). The t-test analysis did not yield a significant t-value ($t = 0.123$, $p > .05$) (Table XX). Therefore, Hypothesis VI was not rejected. No significant change occurred in the cognitive and affective growth regarding the environment at the conclusion of the Aerospace Academy.

TABLE XX

T-TEST COMPARISONS OF PRE AND POST TEST MEAN SCORES OF AEROSPACE ACADEMY

Variable: Total Test	N	X	Sd	Sdx	DF	T
Pre	28	20.34	6.93	1.865	55	0.123
Post	29	20.57	6.90			

Hypothesis VII

As a result of participating in the Aerospace Academy, no significant change occurred in affect (emotionality) regarding environmental problems (pre and post test mean scores of the Affect subscale of the Ecology Attitude Inventory) at the conclusion of the three week academy.

The pre and post test mean scores of the AS group on the Affect subscale indicated a slight increase (pre $x = 5.69$; post $x = 5.92$). However, the t-test analysis did not yield a significant value ($t = .359$, $p > .05$) (Table XXI). Therefore, Hypothesis VII was not rejected. The AS participants did not experience a significant change in affect (emotionality) at the conclusion of their academy.

TABLE XXI

T-TEST COMPARISONS OF PRE AND POST TEST MEAN SCORES OF AEROSPACE ACADEMY

Variable: Affect Test	N	X	Sd	Sdx	DF	T
Pre	28	5.69	2.54	.6414	55	0.359
Post	29	5.92	2.21			

Hypothesis VIII

As a result of participating in the Aerospace Academy, no significant change occurred in verbal commitment regarding efforts to improve environmental quality (pre and post test mean scores of the Verbal Commitment subscale of the Ecology Attitude Inventory) at the conclusion of the three week academy.

Verbal Commitment pre and post mean scores showed a slight increase (pre $x = 5.76$; post $x = 5.93$). However, the t-test analysis did not yield a significant t-value ($t = .226$, $p > .05$) (Table XXII). Therefore, Hypothesis VIII was not rejected. Aerospace Academy participants did not experience a significant change in verbal commitment after attending their academy.

TABLE XXII

T-TEST COMPARISONS OF PRE AND POST TEST MEAN SCORES OF AEROSPACE ACADEMY

Variable: Verbal Commitment Test	N	X	Sd	Sdx	DF	T
Pre	28	5.76	2.79	.7525	55	0.226
Post	29	5.93	2.79			

Hypothesis IX

As a result of participating in the Aerospace Academy, no significant change occurred in actual commitment (behavior) to improving environmental quality (pre and post mean scores of the Actual Commitment subscale of the Ecology Attitude Inventory) at the conclusion of the three week academy.

The pre and post test mean scores of the AS students on the actual commitment subscale actually decreased (pre $x = 4.21$; post $x = 3.96$). However, the t-test analysis did not yield this to be a significant decrease ($t = .375$, $p > .05$) (Table XXIII). Therefore, Hypothesis IX was not rejected. No significant change occurred in actual commitment (behavior) of the AS participants after attending their academy.

TABLE XXIII

T-TEST COMPARISONS OF PRE AND POST TEST MEAN SCORES OF AEROSPACE ACADEMY

Variable: Actual Commitment Test	N	X	Sd	Sdx	DF	T
Pre	28	4.21	2.51	.6675	55	0.375
Post	29	3.96	2.44			

Hypothesis X

As a result of participating in the Aerospace Academy, no significant growth occurred in knowledge about environmental issues (pre and post test mean scores of the Knowledge subscale of the Ecology Attitude Inventory) at the conclusion of the three week academy.

The Knowledge subscale pre and post mean scores of the AS group slightly increased (pre $x = 4.69$; post $x = 4.75$). However, the t-test analysis did not yield a significant t-value ($t = 0.105$, $p > .05$) (Table XXIV). Therefore, Hypothesis X was not rejected. The AS participants did not undergo a significant change in knowledge about environmental issues after attending the Aerospace Academy.

TABLE XXIV

T-TEST COMPARISONS OF PRE AND POST TEST MEAN SCORES OF AEROSPACE ACADEMY

Variable: Knowledge Test	N	X	Sd	Sdx	DF	T
Pre	28	4.69	2.11	.5774	55	0.1048
Post	29	4.75	2.17			

Upon tabulating the mean scores of all four subscales of the pre, post, and delayed post tests of the ES group, it was observed that the mean scores increased in each subscale from pre to post to delayed post test. Therefore, it was expected that a significant increase occurred in each case. However, this was not what happened, with the exception of actual commitment (pre - delayed post). Therefore, it could be argued that the only significant effect that the Environmental Science Academy had on its participants was an enduring increase in commitment to solve environmental problems. However, it must be argued that the academy also had an educational effect in regard to increases in values on all four subscales. Each test showed an increase in mean scores, that if not statistically significant, may have been of educational significance. The academy had an educational effect on the enhancement of participants' attitudes (affect), knowledge, and action (actual and verbal commitment). As an educator, if one student in a classroom improves his/her scores, individual success has occurred.

Furthermore, when observing the mean scores of the pre and post tests of the AS group, no significant increases occurred in any subscale, and the increases that occurred were less than the comparable increases for the ES group. Also, actual commitment mean scores decreased.

The Environmental Science Academy focused on the impact that humans, as individuals and as societies, have on the environment. In contrast, the Aerospace Academy focused on the impact that technology has on humans and the environment. Thus, it could be argued that the AS participants reported doing less for the environment after attending their academy because they acquired a greater belief in the power of

technology for solving problems rather than a commitment of personal responsibility towards those problems.

Mean scores for students in the ES academy on all four subscales were slightly less than those scores for teachers in the study done by Edwards and Iozzi (1983). Also the scores were comparable to scores made by college students in a study done by Maloney et al. (1975). The mean scores of the AS academy participants were lower on all four subscales than the ES students. The AS scores were comparable to those made by non-college students in the study conducted by Maloney et al (1975). The highest scores in the study done by Maloney et al. (1975) were those reported by Sierra Club members. Neither the ES scores nor the AS scores were equivalent to this group, with the exception of verbal commitment. The ES group on the delayed post test had a mean score similar to the mean score of the Sierra Club members on the subscale of verbal commitment. Three months afterwards, the ES high school students are almost equal to the Sierra Club members (an environmental sensitive group) in saying what they will do to solve environmental problems. Likewise, the ES high school students are equal to the teachers in their verbal commitment to solving environmental problems. The other lower scores of the ES group could be attributed to their lower ages, grade levels, and maturity, when comparing them to teachers, Sierra Club members, and college students, and not directly to the environmental variables being evaluated. However, the ES participants obtained scores on the delayed post test that are similar to the scores of teachers, college students, and a highly environmental sensitive group, Sierra Club members, whereas the AS scores remained lower and comparable to non-college students. This could indicate a

growth in the Environmental Science students' depth of understanding and maturity in regard to environmental issues and their sense of personal environmental responsibility.

Hypothesis XI

As a result of participating in the Environmental Academy, no significant relationships existed between and/or among the Affect subscale of the Ecology Attitude Inventory and the following subscales:

1. Actual Commitment
    a. Prior to attending the academy (pre test mean scores)
    b. At the conclusions of the academy (post test mean scores)
    c. Three months after completion of the academy (delayed post test mean scores)
2. Verbal Commitment
    a. Prior to attending the academy (pre test mean scores)
    b. At the conclusions of the academy (post test mean scores)
    c. Three months after completion of the academy (delayed post test mean scores)
3. Knowledge
    a. Prior to attending the academy (pre test mean scores)
    b. At the conclusions of the academy (post test mean scores)
    c. Three months after completion of the academy (delayed post test mean scores)

Affect vs. Actual Commitment. Comparison of affect and actual commitment yielded a significant r value when using pre test scores (r = .634), and slightly decreasing, yet still significant values using post test scores (r = .524) and delayed post test scores (r = .433) (Table XXV). Before participating in the academy, the subjects who showed the highest actual commitment scores were also the ones who were the most emotional about environmental issues. Immediately after completing the academy, and after three months, the most actually committed seemed to be less emotional about environmental issues. However, the relationships were still significant. Therefore, Hypotheses XIA1, XIa2, and XIa3 were all rejected. Significant relationships were observed between affect and actual commitment prior to attending the academy, upon completion, and three months afterwards.

TABLE XXV

PEARSON PRODUCT MOMENT CORRELATION COMPARING AFFECT, ACTUAL COMMITMENT, VERBAL COMMITMENT, AND KNOWLEDGE

	Affect	Actual Commitment	Verbal Commitment	Knowledge
Affect				
Pre test	-	.634**	.673**	.310
Post test	-	.524**	.750**	.147
Delayed post test	-	.433*	.720**	.530*
Actual Commitment				
Pre test	-	-	.675**	.234
Post test	-	-	.625**	.032
Delayed post test	-	-	.562**	.210
Verbal Commitment				
Pre test	-	-	-	.196
Post test	-	-	-	.265
Delayed post test	-	-	-	.445*
Knowledge	-	-	-	-

* .05
** .01
N = 21

Affect vs. Verbal Commitment. Comparison of affect and verbal commitment yielded a significant r value when using pre test mean scores (r = .673) and these values remained significant as they increased in post test scores (r = .750) and delayed post test scores (r = .720) (Table XXV). After participating in the academy, the relationship between verbal commitment and emotionality was significant and remained so after three months. Therefore Hypotheses XIb1, XIb2,and XIb3 were rejected. A significant relationship occurred between affect and verbal

commitment prior to attending the academy, upon completion, and three months afterwards.

Affect vs. Knowledge. Prior to attending the academy the subjects showed no significant relationship between affect and knowledge pre test means scores ($r = .310$). Consequently, immediately after attending the academy, the post test mean scores showed an even less and insignificant r-value ($r = .147$). However, three months after completing the academy, a moderate, significant r-value ($r = .530$, $p < .05$) existed, yielding a significant relationship between emotionality and knowledge (Table XXV). Therefore, while Hypotheses XIc1 and XIc2 were not rejected, Hypothesis XIc3 was rejected. Whereas no significant relationship existed between affect and knowledge prior to academy attendance and upon completion, a significant relationship did exist three months afterwards.

Hypothesis XII

As a result of participating in the Environmental Science Academy, no significant relationship existed between and/or among the Actual Commitment subscale of the Ecology Attitude Inventory and the following subscales:

a. Verbal commitment
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)
b. Knowledge
    1. Prior to attending the academy (pre test mean scores)

2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

Actual Commitment vs. Verbal Commitment. The subjects who were most committed actually were also more verbally committed both prior to ($r = .675$), immediately afterwards ($r = .625$), and three months afterwards ($r = .562$) (Table XXV). Those who said they would do more for environmental quality reported that they actually did more. However, this correlation relationship, even though it remained significant in all three instances, did decrease with each test. Hypotheses XIIa1, XIIa2, and XIIa3 were all rejected. There was a significant relationship between actual commitment and verbal commitment prior to the academy, upon completion and three months afterwards.

Actual Commitment vs. Knowledge. No relationships were observed between how much the subjects knew about the environment and how much they actually did to improve environmental quality on either pre, post, or delayed post tests (Table XXV). Therefore, Hypotheses XIIb1, XIIb2, and XIIb3 wer not rejected.

Hypotheses XIII

As a result of participating in the Environmental Science Academy, no significant relationships existed between and/or among the Verbal Commitment subscale of the Ecology Attitude Inventory and the following subscales:

A. Knowledge
    1. Prior to attending the academy (pre test mean scores)

2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

Verbal Commitment vs. Knowledge. Prior to attending the academy and immediately afterwards, no relationships occurred between what the subjects said they were willing to do to improve environmental quality and how much they knew. However, three months after completing the academy, comparison of verbal commitment and knowledge yielded a moderate, significant r-value ($r = .445$, $p < .05$) (Table XXV). Therefore, while not rejecting Hypotheses XIIIa1 and XIIIa2, Hypothesis XIIIa3 was rejected. A significant relationship occurred between verbal commitment and knowledge three months after completion of the academy.

The correlation coefficients reveal several interesting relationships between the four subscales that have significance in future EE curricula design and emphasis. Affect was significantly correlated in all three tests to both actual commitment and verbal commitment. How emotional an individual is about environmental issues definitely is a factor as to what that individual says he/she will do to improve the environment and what he/she actually does. Likewise, actual commitment was significantly related to verbal commitment--what an individual says he/she will do is related to what he/she will do. In contrast, knowledge was not significantly correlated to any other subscale except for affect and verbal commitment on the delayed post test. When the knowledge value went up significantly on the delayed post scores for affect and verbal commitment, all other correlation scores went down (affect - actual commitment; affect - verbal

commitment; actual commitment - verbal commitment). It appears that three months after completing the academy, the participants who were most knowledgeable about environmental issues were less emotional and less verbally committed to solving environmental problems.

This study substantiates several conclusions from Borden and Schettino (1979). Affect (emotionality) appears to be a more important determinant of actual commitment and verbal commitment than knowledge. Also, increased concern about the environment does not lead to the seeking of knowledge; or conversely, the acquisition of environmental facts does not necessarily result in increased affective reactions.

Furthermore, this study supports Edwards and Iozzi (1983) in that the increase in emotionality had a significant impact on the changes in the actual environmental behavior skills of the subjects involved. Also, no relationship between knowledge and actual commitment was reported, and only a slight relationship between knowledge and verbal commitment and knowledge and affect existed. Furthermore, a significant relationship existed between verbal commitment and actual commitment; those who said they would do more actually did more.

These relationships have a significant emphasis. Knowledge alone is not sufficient to change an individual's behavior. How a person feels (emotionality) about an issue seems to have a greater impact on behavior change than what that individual knows.

Hypotheses XIV

As a result of participating in the Environmental Science Academy, no significant relationships existed between gender and each of the following subscales of the Ecology Attitude Inventory:

A. Affect
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

B. Actual Commitment
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

C. Verbal Commitment
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

D. Knowledge
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

Gender vs. Affect. No significant relationship existed between gender and emotionality towards environmental problems before, immediately afterwards, or three months after the academy (Table XXVI). Hypotheses XIVa1, XIVa2, and XIVa3 were not rejected.

TABLE XXVI

PEARSON PRODUCT MOMENT CORRELATIONS COMPARING AFFECT, ACTUAL COMMITMENT, VERBAL COMMITMENT, AND KNOWLEDGE WITH SELECTED PERSONAL VARIABLES OF S_s

	Affect	Actual Commitment	Verbal Commitment	Knowledge
Gender				
Pre test	.112	.283	.336	-.132
Post test	.303	.130	.239	-.122
Delayed post test	-.191	-.269	-.106	-.229
Ethnic				
Pre test	-.545*	-.251	-.394	-.118
Post test	-.230	-.415	-.317	-.310
Delayed post test	.093	-.137	.058	.049
Community				
Pre test	.194	.162	.064	-.142
Post test	-.002	-.036	-.141	-.178
Delayed post test	.345	.399	.228	.069

* .05
** .01
N = 21

Gender vs. Actual Commitment. No significant relationship exited between gender and actual commitment prior to the academy, at the conclusion of the academy, or three months afterwards (Table XXVI). Therefore, Hypotheses XIVb1, XIVb2, and XIV63 were not rejected.

Gender vs. Verbal Commitment. There was no significant relationship existed between gender and verbal commitment prior to the academy, at the conclusion of the academy, and three months afterwards (Table XXVI). Therefore, Hypotheses XIVc1, XIVc2, and XIVc3 were not rejected.

Gender vs. Knowledge. No significant relationship existed between gender and knowledge prior to the academy, at the conclusion of the academy, and three months afterwards (Table XXVI). Hypotheses XIVd1, XIVd2, and XIVd3 were not rejected.

Even though the personal variable of gender yielded no significant relationships to the four subscales, a few interesting observations need to be noted. In all four subscales, the relationships moved in the direction from pre to delayed post test to include more males being correlated to the scales. The only exception was the Affect subscale. Post test scores yielded an r-value of slight increase towards females, but delayed post test scores had a smaller r-value in the direction of males. Thus, females seemed to be more emotional about environmental issues at the conclusion of the academy, but after three months they appeared to have lost much of their emotionality.

Hypothesis XV

As a result of participating in the Environmental Science Academy, no significant relationships existed between ethnicity and each of the following subscales of the Ecology Attitude Inventory:

A. Affect
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

B. Actual Commitment
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

C. Verbal Commitment
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

D. Knowledge
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

Ethnicity vs. Affect

Prior to attending the academy, the majority students (White, Anglo) were significantly more emotional about environmental issues than minority students ($r = .545$, $p < .05$). Immediately after completing the academy and three months afterwards, there was no significant relationship existed between ethnicity and emotionality (Table XXVI). Hypotheses XVa1, thus, was rejected, yet Hypotheses XVa2 and XVa3 were not rejected.

Ethnicity vs. Actual Commitment. No significant relationship existed between ethnicity and actual commitment prior to the academy, at the conclusion of the academy, or three months afterwards (Table XXVI). Hypotheses XVb1, XVb2, and XVb3 were not rejected.

Ethnicity vs. Verbal Commitment. No significant relationship between ethnicity and verbal commitment prior to the academy, at the conclusion of the academy, or three months afterwards (Table XXVI). Hypotheses XVc1, XVc2, and XVc3 were not rejected.

Ethnicity vs. Knowledge. No significant relationship existed between ethnicity and knowledge about environmental issues prior to, at the conclusion, nor three months after the academy (Table XXVI). Hypotheses XVd1, XVd2, and XVd3 were not rejected.

With the exception of the significant r-value between majority students and affect on the pre test, there was no significant relationships between ethnicity and the four subscales. However, there are a few interesting observations. The correlated relationships are dominated by the majority students. However, in all four subscales on

the delayed post test the r-values have moved in the direction of the minority students. Educationally, the Environmental Science Academy had a positive effect on minority students' attitudes, knowledge, and behavior towards environmental issues.

Hypothesis XVI

As a result of participating in the Environmental Science Academy, no significant relationships exist between community size background and each of the following subscales of the Ecology Attitude Inventory:

a. Affect
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)
b. Actual Commitment
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)
c. Verbal Commitment
    1. Prior to attending the academy (pre test mean scores)
    2. At the conclusion of the academy (post test mean scores)
    3. Three months after completion of the academy (delayed post test mean scores)

d. Knowledge

1. Prior to attending the academy (pre test mean scores)
2. At the conclusion of the academy (post test mean scores)
3. Three months after completion of the academy (delayed post test mean scores)

Community Size vs. Affect. No significant relationship exists between community size background and affect prior to the academy, at the conclusion, and three months afterwards (Table XXVI). Hypotheses XVIa1, XVIa2, and XVIa3 were not rejected.

Community Size vs. Actual Commitment. No significant relationship existed between community size background and actual commitment prior to, at the conclusion, and three months after the academy (Table XXVI). Hypotheses XVIb1, XVIb2, and XVIb3 were not rejected.

Community Size vs. Verbal Commitment. No significant relationship existed between community size background and verbal commitment prior to, at the conclusion, and three months after the academy (Table XXVI). Hypotheses XVIc1, XVIc2, and XVIc3 were not rejected.

Community Size vs. Knowledge. No significant relationship existed between community size background and knowledge prior to, at the conclusion, and three months after the academy (Table XXVI). Hypotheses XVId1, XVId2, and XVId3 were not rejected.

No significant relationships existed between community size background and affect, actual commitment, verbal commitment, and knowledge. However, it must be noted that in all four delayed post tests, the r-values have increased in the direction towards urban

(population > 25,000). This came as somewhat of a surprise. Greater correlation was expected from those students from rural backgrounds--the "country kids". Perhaps the academy's participants perceived that the curriculum focused more on environmental issues (solid waste management, water quality) and remediation methods (recycling, consumerism) that affect urban communities more. Perhaps the environment is such a part of rural students' lives that they had trouble perceiving the extent of the issues. In many rural situations the environment and its components are seen as economic commodities. Many rural students come from families who financially depend upon the land. Attitudes exist that the environment is there to economically serve people, rather than for people to live in balance with their surroundings. Many times it is inferred that if a person lives in the country, he/she automatically has greater insights, awareness, and knowledge about the environment than his/her city counterpart. This research study, although inconclusive, suggests that this inference needs to be challenged.

Hypotheses XVII

In regard to affect, no significant differences will occur:

a. In the treatment from which the sample means were drawn (pre x post tests)
b. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)
c. In interaction between group and treatment from which sample means were drawn.

Two-way analysis of variance yielded a significant F value ($F = 6.77$, $p < .05$) for group. However, neither treatment, nor the

interaction between group x treatment produced a significant F value (Table XXVII). This is further verified in the interaction plot. The lines are almost parallel, signifying an ordinal interaction. This interaction is not significant. The differences in attitudes between the ES and AS students do not increase with treatment. The interaction plot also helps summarize the significance of the main effect of group. In both pre and post scores the environmental science group scored higher than the aerospace group. Therefore, Hypothesis XVIIa and XVIIc were not rejected, while XVIIb was rejected.

TABLE XXVII

TWO-WAY ANALYSIS OF VARIANCE FOR AFFECT

Source	DF	SS	MS	F	Pr>F
Treatment	1	1.93	1.93	0.33	0.5652
Treatment Group	1	39.15	39.15	6.77*	0.0107
Group x Treatment	1	0.08	0.08	0.01	0.9056

*p < .05
**p < .01

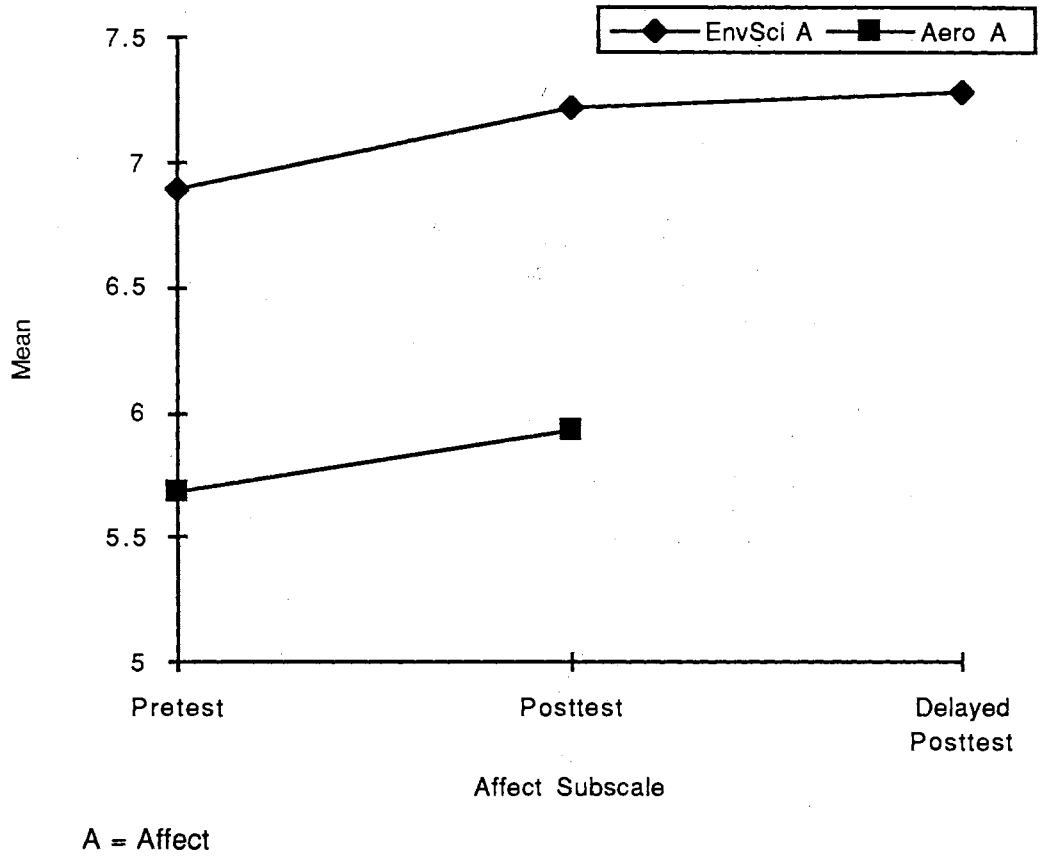


Figure 17. Interaction Plot for Affect

TABLE XXVIII

SCHEMATIC DIAGRAM FOR AFFECT

	Pre Test	Post Test	
Environmental Science	$x = 6.88$ $n = 24$	$x = 7.23$ $n = 22$	$x_{R1} = 7.06$
Aerospace	$x = 5.69$ $n = 29$	$x = 5.93$ $n = 28$	$x_{R2} = 5.81$
	$x_{c1} = 6.29$	$x_{c2} = 6.58$	$x_t = 6.44$

Hypothesis XVIII

In regard to knowledge, no significant differences will occur:

a. In the treatment from which the sample means were drawn (pre x post tests)

b. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)

c. In the interaction between group and treatment from which sample means were drawn

The interaction plot for knowledge reveals a slight deviation from parallel lines, signifying a possible significant interaction effect. However, the two-way ANOVA did not reveal a significant F value for interaction (Table XXIX). However, a significant F value ($F = 7.24$, $p < .05$) was obtained for the main effect of group. Treatment was found to

not be significant. Therefore, Hypothesis XVIIIa and XVIIIc were not rejected, while XVIIIb was rejected. The interaction plot reveals that the Environmental Science participants had higher knowledge mean scores at both pre and post tests. However, the differences of the Knowledge scores between the ES and AS students do not significantly increase with treatment (no interaction effect).

TABLE XXIX

TWO-WAY ANALYSIS OF VARIANCE FOR KNOWLEDGE

Source	dF	SS	MS	F	Pr>F
Treatment	1	7.57	7.57	1.26	0.2652
Group	1	43.66	43.66	7.25**	0.0083
Group x Treatment	1	7.94	7.94	1.32	0.2537

*p < .05
**p < .01

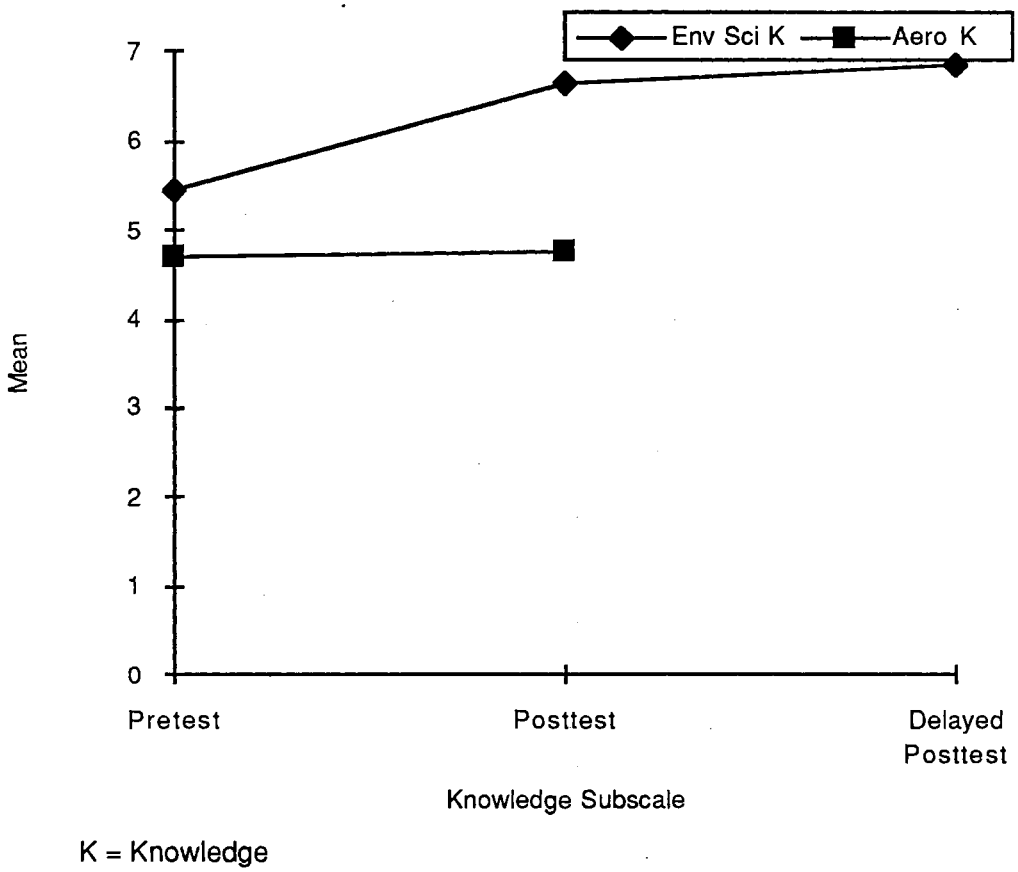


Figure 18. Interaction Plot for Knowledge

TABLE XXX

SCHEMATIC DIAGRAM FOR KNOWLEDGE

	Pre Test	Post Test	
Environmental Science	$x = 5.46$ $n = 24$	$x = 6.36$ $n = 22$	$x_{R1} = 5.91$
Aerospace	$x = 4.69$ $n = 29$	$x = 4.75$ $n = 28$	$x_{R2} = 4.72$
	$x_{c1} = 5.08$	$x_{c2} = 5.55$	$x_T = 5.32$

Hypothesis XIX

In regard to actual commitment, no significant differences will occur:

a. In the treatment from which the sample means were drawn (pre x post test)

b. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)

c. In the interaction between group and treatment from which sample means were drawn.

The interaction plot revealed a slight deviation from parallel lines that would signify a possible significant interaction effect between group x treatment. However, the two-way ANOVA did not produce a significant F value for interaction (Table XXXI). Also, no significant

F values were obtained for the main effects of group and treatment. Therefore, Hypotheses XIXa, XIXb, and XIXc were not rejected.

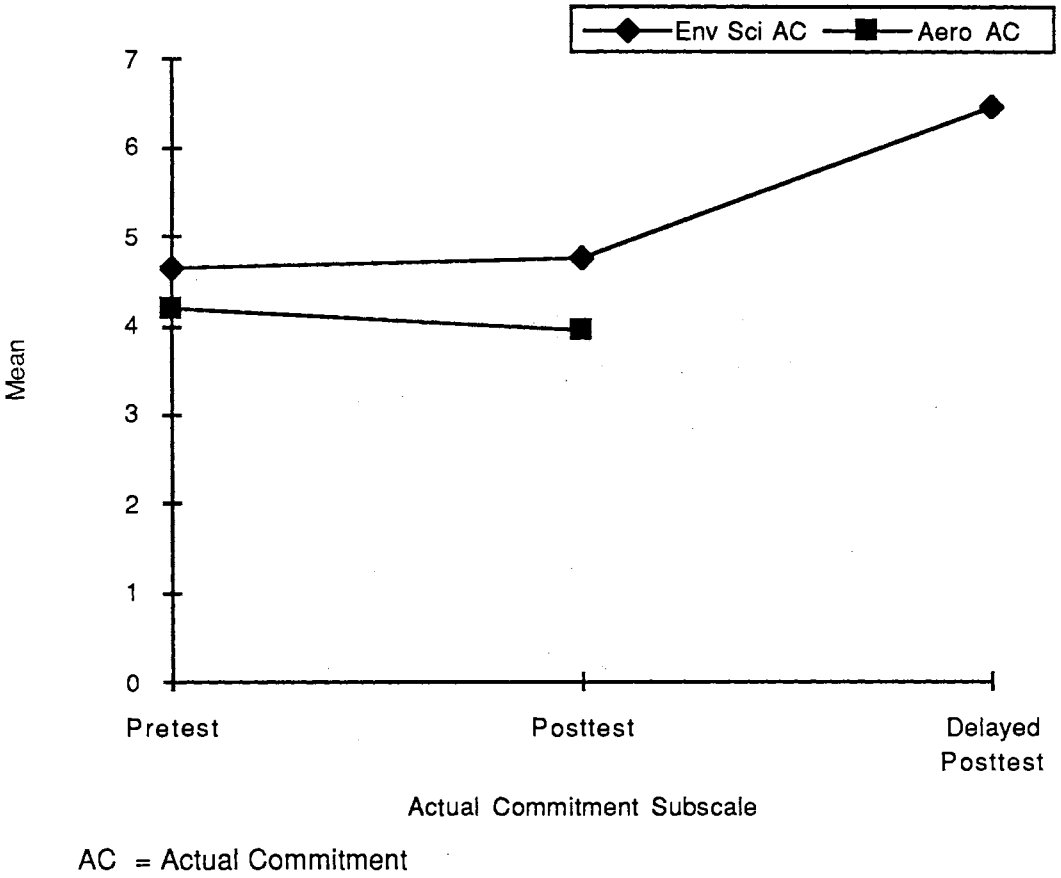
One observation from the interaction plot needs to be noted. The mean scores of the AS participants actually decreased in actual commitment from pre test to post test while the ES participants' scores increased, if not significantly.

TABLE XXXI

TWO-WAY ANALYSIS OF VARIANCE FOR ACTUAL COMMITMENT

Source	dF	SS	MS	F	Pr>F
Treatment	1	0.15	0.15	.02	0.8754
Group	1	9.38	9.38	1.55	0.2161
Group x Treatment	1	0.97	0.97	0.16	0.6900

*p < .05
**p < .01



AC = Actual Commitment

Figure 19. Interaction Plot for Actual Commitment

TABLE XXXII

SCHEMATIC DIAGRAM FOR ACTUAL COMMITMENT

	Pre Test	Post Test	
Environmental Science	$x = 4.63$ $n = 24$	$x = 4.77$ $n = 22$	$x_{R1} = 4.70$
Aerospace	$x = 4.21$ $n = 29$	$x = 3.96$ $n = 28$	$x_{R2} = 4.09$
	$x_{c1} = 4.42$	$x_{c2} = 4.37$	$x_T = 4.40$

Hypothesis XX

In regard to verbal commitment, no significant differences will occur:

a. In the treatment from which the sample means were drawn (pre x post tests)

b. In the group from which the sample means were drawn (Environmental Science Academy vs. Aerospace Academy)

c. In the interaction between group and treatment from which sample means were drawn

The interaction plot revealed almost parallel lines, indicating an ordinal interaction (not significant). The two-way ANOVA verified this by not producing a significant F value for an interaction effect (group x treatment). However, a significant F value ($F = 12.81$, $p < .05$) was

obtained for the main effect of group (Table XXXIII). A non-significant F value was obtained for the main effect of treatment. Therefore, Hypotheses XXa and XXc were not rejected while XXb was rejected. The ES participants had significantly higher mean scores on both pre and post tests for verbal commitment (what they said they would do to improve environmental quality) than the AS participants.

TABLE XXXIII

TWO-WAY ANOVA FOR VERBAL COMMITMENT

Source	dF	SS	MS	F	Pr>F
Treatment	1	0.98	0.98	.14	0.7093
Group	1	89.78	89.78	12.81**	0.0005
Group x Treatment	1	0.08	0.08	0.01	0.9165

*p < .05
**p < .01

TABLE XXXIV

SCHEMATIC DIAGRAM FOR VERBAL COMMITMENT

	Pre Test	Post Test	
Environmental Science	$x = 7.58$ $n = 24$	$x = 7.86$ $n = 22$	$x_{R1} = 7.72$
Aerospace	$x = 5.76$ $n = 29$	x 5.93 $n = 28$	$x_{R2} = 5.85$
	$x_{c1} = 6.67$	$x_{c2} = 6.90$	$x_T = 6.79$

Hypotheses XXI

In regard to the combined scores of the Ecology Attitude Inventory, no significant differences will occur:

a. In the treatment from which the sample means were drawn (pre x post tests)

b. In the group from which the sample means were drawn (Environmental Science Academy x Aerospace Academy)

c. In the interaction between group and treatment from which sample means were drawn.

The interaction plot revealed a possible disordinal interaction (non-parallel lines) that would signify a significant interaction effect. However, the two-way ANOVA did not produce a significant F value for interaction between group x treatment. The main effect of

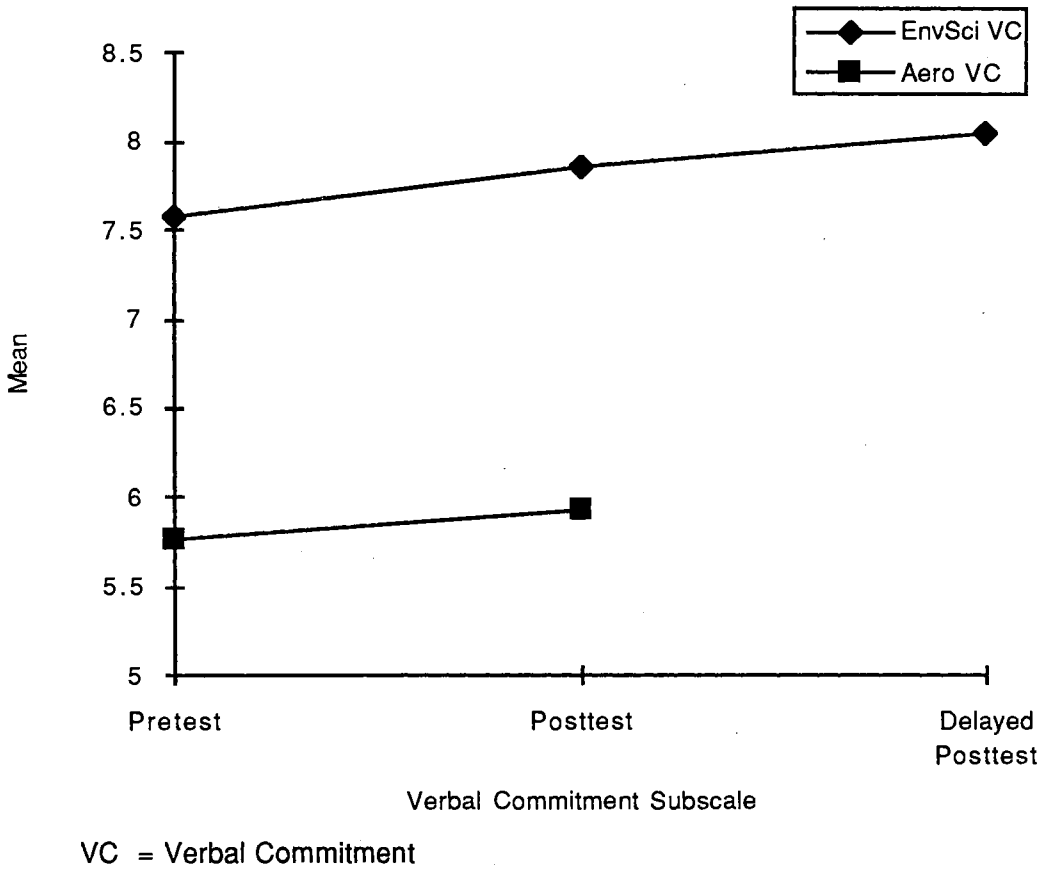


Figure 20. Interaction Plot for Commitment

group did produce a significant F value ($F = 12.45$, $p < .01$) whereas the main effect of treatment was not significant (Table XXXV). Therefore, Hypotheses XXIa and XXIc were not rejected, while XXIb was rejected. For combined scores of all subscales of the Ecology Attitude Inventory, the ES participants scored significantly higher on both pre and post tests than the AS participants.

TABLE XXXV

TWO-WAY ANOVA FOR COMBINED SCORES

Source	dF	SS	MS	F	Pr>F
Treatment	1	22.48	22.48	.43	0.5118
Group	1	645.26	645.26	12.45**	0.0006
Group x Treatment	1	19.06	19.06	0.37	0.5457

*p < .05
**p < .01

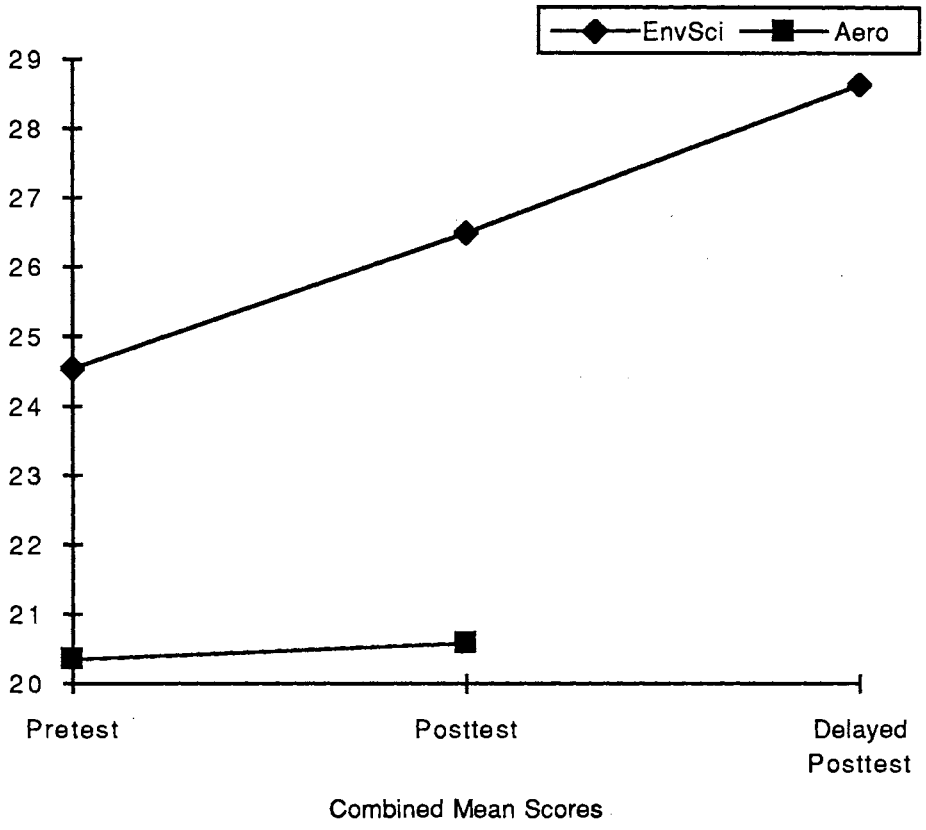


Figure 21. Interaction Plot for Combined Mean Scores

TABLE XXXVI

SCHEMATIC DIAGRAM FOR COMBINED SCORES

	Pre Test	Post Test	
Environmental Science	$x = 24.54$ $n = 24$	$x = 26.50$ $n = 22$	$x_{R1} = 25.52$
Aerospace	$x = 20.34$ $n = 29$	$x = 20.57$ $n = 28$	$x_{R2} = 20.46$
	$X_{c1} = 22.44$	$x_{c2} = 23.54$	$x_T = 22.99$

On observing the mean scores of all four subscales of pre and post tests of both groups, the ES group consistently had higher scores than the AS group for the comparable scale. Therefore, it was expected that there would be some interaction effect between the two groups in regard to treatment and group. This did not occur statistically in any of the four subscales. However, the main effect of group was statistically significant in all four subscales and the combined scale, with the exception of the actual commitment subscale.

The data analyses resulting from the two-way ANOVA were intriguing. Because all of the mean scores of the pre and post tests of the ES group were higher than the comparable mean scores of the AS group, it was decided to run t-test analyses comparing the mean scores of the two groups at pre test and again at post test "to see what was going on". Those results are indicated in Tables XXXVII and XXXVIII.

TABLE XXXVII

T-TEST COMPARISONS OF PRE TEST MEAN SCORES
OF ALL SUBSCALES

Group	N	X	Sd	Sd_x	dF	T	P > T
Variable: Verbal Commitment							
Env. Science	24	7.58	2.39	0.517	51	2.5272*	0.0146
Aerospace	29	5.76	2.79				
Variable: Affect							
Env. Science	24	6.88	2.77	0.471	51	1.6239	0.1106
Aerospace	29	5.69	2.54				
Variable: Actual Commitment							
Env. Science	24	4.63	2.39	0.690	51	.6087	0.4700
Aerospace	29	4.21	2.51				
Variable: Knowledge							
Env. Science	24	5.46	2.55	0.391	51	1.2014	0.2351
Aerospace	29	4.69	2.11				
Variable: Total							
Env. Science	24	24.54	7.56	1.288	51	2.0785*	0.0427
Aerospace	29	20.34	6.93				

*$p < .05$

TABLE XXXVIII

T-TEST COMPARISONS OF POST TEST MEAN SCORES
OF ALL SUBSCALES

Group	N	X	Sd	Sd_x	dF	T	P > T
Variable: Verbal Commitment							
Env. Science	22	7.86	2.39	0.527	48	2.5355*	0.0145
Aerospace	28	5.93	2.79				
Variable: Affect							
Env. Science	22	7.23	1.99	0.418	48	2.1503*	0.0366
Aerospace	28	5.93	2.21				
Variable: Actual Commitment							
Env. Science	22	4.77	2.51	0.718	48	1.1280	0.0916
Aerospace	28	3.96	2.44				
Variable: Knowledge							
Env. Science	22	6.64	3.05	0.410	48	2.5550*	0.0138
Aerospace	28	4.75	2.17				
Variable: Total							
Env. Science	22	26.50	7.29	1.305	48	2.9414**	0.0050
Aerospace	28	20.57	6.90				

*p < .05
**p < .01

At pre test time, despite the higher mean scores, the ES group was significantly different from the comparable AS group on only the Verbal Commitment subscale and the total combined score. The ES high school students' knowledge, attitudes, and actual behavior skills were not significantly different from their peers in the Aerospace group. However, at post test time, this changed. According to the t-test analyses, the ES group's post test mean scores were significantly different on three subscales--verbal commitment, knowledge, and affect--

and on the total combined scores. Only the actual commitment difference remained insignificant. Thus, after the three week academies, the ES high school students' knowledge, attitudes, and verbal commitment to responsible environmental behavior are significantly different than their peers in the AS academy. More importantly, the ES combined scores were significantly greater at both pre test and post test times. Also, the increase in the combined mean scores for the ES students, which not significant, was greater than the AS combined mean scores increase (ES: 24.54 - 26.50 vs AS: 20.34 - 20.57

At first, it was surprising to notice that the difference in actual commitment between the ES and AS groups remained insignificant at the end of each academy. However, it must be remembered that the results of the one-way ANOVA analyses of pre, post, and delayed post mean scores of the ES group showed that the significant increase in actual commitment occurred three months after the academy (pre - delayed post). This might account for the insignificant differences between the ES and AS groups. Actual commitment is what the individual does towards environmental remediation. Commitment may be limited at the conclusion of the academy because the students had not been in their home environment for three weeks. Thus, it is only when they leave the academy and have some time to make some personal lifestyle changes that actual commitment becomes a significant factor.

Environmental Knowledge and Personal Action Assessment

The stated goal of environmental education is to develop an environmental literate citizen, defined as one who takes responsible

environmental action. Because of the importance, and the impact of this personal environmental responsibility, the Environmental Action Assessment instrument was chosen to further evaluate the effect the Environmental Science Academy had on its participants' acquisition of environmental action knowledge and skills. This instrument was administered as a pre test, on the first day of the academy, and as a post test at the academy reunion three months afterwards. The Environmental Science participants reported what environmental action skills that they were familiar with and that they had participated in three months prior to and three months after the three week residential academy. Responses to open-ended questions were tabulated and grouped into seven categories--ecomanagement, persuasion, consumerism, political action, legal action, organizational membership, and education. The responses were statistically analyzed utilizing the correlated, one-way t-test.

Hypothesis XXII

As a result of participating in the Environmental Science academy, no significant difference exists between the mean pre and delayed post test scores of the number of appropriate knowledge responses on Item I (Personal Knowledge) of the Environmental Action Assessment.

As seen in Table XXXIX, the total number of appropriate responses on Item I increased from 82 on the pre test to 108 on the post test. The mean differences of responses per student were found to be significantly different at the .05 significance level when a correlated t-test was conducted ($t = 1.85$, $p < .05$) (Table XLIII). Therefore, the null hypothesis was rejected. The Environmental Science Academy did

have a significant positive influence on the acquisition of knowledge of environmental action skills which the students could participate in.

TABLE XXXIX

ITEM I: KNOWLEDGE RESPONSES AND CATEGORIES

	Pre Test Scores	Post Test Scores
Total No. Responses	82 x = 3.90	108 x = 5.14
Total No. Categories	35 x = 1.68	58 x = 2.76

TABLE XL

ITEM I: KNOWLEDGE RESPONSES AND CATEGORIES

Categories	Pre Test # Responses	Post Test # Responses
Persuasion	3	19
Ecomanagement	60	56
Consumerism	13	15
Political Action	3	9
Legal Action	0	0
Organizational Membership	1	7
Self-Education	2	2
Total	82	108

Hypothesis XXIII

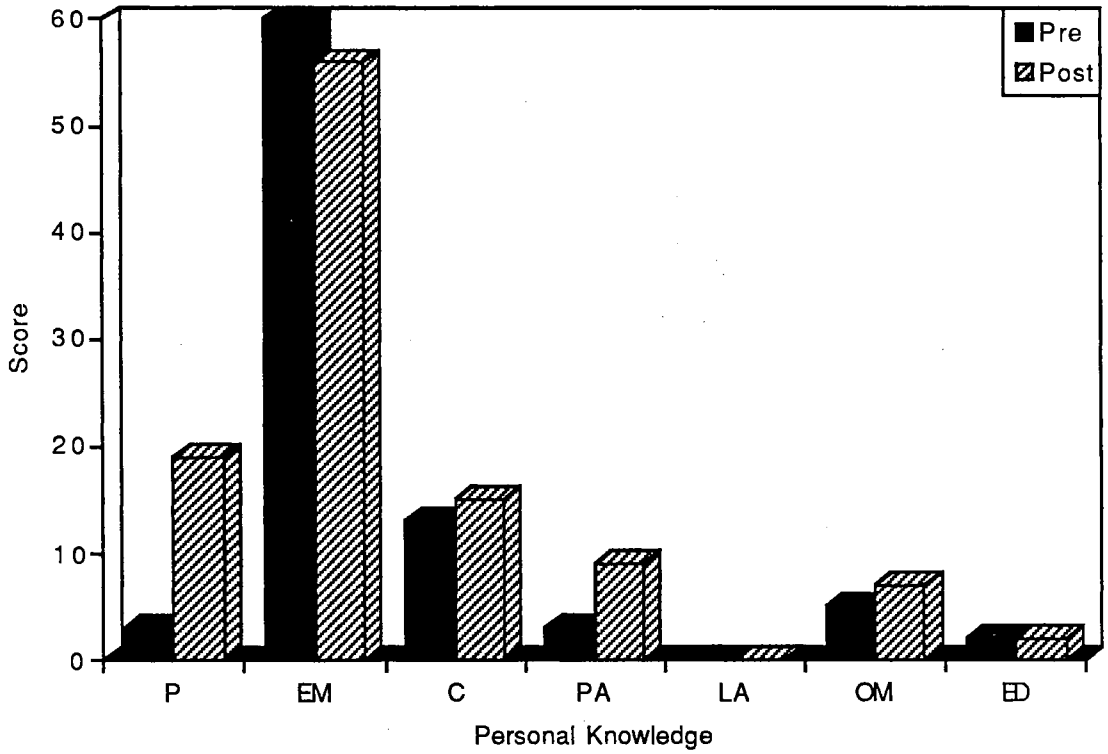
As a result of participating in the Environmental Science Academy, no significant difference exists between the mean pre and delayed post test scores of the number of appropriate knowledge response categories on Item I (Personal Knowledge) of the Environmental Action Assessment.

The total number of categories in which the responses fell into increased from 35 on the pre test to 58 on the post test (Table XXXIX). When the correlated t-test was done, a significant t-value of 3.04, $p < .05$, was calculated (Table XLIII). Therefore, the null hypothesis was rejected. The Environmental Science Academy did have a positive significant influence on the number of response categories. Students increased significantly their knowledge of individual environmental action skills, and also increased significantly their knowledge in different categories.

Table XL depicts the breakdown of the number of responses in each category. Figure 22 graphically pictures the breakdown of the number of responses found in each category for the pre and post test scores. The number of responses in each category increased with the exception of a slight decrease in ecomanagement (60 - 50) and education responses remaining the same (2 - 2). Legal action received no responses on either test.

Hypothesis XXIV

As a result of participating in the Environmental Science Academy, no significant difference exists between the mean pre and delayed post



P = Persuasion; EM = Ecomanagement; C = Consumerism; PA = Political Action; LA = Legal Action; OM = Organizational Member and ED = Education.

Figure 22. Personal Knowledge Response Scores on Seven Environmental Categories Before (Pre) and After Treatment (Delayed Post)

test scores of the number of appropriate action responses on Item II (action skills) of the Environmental Action Assessment.

The total number of action skills the students participated in increased from 34 at the beginning of the academy to 57 three months afterwards (Table XLI). The correlated, one-tailed t-test resulted in a significant value of 2.28, $p < .01$ (Table XLIII). Therefore the null hypothesis was rejected. The Environmental Science Academy did have a positive influence on the number of action skills in which the participants were actively engaged.

TABLE XLI

ITEM II: ACTION RESPONSES AND CATEGORIES

	Pre Test Scores n = 21	Post Test Scores n = 21
Total No. Responses	34 x = 1.62	57 x = 2.714
Total No. Categories	21 x = 1.00	37 x = 1.762

Hypothesis XXV

As a result of participating in the Environmental Science Academy, no significant difference exists between the mean pre and delayed post

test scores of the number of appropriate action response categories on Item II (action skills) of the Environmental Action Assessment.

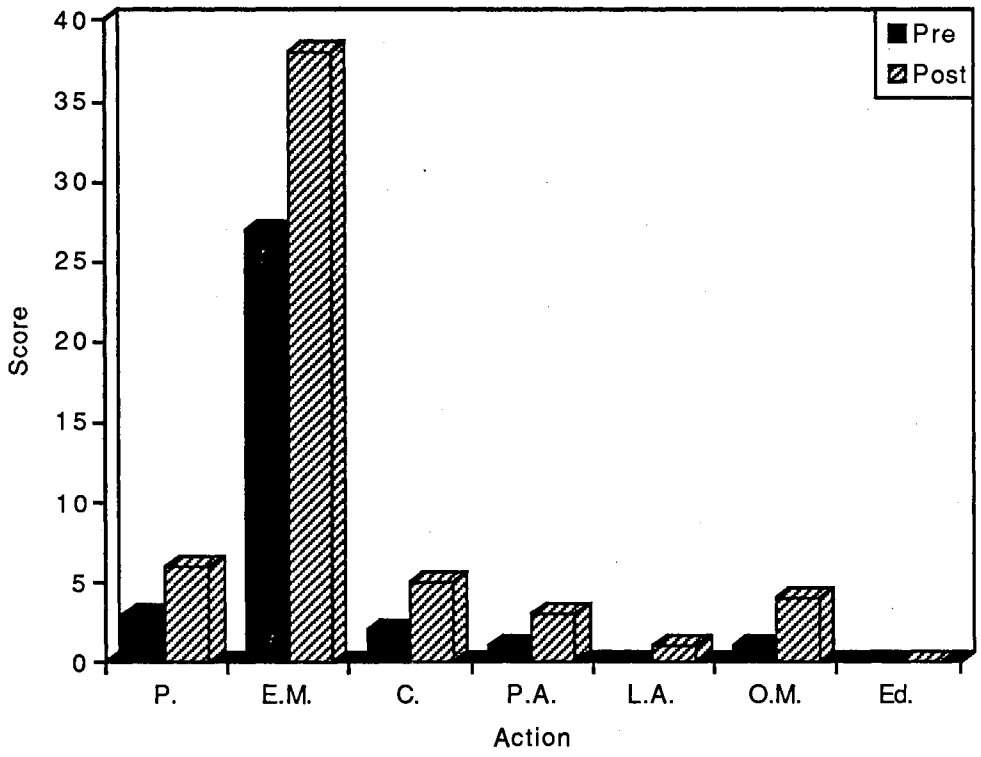
The total number of action skill categories the students participated in increased from 21 prior to the academy to 37 three months afterwards (Table XLI). The correlated t-test value calculated was a significant value of 2.28, $p < .01$ (Table XLIII). Therefore, the null hypothesis was rejected. The Environmental Science Academy did have a significant positive influence on the increase of the number of action skill categories in which the students participated in.

Table XLII depicts the breakdown of action skills into the appropriate categories. Figure 23 illustrates that there was an increase in the number of responses occurred in each category, with the exception of education, which had no responses on either test.

TABLE XLII

ITEM II: ACTION RESPONSES AND CATEGORIES

Categories	Pre Test No. Responses	Post Test No. Responses
Persuasion	3	6
Ecomanagement	27	38
Consumerism	2	5
Political Action	1	3
Legal Action	0	1
Organization Membership	1	4
Education (self)	0	0
Total	38	57



P. = Persuasion; E.M. = Ecomanagement; C. = Consumerism; P.A. = Political Action; L.A. = Legal Action; O.M. = Organizational Member and Ed. = Education.

Figure 23. Action Response Scores on Seven Environmental Categories Before (Pre) and After Treatment (Delayed Post)

TABLE XLIII

ANOVA SUMMARY FOR ITEM I AND ITEM II KNOWLEDGE AND ACTION RESPONSES AND CATEGORIES

	No. of Responses		No. of Categories	
	Pre Test	Post Test	Pre Test	Post Test
Knowledge	82	108	34	57
	x = 3.90	x = 5.14	x = 1.62	x = 2.71
	t = 1.85*		t = 3.04**	
Action	35	58	21	37
	x = 1.68	x = 2.76	x = 1.00	x = 1.762
	t = 2.28*		t = 2.52**	

*p > .05
**p > .01

The results of the Environmental Action Assessment identify the strengths of this study. Environmental literacy is synonymous with responsible environmental action. The overall goal of the Environmental Science Academy was to create environmental literate students, and the overall objective of this study was to evaluate the effectiveness of the ES academy in achieving its goal. According to the data from the Environmental Action Assessment, this was accomplished. The ES students significantly increased their knowledge of action skills and the categories into which that knowledge was grouped. Also, the ES students

significantly increased their participation in environmental responsible action skills and the categories in which those skills were grouped.

One other observation needs to be made in regard to the responses the students gave on this instrument. In both knowledge of and participation in the action skills, the students not only significantly increased the numbers in the categories, but that the numbers increased in categories of higher levels of behavior. According to Ramsey (1979), the lower level categories are those that are more convenient and involve less problem-solving skills. This would include many items found in the categories of ecomanagement, persuasion, and consumerism. Categories such as legal and political action and personal education involve more effort and skills. The ES students appear to be more knowledgeable and participated in those higher order skills as a result of their academy experience.

Qualitative Data

> Efficacy is a concept I think about often. It has to do with whether or not a person thinks he or she can make a difference. It makes sense to think about how we can encourage a sense of efficacy in young people. To the extent that youth believe they can make a difference out of experience with success at an early age, they are more apt to continue to carry this belief with them throughout their lives. As a result, they are more apt to be ecologically responsible citizens who take actions to benefit people, wildlife, and the environment (Charles, 1992, p. 2).

The above statement, describes the goal of student achievement as a staff member of the Environmental Science Academy and also summarizes the final accomplishments of the academy. Statistically and educationally, the academy had an impact on the lives of the participants involved. Some of the greatest insights into the actual

depth of this impact that the academy had on the students were gained from the informal interviews conducted at the academy reunion and from the personal journals the students kept during the three week academy. A discussion of this descriptive data follows.

Interviews

Fourteen participants were interviewed (see Appendix for Interview Form). All 14 answered "yes" to the question "Has your participation in the Summer Academy for Environmental Science changed your outlook on environmental issues?" Their explanations proved to be very interesting. One student remarked that before the academy, he did not really care about the environment, that he felt a sense of hopelessness of any personal effect on the environment. Yet, the biggest effect of the academy had been that he now CARED. Another student admitted that before the academy he really had no idea that his actions had any relationships to the problems of the environment. He believed in a "bottomless pit for trash". After the academy this student now thinks about his personal impact on the environment. He also admitted to a better understanding of who and what environmentalists are--he had previously thought they were all "crazed sixties fanatics!"

Several students remarked that the academy helped them to realize that environmental issues are complex issues and, as one young lady remarked, "I'm now able to look at both sides of an issue. Even though you might not agree with someone, you need to understand why they believe what they do." And perhaps one of the most profound statements

made came from a 16-year old girl, "Before the academy, all I knew was you could recycle aluminum. Now I'm concerned about what's going to be left for my children."

To the question "If you could do it all over again, would you?", all 14 answered "yes", or as one student responded, "in a heartbeat." To further explain why, all 14 responded with the main reason that it gave them the opportunity to better see and understand their state of Oklahoma. As one student remarked, "it made Oklahoma more mine". The young man from the high plains of the panhandle in western Oklahoma remarked, "I discovered Oklahoma has water and trees!" For many of the students, the field trips proved to be the first time they were exposed to areas of the state other than their home communities.

To the question "What activities are you currently involved in or plan to be involved in in regard to environmental issues?", the answers were varied. Nine out of the 14 had joined and/or organized a school environmental club. Three of the students now want to pursue careers in the environmental sciences. Several students started neighborhood, school and/or community recycling programs. All 14 started home recycling. One young man was quite proud that he was instrumental in changing the environmental attitudes and behaviors of his entire family. His family now actively recycles, composts, and are becoming environmental conscious consumers as a result of his influence. Several students taught grade school classes about environmental topics and gave presentations to local school boards, girl scouts, PTA, and Lion's Club.

Perhaps the greatest sense of accomplishment of the academy was the answer to the question "What recommendations would you make for improvements?" All answered that they wished the academy was longer

(four weeks instead of three weeks). The No. 2 answer was that they wished they had had more free time and time to sleep! As a staff member, this author interpreted that statement as a compliment--the students were kept busy, productive, and on task, which can be a challenge for any educator working with adolescents.

Journals

The students were asked to keep a journal throughout the three weeks of the academy. They were encouraged not only to write the events of each day, but also to write of their feelings, reactions, and analyses of events, trips, speakers, and issues. Surprising to this author, writing the journal was more difficult for most of the students than expected. All of the students did a good job of writing of the events, chronologically, that they experienced. Only a few could synthesize and analyze those events, and ultimately, give an evaluation. The students could verbalize these points better in small group discussions, yet the writing was more difficult. Thus, a recommendation follows to spend more instructional time during the academy in regard to journal writing.

The journals were read by this author to gain more insight into the development of the environmental consciousness of the students. The unforeseen insight that was gained was the recognition of the thoughts of teenagers--what interests them, frightens them, worries, and delights them. This author, after reading the journals, began to realize that the effect of the academy on the students was much more than learning environmental appreciation and facts. The academy affected them

socially, mentally, and ethically, as well as helping several undergo personal self-evaluation. Examples of students' writings follow.

> As I sat on the rock in the middle of a crystal clear stream, I felt a blanket come over me to shield all the human eyes. The water seemed to be inviting me to put my feet in. I eagerly striped off my shoes and socks and put my feet in. I scooped a handful of water and it didn't taste like water. It was sweet and fresh. It was like food for my soul.

> Throughout this academy, I found myself judging industry, the NIMBY's, and environmental fanatics. Then I'd look at myself and mentally shake my head in self-reproach. I am all of them in one way or another. I am a daily contributor to landfills. I would hate to have a toxic waste disposal facility in my county. And I feel the fervor of the movement so much sometimes that I can't see the facts sometimes. This is who I am. Who we all are. Just look around. This is what is. And work from there.

Several journal entries illustrated that the students were being exposed to existing and potential environmental problems and that they were being challenged to analyze and evaluate these issues as to what their role can be in alleviation and prevention.

> Analysis of The Lorax. It pointed out man's inhumanity to natural resources and how that affects the ecosystem as a whole. This practice comes under the heading "Progress". As we are taking so many steps forward, we don't look around at how this affects everything else (including people sometimes). Once our blunders come to light and begin to touch our lives, then there is concern. To rectify the mistakes, we have to step back further than where we started. In a lot of cases, extreme progression begets extreme regression. If we just PAY attention along the way, we could save time, money, and heartache. At least I think so.

> Random notes on The Little Prince. "Be responsible for your rose." The earth is an untamable rose, though mankind would like to think otherwise. However, we have the power to save it or to continue to destroy it. Whatever the choice, it is ours forever. Our capacity to reason is sometimes a curse. It allows us to deceive ourselves, with the ideas of "progress" and material love. It is almost time to give an absolute yea or nay to the government. We can't get back to the Garden.

> I truly enjoyed reading the Little Prince. I found the Prince's visit to the Tippler's planet most moving. In a way everyone has their own planet. I only wish they would take better care of it. Often times I find myself hindered from taking certain actions. Hinderness being discouragement, inconvenience, and others. These are all cop-outs that seem very real, unfortunately.
>
> Lone Mountain brought into focus the impact man has had on the planet. The hazardous waste that the world has created is not created by factories alone. We as consumers create hazardous wastes as well. But the question is brought to mind, Where does it go? That is what Lone Mountain is about.

Several final entries involved the students' overall evaluations of the academy and its influence on their personal lives.

> I have mixed feelings about leaving here. I know my experiences can never be duplicated. The friends I have met here will never be forgotten.
>
> We evaluated the academy today. I thought it was a lot of fun and I really learned a lot. The only suggestions I would have are a little more free time and maybe even another week; this would allow more fun and educational field trips and free time. Overall the academy was great and I would go again without hesitation. Hopefully, I'll be able to come back as a junior counselor and share my experiences. The knowledge I've gained and the friends I've made are invaluable. When I go home I hope to implement the thing I've learned and become a positive influence on my community in improving the environment. I am now considering a career in environmental engineering thanks to the academy. Well, I guess it's been a lot of fun and I'm also kind of sad to leave. Oh well, I'm looking forward to the reunion in September.

On closing, one student chose to compose a poem that summarized her thoughts about what she had learned and experienced during the academy.

To the last person on earth

> Congratulations, you found my note
> No wonder, you're the last survivor
> So what's it like being all alone?
> Hope you like your present, Pollution
> We made it especially for you to enjoy it.
> Too bad you have no water left or unpolluted food.
> I guess you'll be joining us soon.

Too bad also that you can't see the stars one last time.
Well I guess there's not much noise pollution
Seeing that it's kind of hard to hear it through all the
buildings around you.

Hey let's face it, you'll go down in all the history books
of the world, like I wish I could be you.

Hey when you leave don't forget to turn out the sun.

Summary of the Data

The results from the two instruments administered to the participants in the Environmental Science Academy and the Aerospace Academy were reported in this Chapter. The Ecology Attitude Inventory evaluated what effect a residential three-week environmental science academy for high school students had on the components of environmental literacy--awareness, knowledge, and action--of its participants. The instrument was also administered to participants in the Aerospace Academy for comparison purposes. A second instrument, the Environmental Knowledge and Personal Action Assessment, was also administered to the Environmental Science Academy participants to further investigate the impact the ES academy had on increasing responsible environmental behavior.

Means scores on all four subscales of the Ecology Attitude Inventory--affect, actual commitment, verbal commitment, and knowledge--were higher for the ES academy students than the AS students on pre and post tests. Whereas the one-way ANOVA analyses yielded only a significant increase in actual commitment for the ES students three months after the academy, mean scores did increase in all four subscales on each test (pre, post, delayed post). In comparison, mean scores for AS students increased less than scores for the ES student on each

subscale from pre to post tests, and actually decreased on the Actual Commitment subscale. T-test correlations yielded no significant changes in any subscale for the AS students' scores.

Therefore, the only statistically significant change was experienced by the ES students who did exhibit a significant enduring increase in actual commitment to environmental action. However, educationally speaking, the ES students experienced increases in all four subscales on each subsequent test whereas the AS students experienced less increases and even a decrease in actual commitment.

To further compare the two groups, a two-way ANOVA analysis was conducted to investigate the interaction of two variables--group (ES and AS academies) and treatment (pre and post tests). Whereas no significant interaction occurred, significant main effect differences occurred between the two groups in regard to affect, verbal commitment, knowledge and combined scores. T-test correlations were conducted on pre and post mean scores to further compare the two groups. The ES and AS groups were similar in knowledge, actual commitment, and affect at the beginning, but the ES group was significantly higher in affect and knowledge at the end. In verbal commitment, the ES group was significantly higher at both the pre test and post test times as well as on the combined subscale. The two groups were not significantly different in actual commitment at the end of the programs.

Correlation coefficients indicated significant correlations between affect and actual commitment, affect and verbal commitment, and actual commitment and verbal commitment at pre, post, and delayed post times. Knowledge was significantly correlated to affect and verbal commitment only at delayed post time. Gender and community background

yielded no significant correlations to the four subscales, where ethnicity yielded a significant correlation of majority students to affect only at pre test time. While not significant, several observations were noted. The correlation coefficients tended to move in the direction of males, minority students, and urban students in each subsequent test. The small sample size of this study could play a major role in why these correlations were not significant.

The Environmental Knowledge and Personal Action Assessment instrument administered to the ES students yielded significant results. The ES students significantly exhibited an enduring increase in their knowledge of action skills, and their actual participation in those skills, as well as in the categories in which the action skills were grouped.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Introduction

According to Dewey, as quoted in Iozzi (1989, p. 3), "intellectual force does not exist apart from the attitudes, feelings, or emotions that make us open-minded rather than close-minded, responsible rather than irresponsible." Similarly, the common person does not deal with knowledge alone because knowledge, feelings, and emotions are, in reality, inseparable (Iozzi, 1989). As stated by Eiss and Harbeck (1969):

> The affective domain is central to every part of the learning and evaluation process. It begins with the threshold of consciousness, where awareness of the stimulus initiates the learning process. It provides the threshold for evaluation, where willingness to respond is the basis for psychomotor responses without which no evaluation of the learning process can take place. It includes values and value systems that provide the basis for continued learning and for most of an individual's overt behavior. It provides the bridge between the stimulus and the cognitive and the psychomotor aspects of an individual's personality (p. 4).

The Eiss and Harbeck model illustrates how all sensory input may enter the subconscious, interact with the affective, cognitive, and psychomotor domains, and exit as overt behavior that then leads back and into the total system (Iozzi, 1989).

Focusing on the affective domain is extremely important if programs in environmental education are to be effective in teaching

positive environmental attitudes and values. Knowing how to improve environmental quality is certainly important, yet possessing such knowledge does not insure one will be motivated to the action. Also, one may not necessarily use such knowledge to select the environmental responsible choice from among the many possible alternatives. One's value system is instrumental in determining whether positive or negative action, or any action, is taken in regard to environmental issues. Likewise, attitudes alone will not guarantee responsible action. Knowledge is needed to make wise choices, and knowledge of what problem-solving skills can be made must precede effective action.

The cognitive and the affective domains function cooperatively. However, previous research in environmental education has focused on examining these domains separately. The recent movement to "define" environmental literacy, and further, to conduct research into the relationships of its components is a trend to look at the complex phenomena of values, knowledge, and action as a whole rather than as separate entities. The purpose of this investigation was to investigate the components of environmental literacy--attitudes, knowledge, and action-- and the effect a residential environmental science program had on the environmental literacy components of its participants. Educationally, this research evaluated the effect of an environmental science curriculum on both the affective and the cognitive domains of its participants and the interrelationships between these domains.

Overview of Study

The overall purpose of this study was to investigate the immediate, intermediate, and enduring effects that a three-week long

environmental education program would have on the environmental literacy levels of the high school students who participated. More specifically, the major objectives of this study were to determine:

1. How successful the academy was in promoting positive environmental growth in both the cognitive and affective domain of program participants.
2. Whether any cognitive and/or affective changes resulting from participation in the academy continued to exist after a delayed period of time of three months.

The field testing for this study occurred in June, 1991. Twenty-four students who participated in the Oklahoma State University Summer Academy for Environmental Science represented the experimental population. Thirty students enrolled in the Oklahoma State University Aerospace Academy were also tested as a comparative population. These 54 students represented junior and senior high school students from across the state of Oklahoma.

The students were pre tested the first day of each academy, as well as post tested on the last day of each academy. The Environmental Science participants were also delayed post tested three months later in September, 1991. The Ecology Attitude Inventory, an instrument which measures environmental attitudes, knowledge, and behavior, was used as the pre, post, and delayed post test.

The Environmental Science participants were further assessed by use of the Environmental Knowledge and Personal Environmental Action Assessment. This instrument was administered to the ES students as a

pre test and then as a delayed post test to evaluate knowledge of and participation in action skills three months prior to the ES academy and three months afterwards.

Conclusions

The results of this investigation are as follows:

Research Objective #1

To determine if students who participated in the Environmental Science Academy exhibited a change in environmental literacy.

The ES academy participants showed a statistically significant enduring increase in Actual Commitment. The changes in the other components of environmental literacy--Knowledge, Affect and Verbal Commitment--were not statistically significant although mean scores increased in all four subscales on all three tests.

Research Objective #2

To determine if students who participated in the Aerospace Academy (a comparative group) exhibited a change in environmental literacy.

No statistically significant change occurred in any component of environmental literacy--Verbal Commitment, Actual Commitment, Affect or Knowledge--for the AS participants.

Research Objective #3

To determine if students who participated in the Environmental Science Academy exhibited the same levels of environmental literacy as students who participated in the Aerospace Academy.

ES participants were similar to AS participants in Actual Commitment, Knowledge, and Affect at the outset, but became

significantly greater in Knowledge and Affect at the post test. ES participants exhibited significant higher Verbal Commitment than AS students throughout the investigation. Overall, the environmental assessment showed that the ES students entered their academy with higher mean scores than the AS students and that they progressed further because of their participation in the ES academy. The mean scores for AS students increased only slightly and actually decreased on the actual commitment subscale. Interestingly, the ES students represented a younger age group, yet their mean scores indicated a greater increase then the AS students.

Research Objective #4

To determine if correlations existed between the three components of environmental literacy--Attitude (affect), Knowledge, and Action (Verbal and Actual Commitment).

Affect was significantly correlated with verbal commitment and actual commitment. Actual commitment was also significantly correlated with Verbal Commitment. Knowledge was not significantly correlated with any other scale except slightly on the delayed post test with Affect and Verbal Commitment.

Research Objective #5

To determine if correlations existed between personal characteristics (Gender, Ethnicity, and Community Size background) and environmental literacy.

Gender, Ethnicity and Community background were not significantly correlated with any component of environmental literacy with one

exception; majority students were significantly correlated with affect only on the pre test.

Research Objective #6

To determine if students who participated in the Environmental Science Academy sustained a positive change in environmental responsible action after a delayed period of time.

The ES participants exhibited a positive significant increase in environmental responsible action (both knowledge of and participation in) after a delayed period of time.

Recommendations

A major outcome of a scientific investigation is the knowledge it generates and the extended questions which thus arise. This acquired knowledge allows for the formulation of recommendations for future effort, both educational and empirical.

Educational Recommendations

The conclusions resulting from the present study suggest several major recommendations from an educational perspective.

1. The emphasis of the curriculum of the Environmental Science Academy needs to strengthen in the area of responsible instruction for environmental action. The ultimate goal of any environmental education program should be to create an environmental literate citizen. Consequently, the ultimate goal of environmental literacy is acquiring life-sustaining responsible environmental action skills. This study and those

done previously (Hungerford, et al. 1980; Ramsey, 1979); Jordan et al. 1986) conclude that teaching only awareness and knowledge are not enough. Instruction and modeling of action skills must be done. The academy did have some impact on changing environmental behavior skills of the participants. However, this author believes that more potential for more change in behavior and personal commitment exists. This can be done with a curriculum whose major objectives revolve around action instruction. The instructional materials of the academy must be designed with the major goals in mind of developing skills associated with investigating and evaluating issues and creating responsible citizen participation. This also involves an academy with a staff committed to responsible environmental behavior and who models this commitment.

2. Hungerford and Volk (1990) take the above recommendation of investigating and evaluating of issues as the focus of instruction one step further. They recommend a curriculum that emphasizes education for a generalizable responsible environmental behavior. Many times it is relatively easy to get learners to focus on one issue and to acquire citizenship action strategies related to that issue. However, little opportunity exists for these learners to generalize the knowledge and skills to other issues. According to Hungerford and Volk (1990):

> Thus the result of our efforts are learners who may act in an environmental positive manner with relation to one issue (or set of issues), but who do not have the knowledge, skills, and willingness to assume environmental responsibility in their day-to-day lives (p. 17).

Therefore, it is recommended that the academy curriculum not only focus on environmental issues affecting Oklahoma and what role the students can play in remediating them, but also focus on personal skills in which the students can be involved, such as recycling, responsible consumer buying, composting, etc.

3. An immediate and critical need exists for inservice teacher education in the field of environmental education. It is needed at all levels of education (elementary, secondary, and college), and for all the components of environmental literacy (ecological foundations knowledge, awareness of issues and human values, and citizenship action). It is recommended that inservice teacher education should be made available and encouraged. Educational efforts should focus on all three of the components of environmental literacy, and should develop in participants an understanding of the objectives of environmental education. Emphasis should be given to recruiting the teachers of the Environmental Science Academy participants, yet all teachers at all academic levels should be encouraged to attend.

In addition, the inservice teacher education should prepare teachers as environmental educators and environmental activists. As purposed by the UNESCO authors (1987) this preparation should enable them to:

> ...play a decisive role in the prevention and solution of environmental problems... through their participation, as citizens and professionals, in the elaboration and carrying out of environmental policies (p. 16).

4. In reading the academy journals, it became evident that the majority of the students lack skills in synthesizing, analyzing, and evaluating material. Benjamin Bloom, in his hierarchy of intellectual objectives, as listed below, recognizes these skills as higher level (Cain, 1993):

Bloom's Order of Cognitive Domain

1. Knowledge of facts and principles (direct recall)
2. Comprehension (understanding facts and ideas)
3. Application (applying facts and ideas to new situations)
4. Analysis (breaking concepts down into parts and seeing their relationships)
5. Synthesis (putting facts and ideas together
6. Evaluation (judging value of facts and ideas) (p. 148).

Students must learn to think in one level before progressing to the next level. The ultimate goal of education should be to create students who can process information on all three levels efficiently.

All through the literature of environmental education the words problem-solving and critical thinking appear as goals of EE. These goals are synonymous with Bloom's skills of analysis, synthesis, and evaluation. Yet, it was discovered that it cannot be assumed that the students can engage in these skills without instruction. Group discussions, pre and post field trip analyses, and journal writings are methods to instruct and encourage these higher order of thinking skills.

These methods need to be continued and strengthened, especially the journal writings. The students need to be given more instruction as to expectations of their writings, more feedback and encouragement as to what they write, and more structured time to write. Pertinent discussion questions could be given that must be addressed in their journals, as well as allowing for individual creative writing.

The comparison of Bloom's Order for Cognitive Domain with the primary goal of environmental education raises some interesting questions. EE desires to create a citizenry (students) who are problem-solvers and critical thinkers and who will take responsible action because of their ability to synthesis and analyze environmental problems. Yet, it is generally agreed among the education community that a large number of students are not able to sufficiently undertake these tasks. General educators and environmental educators agree that students need instruction in the higher level skills of thinking as well as instruction in action strategies. Yet, nowhere in the EE literature, where instruction of action strategies was discussed, was instruction of higher thinking skills also discussed. It was almost assumed that students can already engage in these skills. However, as evidenced in this academy evaluation, students do need instruction and encouragement in developing their critical thinking skills. This poses the question of how efficient will action strategy instruction really be if no instruction of thinking skills are done simultaneously.

5. The OSU Summer Academy for Environmental Science is a successful program. Therefore it is recommended that it serve as a model for the establishment of similar supplementary programs or that parts of its curriculum be implemented into the traditional public school curriculum, such as field trips, cooperative learning, speakers, and environmental action skill training. The academy curriculum focused on not what to think but how to think. This model should be attempted in secondary public schools to promote greater critical thinking and problem solving skills.

   The academy can also serve as a model program for greater cooperation between universities and the public school system, as well as cooperative endeavors between corporate sponsors and governmental agencies with education.

Recommendations for Further Research

On the basis of the findings of this study and the related literature, the following recommendations for further research are presented.

1. The Ecology Attitude Inventory proved to be a strong assessment instrument in its design and analysis. However, in the opinion of this author, some of the questions need to be rewritten to reflect contemporary environmental issues. The original instrument was written and pilot tested in 1973. Major environmental issues at that time centered around the areas of pollution--water, air and soil. These concerns are reflected in several attitude and action questions. Also,

several knowledge questions, such as those dealing with DDT and mercury poisoning, do not adequately reflect current issues. Even though knowing about DDT and its implications is important information, perhaps in the world today it does not warrant enough priority to be chosen as one of the only 15 knowledge questions on the research instrument. The instrument has no questions on solid waste management, hazardous and toxic waste, global climate change, deforestation, soil degradation, or water quality. The Environmental Science Academy attempted to address in its curriculum current environmental issues that are directly affecting the state of Oklahoma, the nation, and the world. The instrument used to assess the impact of the academy on students participating needs to be more clearly related to the curriculum.

2. A further longitudinal study of environmental action skills should be done. Edwards and Iozzi (1983) conducted their longitudinal study one year and two years after completing a summer institute. This model should be done with the Environmental Science Academy participants to determine what lasting lifestyle changes in regard to environmental behavior skills are a direct result of participation in the academy. A fundamental goal of education is that learning contributes to future behavior as citizens. Such a longitudinal research study would measure the retention strength of the action treatment by the academy.
3. Further longitudinal research on career choices and/or college

coursework choices of the Environmental Science Academy participants is recommended. Choosing a career in the environmental sciences or a related field would be an example of a lifestyle change and a environmental action commitment. Another similar research would be to track the students as to college and non-college choices, and as to whether the college choice was Oklahoma State University. All of the above research could be conducted to study the impact of the Environmental Science Academy on future commitment and college recruitment of the participants.

4. According to Ramsey (1979), a theoretical continuum of environmental action behaviors exists. Behavior at one end of the continuum is overt, usually occurring over time, and directed at problem-solving actions (i.e., persuasion, ecomanagement, political action). These overt behaviors were measured in this study. However, at the other end of the continuum, behaviors are subtle, short-lived, and may not be directly related to active problem-solving. Examples might include viewing an environmental television program, hanging up an environmental poster, or wearing an environmental T-shirt. Research should be attempted to determine if the more subtle environmental behaviors can be identified and if they can be modified with environmental action training. This research could identify and clarify the theoretical continuum of environmental action behavior and help strengthen the development of environmental action instruction.

5. Minorities are a fast-growing, significant proportion of the population (Gigliotti, 1990). However, it has been criticized that the environmental movement is primarily a white, middle-class cause (Humphrey and Buttel, 1982). Research done by Caron (1989) concluded that blacks are just as concerned as whites about certain types of environmental issues, such as toxic wastes and other health threats from pollution. Further research needs to be done and education curricula needs to be prepared to evaluate and address minority concerns about the environment. This study was statistically inconclusive, because of small sample size, to conclude any relationship between minorities and environmental concerns. However, further research into this area is needed.

   Also, in a study done by Kreger (1973), Blacks reported that their lack of interest in and concern with ecological problems was related to their low economic status. This implied that their level of environmental concern would not increase until they have the capabilities and resources to enjoy more of the benefits of society. Further research in this area of economic status--ethnicity--environmental concern needs to be done.

Summary

This author believes that there is more potential to the OSU Summer Academy for Environmental Science and consequently, any environmental education program, than simply creating a curriculum that emphasizes action instruction and designing a program that can be

statistically evaluated. The Environmental Science Academy has the potential of helping to develop a responsible environmental citizenry from the youth of today. This means developing a citizenry who will exist and think in a different paradigm of beliefs. Whether this new set of beliefs is entitled "Deep Ecology" (Devall and Sessions, 1985) or "The New Environmental Paradigm" (Dunlap and Van Leire, 1978) is somewhat irrelevant. What is relevant is that education must produce individuals who will willingly and responsibly participate in environmental maintenance and remediation. In order for this to occur, individuals and consequently, society, must make major lifestyle changes and commitments and begin to look at the environment as a whole, rather than at its many separate parts.

The Environmental Science Academy can and has in the past, made dramatic impacts on the way some of the youth view their world. The academy, for several participants, has been a "rite of passage"--socially, academically, and ethically. For the first time in their lives many of the academy participants are subjected to a new perception of themselves and their "place" in the world. For some, this new perception has thrown them into personal "chaos" whereas in others, the new perceptions gave them greater self-confidence and a "sense of place". Regardless of the new paradigm presented and whether it was accepted by the individual student, personal critical thinking and problem-solving occurred.

This author believes that the ultimate goal of the Environmental Science Academy is not just to change environmental behavior and to change lifestyles, and levels of commitment. The ultimate goal of the academy should be to create a responsible environmental literate citizen

and a citizen who understands and believes in the way of thinking so eloquently presented below by Wilma Mankiller, chief of the Cherokee Nation (1991):

> We human beings are only one small part of creation. Sometimes we act as if we were the whole rather than merely a part of creation. There are other worlds besides the human world. The plant world and the animal world are equally important parts of this creation.
>
> The meaning of life is to live in balance and harmony with every other living thing in creation. We must all strive to understand the interconnectedness of all living things and accept our individual role in the protection and support of other life forms on earth. We must also understand our own insignificance in the totality of things.

Finally, the Environmental Science Academy has also had a lasting impact on this author. Because of my participation in the academy and my work with its young students, I have set personal future goals to strive for as an educator. These goals are expressed most eloquently by Miller (1973):

> I want my students to come away from any course I teach feeling that their experience with me made a significant difference to them, that they are better persons in some important way because of our association.
>
> I want my students to come away from their experience in environmental education feeling that they want to continue to know--must continue to know--the out-of-doors as an integral part of their personal lives for the remainder of their days. I want them hiking for the joy of it on Sunday afternoons. I want them seeking out the call of the loon because I said it was unforgettable, and they know from the other things we did that this must be so. I want them to watch wild creatures because they are fascinating and because there are things to be learned from them. In short, I want them to come to love the earth. And if they can learn to love the earth, why then perhaps they will become active in the fight to protect it from the depredations of man.

> My relationship with the earth is a moral one. There is no escaping this once I become conscious of it. I am responsible for my acts, both of commission and of omission. So are my students, though too few are likely to be aware of it when they first come into my class. When they leave, I hope they will have gained a sense of moral responsibility they bear in improving the quality of life on this planet. If I can succeed in this perhaps they can pass this consciousness on to their students who will in turn pass it on to others in an ever-widening circle (p. 35).

LITERATURE CITED

Alliance for Environmental Education. (1982). The Alliance Exchange (quarterly newspaper), Winter, 2-3.

Archbald, D. and P. Gundlach. (1970). Environmental education: an integrated approach. Environmental Education, 1(3): 75-76.

Bartz, A. (1988). Basic Statistical Concepts (3rd ed.). New York, NY: Macmillan Publishing Co.

Bohl, W.B. (1976). A survey of cognitive and affective components of selected environmentally related attitudes of tenth and twelfth grade students in six midwestern, four southwestern and twelve plains and mountain states. Doctoral dissertation, Ohio State University, Columbus, OH.

Borden, R.J. and A.P. Schettino. (1979). Determinants of environmentally responsive behavior. Journal of Environmental Education, 10(4): 36-39.

Borden, R.J. (1984-85). Psychology and ecology: belief in technology and the diffusion of ecological responsibility. Journal of Environmental Education, 16(2): 14-19.

Cain, A.A. (1993). Teaching Science Through Discovery, (7th Ed.) New York, NY: Macmillan Publishing Co.

Caron, J.A. (1989). Environmental perspectives of Blacks: acceptance of the new environmental paradigm. Journal of Environmental Education, 20(3): 21-26.

Charles, C. (1992). Making a conscious choice: to take responsible action. Habitrends, 9: 2-4.

Childress, R.B. (1978). Public school environmental education curricula: a national profile. Journal of Environmental Education, 9(2): 2-11.

Cummings, S.J. (1976). A methodology for environmental education. Journal of Environmental Education, 6(2): 16-20.

Devall, B. and G. Sessions. (1985). Deep Ecology. Salt Lake City, Utah: Gibbs Smith, Publisher.

Disinger, R. and C. Schoenfield. (1978). Environmental education today. Environmental Technology, 1:25-31.

Donaldson, G.W. (1972). Research in outdoor education. Journal of Environmental Education, 3(1):9.

Dunlap, R.E. and D.D. Van Liere. (1978). The "new environmental paradigm". Journal of Environmental Education, 9(2): 10-19.

Edwards, A. and L. Iozzi. (1983). A longitudinal study of the cognitive and affective impact on inservice teachers participating in an intensive environmental education institute. Current Issues in Environmental Education and Environmental Studies, edited by Arthur Saks, Louis Iozzi, and R. Wilke. Troy, OH: NAAEE.

Eiss, A. and M. Harbeck. (1969). Behavioral Objective in the Affective Domain. Washington, DC: National Science Teachers Assn.

Gay, L.R. (1987). Educational Research. Columbus, OH: Merrill Publishing Co.

Gigtiolli, L.M. (1990). Environmental education: what went wrong? what can be done? Journal of Environmental Education, 22(1): 9-12.

Gray, D.B., R.J. Borden, and R.H. Wiegel. (1985). Ecological Beliefs and Behaviors. Westport, CT: Greenwood Press.

Hart, P. and M. McClaren. (1978). Attitudes of high school students toward environmentally oriented issues. Science Education, 62: 497-508.

Harvey, G.D. (1976). Environmental education: a delineation of substantive structure. Doctoral dissertation, Southern Illinois University at Carbondale.

Hawkins, D.E. and D.A. Vinton. (1973). The Environmental Classroom. Englewood Cliffs, NJ: Prentice Hall, Inc.

Hendee, J.C. (1972). Challenging the folklore of environmental education. Journal of Environmental Education, 3(3): 19-23.

Hendee, J.C. (1972). No to attitudes to evaluate environmental education. Journal of Environmental Education, 3(3): 65.

Hines, J.H. (1986-87). Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. Journal of Environmental Education, 18(2): 1-8.

Huber, R.A., W.C. Kyle, and E.L. Pizzini. (1981). The effect of personal growth and development activities on student attitudes toward social issues. Journal of Environmental Education, 12: 34-39.

Humphrey, C. and F. Buttel. (1982). Environment, Energy, and Society. Belmonet, CA: Wadsworth.

Hungerford, H.R. (1975). Myths of environmental education. Journal of Environmental Education, 2:21-26.

Hungerford, H.R. and R. Litterland. (1975). Process Modules for Investigating Environmental Problems. Department of Curriculum, Instruction, and Media, Southern Illinois University at Carbondale.

Hungerford, H.R. and R.B. Peyton. (1976). Teaching Environmental Education. Portland, ME: J. Weston Walch.

Hungerford, H.R. R.B. Peyton, and R.J. Wilke. (1980). Goals for curriculum development in environmental education. Journal of Environmental Education, 11(1): 42-47.

Hungerford, H.R. and T.L. Volk. (1990). Changing learner behavior through environmental education. Journal of Environmental Education, 21(3): 8-20.

Iozzi, L.A. (1989). What research says to the educator. Part one: environmental education and the affective domain. Journal of Environmental Education, 20(3): 3-9.

Jeter, Jan. (1982). Environmental education. Encyclopedia of Educational Research, (5th ed.), 2: 576-580.

Jordan, J.R., H.R. Hungerford, and A.N. Tomera. (1986). Effects of two residential environmental workshops on high school students. Journal of Environmental Education, 18: 15-22.

Katz, Daniel. (1960). The functional approach to the study of attitude. Public Opinion Quarterly XXIV, 163-204.

Klingler, G. (1981). The effect of an instructional sequence on the environmental action skills of a sample of southern Illinois eighth graders. Master's thesis, Southern Illinois University-Carbondale.

Knapp, C.E. (1972). Attitudes and values in environmental education. Journal of Environmental Education, 3(4): 76-79.

Kreger, J. (1973). Ecology and Black student opinion. Journal of Environmental Education, 4(3): 30-34.

Leopold, Aldo. (1949). Sand County Almanac. New York: Ballantine Books.

Lewis, J. and M. Zeldin. (1991). A new law with new directions. EPA Journal, Sept/Oct: 6-9.

Lucko, B.J., J.E. Disinger, and R.E. Roth. (1982). Evaluation of environmental education programs at the elementary and secondary school levels. Journal of Environmental Education, 12(3): 7-12.

Maloney, M.P. and M.P. Ward, and G.N. Braucht. (1975). Psychology in action: a revised scale for the measurement of ecological attitudes and knowledge. American Psychologist, 30: 787-790.

Mankiller, W. (1991). The meaning of life. Life, 14(16): 20.

Marcinkowski, T.J. (1989). An analysis of correlates and predictors of responsible environmental behavior. Dissertation Abstracts International 49(2): 3677-A.

Marcinkowski, T.J. (1991). The new national environmental education act: a renewal of commitment. Journal of Environmental Education, 22(2): 7-10.

Marks, S. (1992). Final report - Oklahoma State University Summer Academy for Aerospace Education. Oklahoma Board of Higher Regents.

McClaren, M. (1989). Environmental literacy: a critical element of a liberal education for the 21st century. Education Manitoba, Jan: 1-12.

Miller, W. (1973). Environmental education: a romantic replies to a hard-liner. The Science Teacher, 40: 34-35.

Mills, T.E. and C. Moseley. (1991). Reflections: a model field-based, multicultural, high school environmental science academy. Proceedings - NAAEE Conference, St. Paul, MN.

Monroe, M.C. and S. Kaplan. (1990). When words speak louder than actions: environmental problem-solving in the classroom. Journal of Environmental Education, 19(3): 38.

Moore, K.M. (1988). Farmer and non-farmer attitudes toward environmental policy issues: an exploratory survey. University Center for Water Research, Oklahoma State University, E-046.

Muir, J. (1901). Our National Parks. Boston: Houghton Mifflin Co.

National Education Association (NEA). (1970). Environmental Education in the Public Schools. Washington, DC: NEA.

New York Times. (1992). The conference on environment and development. April 5: 10.

O'Hearn, G.T. (1982). What is the purpose of evaluation? Journal of Environmental Education, 13(4): 1-3.

Ramsey, J.M. (1979). A comparison of environmental action and environmental case study instruction on the overt environmental behavior of eighth grade students. Master's thesis. Southern Illinois University - Carbondale.

Ramsey, J. (1981). The effects of environmental action and environmental case study instruction on the overt environmental behavior of eighth-grade students. Journal of Environmental Education, 13(1): 24-30.

Ramsey, J. (1989). A study of the effects of issue investigation and action training on characteristics associated with environmental behavior in seventh grade students. Doctoral Dissertation, Southern Illinois University at Carbondale.

Renew America. (1992). Environmental education: a new priority. Sharing Success.

Richmond, J.M (1972). A survey of the environmental knowledge and attitudes of fifth year students in England. Doctoral dissertation, Ohio State University, Columbus, Ohio.

Roth, C.E. (1991). Towards shaping environmental literacy for a sustainable future. ASTM Standardization News, April: 42-45.

Roth, C.E. (1990). The endangered Phoenix - lessons from the firepit. Journal of Environmental Education, 19(3): 3-9.

Roth, R.E. (1970). Fundamental concepts for environmental management education (K-16). Journal of Environmental Education, 1: 65-74.

Roth, R.E. (1972). The environment and man. Journal of Environmental Education, 3(3): 45.

Roth, R.E. (1979). Conceptual development and environmental education. Journal of Environmental Education, 11(1): 6-9.

Schoenfield, C. (1970). Towards a national strategy for environmental education. Journal of Environmental Education, 4(1): 3-11.

Sheldon, D.S. (1973). An analysis of the effects of an environmental program upon the participants enrolled. Doctoral dissertation, University of Iowa.

Sia, A.P., H.R. Hungerford, and A.N. Tomera. (1985-86). Selected predictors of responsible environmental behavior: an analysis. Journal of Environmental Education, 17(2): 31-40.

Slavin, R.E. (1980). Using Student Team Learning (3rd ed.). Baltimore, MD: Johns Hopkins University.

Slavin, R.E. (1981). Synthesis of research on cooperative learning. Educational Leadership, 38: 655-660.

Slavin, R.E. (1988). Cooperative learning and student achievement. Educational Leadership, 38: 31-33.

Southern, C. (1972). Vitalizing natural resources education. Journal of Environmental Education, 3(3): 16.

Stapp, W.B. (1969). The concept of environmental education. Journal of Environmental Education, 1(3): 31-40.

Stapp, W.B. (1970). Environmental encounters. Journal of Environmental Education, 2(1): 35-41.

Tanner, R.T. (1974). Ecology, Environment, and Education. Lincoln, NB: Professional Educators Publications.

The Tbilisi Declaration. (1978). Connect 3, No. 1: 1-8.

Tognacci, L.N., R.H. Wiegel, M.F. Wideen, and D.T.A. Vernon. (1972). Environmental quality: how universal is public concern? Environment and Behavior, 4: 73-86.

United Nations Educational, Scientific, and Cultural Organizations (UNESCO). (1977). Needs and Priorities in Environmental Education: An International Study. France.

UNESCO. (1980). Environmental Education in Light of the Tibilisi Conference. France, 40 pp.

Wiegel, R.N. and J. Wiegel. (1978). Environmental concern: the development of a measure. Environment and Behavior, 10: 3-15.

Wiegel, R.N. and L.S. Newman. (1976). Increasing attitude-behavior correspondence by broadening the scope of behavioral measure. Journal of Personality and Social Psychology, 33: 793-802.

Wiegel, R.N., D.T.A. Vernon, and L.N. Tognacci. (1974). The specificity of the attitude as a determinant of attitude-behavior congruence. Journal of Personality and Social Psychology, 30:L 724-729.

Willard, B.E. (1976). Fundamentals of environmental education. Paper developed by the subcommittee on environmental education, U.S. Department of Health, Education and Welfare, Office of the Assistant Secretary for Education, Washington, DC.

Volk, G.L. (1983). A national survey of curriculum needs as perceived by professional environmental educators. Doctoral dissertation, Southern Illinois University at Carbondale.

APPENDIXES

APPENDIX A

ENVIRONMENTAL SCIENCE ACADEMY

Final Report

Oklahoma State University

Summer Academy for Environmental Science:
Science, Technology, and Societal Interaction
June 7 - June 29, 1991

Co-Directors

Dr. Ted Mills
Professor of Curriculum and Instruction

Dr. John Vitek
Assistant Dean, Graduate College

FINAL REPORT

1991 OSU SUMMER ACADEMY FOR ENVIRONMENTAL SCIENCE

Introduction

The purpose of the OSU Summer Academy for Environmental Science was to conduct an intensive three week program of study, with follow up activities, for twenty-five 11th and 12th grade Oklahoma high school students interested in Environmental Science. The results of this academy received international recognition at the 1991 conference of the North America Association for Environmental Education (NAAEE). An environmental issues photography contest was held during this international meeting. Eight outstanding photographs taken by the Academy participants won high honors. These photos demonstrate environmental problems, goals, and solutions. In addition, the photos express the intent and results of the 1991 OSU Summer Academy for Environmental Science.

One photo, Oklahoma Native Wildflower Plot, was also featured on the cover of the Environmental Communicator, a national environmental education newsletter published by NAAEE. Also,d two of the photos will be used as part of a brochure produced by OSU Cooperative Extension Service and the Oklahoma Department of Agriculture that outlines the state's citizen complain system of pollution incidences.

Goal

The overall goal of the academy for interdisciplinary science was to make a select group of high school students:

(1) aware of major environmental issues and problems

(2) knowledgeable about the ecological concepts that connect the issues and problems; and

(3) able to identify the existing opportunities they have to deal with the problems in the future.

Design

The Summer Academy was designed in two phases. The first phase took place on the OSU campus from June 7, 1991 - June 29, 1991, and it involved classroom, laboratory, and field instruction. One major feature of this year's academy was that nine 1990 academy participants were brought back the first weekend to serve as junior counselors. They helped with registration, team-taught several activities, and conducted an informal discussion with new participants about their academy experiences and effects it had on their personal lives.

The second phase involved follow-up activities in the form of a home analysis of use patterns for energy, water, toxics, sold waste recycling, and transportation. The Earth Day 1990 Home Survey was the model used for gathering the data. Students brought their data back to campus for the Fall Equinox weekend, September 21-22, 1991, to summarize and analyze their findings.

Students were also instructed to conduct and/or initiate a community action project upon completion of the academy in June. They each gave a presentation of their project at the reunion. Some of the community action projects are:

- One student was instrumental in implementing mandatory recycling in her town.

- One student approached the mayor of his town about starting a recycling program and was met with a very negative response. The student successfully worked to get that mayor defeated in the next election and the new mayor has started a recycling program.

- Two students have initiated recycling programs in their neighborhoods.

- Two students are presenting programs to elementary school children.

- Two students have cleaned up parks near their homes.

- Two students are in the process of starting environmental clubs at their schools.

- Three students are trying to initiate recycling programs at their schools.

- Several of the students have become active in their high school environmental club.

Selection of Participants

Participants were selected from applications received from across the state. Twenty-four students participated in the academy and fourteen students, along with eleven family members, returned for the reunion. Nine junior counselors attended the first weekend. Selection criteria included:

1) Academic potential as measured by an acceptable grade point average

2) Leadership potential

3) Student letter of application

4) Documented member of an under-represented minority group

	Anglo	Native American	Black	Asian	Hispanic	Total
Males	7	0	2	1	1	11
Females	10	1	1	0	1	13

5) Maintenance of a multicultural balance consistent with the faculty of the Summer Academy.

Curriculum

The students participated during the three week program in a variety of learning styles - lectures, seminars, research teams, discussion groups, laboratories, and field trips - planned around the study of Oklahoma's major biomes and major environmental issues confronting Oklahoma, the United States, and the world.

The state of Oklahoma was divided into four major quadrants and then the field trips were planned around local environmental issues of each representative quadrant. The Southeastern Oklahoma trip concentrated on the timber and poultry industries, Southwestern Oklahoma on federal and state government resource interactions, Northwestern Oklahoma on geological and agricultural differences, and Northeastern Oklahoma on the Tar Creek Superfund site, the Illinois River watershed, and the petroleum industry. Local field trips were conducted in Central Oklahoma to several electric energy source sites and to waste management facilities. On-campus activities included lectures and discussions about the issues discussed on the field trips.

A significant portion of time during the three week program was spent with the students working together in teams. Each team constructed a computer data base of required information about each county they visited on field trips. Sources of information the terms used for compiling the data base included county soil surveys and data collected by use of water and soil test kits. This data was recorded in a field data workbook.

Student Evaluation

Student progress was monitored by several methods. To promote participation in the programs, weekly questions covering the proposed

week's programs and trips were administered each Monday. Responses to questions were to be completed and returned to the staff on the following Friday. Also, the students (1) kept daily journals, not only of what they did but their reactions and analysis of the activities, (2) elected two representatives, male and female, who served as liaisons to the staff in regard to suggestions and planning, (3) formed research teams that completed a data base and submitted a final printout for evaluation, and (4) research teams developed a slide presentation of the three week experience and all participants chose two presentations that were presented at the final awards banquet. Two students were selected by their peers to serve as masters of ceremony at the banquet.

Program Evaluation

Students completed an evaluation form at the conclusion of the academy and another evaluation at the conclusion of the weekend reunion. Also, each parent was sent an evaluation form designed to solicit their feedback to the academy.

The evaluations from all participants proved to be very positive. One hundred percent of the participants responded "yes" as an answer to the question "If you could do it all over again, would you?" No participant responded negatively to the question soliciting general comments on the academy.

Participants shared their comments, suggestions,s and ideas about field trips, speakers, computer and field work, and assignments. Using a Likert Scale, the participants rated the speakers and field trips. The results follow. These suggestions are valid and will be given serious consideration in planning another academy.

1991 Summer Academy for Environmental Science Participant Rating of Speakers and Field Trips (shown in percentage)

Speakers

	poor	fair	average	good	excellent
Rev. Mendle Adams (Environmental Ethics)	0	8	13	33	33
Dr. Larry Perkins (Social Ecology)	0	17	13	25	46
Harvey Payne (Nature Conservancy)	0	8	25	54	13
Russ Peterson (Dolco)	0	4	29	42	25
Elmer Walls (Bureau of Land Management)	0	21	42	25	13
Dr. S.L. Burkes (Illinois River)	21	29	29	17	4
Dr. Steve Anderson (Forest Industry)	0	13	33	33	13
Mark Gregory (Remote Sensing)	0	8	46	17	17

FIELD TRIPS

	poor	fair	average	good	excellent
Britta Heglund-Cantrell (Assistant A.G.)	0	0	29	33	29
State Capital	0	8	21	29	42
Water Resources Board & State Agencies	4	0	21	29	46
National Toxics Campaign Office	4	21	17	25	33
Wichita Mountains Wildlife Refuge	0	0	17	25	33
Tall Grass Prairie	0	0	8	21	71
Phillips Petroleum	4	0	29	42	25
Prairie Song	4	13	17	17	50
Butch Richardson (Wild Horse Sanctuary)	4	13	21	38	21
Sutton Avian Research Center	4	0	8	21	67
Tar Creek	4	4	21	38	33
Trail of Tears Drama	4	4	25	25	42
Illinois River	0	4	0	17	79
Cherokee Heritage Center	0	4	17	46	33
HEW Landfill and Recycling	0	0	33	29	38
Waste Water Treatment Plant	8	29	21	33	25
Alabaster Caverns	0	0	0	21	79
Little Sahara	0	4	13	21	54
Cimarron River	4	0	38	42	17
Glass Mountains	0	0	4	42	46
Great Salt Plains	0	0	13	29	58
Save the Cimarron (Claire Newsom)	0	4	25	46	21

FIELD TRIPS (continued)

	poor	fair	average	good	excellent
Sooner Power Plant	0	4	29	25	38
OK Poultry Farm	4	8	21	42	21
Talimena Drive	0	0	17	21	14
Kerr Arboretum	0	17	13	33	33
Barbara Hicks (Community Action)	0	8	25	42	25
Broken Bow Hydroelectric Plant	4	13	21	21	33
Tyson Poultry Processing Plant	4	0	21	33	33
Weyerhaeuser Paper Plant	0	8	29	38	25
Weyerhaeuser Nursery	0	8	29	33	21
BLM Oil Lease	17	13	38	21	4

Recognition

Two students were selected by the staff to receive outstanding participant recognition at the banquet based on attributes of leadership, cooperation, interest, and participation during the academy. These two students also represented the academy at the annual conference of the North American Association for Environmental Education, held in St. Paul, Minnesota, September 27 through October 2, 1991. While at this conference they presented a paper and a slide presentation on the academy. Fifteen outstanding academy student photos were selected and submitted to an environmental issues photography contest held during the conference. The academy photos won first place in the categories Environmental Problems and Environmental Goals, second place in the category Environmental Solutions and five Honorable Mentions in the various categories. The academy was recognized for its accomplishments during the NAAEE conference awards luncheon.

KWTV, Channel 9 in Oklahoma City, featured the academy on the June 14, 1991 newscast as part as series regarding Oklahoma's environmental issues. The segment showed the students attending a lecture and included interviews with the students and staff.

The Summer Academy for Environmental Science was chosen by Renew America to be listed in the 1991 Environmental Success Index (ESI). The index is a clearinghouse of information that will be made available to policymakers, citizens' groups, private and public organizations, the media, and individuals interested in finding solutions to environmental problems. Being part of the ESI means the academy will be promoted as a model for others.

Faculty and Staff

The faculty, staff, and program contacts participating in the academy represented a broad base of scientific expertise. The OSU graduate program in Environmental Science was well represented by many of its graduate students assisting with the program. Also, the staff was purposely solicited in order to achieve a balance in the sex, race, and ethnic backgrounds. This balance significantly complemented the mix of the multi-ethnic, race, and sex of the participants in a program dealing with a multidisciplinary science.

Parental Support

One of the strengths of the program proved to be the parental support, which the academy staff actively sought. From the beginning the staff sent letters, not only to the participants, but also to their parents. These letters kept the parents informed of activities and trips, invited them to special events, and requested their comments and suggestions. In addition, the banquet invitation list not only included parents' names, but any other family members the students wished to invite and a representative from their high schools. One hundred fifty students, family members, teachers, academy staff and faculty, and honored guests were in attendance at the banquet.

Summary

Academy evaluations and ongoing student activities are indicators of the quality of the program. The academy objectives were met. yet, even more importantly, was the success of the program in areas not realized in the original proposal. The students literally grew in front of the staffs' eyes - grew in maturity, responsibility, compassion, understanding, awareness, and tolerance. The students have corresponded

with the staff throughout the year and plans are being made to continue contact with each other through letters and a newsletter. **Over half of the students are requesting to return next year as junior counselors.**

Conclusion

The 1991 OSU Summary Academy for Environmental Science was a valuable asset in preparing twenty-four Oklahoma high school students - Oklahoma's next generation - to cope with major environmental issues. The Academy complemented the four major goals of science education as suggested by Project Synthesis (Harms & Yager, 1981):

1. to prepare individuals to use science for improving their own lives and for coping with an increasingly technological world
2. to produce informed citizens prepared to deal responsibly with science-related social issues
3. to allow students who are likely to pursue science academically as well as professionally to acquire attitudes, knowledge, and skills appropriate for their needs
4. to give all students an awareness to the nature and scope of a wide variety of science and technology-related careers open to students of varying aptitudes and interests.

Without the support of the Oklahoma State Regents for Higher Education this educational experience could not have taken place. In addition the Phillips Foundation and Dolco Packaging Corporation made significant contributions by providing speakers as well as financial support.

Academy Faculty and Staff

Dr. John Vitek
Professor, Geology
Associate Dean, Graduate College
Environmental Science Steering Committee

Dr. Ted Mills
Professor, Curriculum and Instruction
Environmental Science Steering Committee

Chris Moseley
Lecturer, Curriculum and Instruction
Doctoral Candidate, Environmental Sciences

Dr. Robert Raze
Program Specialist, Office of Environmental Education
Florida Department of Education
Graduate, OSU Environmental Science

Gary Layman
Science Teacher, Duncan High School
Graduate, OSU Instructional Media Technology

Lisa Anderson
Graduate Assistant
Masters Candidate, Environmental Science

Karen Rogers
Graduate Assistant
Masters Candidate, Environmental Science

DouGlas Palenshus
Graduate Assistant
Masters Candidate, Environmental Science

Christine Lalonde
Graduate Assistant
Masters Candidate, Environmental Science

Randy Hunt
Graduate Assistant
Doctoral Candidate, Science Education

Mark Everett
Administrative Assistant
Undergraduate, Environmental Science

Shelley Shoulders
Undergraduate Aide
Undergraduate, Environmental Science

OSU Faculty Giving Presentations

Dr. Steve Anderson - Forestry Industry
Assistant Professor, Forestry

Dr. Sterling Burks - Illinois River
Professor, Zoology

Dr. Ted Mills - Water Simulation
Professor, Curriculum and Instruction

Dr. Larry Perkins - Social Ecology
Professor, Sociology

Dr. John Vitek - Tar Creek
Professor, Geology

Consultants

Rev. Mendle Adams - Environmental Ethics
Chaplain, United Ministry to Oklahoma State University

Mark Gregory - Remote Sensing Lab
Graduate Assistant, Environmental Science

Dick Hackett - Northwestern Oklahoma Geology
Instructor, Geology

Program Contacts

Rev. Mendle Adams
1908 Stepping Stone Drive
Edmond, OK 73013
Environmental Ethics

Alabaster Caverns
(405) 621-3381

Dr. Steve Anderson
239 Ag Hall
X46432
Forestry Department

Mr. George Bearclaw
(918) 456-0671 ext. 416
Cherokee Nation of Oklahoma

Broken Bow Hydroelectric Plant
Attn: Mr. Wayne Parris, Supt.
P.O. 730
Broken Bow, OK 74728
(405) 494-6379

Bureau of Land Management
Attn: Mr. Elmer Walls
200 NW 5th
Oklahoma City, OK 73102
(405) 231-5491
or
221 N. Service Rd.
Moore, OK 73160-4946

Dr. S.L. Burks
426 LSW
X45551
Zoology Department

Ms. Britta Heglund-Cantrell
Attorney General's Office
112 State Capitol
Oklahoma City, OK 73105
(405) 521-3921

Cherokee Heritage Center
Attn: Mr. Tom Mooney
P.O. Box 515
Tahlequah, OK 74415
(918) 456-6007
Trail of Tears/Cherokee Heritage Center

Cherokee Nation Environment
Attn: Mr. Ken Purdy or Mr. Duane Beavers
111 W. Shawnee
Tahlequah, OK 74464

Corporation Commission
Attn: Ms. Tanna Walker or Mr. Jim Baker
Jim Thorpe Office Bldg.
2101 Lincoln Blvd.
Oklahoma City, OK 73105

Dolco Packaging Corporation
Attn: Mr. Russ Peterson
4700 S. Westmoreland Road
Dallas, TX 75237-1629
(214) 337-4711

Doris Campground
Attn: Refuge Manager
Wichita Mountains Wildlife Refuge
Route 1, Box 448
Indiahoma, OK 73552
(405) 429-3222

The George Miksch Sutton
Avian Research Center, Inc.
Attn: Ms. Patty Alexander
P.O. Box 2007
Bartlesville, OK 74005-2007
(918) 336-7778

Ms. Gina Gray
One Plaza South
Suite 175
Tahlequah, OK 74464
(918) 456-2665
Artist of the Cherokee Nation

Mr. Mark Gregory
313 HEE
X45178
X49603
Remote Sensing

Mr. Dick Hackett (Maurice)
306C HEE
X49175
Geography Department

HEW Landfill and Recycling Plant
Attn: Mr. Mike Adams
3303 N. Marine Road
Stillwater, OK 74075

Ms. Barbara Hicks
Owner, Whip-Poor-Will Cabins
Pres., Broken Bow Lake Assoc.
Star Rt. Box 3B
Broken Bow, OK 74728
(405) 494-5476

Horsethief Canyon
Attn: Mr. Ben Holder
Box 772
Perkins, OK 74059
(405) 547-2262

Kerr Arboretum
Choctaw Ranger District
HC-654
Box 3467
Heavener, OK 74937

KWTV 9
Attn: Mr. Mitch Jeiniker
7401 N. Kelly Avenue
Oklahoma City, OK 73111

Little Sahara St. Park
Attn: Ms. Lorraine Howley
Rt. 2, Box 154
Waynoka, OK 73860
(405) 824-1471

Ms. Wilma Mankiller, Principal Chief
Cherokee Nation of Oklahoma
P.O. Box 948
Tahlequah, OK 74465
(918) 456-5279

Ms. Lynn Moroney
6002 N. Villa
Oklahoma City, OK 73112
(405) 840-2152

Mr. John Mott
463 S. Emily Street
Picher, OK 74360
(918) 673-1212

National Toxics Campaign
Attn: Mr. Earl Hatley, Oklahoma Director
3000 United Founders Blvd. #125
Oklahoma City, OK 73112
(405) 843-3249

Nature Conservancy
Attn: Mr. Bob Hamilton
320 South Boston
Suite 1222
Tulsa, OK 74103
(918) 585-1117
(918) 637-5415 mobile

OG&E Sooner Generating Station
Attn: Ms. Gobel
Rt. 1, Box 85
Red Rock, OK 74651
(405) 723-4415

Oklahoma Conservation Commission
Attn: Mr. Mason Mungle
2800 N. Lincoln Blvd.
Oklahoma City, OK 73112

OK Poultry Farms
Attn: Mr. Bill Hardin, Farm Manager
1-800-643-2506

Osage Hills St. Park
Attn: Leatha
Red Eagle Rt. Box 84
Pawhuska, OK 74056
(918) 336-4141

Outdoor Adventure
Attn: Mr. Kirk Wimberley
119 Colvin PEC
X47315
Camp Redlands, Challenge Course, Canoes

Dr. Larry Perkins
2 CLSM
X46129
Sociology Department

Phillips Petroleum Foundation, Inc.
Attn: Mr. John C. West, Executive Manager
16th Floor Phillips Bldg.
Bartlesville, OK 74004
(918) 661-4597

Prairie Song
Attn: Ms. Marilyn Tate
Route 1, Box 286
Dewey, OK 74029
(918) 534-2662

Riverside Camp
Attn: Mr. Woody Garman
HC 61, Box 172
Tahlequah, OK 74464

Save the Cimarron
Attn: Ms. Claire Newsom
2712 Bobwhite Ln.
Enid, OK 73703
(405) 242-0302

Soil Conservation Service
Attn: Mr. Joe Schneider
630 E. Steve Owens Blvd.
Miami, OK 74353
(918) 542-4771

Stillwater Waste Water Treatment Plant
Attn: Mr. Reed and Hophi
2520 S. Brush Creek Road
Stillwater, OK 74074

Tallgrass Prairie Preserve
Attn: Mr. Dick Whetsell
Rt. 1, Box 173W
Pawhuska, OK 74056
(918) 287-1427
(918) 636-1957
or
Attn: Mr. Harvey Payne
Tallgrass Prairie Preserve
Pawhuska Office
P.O. Box 458
Pawhuska, OK 74056
(918) 287-1290

Taylorsville
Attn: Mr. O.E. Taylor
Rt. 4, Box 209
Stillwater, OK 74074

Tyson Poultry Processing Plant
Attn: Mr. Daryl Crusoe
P.O.1 Box 220
Broken Bow, OK 74728
(405) 584-9191

USPCI, Inc.
Attn: Ms. Becky O'Dell
Box 416
Fairview, OK 73737
(405) 227-2583
(405) 697-3236

Weyerhaeuser Nursery
Attn: Mr. Danny Menefee
Ft. Towson, OK 74735
(405) 873-2277

Weyerhaeuser Paper Company
Attn: Ms. Diane Taylor
P.O. Box 890
Valliant, OK 74764
(405) 933-7211

Wichita Wildlife Refuge
Attn: Ms. Claudine Daniel
Rt. 1, Box 448
Indiahoma, OK 73552
(405) 429-3221

Wild Horse Sanctuary
Attn: Mr. Butch Richardson
Route 1, Box 455
Bartlesville, OK 74003
(918) 534-2127

ACADEMY SCHEDULE

Saturday, June 8

9am--staff
10-11:30am-- Registration at Camp Redlands
11:30am-1pm-- Picnic Lunch
1-2pm-- Orientation
2-3pm-- Evaluation Surveys
3-5pm-- WILD Games
6pm-- Dinner
7-9pm-- Environmental Ethics (Rev. Mendle Adams)
10pm-- Junior Counselors

Sunday, June 9

8am-5pm-- Ropes Course
7-9pm-- Social Ecology (Dr. Larry Perkins)

Monday, June 10

9-10am-- Acid Rain Water Relay (Dr. Ted Mills)
10-11am-- Water and Soil Tests (Dr. Tom Bates)
11am-12pm-- Canoeing (Dr. Ted Mills)
12pm-- Junior Counselors leave
2-3pm-- Check in at Residence Halls
6-6:45pm-- Soil Map Work (Karen)
6:45-9pm-- Computer Orientation

Tuesday, June 11

9am-12pm-- Program Orientation
1-2pm-- Nature Conservancy (Bob Hamilton)
2:30-3:30pm--Bureau of Land Management (Elmer Walls)
4-5pm-- Field Trip Introduction
6-9pm-- Computers

Wednesday, June 12

7am-- Load Bus
7:30am-- Depart
9am-- Capital (Britta Heglund-Cantrell, Assistant Attorney General)
10:30am-- Water Resources Board (Patricia P. Eaton, Secretary of Environment)
10:40am-- Dave Dillon, Chief of Water Quality division, Water Resources Board
Shon Simpson, Assistant Chief
11:45am-- Lunch
1pm-- Fenton Rood, Chief of Solid Waste Management Service, Department of Health
1:45pm-- Mason Mungle, Executive Director, Conservation Commission
2:15pm-- Mike Battles, Director of Fuel division, Corporation Commission
3:30pm-- Earl Hatley- National Toxics Campaign
Overnight at Cameron University, Lawton

Thursday, June 13

8am-5pm-- Wichita Mtn. Wildlife Refuge (Claudine Daniel)
Lunch at Meers
9pm-- Return to OSU

Friday, June 14

9-10am-- Recap Field Trip
10am-12pm-- Dolco (Russ Peterson)
1-2pm-- Introduction to Tar Creek
2:15-3:15pm-- Illinois River Pollution Controversy (Dr. S.L. Burks)
3:30pm-- Introduction to field trip
Check-out by 5pm

Saturday, June 15

Home

Sunday, June 16

Check-in by 4pm
5-7pm-- Eskimo Joe's
7-9pm-- Recycling (Christine Lalonde)

Monday, June 17

7am-- Load Bus
7:30am-- Depart
9:30-11:30am-- Tall Grass Prairie (Dick Whetsell)
12-1pm-- Picnic lunch at Osage Hills
1-4pm-- Phillips Petroleum
4:30-6:30pm-- Prairie Song (Marilyn Tate)
6:30-8pm-- Wild Horse Sanctuary/Dinner
9-10:30pm-- Swim
Overnight at Osage Hills

Tuesday, June 18

7:30am-- Load Bus
8am-- Depart
9-10am-- Sutton Avian Research Center (Patti Alexander)
12:30pm-- Lunch at McDonald's (Baxter Springs, KS)
1-4:30pm-- Tar Creek (John Mott, Joe Schneider)
6:30pm-- Check in at Riverside
7pm-- Dinner at Six Killers
8-11pm-- Trail of Tears Drama
Overnight at Riverside Camp

Wednesday, June 19

8am-12pm-- Canoe Illinois River
2-6pm-- Cherokee Heritage Center
10pm-- Return to OSU

Thursday, June 20

9:30am-- Load Vans
10am-12pm-- HEW Landfill/Recycling Plant (Mike Adams)
1:30pm-- Load vans
2-4pm-- Waste Water Treatment Plant
7-9pm-- Recap field trip, Introduction to field trip

Friday, June 21

7am-- Load Bus
7:30am-- Depart
10am-12pm-- Lone Mtn. Hazardous Waste Facility (Becky O'dell)
Picnic Lunch
2-3pm-- Alabaster Caverns
3-4pm-- Swim
5:30pm-- Check in at Little Sahara/Dinner
7-9pm-- Glass Mountains (Dick Hackett)
Overnight at Little Sahara State Park

Saturday, June 22

8-9:30am-- Little Sahara Sand Dunes (Dick Hackett)
10-11am-- Cimarron River (Dick Hackett)
Lunch/Check-out
2-4pm-- Great Salt Plains
6-7pm-- Save the Cimarron (Claire Newsom)
9:30pm-- Return to OSU

Sunday, June 23

Church/free time
2pm-- Load vans
Horsethief Canyon
Recap field trip
Horse Rides
Cookout

Monday, June 24

9am-- Load vans
10am-- Sooner Power Plant
1-2pm-- The Forest Industry (Dr. Steve Anderson)
2:30pm-- Introduction to field trip
Slide Work
6-9pm-- Computers

Tuesday, June 25

7am-- Load bus
7:30am-- Depart
Picnic Lunch
1-2pm-- OK Poultry Farms (Bill Hardin)
Talimena Drive
4-5:30pm-- Kerr Arboretum (Rhonda Stewart)
7pm-- Community Involvement (Barbara Hicks)
Overnight at Whip Poor Will Cabins

-

Wednesday, June 26

7am-- Load buses
7:30am-- Depart
8-9:30am-- Broken Bow Hydroelectric Plant
10am-- Tyson Poultry Processing Plant (Darrell Crusoe)
11:30am-- Lunch at Catfish King
1-3pm-- Weyerhaeuser Paper Plant
3:30-5pm-- Weyerhaeuser Nursery
Dinner
10pm-- Return to OSU (Turn in all film!!!)

Thursday, June 27

9am-- Recap Field Trip
Slide Work
12-1pm-- Lunch
1-4pm-- Water Simulator (Dr. Ted Mills), Remote Sensing (Mark Gregory)
6-9pm-- Computers

Friday, June 28

9-10am-- Wrap-up (Dr. Larry Perkins)
Environmental Action Evaluation (Chris & Lisa)
12-1pm-- Lunch
1-4pm-- Slide Work
Computers
6pm-- Preview slide presentations

Saturday, June 29

11:30am-2pm-- Banquet
Check-out by 4pm

Academy Reunion September 21 & 22!!!

Staff:

Friday, June 7
9am-12pm-- Staff Workshop
12-2pm-- Lunch w/ Junior Counselors
2-5pm-- Staff Workshop w/ Junior Counselors
7pm-- Staff Social at Chris' house

Saturday, June 29
6-7pm-- Staff Meeting at Lisa's
7pm-- Staff Social at Lisa's

APPENDIX B

AEROSPACE EDUCATION ACADEMY

OKLAHOMA STATE UNIVERSITY

HIGH SCHOOL AEROSPACE

EDUCATION ACADEMY

June 9 - 28, 1991

Summary prepared by

Steven K. Marks, Ed.D.

For the

Oklahoma Regents for Higher Education

and the

Federal Aviation Administration

College of Education

Department of Aviation and Space Education

AEROSPACE EDUCATION HIGH SCHOOL STUDENT SUMMER ACADEMY

The purpose of the Oklahoma State University (OSU) Aerospace Education High School Summer Academy was to make it possible for 30 students who are between their sophomore and junior, or junior and senior years in high school to engage in active study of aerospace education concepts. The two target groups of high school students which were actively sought for the OSU summer academy were composed of primarily female and underrepresented minority groups.

Need

The latest research indicates that a multi-disciplinary approach to science will be necessary to educate high school as well as elementary school students in the future. The American Association for the Advancement of Science (AAAS) suggests in their latest report entitled PROJECT 2061 that this integration should cross the lines of biology, chemistry, physics, and earth science with its emphasis on ideas rather than facts and concepts rather than terms. This process also includes the integration of mathematics at every level, as well as the inclusion of communication and decision making skills as part of science and not merely add-ons to the curriculum. This proposed high school student summer academy would be a model of how to relate the integration of science into aerospace education at the local and state levels. Research also shows that females and underrepresented minority groups are not entering science fields; therefore, this summer academy targeted these two groups as participants.

An outgrowth of this project was that each student accumulate experience in career exploration in the field of aerospace industry.

Students were shown the importance of the aviation industry to Oklahoma's economy as well as the international aspects of space exploration.

Institutional Support

With an enrollment of approximately 20,000 students on its main campus in Stillwater, Oklahoma State University is the largest institution of higher education in the state. A land-grant institution, OSU was founded in 1890 and in 1991 is a comprehensive university, which, through its programs of instruction, research, and extension, serves the people of the State of Oklahoma, the nation, and the world.

Throughout its history, the University has maintained a consistent philosophy that direct service to people must always remain of central importance to the accomplishment of the University's mission "to provide an environment in which its constituents can discover, examine, preserve and transmit knowledge, wisdom and values that will insure the survival of present and future generations with enrichment in the quality of life."

The College of Education, from which the project staff comes, has long been recognized as the leading educational College in the state and has a history of providing quality seminars and workshops to a wide variety of clientele. This background provided a basis for the successful completion of the Aerospace Academy.

Project Objectives

The objectives of the Aerospace Education High School Student Summer Academy are to:

1. nurture the interest of students in biology, chemistry, physics, earth science and mathematics, and demonstrate how they can be integrated into aerospace education studies;
2. interest females and underrepresnted minority groups in the sciences; and
3. conduct an evaluation of the summer academy for future research purposes.

Selection of High School Students

In order to identify the high school students who were invited to participate in the summer academy, a brochure was developed and mailed to all high school principals, school counselors, as well as all superintendents in the State of Oklahoma, see Appendix A. Efforts were also made to place the information in the Oklahoma Educator, and all Oklahoma Science Teachers Association Board Members were requested to assist in the distribution of the information. This brochure contained an application for students to fill out and return to Oklahoma State University. A Selection Committee was in place to screen the applications as they were returned and made recommendations to the Co-Directors of the academy as to which students the Committee felt should be involved. This Committee was made up of the OSU project personnel, an Oklahoma Science Teachers Association Board Member and a representative from the aerospace industry. This process was very successful in making it possible to target females as well as underrepresented minority groups for participation in the academy. The committee chose from over 119 applications.

From the students selected, the following tables indicate the background of the group.

TABLE A
ETHNIC BACKGROUND

	Native American	Afro American	Asian	Hispanic	Caucasian	Total
Female	7	0	3	0	10	20
Male	6	1	3	0	0	10
Total	13	1	6	0	10	30

TABLE B
HIGH SCHOOL STATUS

	Junior	Senior	Total
Female	11	9	20
Male	5	5	10
Total	16	14	30

A very good representative from across the State of Oklahoma was also achieved.

Program

The OSU Aerospace Education High School Student Summer Academy was offered June 9-28, 1991. During the three weeks of on-campus studies, the students were housed in the OSU dormitories. This time was devoted to curricular matters in aerospace education studies. The third week was devoted to field experiences.

Weeks One and Two. The curriculum for the first two weeks was basically one-half lecture and one-half hands-on classroom activities. The initial training was with the topic of aeronautics or the study of flight and its physics. Concepts that were discussed included flight computers, navigational skills, forces of flight, and meteorological conditions that affect the study of flight.

There was also an astronomy section which included the classification of stars, a night session of star gazing, and a study of the planets and their exploration. A significant portion of this session covered the study of lunar geology. A highlight was the inspection of some actual lunar samples which were brought back from the Apollo 17 mission.

There was a session on remote sensing during which students made Landsat mosaics of Oklahoma. This key activity focused on the study of water resources, geology, and urban mapping as well as various environmental issues facing Oklahomans.

The students were also exposed to the study of the space shuttle. This included the exploration of hardware, as well as conditions of living in space (i.e. biological and physiological aspects of space flight, and environmental conditions in a spacecraft).

In addition, careers in space exploration as well as the aerospace industry were discussed by the students, culminating in a study of the proposed U.S. space station. In this manner, the space station provided a pivotal point from which to provide instruction in the multi-disciplinary nature of science through showing how astronauts would live in space.

Students also learned the importance of computer technology in the aviation industry. A significant amount of time was devoted to the use of computers and how they can hook up with the space link network that is in use across the United States.

Week Three. The third week was devoted to field experiences. These experiences reinforced the mathematics and science concepts learned during the first two weeks of the academy, and identified how

these concepts apply to the on-site visitations as used by scientists, lab personnel, and support staff. In this manner, students had real-life experiences in talking with on-the-job personnel in the aerospace field.

The first field experiences visited several Oklahoma aerospace industries. Also, field trips were made to the Mike Monroney Federal Aviation Administration in Oklahoma City and the Oklahoma Air and Space Museum, to study how Oklahoma's rich aviation past intertwines with present demands and how Oklahoma will play an important role in the future of aviation and aerospace education studies. A copy of the news release is found in Appendix C.

A more extensive field trip was conducted to the National Aeronautics and Space Administration (NASA) Johnson Space Flight Center, Houston, Texas. This visit included presentations concerning space operations, materials in space, and lab requirements for space flight, as well as visits with support staff and scientists working on various NASA projects. The highlight of the visit was the conversations with the NASA Astronauts. In this manner, students were able to follow up and integrate their experiences acquired on campus with their experiences at a site. See enclosed schedule for further details.

Oklahoma State University
High School Summer Aerospace Academy
Stillwater, Oklahoma
June 9-28, 1991

Sunday June 9, 1991	
3:00 - 5:00 p.m.	Move in to OSU dormitory--Participants
5:00 p.m.	Welcome--Dr. Steven Marks, Director Orientation for students and parents-- Noble Research Auditorium
5:45 p.m.	Picnic--Noble Research Center
6:30 p.m.	Parents' depart
7:00 - 10:00 p.m.	T-shirt design--Participants Get to know your activities--Marilyn McIntosh
Monday June 10, 1991	
8:30 - 9:00 a.m.	Pre-Test--Staff
9:00 - 11:45 a.m.	Principles of Flight--Jamie Roberts
1:15 - 3:30 p.m.	Aircraft Performance--Jamie Roberts
3:30 - 4:00 p.m.	Press Photos--Dottie Witter
4:00 - 6:00 p.m.	Campus Tour--Dr. Kevin Allen
6:00 - 7:30 p.m.	Dinner
7:30 - 10:00 p.m.	Construct Hot Air Balloons--Staff and Participants
Tuesday June 11, 1991	
8:00a.m.-5:00 p.m.	Challenge Course--Camp Redlands
7:30 - 10:00 p.m.	Construct Hot Air Balloons--Staff and Participants
Wednesday June 12, 1991	
8:30 - 11:45 a.m.	Control Tower - Tulsa Riverside/Orientation Rides
1:15 - 4:30 p.m.	Orientation Rides/Control Tower - Tulsa Riverside
6:00 - 7:30 p.m.	Dinner
7:30 - 10:00 p.m.	Kites--Staff and Participants
Thursday June 13, 1991	
8:30 - 11:45 a.m.	Flight Computers--Jamie Roberts
1:15 - 4:00 p.m.	Cross Country Flight Planning--Jamie Roberts
4:00 - 6:00 p.m.	Softball
6:00 - 7:00 p.m.	Dinner
7:30 - 10:00 p.m.	Kites--Staff and Participants
Friday June 14, 1991	
8:30 - 11:45 a.m.	Space Shuttle/Living in Space--Stanley Jones
1:15 - 3:00 p.m.	Paper Airplanes--Kevin Allen
3:00 p.m.	Return home for weekend (if this is a problem, please contact Steve Marks)

Sunday June 16, 1991	
5:00 - 7:00 p.m.	Return to OSU Campus
7:30 - 10:00 p.m.	Construct Model Rockets--Staff and Participants
Monday June 17, 1991	
8:30 - 11:45 a.m.	Aviation Weather--Steve Marks
	Weather Activities--Steve Marks
1:15 - 4:00 p.m.	Remote Sensing--Kevin Allen
4:00 - 6:00 p.m.	Swimming
6:00 - 7:30 p.m.	Dinner
7:30 - 10:00 p.m.	Construct Model Rockets--Staff and Participants
Tuesday June 18, 1991	
9:00 - 11:00 a.m.	Oklahoma Air Guard - OKC
12:30 - 2:00 p.m.	Air and Space Museum
2:00 - 5:00 p.m.	OKC Zoo
6:00 - 7:00 p.m.	Dinner
7:30 - 10:00 p.m.	Mars Project--Participants
Wednesday June 19, 1991	
8:30 - 11:45 a.m.	Astronomy--Steve Marks
1:15 - 4:00 p.m.	Space Station--Kevin Allen
	Space Link--Kevin Allen
	Build Hubble Space Telescope--Steve marks
4:00 - 6:00 p.m.	Volleyball
6:00 - 7:30 p.m.	Dinner
7:30 - 10:00 p.m.	Delta Darts--Participants
Thursday June 20, 1991	
8:30 - 11:45 a.m.	FAA Center, OKC
1:15 - 4:30 p.m.	FAA Center, OKC
6:00 - 7:30 p.m.	Dinner
7:30 - 10:00 p.m.	Mars Project--Participants
Friday June 21, 1991	
8:30 - 11:45 a.m.	Lunar Geology--Steve Marks
	View Apollo 17 Lunar Samples
1:15 - 4:00 p.m.	Egg Drop and Mars Project Models--Staff
4:00 - 6:00 p.m.	Pack for Trip
6:00 - 7:30 p.m.	Dinner
7:30 - 10:00 p.m.	Launch Model Rockets and Star Gazing--Staff
	Movies and Popcorn
Saturday June 22, 1991	
5:30 a.m.	Leave Stillwater for OKC Will Rogers Airport
9:00 a.m.	Depart Oklahoma City for Houston
	Southwest Flight, Arrive Hobby
	Arrive at Ramada Inn
	NASA Road 1
	Houston, TX
	713-488-0220
2:00 p.m.	Astros Baseball Game - LA Dodgers

Sunday June 23, 1991	
10:00 a.m.	Houston Ship Channel Tour
12:00 - 6:00 p.m.	Houston Museum of Natural History
1:00 p.m.	Planetarium
3:00 p.m.	IMAX Film
	Water Park
Monday June 24, 1991	
9:00a.m.-4:00p.m.	Tour Johnson Space Flight Center (JSC)
5:00 - 7:00 p.m.	Pizza Party by Motel Pool for Dinner
Tuesday June 25, 1991	
8:30 - 11:00 a.m.	View Rocket Park, JSC
1:00 - 3:00 p.m.	Lone Star Flight Museum
3:00 - 8:00 p.m.	Galveston Area
8:00 p.m.	Return to Houston
Wednesday June 26, 1991	
10:00 a.m.	Check out of Motel
12:50 p.m.	Depart Houston for Oklahoma City
	Southwest Flight #
2:05 p.m.	Arrive Oklahoma City
7:00 - 10:00 p.m.	Movies
Thursday June 27, 1991	
8:30 - 11:45 a.m.	Summary of Field Trip--Staff
1:15 - 4:00 p.m.	Prepare Video Presentation--Participants
4:00 - 6:00 p.m.	Swimming
7:30 - 10:00 p.m.	Complete Reports--Participants
Friday June 28, 1991	
8:30 - 9:30 a.m.	Reflective Summary--Staff
	Post-Test--Staff
	Clean-up Room and Pack for Departure
10:00 a.m.	Closing Program--Staff, Participants and Parents
	101 & 102 CITD Building

The OSU Aerospace Education High School Summer Academy is sponsored by the Oklahoma Regents for Higher Education and the Federal Aviation Administration (ACE Academy).

Management Structure

The Department of Aviation and Space Education (AVSED) has managed the national NASA Aerospace Education Services Project (AESP) for over 18 years. During this period, the Department has had considerable experience in directing the educational programs at all NASA centers. Many of these services have included in-service activities for educators in the field, as well as on-site presentations for students. Personnel in the Department are responsible for training the NASA specialists to conduct these educational programs across the United States and are highly versed in all aspects of aviation and aerospace education. All personnel have had abundant experience in dealing with elementary through high school students as well as educators and administrators. Effective management of the national NASA contract has been possible only through the considerable support and encouragement offered by the OSU administration.

Faculty of the Academy

The faculty of the summer academy was selected by the Department of Aviation and Space Education at OSU. The faculty included: Ms. Jamie Roberts, junior, Aviation Education major, OSU; Ms. marilyn McIntosh, teacher, White Rock School; Ms. Becky Allen, Biology Teacher, Ripley Public Schools; Ms. Beth White, teacher, Cleveland Public Schools; and Mr. Kevin Allen, Doctoral Graduate Assistant in AVSED.

Key Project Personnel

The grant was housed in and administered by the College of Education. Dr. Steve Marks and Dr. Kenneth Wiggins of the AVSED

Department served as Co-Directors in charge of the overall coordination of the project. Table C identifies the timeline used to conduct the project.

Budget

The budget for this academy reflected the three weeks of on-campus experience, along with the third week of field experiences at the NASA center. This unique approach to a summer academy required both the OSU faculty and staff to work in collaboration to implement a rigorous three-week aerospace education studies program. The FAA also made a contribution of $3,500 for supplies and materials. The cost of this summer academy was $54,100.

Evaluation Plan

The evaluation of the Aerospace Education High School Student Academy was conducted in two parts. The students were given a pre-test upon arrival at the academy to determine their cognitive skills as well as attitudinal preferences towards aerospace education. At the conclusion of the academy, students were administered a post-test to measure cognitive as well as attitudinal changes which occurred during the three weeks of training. This questionnaire was developed from previous research done with in-service aerospace education teachers at OSU. The following is a descriptive of the pre-, post-test information.

TABLE D
OSU Aerospace Academy
Questionnaire

			Pre-Conference %	Post-Conference %	Change
1.	Space exploration is important to the U.S. economy	Disagree	5	3	-2
		Agree	95	97	+2
		No opinion	0	0	0
2.	I find the study of aeronautics interesting and meaningful.	Disagree	0	0	0
		Agree	100	100	0
		No opinion	0	0	0
3.	I feel I know the name and function of all of the parts of aircraft.	Disagree	97	0	-97
		Agree	3	100	+97
		No opinion	0	0	0
4.	Construction in space, without the hindrance of gravity, is very easy.	Disagree	60	80	+20
		Agree	40	20	-20
		No opinion	0	0	-0
5.	No **useful** technology for "normal" Americans has come about because of the space program.	Disagree	80	89	+9
		Agree	18	9	-9
		No opinion	2	2	0
6.	Physical features and body measurements do not change while in a weightless environment.	Disagree	60	75	+15
		Agree	30	15	-15
		No opinion	10	10	0
7.	There are very few careers in aviation or aerospace that I could do.	Disagree	95	97	+2
		Agree	3	0	-3
		No opinion	2	3	+1
8.	Studying the earth from space is a very useful tool in analyzing our natural resources.	Disagree	0	0	0
		Agree	97	100	+3
		No opinion	3	0	-3
9.	In a cross county flight, it is vital to know the elevation of both the airport you take off from and the airport in which land.	Disagree	20	0	-20
		Agree	75	95	+20
		No opinion	5	5	0

TABLE D (Continued)

			Pre-Conference %	Post-Conference %	Change
10.	I feel that my high school studies have adequately prepared me for aerospace education concepts.	Disagree	50	40	-10
		Agree	3	56	+43
		No opinion	47	4	-43

TABLE D
Results of Question 1-37

	Number	Mean	Change	Standard Deviation	±	Level of Significance
Pre-Academy	30	41.5				
			+23.9	2.84	8.18	.05
Post-Academy	26	64.9				

Although each section of the questionnaire had its restrictions and limitations, one can conclude that there are significant possibilities differences in the areas of knowledge and attitudes between the two groups. This significance was recorded at the .05 level.

The students were also asked to complete a more subjective evaluation. From the first part of the evaluation, 41% of the students completed their first flight in any type of airplane, 77% had their first flight in a small airplane, 27% had their first stay away from home and family for a week or more, 27% saw their first planetarium

show, 19% made their first visit to the Oklahoma Air and Space Museum, 73% made their first visit to a NASA facility, and 54% made their first model rocket.

Students were also asked to evaluate each session of the academy. Nine-five to 100% of the students rated each of the sessions in the "decent" to "super' categories.

Academy Outcomes

This project served as a model of how to relate the integration of science into aerospace education. The outcomes were, a:

1. three-week institute which can, in the future, be used as a basis to facilitate the development of similar mathematics, science, and aerospace education experiences both on and off campus;
2. set of procedures whereby students, especially females and underrepresented minority groups, were identified and encouraged to explore career opportunities in the fields of mathematics, science, and aerospace industry; and
3. pre-, post-test instrument to be used in the future to determine the cognitive skills as well as attitudinal preferences of students towards aerospace education.

The primary impact of this grant on special populations was in the area of future recruitment of females and underrepresented minority groups into science fields. The analysis of the cognitive skill level attitudinal preference data collected from the pre-tests showed how institutions of higher education can build curriculums which will encourage these groups to consider to career in aerospace education.

A secondary impact was felt within the ranks of the faculty members of the academy in that they, in conjunction with the students, learned various components of aerospace education and possibilities for the implementation of these concepts into the science curriculum. To share their support of the Academy, students composed and a letter to the Oklahoma Chancellor for Higher Education. With these positive outcomes of the Aerospace Education High School Academy, it is the hope the academy faculty to continue the program in the future.

APPENDIX C

ECOLOGY ATTITUDE INVENTORY

ECOLOGY ATTITUDE INVENTORY

Affect

Items 1 - 10 are true/false statements. A = True, B = False.

__B__ 1. I feel people worry too much about pesticides on food products.

__A__ 2. It frightens me to think that much of the food I eat is contaminated with pesticides.

__A__ 3. It genuinely infuriates me to think that the government doesn't do more to help control pollution of the environment.

__B__ 4. I feel fairly indifferent to the statement: "The world will be dead in 40 years if we don't remake the environment."

__A__ 5. I become incensed when I think about the harm being done to plant and animal life by pollution.

__B__ 6. I'm usually not bothered by so-called "noise pollution".

__A__ 7. I get depressed on smoggy days.

__A__ 8. When I think of the ways industries are polluting, I get frustrated and angry.

__B__ 9. The whole pollution issue has never upset me too much since I feel it's somewhat overrated.

__B__ 10. I rarely ever worry about the effects of smog on myself and family.

Verbal Commitment

Items 11 - 20 are true/false statements. A = True, B = False.

__A__ 11. I'd be willing to ride a bicycle or take the bus to work in order to reduce air pollution.

__B__ 12. I would probably never join a group or club which is concerned solely with ecological issues.

__A__ 13. I would be willing to use a rapid transit system to help reduce air pollution.

__B__ 14. I'm not willing to give up driving on a weekend due to a smog alert.

__A__ 15. I'm really not willing to go out of my way to do much about ecology since that's the government's job.

__A__ 16. I would donate a day's pay to a foundation to help improve the environment.

__A__ 17. I would be willing to stop buying products from companies guilty of polluting the environment, even though it might be inconvenient.

__A__ 18. I'd be willing to write my congressman weekly concerning ecological problems.

__B__ 19. I probably wouldn't go house to house to distribute literature on the environment.

__B__ 20. I would not be willing to pay a pollution tax even if it would considerably decrease the smog.

Actual Commitment

Items 21 - 30 are true/false statements. A = True, B = False.

__B__ 21. I guess I've never actually bought a product because it had a lower polluting effect.

__A__ 22. I keep track of my congressman and senator's voting records on environmental issues.

__B__ 23. I have never written a congressman concerning the pollution problems.

__A__ 24. I have contacted a community agency to find out what I can do about pollution.

__B__ 25. I don't make a special effort to buy products in recyclable containers.

__A__ 26. I have attended a meeting of an organization specifically concerned with bettering the environment.

__A__ 27. I have switched products for ecological reasons.

__B__ 28. I have never joined a cleanup drive.

__B__ 29. I have never attended a meeting related to ecology.

__A__ 30. I subscribe to ecological publications.

Knowledge

Items 31 - 45 are multiple choice questions. Choose the best answer.

__C__ 31. Soil pollution is generally due to: (a) sparse rains, (b) improper farming methods, (c) poisonous metals, (d) over fertilization, (e) poor crop rotation.

A 32. Most smog in our big cities comes from: (a) automobiles, (b) supersonic jets, (c) industrial plants, (d) large trucks, (e) refuse disposal.

C 33. High concentrates of chlorinated hydrocarbon residues: (a) cause sheep to die, (b) are found in large amounts in our atmosphere,1 (c) accumulate in flesh-eating birds and upset breeding behavior, (d) are no longer legal in pesticides, (e) are readily biodegradable.

C 34. Mercury has been found at unacceptable levels in: (a) fruit, (b) vegetables, (c) seafood, (d) beef, (e) soft drinks.

B 35. Which of the following does not appreciably reduce the pollution by automobiles? (a) properly tuned engine, (b) high octane gas, (c) low lead gas, (d) smog control devices, (e) propane engines.

E 36. The most common pollutants of water are: (a) arsenic and silver nitrates, (b) hydrocarbons, (c) carbon monoxide, (d) sulphur and calcium, (e) nitrates and phosphates.

B 37. Ecology is best described as the study of: (a) the relationship between humans and the environment, (b) the relationship between organisms and the environment, (c) pollution and its control, (d) the environment, (e) recycling of products.

D 38. Which of the following materials usually takes longest to decompose? (a) tin, (b) iron, (c) copper, (d) aluminum, (e) steel.

B 39. Birds and fish are being poisoned by: (a) iron, (b) mercury, (c) silver, (d) lead, (e) magnesium.

D 40. All but one of the following decompose in ocean water: (a) sewage, (b) garbage, (c) tin cans, (d) plastic bags, (e) chemical fertilizer.

E 41. What is the harmful effect of phosphates on marine life? (a) causes cancer, (b) renders fish sterile, (c) induces nervous reactions in fish, (d) makes water cloudy, (e) feeds algae which suffocates fish.

B 42. Which of the following well-known groups is primarily interested in conservation issues? (a) Boy Scouts of America, (b) Sierra Club, (c) Kiwanis, (d) 4-H Club, (e) the Ecology Association.

A 43. Practically all of the lead in our atmosphere is caused by: (a) cars, (b) industrial plants, (c) airplanes, (d) burning refuse, (e) cigarettes.

__C__ 44. DDT takes how long to deteriorate into harmless chemicals? (a) it never does, (b) 10-20 months depending on the weather, (c) about 200 years, (d) about 400 years, (e) anywhere from several days to several years.

__B__ 45. Ecology assumes that man is: a(an) _____part of nature. (a) differential, (b) integral, (c) inconsequential, (d) superior, (e) original.

APPENDIX D

ENVIRONMENTAL KNOWLEDGE AND PERSONAL ENVIRONMENTAL ACTION ASSESSMENT

Date _____

INSTRUMENT I:

ENVIRONMENTAL KNOWLEDGE AND PERSONAL
ENVIRONMENTAL ACTION ASSESSMENT

Name _____ Academy _____

1. Environmental problems are problems because they have not been solved as yet. This means that citizens must work toward solving these issues. As a citizen, what kind of actions do you think you could use in helping solve environmental problems? Please list below as many different kinds of environmental actions as you can that could be taken by an individual in helping to remedy environmental problems.

2. Have you ever taken any environmental actions which were directed at solving an environmental issue? If so, list below the actions and the problems that action was directed toward solving. If you have taken no actions, please write none.

Past Environmental Actions	Environmental Problems
1.	1.
2.	2.
3.	3.
4.	4.

Note: Use the back of this sheet if you need more space.

APPENDIX E

DEMOGRAPHIC DATA FORM

Date _____

Demographic Data

1. Name/Code # _____

2. Age _____

3. Highest grade completed in school:
   Sophomore _____ Junior _____ Senior _____

4. Gender: Male _____ Female _____

5. In school, are you a(n) A _____, B _____, C _____, or D _____ student?

6. Do you plan on going to college after you graduate from high school?
   Yes _____ No _____ Undecided _____

7. In what occupation do you wish to be employed after completing school? _____

8. What are the primary/major occupations of your parents?
   Father _____
   Mother _____

9. What is the population of the community in which you now live?
   below 2,500 _____ 25,001 - 50,000 _____
   2,501 - 10,000 _____ 50,000 - 100,000 _____
   10,001 - 25,000 _____ over 100,000 _____

10. Ethnic Group: Native American _____ Caucasian _____
    Afro-American _____ Asian _____
    Hispanic _____ Other _____

11. How many languages are spoken in your home?
    _____

12. High School Academy you are attending?
    Name _____
    Date _____

13. Why did you choose this academy?
    _____

14. Have you attended an Academy prior to this one?
    Yes _____ No _____

15. If you answered YES in #14, what was its name and time you attended it?
    Name _____
    Fall _____ Winter _____ Spring _____ Summer _____ ,
    19 _____

16. Have you previously taken any junior or senior high classes or attended any workshops that dealt with conservation and/or environmental concerns?
    Number of classes? _____ workshops? _____ none _____

17. Do you belong to any conservation and/or environmental organizations, for example, National Wildlife Federation, Sierra Club, School Environmental Club, etc.?
    Yes _____ No _____
    Organizations_____
    _____

18. Do your parents belong to any conservation and/or environmental organizations?
    Yes _____ No _____
    Organizations_____
    _____

19. Please provide your best estimate of your level of environmental sensitivity (i.e., your concern for the environment; viewing the environment from an empathetic perspective): Circle one of the numbers below.

    1 2 3 4 5 6 7 8 9 10
    low moderate high

APPENDIX F

INTERVIEW FORM

INTERVIEW

Has your participation in the Summer Academy for Environmental Science changed your outlook on environmental issues? Explain.

What kind of changes have you personally made in your daily life as a direct result of participation in the Academy?

What activities are you currently involved in or plan to be involved in as a direct result of the Academy in which you can apply the information you learned at the Academy?

If you could do it all over again, would you? Why or why not?

What recommendations would you make for improvements?

APPENDIX G

STUDENT INFORMAL EVALUATION

1991 SUMMER ACADEMY FOR ENVIRONMENTAL SCIENCE
Evaluation Form

Please help us plan for next year and tell us your opinion about the past three weeks.

What did you think about the:

Computer work?

Assignments?

Speakers?

Field Trips?

Ropes Course?

Meeting and staying at Camp Redlands before moving into the dorm?

Please rate each of the following. Think about how much you learned, not just how fun it was!

5 = I thought it was excellent
4 = I thought it was good
3 = I thought it was average
2 = I thought it was fair
1 = I thought it was poor

SPEAKERS

Rev. Mendle Adams (Environmental Ethics)	1	2	3	4	5
Dr. Larry Perkins (Social Ecology)	1	2	3	4	5
Harvey Payne (Nature Conservancy)	1	2	3	4	5
Russ Peterson (Dolco)	1	2	3	4	5
Elmer Walls (Bureau of Land Management)	1	2	3	4	5
Dr. S.L. Burkes (Illinois River)	1	2	3	4	5
Dr. Steve Anderson (Forest Industry)	1	2	3	4	5
Mark Gregory (Remote Sensing)	1	2	3	4	5

FIELD TRIPS

Britta Heglund-Cantrell (Assistant A.G.)	1	2	3	4	5
State Capitol	1	2	3	4	5
Water Resources Board & State Agencies	1	2	3	4	5
National Toxics Campaign Office	1	2	3	4	5
Wichita Mountains Wildlife Refuge	1	2	3	4	5
Tall Grass Prairie	1	2	3	4	5
Phillips Petroleum	1	2	3	4	5
Prairie Song	1	2	3	4	5
Butch Richardson (Wild Horse Sanctuary)	1	2	3	4	5
Sutton Avian Research Center	1	2	3	4	5
Tar Creek	1	2	3	4	5
Trail of Tears Drama	1	2	3	4	5
Illinois River	1	2	3	4	5
Cherokee Heritage Center	1	2	3	4	5
HEW Landfill and Recycling	1	2	3	4	5
Waste Water Treatment Plant	1	2	3	4	5
Lone Mountain Hazardous Waste Facility	1	2	3	4	5
Alabaster Caverns	1	2	3	4	5
Little Sahara	1	2	3	4	5
Cimarron River	1	2	3	4	5
Glass Mountains	1	2	3	4	5
Great Salt Plains	1	2	3	4	5
Save the Cimarron (Claire Newsom)	1	2	3	4	5
Sooner Power Plant	1	2	3	4	5
OK Poultry Farm	1	2	3	4	5
Talimena Drive	1	2	3	4	5
Kerr Arboretum	1	2	3	4	5

5 = I thought it was excellent
4 = I thought it was good
3 = I thought it was average
2 = I thought it was fair
1 = I thought it was poor

Barbara Hicks (Community Action)	1	2	3	4	5
Broken Bow Hydroelectric Plant	1	2	3	4	5
Tyson Poultry Processing Plant	1	2	3	4	5
Weyerhaeuser Paper Plant	1	2	3	4	5
Weyerhaeuser Nursery	1	2	3	4	5
BLM Oil Lease	1	2	3	4	5

General Comments on the Academy:

APPENDIX H

PARENT INFORMAL EVALUATION

1991 SUMMER ACADEMY FOR ENVIRONMENTAL SCIENCE
Parent Evaluation Form

The 1991 Summer Academy for Environmental Science was set up on a three week schedule in which the students went home one weekend.

In regard to length of the Academy, which of the following options do you feel would be best?

____ 3 weeks ____4 weeks ____5 weeks

Do you believe the students should go home during weekends or stay on campus?

____home one weekend ____home all weekends

____campus during weekends

Do you feel that the weekend reunion held in September was worthwhile?

____Yes ____No ____Not in attendance

If yes, in what ways?

1. _____

2. _____

3. _____

4. _____

5. _____

What was your son/daughter's overall opinion of the entire Summer Academy program? What specific activities/field trips were mentioned? List activities/field trips and check positive or negative.

		Positive (+)	Negative (-)
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____

In regard to the environment, have you observed any changes in your son/daughter's way of thinking, behavior, and/or activities that you believe to be a direct result of attending the Academy?

____Yes ____No

If yes, in what ways? (Please check)

Recycling____ Use of Water____ Energy____

Toxic Waste____ Transportation____

Community Action____

Other (please specify) _____

Would you recommend the Summer Academy in Environmental Science to the parents of other young adults?

____Yes ____No

Additional comments, recommendations:

Please return the evaluation by November 1, 1991 in the enclosed stamped, addressed envelope.

In regard to the environment, have your thoughts and actions changed as a result of your son/daughter attending the Academy?

____Yes ____No

If yes, in what ways? (Please check)

Recycling____ Use of Water____ Energy____

Toxic Waste____ Transportation____

Community Action____

Other (please specify) _____

In regard to the environment, have you observed changes in the thoughts and actions of family members (other than yourself and your "participant") that you believe to be a result of your son/daughter attending the Academy?

____Yes ____No

If yes, please describe.

Do you feel that the Summer Academy in Environmental Science is something that you would have been willing to pay for in order for your son/daughter to attend?

____Yes ____No

If yes, approximately what dollar amount would you place on such an experience?

____$1000 ____$1500 ____$2000 ____$2500

____$3000 ____$3500 or more

VITA

Christine A. Moseley

Candidate for the Degree of

Doctor of Philosophy

Thesis: EFFECTS OF A RESIDENTIAL ENVIRONMENTAL SCIENCE ACADEMY ON THE ENVIRONMENTAL LITERACY OF 11TH AND 12TH GRADE STUDENTS

Major Field: Environmental Science

Biographical:

Personal Data: Born in Camden, Arkansas, January 15, 1952, the daughter of Jim and Mary Jane Allen.

Education: Graduated from Brady High School, Brady, Texas, in May 1970; received Bachelor of Science Degree (Major--Wildlife Management, Minor--Range Management, Zoology) from Texas Tech University, Lubbock, Texas, in May 1974; received Master of Arts of Teaching Degree in Biology from Angelo State University, San Angelo, Texas, in December, 1982; completed requirements for the Doctor of Philosophy Degree at Oklahoma State University in July, 1993.

Professional Experience: Science teacher, 7th grade Life Science, Colorado City Junior High, Colorado City, Texas, August, 1974 to January 1975; Remedial Math and English Teacher, 8th through 12th grades, Junction High School, Junction, Texas, August 1975 to May 1977; Science Teacher, Life Science, Chemistry, Physics, Biology, Horticulture, Jayton High School, Jayton, Texas, August 1977 to May 1980; Graduate Lab Assistant, Angelo State University, August 1980 to December 1982; Supervisor of Student Teachers, Angelo State University, January 1976 to May 1987; Graduate Teaching Assistant, Oklahoma State University, August 1988 to May 1989; Acting Instructor, Oklahoma State University, August 1989 to May 1993.