THE EFFECTIVENESS OF SLIDE PRESENTATIONS AND FIELD TRIPS AS METHODS OF INSTRUCTION FOR ENVIRONMENTAL EDUCATION

by

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TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

LIST OF TABLES

LIST OF ILLUSTRATIONS

ABSTRACT

The purpose of this study was to compare the effectiveness of slide presentations and field trips as methods of instruction for environmental education.

Two identical one-hour environmental education programs were developed; one using a field trip and the other a slide presentation. Sixteen sixth grade classes were given the presentations. Teaching method effectiveness was measured through the use of a multiple-choice test, divided into a pretest and posttest, which was designed to sample selected cognitive learning objectives. A second research problem was to examine differences in the methods as related to their ability to elicit responses from the classes and provide a source of information which would measure the methods' potentials for teaching certain affective learning objectives.

The first research problem was analyzed using analysis of covariance in which class mean pretest scores were used to statistically control for pretreatment differences between classes. The results indicate that both methods are equal in effectiveness and superior to providing no instruction. The second problem was evaluated using chi-square analysis in which the number of responses for each treatment type was compared. Findings indicate that the

field trip significantly increased students' willingness to respond.

CHAPTER 1

INTRODUCTION

The Environmental Education Movement

Environmental education is an educational process aimed at providing opportunities for learners to recognize the interdependence of all living things and their environment. Emphasis is placed on man, in addition to the biophysical environment and how human social and cultural systems can affect environmental quality and direct man's resource management decisions.

While the term environmental education has been in existence since 1968 (Schoenfeld, 1975), the process, as it is known today is really an end product of an evolutionary chain of events in education which closely parallels the American conservation movement. Stapp (1974) divides the conservation movement into three phases: preservation, management, and environmental quality; with the coinciding educational phases being nature study and outdoor education, conservation education, and finally, environmental education. Stapp concludes that the philosophies incorporated into these educational movements have a considerable degree of repetition and overlap in their content, but that each was developed to meet the needs of American society at a time when it was most in demand. Environmental quality goals are still in a process of evolution and education is continuing to adapt to changing social values (Maier, 1971, p. 4).

Nature Study

During the preservation period, which began around 1864 with the publishing of George Perkins Marsh's Man and Nature (Swan, 1975), America was confronted with the realization that tremendous quantities of natural resources were being wasted and destroyed. Later, during the administration of Theodore Roosevelt, interest in the preservation period peaked when national priorities were developed to preserve forest lands, wildlife habitats, mineral holdings, and establish areas which would later become some of America's first national parks (Owen, 1971). Education responded to the preservation period with nature education or nature study encouraged by early writings of Wilbur Jackman. Included were Nature Study for the Common Schools and a yearbook of the National Society for the Study of Education, Nature Study (Swan, 1975; Stapp, 1974). The emphasis of Jackman and later proponents of nature study was to help develop an understanding and respect for nature through direct inquiry and observation. The primary aim was, and is, to interest people in the environment and hopefully bring about concern and respect for nature (Stapp, 1974).

Outdoor Education

In the late 1920's, the outdoor education movement emerged with L. B. Sharpe and Julian Smith being two of the movement's major spokesmen (Hammerman and Hammerman, 1968, p. 1). Sharpe emphasized that outdoor areas are laboratories in which the general goals of education could be met. He says, "Authors of textbooks pass on second-hand information they have found by observing and discovery. It is always the person who sees, discovers, or explores a situation who gets the most out of it" (Sharpe, 1968, p. 2). He goes on to say, "Learning in the out-of-doors is a natural process. In a classroom, subjects tend to become artificially separated from the rest of the world" (Sharpe, 1968, p. 3). Smith, on the other hand, stressed how the development of outdoor skills such as camping, hiking, arts and crafts, and archery could be used to augment regular classroom instruction and make the out-of-doors available for education as well as recreational pursuits. Swan (1975) describes the outdoor education movement as an educational approach to learning where all areas of the curriculum including art, music, mathematics, language arts, and science can be taught in an outdoor setting.

Conservation Education

In the decades spanning 1910 through 1940, the management period emerged. Legislative action resulted in organization of such agencies as the Soil Conservation Service, Tennessee Valley Authority, and the National Park Service whose missions were, in part, oriented to the development and conservation of natural resources. Swan (1975) ties the management movement closely to the social turmoil of the Depression and the need for positive government action to relieve the situation. Education mirrored the management period with conservation education which Hernbrode (1975, p. 420) defines as, "The educational process of communicating and understanding of the characteristics, distribution, status, uses, problems, and management policies of basic natural resources, with an emphasis on 'stewardship' and 'wise use'." In the words of Stapp (1974, p. 46), conservation education became ". . . an effort to awaken Americans to the degradation of our natural resources, to help the public better understand the importance of natural resources to our society, and to develop citizen support for natural resource management programs."

Environmental Education

The environmental quality movement emerged as the most recent phase of the conservation movement. While no definite time can be established as the beginning of the phase, Swan (1975) points to the writings of Aldo Leopold and Rachel Carson as being early manifestations of the philosophy behind it. With the realization that some of our technical discoveries and social standards may be a threat to the health of the environment, the movement centered on a wholistic view of the world in which man is a part and whose survival depends upon the survival of all other living things. Environmental education, education's response to the environmental quality movement, is directed at informing individuals through the presentation of objective information so that solutions may be found to improve environmental quality. Stapp (1974, p. 49) defines environmental education as a process ". . . aimed at producing a citizenry that is knowledgeable concerning the total environment and its associated problems, aware and skilled in how to become involved in helping to solve these problems, and motivated to work toward their solution."

Even though Stapp's definition incorporates the major concerns of environmental educators today, there is disagreement as to the general applicability of a single definition (Disinger, 1975, p. 36). Bogan (1973) suggests there are really two definitions, one emphasizing processes and theory, and a second stressing the content and purposes of environmental education. More recently, McInnis (1975) relates that while no single definition exists, a number of components including perceptual awareness, conceptual understanding of both the natural as well as the man-made environment, and value clarification represent its primary concern. In the summer of 1975 at Snowmass, Colorado, The Alliance for Environmental Education came to the conclusion that the lack of an adequate definition has led to problems and confusion in teaching environmental education. This was considered especially true in the areas of providing a direction for curriculum-materials development, teacher training, and administrative and political support (Schafer and Disinger, 1975, p. 7; Disinger, 1975). While definitional problems exist, a consensus was reached at the Alliance Conference as to the future goals of environmental education for elementary and secondary schools. They are meant to give directions to environmental education programs rather than to provide a precise definition. The opinion of the Alliance was that instruction can continue in schools by incorporating the philosophy and processes of environmental education into the existing curriculum rather than waiting until terminology differences are resolved. Developing specific courses or making curriculum changes necessitate considerable time and effort on the part of educators prior to securing administrative approval, and time was viewed as the major obstacle in bringing about desired environmental education outcomes (Schafer and Disinger, 1975, p. 9). The goals, as viewed by the Elementary and Secondary Education Subcommittee of the Alliance for Environmental Education, are to: "develop an environmentally active citizenry through a valuing process aimed at decision-making based on environmental literacy," and to ultimately "evolve a society willing to live according to the fundamental laws of ecology" (Jensen, 1975, p. 4).

Environmental Education in Arizona

In Tucson, as in other cities, public school districts are confronted with a dilemma: that is, how to continue to provide educational services while costs for such services are increasing and school revenues remain constant ("Dist. 1 Seeking Additional Cut in New Budget," 1975). The consequence, in most instances, is a re-evaluation of district priorities and the result is that many activities, including athletics and "noninstructional items," are being lowered in priority and eliminated from the curriculum (Betterton, 1975). Environmental education is viewed by some administrations as desirable, but falling into a noninstructional category (Menesini, 1971, p. 43). Dr. Kenneth Sabo, member of the Environmental Education Advisory Committee, Arizona Department of Education, relates that funding for environmental education materials is severely restricted in Arizona, and fiscal conditions locally are a reflection of state priorities (Sabo, 1976). The future of environmental education programs in Arizona is unpredictable and continuation of instruction is precariously balanced in the minds and perceptions of public school administrators. In this regard, federal funding via Environmental Education Act grants serves as an indication of administrative and political support for environmental education within the state. For fiscal year 1975, Arizona received $795.00 (Disinger, 1976) which is approximately .0005 per cent of the total allocation for the country. With funding support so limited, effectiveness of different teaching methods must be carefully weighed with costs.

Role of Resource Management in Environmental Education

The need for information concerning effectiveness of environmental education techniques exists for many natural resource management agencies as well as school systems. Since all public resource management agencies have a responsibility of maintaining public trust through a continuous exchange of information, this role is particularly important in managing natural resources for direct public uses such as recreation. Thus the National Park Service, in addition to managing parks and recreational lands for a quality environment has a basic role in conveying ". . . environmental knowledge and standards to the public" (Brown, 1971, p. 35). The role of the National Park Service in environmental education is further discussed by Evison (1971). He says the national parks of America are:

> . . . outstanding bases on which to build a communications effort aimed at engendering in Americans the understanding of, and respect for, environmental interrelationships on which the quality of human life depends. An American public possessing that understanding and respect is unlikely to continue the incremental process of befouling and shredding those resource complexes which afford us sustenance and options for diverse pleasurable experiences. So the National Park Service is necessarily in the environmental education "business"--both in defense of the resources for which it is directly responsible and in the valid interest of using those resources to convey the broader message of environmental quality as an essential to worthwhile life (Evison, 1971, p. 181).

A number of other public resource management agencies, including the U.S. Fish and Wildlife Service, U.S. Forest Service, and the Bureau of Land Management (Schafer and Disinger, 1975, pp. 75-78) have assumed increasing roles in environmental education in recent years. However, because of budgetary ceilings and time constraints, evaluations of teaching methods utilized are either lacking or administratively prohibited (Coss, 1976).

Traditionally, the primary educational methods used by agencies to provide instruction has been to take visitors to the field and provide them with limited experiences designed to highlight agency management philosophy in relation to the resources under its jurisdiction or to bring the out-of-doors inside through the use of some type of media technique, i.e., slide shows, displays, movies, etc. When reviewing the relationship between public schools and resource organization, the use of these two instructional methods, or variations thereof, seem to predominate (Hernbrode, 1975; Brown, 1971). With increasing public and legislative pressure to provide a wide variety of instructional activities (Hemphill, 1975; Maier, 1971), both from within the school system as well as from outside resource agencies, an assessment of the effectiveness of these traditional teaching methods seems to be warranted in order to determine how each can best be utilized.

Hendee (1972) has identified the primary research needs of environmental education. These are research in: (1) a definition of the overall social objectives appropriate to all environmental education programs, (2) review of literature to separate factual information from subjective opinions about environmental education programs, and (3) support programs for research. He states, "Basic research questions need to be framed and previous work severely analyzed to determine the current extent of empirical knowledge about the effects of environmental education" (Hendee, 1972, p. 19). Similarly, the Higher Education Subcommittee of the Snowmass Conference (Schafer and Disinger, 1975, p. 14) came to the conclusion that, "For all practical purposes, little research exists or is known to be planned in environmental education--in learing theory, behavior change, curriculum design, and the like."

Problem Statement

At the present time, both the slide presentation and field trip are being utilized by school districts and resource agencies as teaching techniques for environmental education. This project is designed to assist in the determination of the effectiveness of these methods of instruction so that objective information can be made available to school district or resource agency decision-makers as to which method best communicates selected principles and ideas incorporated into an environmental education program.

Background Research

Comparatively little recent research has been conducted on the merits of the field trip or slide presentation as instructional techniques. Harvey (1951) found that the use of field trips with ninth grade general science classes studying a unit on conservation significantly increased the development of scientific attitudes and information. Curtis (1944) demonstrated the value of the field trip as a summary device in teaching conservation. Clark (1943) and Raths (1938) both found the field trip to be an effective means of teaching.

Filmstrips and slide programs have been studied as a teaching device, primarily due to the economy they provide over motion pictures. Early studies by Brown (1928) and

McClusky (1922) compared filmstrips and slides with silent motion pictures and found that, in general, the projected still pictures were as effective in teaching factual information as silent films.

A later study comparing filmstrips and slide presentations with sound motion pictures supported these earlier findings. Goodman (1942) compared sound and silent filmstrips with sound and silent motion pictures in teaching safety topics to sixth and seventh grade students, finding no significant differences among the four methods.

Although the research reported above does indicate that both field trips and slide presentations are of value in presenting factual information and conceptual ideas to students, only one study, that of Helliwell (1952), compared the effectiveness of these two methods. He found that in teaching facts about the dairy and how a newspaper works, field trips were significantly more effective than filmstrips and that the combination of both was even more effective. In Helliwell's study, two commercially prepared filmstrips dealing with these subject areas were shown to a group of students while visits were made to local dairy and newspaper by another group. Both the filmstrips and field trips were of one hour duration, and the combined treatment lasted two hours. Subjects were tested using a forty-question test, exactly one week after the actual instruction to determine student knowledge concerning the processes involved and their memory and comprehension of the subject matter. In both experiments, analysis of variance was used to test the significance of the differences between each method, and in all cases, these differences were shown to be significant at the .01 level. 'T' tests were applied to individual differences, and all were shown to be significant at the .01 level.

Helliwell also investigated the influences of other factors such as student intelligence and teacher quality on the mean test results by utilizing analysis of covariance to adjust student scores for these variables. Findings were again significant at the .01 level. Helliwell concluded, just as before, that the combination method was most effective, the field trip was second best, and the filmstrip was the least effective method of the three techniques used. However, since Helliwell failed to state whether or not a control group was used, determination of the precise comparative effects of the methods is difficult as no base level for the experimental groups was established. By utilizing a control as well as experimental treatment groups, the present research attempts to clarify questions concerning the relative effectiveness of field trips and slide presentations as teaching methods.

Research carried out to date indicates that ideas and concepts conveyed through the use of slides and field trips do have a significant effect on learning (Helliwell, 1952; Clark, 1943; Raths, 1938; Brown, 1928; McClusky, 1922, Harvey, 1951; Curtis, 1944; Goodman, 1942). However, as educational costs increase, decisions will have to be made by school district curriculum planners or resource specialists in environmental education as to their continued use.

Objectives

The primary objective of the project is to determine the comparative effectiveness of three commonly used methods of teaching environmental education in public schools: (1) slide presentation, (2) field trip, and (3) combined program of both the field trip and slide presentation. A secondary objective of the project is to examine the differences, if any, between the two general methods as related to their potential to elicit student participation and interest in the learning experience.

CHAPTER 2

METHODS

Because the sample population from which this study was conducted possessed a high degree of variability for a number of possible relevant attributes, a reduction in variation prior to presenting the experimental treatments was necessary. To accomplish this goal, the randomized complete block research design (Cochran and Cox, 1957, Ch. 4) was utilized. By separating the sample into homogeneous groups or blocks, the design attempts to place the majority of variability in the population between groups rather than within. As a result, variation due to the experimental treatment may more easily be separated from the population's inherent variation. In the following sections of this chapter, the reasoning behind the selection of the research design will be discussed as will the methods of data collection and analysis, and the development of the actual methods of instruction to be tested.

Research Design

As described above, the rationale underlying the selection of the randomized complete block design was to separate the sample population into homogeneous subgroups that would minimize the variability of characteristics which are perceived to have a possible effect on the outcome of the experiment. In selecting the Amphitheater School District in Tucson, Arizona, as the sample population for the study, the researcher was confronted with a situation in which there existed a high degree of diversity regarding basic socioeconomic characteristics and ethnic minority compositions within the city and the school district as well. While these characteristics were not perceived to be the only variables operating to confound the study, they were considered important enough to necessitate the use of the research design selected.

District Selection

The Amphitheater School District (Figure 1) lies in north central Tucson, but has jurisdiction extending as far northward as the town of Catalina, Arizona. District boundaries include Grant Road on the south; Campbell Avenue, First Avenue, and the Coronado National Forest on the east; and Flowing Wells Avenue, the Rillito River, and Shannon Road on the west. The population residing within the district totals approximately 50,000, with 9,000 residents attending the district's two high schools, two junior high schools, eight elementary schools, and one special education facility. Primarily, the Amphitheater School District was selected for the study because: (1) district administrators expressed an interest to participate, and (2) the field trip

Figure 1. Map of Amphitheater Public School District, Tucson, Arizona.

site at Tumamoc Hill environmental study area (see Development of Methods of Instruction) was located nearby.

Based upon personal observations, interviews with district officials, and inspection of district records, there is an apparent income gradient operating within the district, with low and middle income neighborhoods in the district's southern regions and higher income neighborhoods in the north. This north-south pattern is repeated when examining the minority ethnic composition of the district. The percentage of ethnic and minority residents is relatively high in the southern areas and lower as one moves northward. For the most part, data collected by the Comprehensive Planning Process (1975) (see Appendix A) substantiate these observations. By minimizing bussing, the district has, in effect, maintained these local differences so that children who live in a neighborhood attend a school in that same area. For this reason classes were selected as the unit of analysis, and neighborhoods were utilized as the criteria for blocking. By reducing the variation due to differences in these social characteristics through the use of blocking, homogeneous subregions for the experiment were defined.

Unit of Analysis

Rather than pooling all students before randomly assigning them to treatments, the project design assigned full classes to blocks of four classes each (one class for each treatment including the control treatment). Once treatments were assigned, a second randomization was performed to vary the order of treatment so as to control for improvements in the presentation which might occur due to increased familiarity and repetition on the part of the researcher.

The purpose of using the classroom as the unit of analysis, aside from reflecting neighborhood characteristics, was to lessen classroom disruption and reduce the possibility of resistance by the school district due to such disruptions. By assigning an entire class to a treatment, the teacher was not troubled by having to arrange for someone to supervise portions of the class while the remainder of the group received the experimental treatment. Also, the risk of interaction between students from differing treatments was reduced. The objective was to present the class with one treatment and avoid contamination which could result if students discussed "their" presentation before all subjects had been tested.

In total, sixteen classes participated in the study resulting in four blocks of four classes each. Criteria used to group classes were: (1) the number of classes per school, (2) their proximity to each other, and (3) their geographical location within the district boundary. If a school contained four classes, one block was formed from that school. Otherwise, the schools and classes in each geographical area were combined so as to maximize the homogeneity of the experimental unit. Following this rationale, the schools of E. C. Nash and Helen Keeling were grouped into one block as was Edward L. Wetmore and L. M. Prince with Winifred Harelson and Marion Donaldson elementary schools each becoming a sampling block as they had four sixth grade classes apiece. F. O. Holaway Elementary School was not used for the experiment, but its two classes were given the slide presentation treatment to rehearse its content, dialogue, and organization. The remaining elementary school, Lulu Walker, was not used for the project due to its unique multi-class organization. Locations of schools and blocks are presented in Figure 2.

All students participating in the study were tested according to a prearranged test schedule (see Appendix B). Based upon this schedule, each class was pretested on Friday, September 5, 1975, and posttested from three to five days after their presentation was given. This choice of waiting period was based on results of psychological experiments conducted by Ebbinghaus (1885) and later verified by Cain and Willey (1939). These researchers found that the majority of memory loss occurs immediately after the exposure of information, but the rate of memory loss per day declines after a few days so that differences in retention are slight when measured over a short time

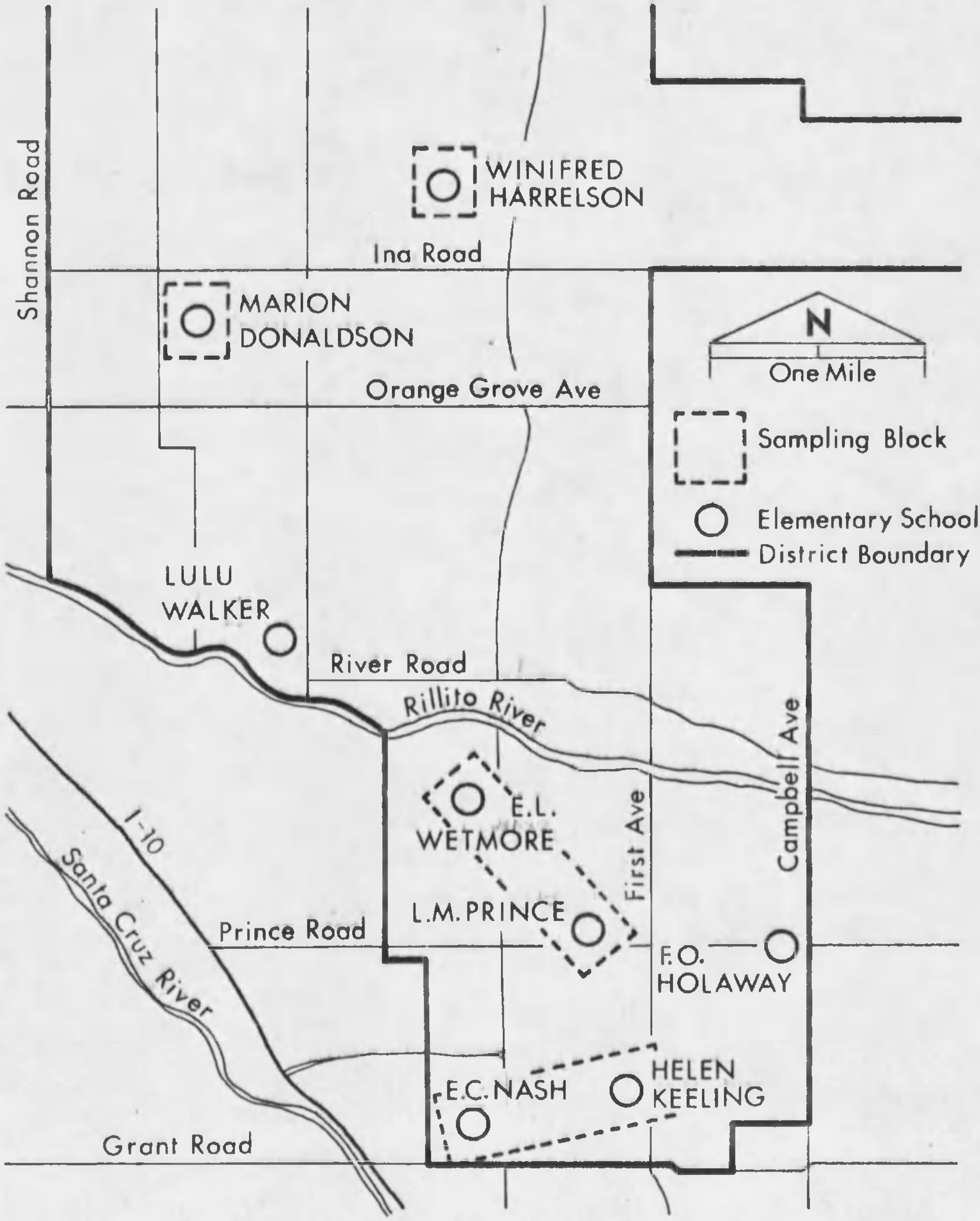

Figure 2. Locations of Elementary Schools and Blocking Design

interval after the initial memory loss has occurred. Waiting three to five days also allowed for greater flexibility in the treatment presentation schedule as all days of the week were available for presentation dates, and therefore weekends, teacher preferences, and class calendars were able to be accommodated into the final treatment schedule. Teacher preferences and district schedules were discussed during meetings with participating teachers prior to the opening of school, so as to be able to modify the tentative presentation schedule into its final form. Because of the time constraints on the project, these meetings were necessary to become familiar with changes in the district school year calendar made during the summer months. In general, the final treatment schedule was adhered to, although some modifications were made in order to deal with last minute changes in class schedules or teacher availability.

The presentation phase lasted approximately four weeks (September 8 through October 6), or one week per block. Considering the size of the district and length of exposure to the subject matter, one week was determined to be sufficient to present all treatments to the block and would reduce the possibility of outside influences such as the regular classroom instructional program or the maturation or mortality of the students to confound the effects of the assigned treatment.

Respondents

In total, sixteen sixth grade classes participated in the study with an overall student population of 405 children. Due to respondent absenteeism for either the presentation, the pretest, or the posttest, the final sample was reduced to a total of 376 subjects. Class sizes ranged from 12 to 30 students with an average class size of 24 students. In all but one case, only sixth grade children were pretested, posttested, and subjected to the assigned method of instruction. The one exception was a combined fifth and sixth grade class in which both grade levels were given the experimental treatment but only the sixth grade portion was posttested and used in the data analysis.

Sixth grade students were selected for the study primarily because of the general intellectual characteristics of children in this age group. Taba (1966, pp. 15-16) describes the sixth grader as being in the stage of "conceptual or reflective thought." During this interval, ". . . an individual acquires the capacity to deal with abstract propositions, symbolic relationships, and hypothetical possibilities. Conscious manipulation of concepts replaces the intuitive grasp of abstract relationships." Prior to this, the child's ability to reason is limited, and he depends, to a large extent, on manipulating objects and using some form of trial and error to solve problems. Since the project confronted the child with environmental ideas and concepts that required a certain degree of reasoning ability, respondents participating should have attained this level of thinking to insure each would be ready for the conceptual ideas presented in the experimental treatments.

The past experiences of the researcher when working with sixth grade students was also a determining factor in selecting the age group utilized. Younger children, while feeling comfortable and working well in group situations, seem to have a limited attention span which might result in difficulties in maintaining student attention. Older children, grades seven through twelve, are much more independent in that some may wish to investigate things on their own, or, in extreme cases, reject the presentation altogether because it is coming from a person of authority. While students from either age group could have been used, it was the opinion of the researcher that sixth grade students possess the best qualities of both older and younger children because they follow instructions well, have the ability to comprehend conceptual ideas, and feel comfortable in group situations. As a result of the natural maturation process, sixth grade students seem most suitable for the types of subject matter and presentation to be dealt with in this project.

Development of the Methods of Instruction

In the introductory chapter of this report, the primary objective presented was to determine the effectiveness of two methods of instruction, excluding the combined program, on teaching environmental education. These two methods are the slide presentation and the field trip. While this project is similar in content to the research conducted by Helliwell (1952), they differ in the degree to which variations in the presentation treatments are controlled. In this project, each presentation is designed to be as identical as possible in all respects except in the medium used and the location where the presentation is given. Helliwell's failure to report how, or if, he was able to control for inherent differences between the filmstrips selected and the instructors employed to teach at the field trip site raised some doubt in the mind of the researcher as to his experimental design. By utilizing the same concepts, subject matter, dialogue, and instructor (the researcher) for each method in this study, differences between the methods of instruction could hopefully be reduced so that a more rigorous experimental situation would exist. In the following sections of this chapter, both presentation types will be discussed, first in regards to their underlying conceptual framework, and then to their preparation and actual delivery to the sample population.

Concept Development

The goals emphasized in both presentations are discussed in the introduction of the Elementary Teachers Resource Guide for Environmental Education (Hernbrode and Kennedy, 1974, p. 1). Each is meant to focus the study on man and his relationship to the environment. These goals, as outlined in the Guide, are designed to:

1. Make students aware of man's dependence on natural resources.
2. Help students gain a fundamental understanding about our natural resources.
3. Aid them in reacting intelligently to problems of waste and damage to natural resources.
4. Provide students with the ability and motivation to search for solutions.

To unify the above goals into a workable program format, the basic theme of a "system" was utilized. A system is ". . . an aggregation or assemblance, of objects united by some form of regular interaction or interdependence" (Webster's New International Dictionary, 1959, p. 2562). This definition was translated into the presentation by emphasizing that a system can be anything that has parts, but whose parts must work together. By showing the students that they too are included in a number of systems, including their school system, economic system, but most importantly for the purposes of the research project, an ecosystem, they would become more personally interested and involved in the environmental education objective listed above.

Organization of the General Program Format

Since the treatments are identical in content, dialogue and time (one hour for each), they will first be discussed regarding their general format, and then their specific differences as to their preparation and delivery.

Each presentation was organized into three major subdivisions or regions. The first region dealt with the primary parts of the ecosystem, the living and the non-living. The nonliving component was further divided into three subparts: (1) the inorganic compounds or never-living things such as rocks and minerals; (2) organic compounds, defined as dead or once living organisms; and (3) the climate. Plants and animals living in the area were divided as the living components.

Region two was devoted to the interactions existing within and beneath the above mentioned parts. Examples used were food chains, the water cycle, and plant and animal adaptations.

The third and final region dealt specifically with man and how he relates to the ecosystem. To emphasize this idea, another set of concepts was utilized. These concepts are taken from Roth's Taxonomic List of Environmental Con-concepts. Four of these are (1970, pp. 69-73):

> (7) Man has ability to manipulate and change the environment. . . . (55) An organism is the product of its heredity and environment. (56) Man is influenced by many of the same hereditary and environmental factors that affect other organisms and their populations. . . . (83) Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures and ecological concepts.

By dividing the ecosystem into parts and then showing how each part works together in order for the system to survive, the hope was that the child would come to the conclusion that he or she is also a member of the living component, and as such, is influenced by and dependent upon the living and nonliving world. The final two concepts listed above are used to emphasize the point that man is different from other animals as he possesses a special gift, that of being able to change the environment. This, in turn, implies a responsibility because he can never separate himself from the system in which he is so firmly entrenched. A final comment made to each participating class was taken from Barry Commoner's The Closing Circle, and was used to summarize the concept of a system. It implores the class to remember that they are a part of a natural system, the ecosystem. If they (the class) choose to work within the system, they have the power to make the world a better place in which to live. If they choose to work against it, they can only hurt themselves because they are still tied to it.

Remember, ". . . everything is connected to everything else" (Commoner, 1971, p. 29).

Each concept from Roth's (1970) list was selected for use by analyzing the item's content in relation to the characteristics and potentials of the study site, Tumamoc Hill Environmental Study Area. The concepts themselves, however, were selected from a list of 111 concepts which met the criterion of "acceptable" by 90 per cent of the 350 scholars who responded to Roth's mailed survey (Roth, 1970, pp. 65-74). Roth's experts were chosen on the basis of their specific knowledge in all fields of environmental management education. Associated with the above concepts, terms pertinent to each are incorporated into the presentations so as to acquaint each student with the verbal tools necessary to understand how man relates to the environment.

Presentation Treatment Development

Based upon the concepts of the general program format discussed in the previous section, two identical presentations were developed, one for the classroom and one for the field trip. Because the items in the field were stationary and more or less permanent, the field trip was developed first in order to organize the presentation into a continuous trail and an orderly teaching program. The slide presentation was then developed to accurately illustrate the scenes, information, and concepts presented at the study area.

Field Trip

Tumamoc Hill Environmental Study Area, located approximately three miles west of downtown Tucson (see Figure 1), was chosen as the field trip site because of: (1) its proximity to The University of Arizona and the Amphitheater School District; (2) University regulations concerning the use of the area for research and environmental education study; (3) extensive research and planning carried out by the Watershed Management Department, The University of Arizona, relating to the development of the area as an environmental study site (Baldwin and others, 1974); and (4) outstanding examples of the natural Sonoran Desert environment contained on site as well as locations directly and indirectly impacted by man.

During the months of March through June, 1975, a preliminary study of Tumamoc Hill Environmental Study Area was conducted using prepared maps, aerial photographs, and suggestions made during discussions with the study area's acting coordinator, Mr. Kerry L. Baldwin. Later, during the months of July and August, an intensive on-site inventory was conducted to locate examples of wildlife and vegetation which could be used as focal points for the slide program and stations for the field trip presentation.

Criteria used for the selection of field trip stations were their: (1) location within the field trip site, (2) relative permanence, (3) photographic potential, and (4) ability to illustrate the salient points to be discussed in both presentation treatments.

The location of the stations selected related directly to the three major subject matter subdivisions discussed previously. In total, 14 stations or focal points at which the field trip actually stopped (Figure 3) were identified. In order to provide insight into the field trip presentation, each major subdivision will be discussed, first as to the stations comprising each region; second, to the topics discussed at each stop; and finally, a description of the stations themselves.

Region 1. Region 1, as discussed above, was used to define the three major components of the ecosystem. In total, seven of the fourteen stations were included in this region. Stations included in Region 1 are:

Station 1: Station 1 is located approximately fifty feet east of the point of entry to the field trip site. The purpose of this station was to provide an introduction to the study area as well as to the field trip on which the class was about to embark. Here, the definition of "system" was given along with examples felt to be familiar to the class. Finally, basic rules of conduct were discussed so as to help orient the class and aid in the protection of the study area.

Station 2: A bare soil area was used to illustrate the presence of two of the three nonliving components in the ecosystem. These were: (1) inorganic (never living) substances found in the soil and rocks, and (2) organic (dead) material found in the soil. At this station, active demonstrations were conducted. These included tests for the presence of carbonates, nitrates, and soil pH. Each test involved some visible change such as color, movement, or the presence of a reaction. Through examples of this type, the potential for maintaining student interest might be increased over static displays or programs utilizing pure oratory. Also located at this station was a dead fishhook barrel cactus (Ferocactus wislizenii) which was used to illustrate the presence of organic matter on the surface of the soil as well as within it. By dropping a small handful of soil into a glass of water, organic matter was seen to float to the surface while much of the inorganic compounds sank to the bottom, thereby providing another example of an action demonstration.

Station 3: A simple weather station was set up at Station 3 to demonstrate the third and final nonliving component of the ecosystem. At this station, several meteorological devices were available to demonstrate climatological aspects of the ecosytem including temperature (a thermograph), rainfall (a rain gauge), and wind (an anemometer). In addition, a discarded milk carton was utilized to illustrate the effects of sunlight on materials, that is, bleaching and fading. Finally, the topic of humidity was discussed.

Station 4: Station 4 was made up of a group of plants including Mormon Tea (Ephedra trifurca), mesquite (Prosopis juliflora), staghorn cholla (Opuntia versicolor), and engelman prickly pear cactus (Opuntia engelmanii). These plants were used to illustrate the vegetation and its role in the ecosystem as a member of the living component. The primary topic discussed was plants as a producer organism.

Station 5: Station 5 was used to illustrate the presence of primary consumers or herbivores through the use of a staghorn cholla whose root area was exposed and partially consumed by a plant-eating animal.

Station 6: Station 6 consisted of a dying engelman prickly pear cactus which was inhabited by a wolf spider (Lycosa Sp.) or a carnivore. Also located here were some bones of a large herbivore. Station 6 was used to illustrate the presence of meat eaters and their relationship to herbivores.

Station 7: Station 7 consisted of a dead teddy bear cholla (Opuntia bigelovii) in a partial state of decomposition. The topic discussed was microconsumers or decomposers. By presenting food production, consumption, and eventual decomposition, the topic of food chains (an interaction of components) could be more easily introduced later since all of the main participants had been presented in order of their appearance.

Region 2. Region 2 was developed to discuss some of the interactions which exist between the parts of the ecosystem presented in Region 1. By presenting examples of how the parts work together, children would be helped to gain an appreciation for what was happening around them and would allow for a logical transition into Region 3. Again, as with Region 1, each station will be described and the topic discussed will be presented. The stations making up Region 2 are:

Station 8: Station 8 consisted of a small number of rabbit pellets. Since the major components of food chains had been presented at Stations 4 through 7, the class was asked to use its knowledge of the rabbit and the material contained in the droppings to determine if the animal was an herbivore, carnivore, or decomposer. Station 8 was also used to develop the pattern of discusssion to be followed in Region 2, that is, looking for evidence of animals in food chains while walking in the wash area.

Station 9: Station 9 was located along the edge of the dry wash and contained a small group of coyote droppings. As was done at Station 8, classes were asked to determine the feeding habits of the animal by examining the droppings' contents.

At this point, the field trip entered the dry wash where further investigations into food chains were made. In the sand of the wash, animal tracks were observed and the class was asked to identify them. Also, the vegetation along the wash was observed and compared to that of the surrounding desert. Finally, bird nests and animal burrows were observed and the children were asked what animals inhabited them and why they were located where they were. Thus, the wash was primarily used as a general observation area rather than a specific station.

Station 10: Station 10 consisted of a large mesquite tree in which a small plastic bag was placed over a branch. The bag, due in part to transpiration, was partially filled with water. The topic discussed here was the water cycle. Classes were asked to determine where the water came from. Once the correct answer was established, the class was asked to determine where the tree obtained its water. Through continued questioning, the concept of a cycle was established; i.e., water from the air down to the earth, to the tree, and back to the air again. Also located near this station was a catclaw acacia (Acacia greggii) which which was infested with mistletoe. The class was asked what type of plant it was and how it obtained nutrients. This was an extension of the food chain discussion developed at Station 8.

Station 11: Station 11 consisted of three different types of plants: (1) desert marigold (Tagetes lemmonii), (2) creosote bush (Larrea tridentata), and (3) jumping cholla cactus (Opuntia fulgida). These plants were used to introduce the three types of plant adaptations to arid environments as developed in Saguaro National Monument (Shelton, 1972, p. 25). These adaptations are: (1) "escaper plants" (the marigold) or annuals which die to escape the dry season; (2) "evader plants" (creosote bush) which drop their leaves and go into a dormant state to evade the dry season, and (3) "resister plants" (the jumping cholla) which possess a water storage capability and do not escape or evade the dry season but resist the extreme conditions existing in the desert. Also discussed in Station 11 was the structural (physical) adaptations of the cactus; i.e., its thorns. The class was asked to determine for what purpose these structures were developed.

Station 12: Station 12 was used to illustrate another physical adaptation of the creosote bush, the soil toxins this plant produces to inhibit other plants from growing in its vicinity. Classes were asked to describe the conditions existing on the ground and why this situation occurred.

Station 13: Station 13, the final station in Region 2, consisted of a rodent burrow into which a thermometer had been placed. Another thermometer was located on the soil surface near the hole to contrast the temperatures within the burrow and on the ground surface. The idea developed here was behavioral adaptations of animals, as opposed to physical adaptations. Also exhibited at this station was a dead insect to illustrate a physical adaptation of insects, their thick skins which allow them to remain active, even during the hottest hours of the day.

Region 3. Region 3, the last subdivision of the field trip presentation, consisted of a single station, Station 14. As outlined previously, man and his relationship to the environment was the primary topic of discussion.

Station 14: Station 14 was the final station of the field trip presentation and was located on the side of the sanitary land fill. Station 14's purpose was two-fold, the first being to summarize the items presented at the previous stations, and second to show the close similarities and differences that exist between man and the animals and plants living in the desert. Man's physical adaptations were discussed as well as his behavioral adaptations, such as his activities and technological developments. Emphasis was placed on man's lack of physical adaptability and need for the ecosystem to provide him with the materials necessary for survival. Examples used were minerals, timber, and food.

At the conclusion of the field trip, the children were asked if there were any questions or comments on what was seen or heard during the presentation. They were then instructed to walk back along their original route of travel to the bus. In total, the walk covered approximately 1/2 of a mile and the time of presentation ranged from 70 to 80 minutes with an average field trip time of 77 minutes; 60 minutes for the actual presentation and 17 minutes walking time. Time variations experienced were primarily due to the number and nature of questions and comments made by the classes. If questions required involved responses, each was answered to the fullest extent possible, and, for this reason, the field trip presentation time was extended. Another factor contributing to time variation was whether or not the field trip was the sole presentation or part of the combination program. If the field trip was the second presentation of the treatment, it was utilized as a review lesson for the treatment given the day before. By modifying the second presentation, the negative aspects associated with repetition of information were reduced. It must be emphasized, however, that all of the stations were presented and the designated topics were discussed.

Slide Presentation

The slide presentation was designed to parallel, as closely as possible, the field trip. In total, the presentation consisted of seventy-two 35 millimeter color slides taken by the researcher at Tumamoc Hill Environmental Study Area. In order to make the slide treatment as identical as possible to the scenes viewed in the field, each slide was photographed at approximately the same hour they would be viewed during the field trip. As discussed above, the concepts, understandings, and dialogue were identical with the only differences between the programs being the method and location of the presentation. Due to the lack of walking time, the three regions of the presentation were not as identifiable as they were in the field. For this reason the discussion of the slide presentation will vary from the format used to discuss the field trip. Rather than presenting each region and the focal points included, the slides or group of slides relating to each will be listed as the topics have been previously presented in the discussion of the field trip. Consult Figure 3 for slide photographing (focal points) locations.

Focal points making up the slide presentation are:

<u>Focal Point 1</u>. Seven slides were used to illustrate the initial focal point of the slide presentation with the first four being used to develop the concept of a system. These slides consisted of photographs of Andy Tolson Elementary School (located across the street from the point of entry). Slides 5 through 7 presented scenes of the study area as seen from Station 1. These slides were used to present the natural environment and the concept of an ecosystem.

<u>Focal Point 2</u>. Slides 8 through 15 were used to photographically present focal point 2. Illustrated here were the soil tests conducted to indicate the presence of carbonates, nitrates, and pH along with the dead barrel cactus and the glass-of-water demonstration discussed above (slides 13 through 15).

<u>Focal Point 3</u>. Slides 16 through 21 were used to illustrate the weather station and the individual meteorological instruments utilized. Also included were photographs of the milk carton and a view of cloud formations normally seen in the area with the latter slide being used to present the idea of humidity.

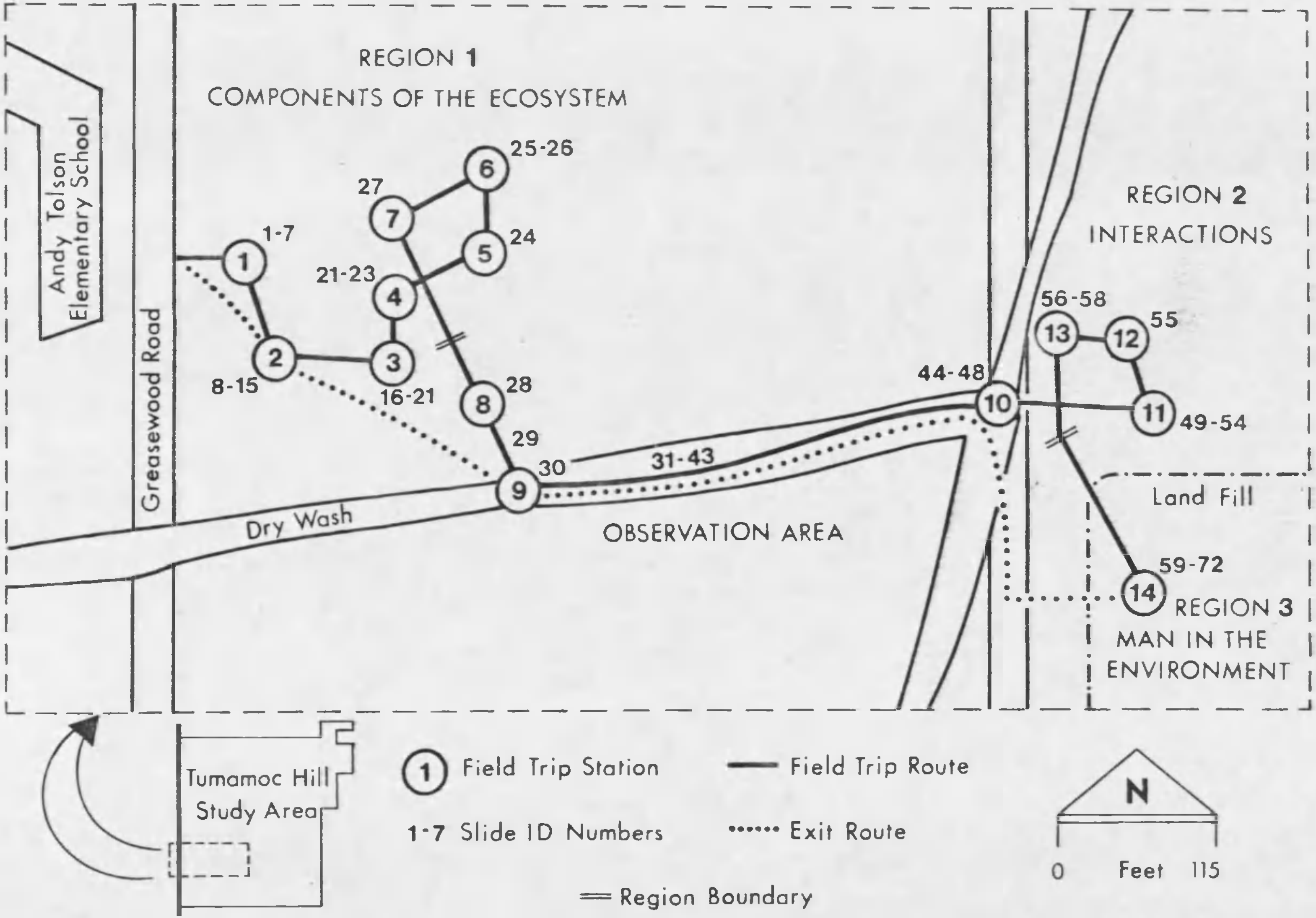

Figure 3. Map of the Field Trip Route and Slide Presentation Focal Points at Tumamoc Hill Environmental Study Area, Tucson, Arizona

Focal Point 4. Slides 22 and 23 were used to illustrate focal point 4. Photographs depicted the vegetation types located at the site.

Focal Point 5. Focal point 5 was presented by slide number 24. Illustrated at this location was the staghorn cholla which had been partially eaten by a herbivore.

Focal Point 6. Slides 25 and 26 were used to illustrate focal point 6. In these photographs closeup views of the wolf spider and its web were shown as well as the bones of a consumed animal.

Focal Point 7. Location 7 was presented in slide 27. Here the decayed teddy bear cactus was shown in closeup and the discussion centered on the role of decomposers.

Focal Point 8. Focal point 8 was illustrated by slide number 28 and consisted of a closeup view of the rabbit pellets discussed previously. Slide 29 was used to show the wash into which the field trip was about to enter. While not presenting a 360 degree view of the area, the class was given an idea of where the program was going so as to aid in the visual transition to the wash community in which focal point 9 was located.

Focal Point 9. Slide 30 was utilized to present focal point 9, or the coyote droppings. Droppings were photographed in order to provide the class with a closeup view of their contents.

At this point, the presentation entered the wash. To illustrate the wash area, slides were taken of the vegetation and animal signs (tracks, nests, and burrows) existing there. In all cases, slides used depicted subjects which were viewed on the field trip as well.

Focal Point 10. Slides 44 through 48 were used to illustrate point 10. In these photographs, the area in and around the mesquite were presented. Closeup photos consisted of the plastic bag along with views of the moist sand under the tree. Also included was a slide of the catclaw acacia which contained the mistletoe.

Focal Point 11. Focal point 11 was illustrated using slides 49 through 54 which depicted the plants mentioned above along with closeups of the thorns of the jumping cholla cactus and the white thorn acacia (Acacia constricta).

Focal Point 12. Location 12 was presented on slide number 55 and consisted of a photograph of the bare soil under and between the creosote bush vegetation.

Focal Point 13. Slides 56 through 58 were utilized to present focal point 13 with slide numbers 56 and 57 illustrating the rodent burrow and the thermometers. Slide 58 consisted of a photograph of the insect mentioned previously and was used to present an example of an animal physical adaptation which, in this case, was the insect's exoskeleton.

Focal Point 14. Slides 59 through 72 were used to present the topics discussed at location 14. In general, the photographs depicted views of the study area as seen from the top of the sanitary land fill. Types of scenes shown included a gas pipe line, a power transmission line, a housing tract located along Greasewood Road, and various closeup views of the land fill itself. Slides 71 and 72 were general views of the desert ecosystem and were utilized as a backdrop to the conclusion to the slide presentation. When these photographs were shown to the class, the quote from Commoner (1971) was presented and the entire program ended.

The time range of the slide presentation was 55 to 60 minutes, with an average presentation time of approximately 57 minutes. Again, as with the field trip, the time variation was primarily due to the questions and comments made by the class and whether the treatment was part of a combined program.

Collection of Data

Data used for the analysis were collected utilizing two separate methods. They are: (1) a multiple-choice examination given before and after the assigned presentation, and (2) tape recordings of the questions and comments made during and after each presentation. The tests were the primary evaluative instrument and were used to analyze both the general and comparative effects of the experimental treatments. The recordings, on the other hand, were used to aid in the interpretation of the test results. In this section of the report, the development and administration of the evaluative instrument will be discussed. Then the methods and purposes of the tape recordings and the organization and treatment of the data collected will be explained.

Evaluative Instrument

Appendices C and D contain the evaluative instruments used in the project. Each consisted of a multiple-choice examination containing 28 questions. Also, both subscales included an instructional section along with an alphabetically arranged word list used to define pertinent terms to aid the student in completing the test and to minimize variation due to vocabulary differences among students.

Questions for the instruments were developed from an initial list of 80 questions designed to reflect the terms and concepts actually presented to the class while in the field or in the classroom. The questions themselves were of two types: (1) questions used to test student knowledge and recall of the subject matter and (2) questions which required the respondent to synthesize the information discussed in the program and make decisions based upon this and other knowledge. An example of the first question type would be item 4 on the pretest which states:

> Producers are (1) animals; (2) plants; (3) soil; (4) nonliving things.

In the programs, producers were defined as plants so that the purpose of the test item was the recall of the term "producer." An example of the second type of question would be item 27 on the posttest which states:

> If houses are built on a hill, what might happen to houses at the bottom of the hill (1) it would make the hill look better; (2) they might be flooded; (3) floods would be smaller; (4) nothing would happen.

In the programs, students were taught that plants protect the soil from the impact of rainfall and hold soil intact. The intent of this item was to see if the children could use this knowledge and recognize that when a house or any structure is built, plants are removed and, when houses are built on a hill, the result would be increased runoff and potential flooding on the lower slopes.

Each test was reviewed using a two-step process (see discussion below) in which the initial list was revised into a final question list containing 56 test items which was then divided in half by randomly assigning questions to either the pretest or the posttest. The feeling was that 28 questions on each test would be a sufficient number of items to obtain an adequate distribution of scores and would also keep the test short enough to as not to interfere with the regular classroom instruction for that day. Random assignment was used to eliminate any biases that the researcher might have prior to the presentation of the experimental treatments. Once the tests were developed, they were administered to all classes participating in the study based upon the prearranged testing schedule (see Instrument Administration).

Review Process. The test review process consisted of two separate evaluations with the first being made to insure that the content and subject matter of the test questions related directly to the general program format. The second review concerned an adjustment of the readability and level of difficulty of the questions and instructions so as to make them appropriate for the sixth grade students participating in the study.

As outlined above, the first evaluation was conducted by selected members of the faculty and staff of the

School of Renewable Natural Resources. Criteria used for this evaluation were: (1) the goals of the program as defined in the project prospectus and (2) the evaluator's knowledge and experise concerning the subject matter. Based upon the above criteria, 24 questions were eliminated due to their complexity and lack of relevance to the general program format.

Review step two related directly to the mechanics of the test and the student information section. This evaluation was performed by representatives of the Elementary Education Department, College of Education. The criteria utilized for this evaluation were developed by Flesch (1949, pp. 147-156, 213-216) in his book, The Art of Readable Writing. In general, Flesch's procedure requires the calculation of a reading ease score (RES) which is computed by counting the number of syllables per 100 words and the number of words per sentence contained in the material under analysis. By reducing the complexity of the words used in the test and instructions as well as the length of the sentences, the RES could be reduced to an appropriate reading level. In terms of Flesch's criteria, the RES for the sixth grade would lie between 80 and 90 with 90 being the dividing point between the fifth and sixth grade and 80 separating the sixth grade from the seventh. The calculated reading ease score of the test and instructions was 80.5, or the low seventh/high sixth grade level. While this

RES is slightly above the grade level of the students, it was the feeling of the evaluators and the researcher that, due to the scientific subject matter of the test, the reading level was acceptable for the purposes of the project and any modifications made would result in major changes in the instrument's emphasis and intent.

Tape Recordings

The purpose of the tape recordings, as discussed in the introduction, was to aid in the interpretation of the test results. Since there may be potential differences in the experimental treatments not measured by the evaluative instrument, the numbers and types of questions and comments made by the classes were thought to be useful in conducting the analysis. In the field, the recordings were made on a cassette recorder carried unobtrusively by the researcher in a backpack. When a question or comment was made, the conversation was recorded by means of a remote control microphone situated on the researcher but out of sight of the student. In this way, the recorder could be inconspicuously controlled by the researcher and the student would not be intimidated by the recorder itself. In the classroom a similar procedure was carried out except that the pack was placed near the researcher (usually behind the projection screen) so that when a question or comment was made, the remote switch could be actuated without having the researcher move from his speaking position in front of the class.

Instrument Administration

Administration of the evaluative instruments (both the pretest and posttest subscales) was made by the classes' regular teacher based upon a prearranged test assignment schedule (Appendix B). Prior to the beginning of the presentation phase of the project, meetings were conducted with all participating teachers to instruct them on how to administer the pretest and posttest. Because the tests were designed to be read by each individual student, teachers were instructed not to read the test to the class. Teachers were, however, told that if a student had a question concerning a word on the test, they were permitted to say the word aloud but not to define or elaborate on its meaning. By making the instructions as clear and as easy to read as possible, student apprehension while taking the test would hopefully be reduced.

Data Organization

Data collected and coded consisted of: (1) basic student information such as name, age, and sex; and (2) student responses to the questions on the evaluative instrument. In addition to the test questions, item 29 on the posttest was designed to elicit student comments about the presentation and act as a checking device to insure the respondent took both tests and attended the assigned treatment. If discrepancies appeared, the two tests could be scrutinized so as to determine the nature of the discrepancy. If it was concluded that the student did not attend a presentation when scheduled to do so, or vice versa, the test results could be eliminated from the analysis so that only those who received their assigned treatment would be included. Once the respondent's pretest and posttest forms were matched and the information coded, all references to students' names were removed to insure complete anonymity.

As the evaluative instruments were completed and returned for each class, all student information was coded by the researcher and punched on standard computer cards. For identification purposes, each student was assigned a five-digit number consisting of: (1) the block number to which the student's class belonged; (2) the assigned treatment (slide presentation, field trip, combined program, or none); and (3) a two-digit class order number developed from an alphabetical list of student names who took both tests. In the next four columns, the student's age and sex were coded. The purpose of these data was to examine basic student characteristics and to use these as a further means of identification. In columns 10 through 69, the student's responses to the test items were coded (one column per question) with the number of the answer selected being coded in the appropriate column. When the test results were computed, the response was judged to be either correct or incorrect based upon a prearranged scoring schedule. For the analysis, the score for the test was the total number of items correct. In total, 69 columns were used to code all student information with one card being required to reference each student.

Treatment of Data

Data collected from the classes participating in the study were analyzed to determine: (1) the quality of the evaluative instrument, as defined by its reliability and validity; and (2) the effects of the experimental treatments on the teaching of environmental education concepts and understandings. Since the purpose of the present chapter is to discuss the methods and procedures used to conduct this study, the basic analytic strategy and statistical procedures used will be presented here with a more thorough discussion of the analysis being made in the following chapter.

Evaluative Instrument Analysis. The evaluative instrument subscales were analyzed using the computer program TESTAT[1], which is designed to: (1) perform test-item analysis on each question comprising the pretest and

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1. TESTAT was developed by Dr. Keith E. Meredith of the Educational Psychology Department, College of Education, The University of Arizona.

posttest; (2) compute the reliability coefficient for each test; and (3) provide the user with basic descriptive statistics such as means, standard deviation, and question alternative response frequencies. While not being the primary objective of the study, the information obtained was considered to be of potential value, especially in interpreting the results of the experimental treatment analysis.

Analysis of Treatment Effects. Information obtained on the evaluative instrument was subjected to preliminary analysis using a number of subprograms and associated optional statistical routines available in the computer program Statistical Package for the Social Sciences (SSPS) (Nie and others, 1975). Specifically, the programs and routines utilized were: (1) FREQUENCIES and CONDESCRIPTIVE, designed to obtain basic distributional characteristics of the variables collected, with FREQUENCIES being developed for categorical variables and CONDESCRIPTIVE being used for continous or metric variables; and (2) ONEWAY (Kim and Kohout, 1975), an SSPS analysis of variance subprogram. In addition to these, a set of procedures specifically developed and described by Steel and Torrie (1960, Ch. 15) for use with the randomized complete block design was employed to perform the primary analysis of the project. These procedures were used to test the general effects of the methods of instruction and to contrast each method in order to determine their comparative effectiveness.

Analysis of Tape Recordings. Tape recorded responses were reviewed by the researcher to determine the number of questions and comments made during each presentation. Responses were categorized by treatment type into a final response list and then subjected to chi-square analysis to determine the relationship, if any, between treatment types and the number of responses made.

CHAPTER 3

ANALYSIS OF THE DATA AND INTERPRETATION OF FINDINGS

In this chapter, the primary analysis objective, that of evaluating the effectiveness of the slide presentation and field trip on teaching environmental education, will be discussed. Prior to this, however, the discussion will concentrate on an analysis of the evaluative instrument since any interpretation of the effectiveness of the experimental treatments must be predicated on the basis of the quality of the testing medium used. While it is not the intent of the researcher to explore all aspects of test measurement evaluation, certain pertinent concepts must be examined so as to provide a basis for interpreting the results which follow.

Analysis of the Evaluative Instrument

The analysis of the evaluative instrument consists of: (1) the determination of the pretest and the posttest reliability and validity and their implications and (2) an individual test item analysis.

Pretest/Posttest Reliability and Validity

In general, the term reliability refers to the repeatability of measurements. If, for example, an individual or group of individuals is tested using an instrument comprised of a series of questions, the degree to which these questions agree or are consistent is the test's reliability and its value can be estimated by means of a reliability coefficient. Like the coefficient of determination (Isaac and Michael, 1974, p. 146), the reliability coefficient ranges in value from .00 to 1.00 and is interpreted in much the same manner, with the coefficient indicating what proportion of the test variance is non-error variance. If the coefficient is low, this suggests that there is a high degree of error in the measurement due to such factors as day-to-day fluctuations in individuals, errors due to guessing and test scoring, and errors in the sampling of content. As the coefficient approaches 1.00, the effects of these and other sources of unreliability are reduced and the test results can be interpreted as measuring the true scores of the individual or group being evaluated.

Depending on what source of variation is under analysis, a number of different reliability coefficients have been developed. For the analysis under discussion, a modified split-half coefficient termed the coefficient alpha (Cronbach, 1951, pp. 297-334) was utilized. Rather than dividing the test into equivalent halves, as is the case for split-half designs, coefficient alpha approaches the question of reliability by testing the internal consistency of the test when it has been divided in half based upon a random procedure. If the test is reliable, each item should measure the same or similar concepts and, therefore, correlate positively with one another. When items show a high correlation, the test is said to be reliable. Since true alternative test forms were not developed for this project, this procedure was especially useful in analyzing the reliability of the instrument's two subscales.

While no strict rules have been established as to what level the reliability coefficient must attain in order to have confidence in the conclusions drawn from the data collected, Selltiz et al. (1959, pp. 181-182) state that relatively low reliability is acceptable when assessing group level performance. They support this by the fact that average scores normally exhibit greater stability than individual scores used to compute the average. Kelley (1927, p. 211) and Jordan (1953, p. 32) set more specific criteria by stating that to evaluate group performance, a reliability of .50 is needed, but to make individual assessments, values of .90 or higher are required. Since the research design used in the study compares group (class) performance on the evaluative instrument, lower reliability values are acceptable but not necessarily desirable. Value below the .50 minimum indicates a lack of test quality and interpretation of results must be made with caution.

On the other hand, since the treatment evaluation method involves an analysis of covariance procedure, the test statistic used is designed to account for variation in measurement due to sources explained by the experimental treatments and to error. Included in this latter source would be variation resulting from the measuring instrument's unreliability. If the statistic is significant, the unreliability of the instrument is not sufficient to increase error variation to a point where it hides the effects of the experimental treatments. If, however, the statistic is not significant or can only be shown significant at levels above the generally accepted criteria of .01 or .05, this suggests that sources of error variation, including unreliability, have lowered the sensitivity of the analysis and made the findings unclear. In this case, interpretation is difficult and the results of the analysis must be considered, at most, to be indicators or trends developed from the data because precise accountability of treatment effects is not possible.

Results. Coefficient alpha figures for the evaluative instrument subscales were .45 for the pretest and .63 for the posttest with a value of .70 for the entire test (56 questions). These values indicate that the pretest did not meet the established criteria of .50 and, therefore, a great deal of variation (55 per cent) in the measurement remains unaccounted for by the test. The posttest, however, seemed to discriminate to a much higher degree as indicated by its reliability value. Still, while meeting the .50

criterion, the coefficient demonstrates that at least 37 per cent of the test variance was not explained by the examination. Apparently the pretest measure is rather unstable and must be used with caution. The posttest measure, however, is acceptable for group level analysis.

Validity is another concept which is extremely important in test measurement evaluation. In general terms, validity may be defined as the extent to which a test measures what it is intended to measure. Isaac and Michael (1974, pp. 82-84) have identified three types of validity. These are: (1) content validity or how well the test samples the information about which conclusions are to be drawn, (2) criterion-related validity or how well the test under analysis compares with variables considered to be a direct measure of the characteristic or behavior in question, and (3) construct validity or to what extent certain explanatory concepts or qualities account for the performance on the test. The type of validity measure that is appropriate must be defined based upon the aims and purposes of the testing.

Since the objective of this study was to assess the effects of the experimental treatment on teaching environmental education concepts, the validity measure of most importance is content validity. Isaac and Michael (1974, p. 82) state that to assess content validity, one must "logically conclude whether or not the test content comprises an adequate definition of what it claims to measure." As discussed in the previous chapter concerning the development of the evaluative instrument, the content was compared to the stated goals of the general program format by persons with a high degree of expertise and familiarity with the program. Questions retained for the actual test were deemed to sample the information presented. In terms of content validity, the instrument is determined to be a valid measuring device.

Test Item Analysis

Item analysis is a statistical procedure used to evaluate the quality of individual test items with its primary objective to identify those items which should be retained for future testing purposes. In general, the process involves the calculation of two measurements: (1) the level of difficulty of each item as represented by an easiness percentage (Nunnally, 1964, pp. 123-133) and (2) a measure of how well the item discriminates between specified groups of respondents. These groups are usually the students in the upper and lower 25 per cent of the test distribution, but their makeup will depend on the nature of the general population sampled and the objectives of the test. One such measure is the biserial correlation coefficient (Downie, 1967, p. 215). The easiness percentage is defined as the per cent of students who answered each item correctly. Nunnally (1964, p. 132) has shown that the ideal test item is one with a 50 per cent value because such an item allows for the greatest number of discriminations and, in addition, allows for discriminations throughout the entire range of test scores. If an item is too difficult or too easy, it provides for the differentiation of only a relatively few number of students. While the 50 per cent figure is said to be the best value, upper and lower limits have been established (Nunnally, 1964, p. 133) with acceptable values ranging from a lower limit of 20 per cent to an upper limit of 80 per cent. If an item percentage falls within this range, it is said to be acceptable and should be retained for future use. If, however, it item's easiness value lies outside the 20 to 80 range, its level of difficulty should be re-evaluated and a determination be made as to its revision or elimination from the test.

Based upon these criteria, the results of this portion of the analysis indicate that pretest items 3, 4, 12, 14, 17, and 20 and posttest item 5 fall outside the acceptable easiness range and should be reassessed as to their level of difficulty and power to discriminate.

The second measure to be concerned with in test item analysis is the index of discrimination for each question. The objective of this measure is to estimate the degree to which each test item is similar to the entire test, thereby establishing each item's contribution to the examination.

The procedure used requires the calculation of the point-biserial correlation coefficient for each test item. In general, the procedure involves the separation of respondents, by test score, into groups based upon a specific percentage cutoff point. In this regard, Kelley (1939, p. 24) suggests using the upper and lower 27 per cent of the test scores, while Nunnally (1964, p. 135) suggests the 25 per cent level. Once divided, the answers made by each respondent are compared, through the use of the biserial correlation coefficient, to the respondent's total score for the test. In this way, each item is evaluated as to the degree it discriminates good students (the upper percentage group) from the poorer students (the lower percentage group). Downie (1967, p. 220) reports that while various lower limits have been established, generally speaking, a value of .20 is adequate to determine whether or not a test item is working. From the second analysis using this .20 criteria, pretest items 1, 4, 7, 8, 12, 13, 14, 15, 17, 20, 23, and 25 and posttest items 5, 14, 15, 18, and 25 are not adequately discriminating respondent performance. For those who wish to utilize the evaluative instrument developed in this report for a future research project, a complete listing of the easiness percentage, biserial correlation coefficients, and percentage response rate for each test item is given in Appendix E.

Results. From the criteria established for the easiness percentage, six pretest and one posttest item fell outside the acceptable easiness range and as such should be re-evaluated as to their level of difficulty. In the analysis of the item point biserial coefficient, it was found that 12 items on the pretest and 5 items on the posttest were not adequately discriminating respondent performance. Based upon both analysis criteria, a total of 13 pretest items and 5 posttest items were found not to be acceptable. Through inspection, it is evident that many of these question items failed on both evaluations. The high number of poor items on the pretest is reflected by its .45 reliability coefficient with these unacceptable items being primarily due to poor question and instruction wording, respondent's reading ability, and guessing. Once the class received a presentation, however, familiarity with the subject matter was increased, the incidence of guessing declined and test items were better able to discriminate as indicated by the fewer number of poor posttest items.

Since reliability and test item analysis was done retrospectively, it was not possible to redesign and improve the overall evaluative instrument and its subscales. The analyses do, however, assist in interpreting the results of the study. Measurement error has many undesirable effects with the most critical being the fact that it tends to "blur" test results. Rather than considering observed scores as a single point on a continuum of scores, scores obtained with a test of low reliability must be viewed as an interval of values. This tends to reduce the precision of the evaluation and lower the confidence that can be placed on score estimates.

However, since the scores used for the analysis of treatment effects are class mean scores, much of the measure's imprecision is removed in the averaging process. Because of this as well as time and monetary constraints placed on the researcher the data collected from the instrument will be utilized, but their limitations have been recognized and considered.

Analysis of Methods of Instruction

In the introductory section of this report, the primary objectives of the project were discussed. They were to: (1) determine the comparative effectiveness of three methods of teaching environmental education concepts in public schools with the methods tested being the slide presentation, the field trip, and a combined program of both presentations; and (2) determine the differences, if any, between the methods as related to their ability to elicit student participation and interest in the subject matter. In this section, the data obtained from the student responses on the evaluative instrument and from tape recordings made of respondent questions and comments will be analyzed in relation to these objectives.

Analysis of Covariance

The research design used in the study attempted to control for potential differences between participating classes by grouping them into blocks based upon neighborhood socioeconomic characteristics. While this design is widely used when a high degree of variation in the sample population is suspected, it did not incorporate controls on inherent differences existing between classes as related to other factors felt to be important. In this particular study, one aspect not considered in the design was the knowledge the respondents' groups possessed regarding the subject matter of the general program prior to the presentation of the experimental treatments. For this reason statistical controls in the form of an analysis of covariance procedure (Fisher, 1951; Lord, 1963; Campbell and Stanley, 1963) were employed.

In its most basic form, this procedure involves the regression of class means obtained on the pretest with class means on the posttest. The dependent variable for the subsequent analysis of variance, used to test treatment effects, is an adjusted posttest score which is merely the deviation of the observed class posttest means from the regression line of the pretest on the posttest at the point where the grand mean pretest score intersects the line. By using the covariate (class pretest mean score), the precision of analysis is hopefully increased as the error variance in the estimate is reduced so that a smaller denominator in the F ratio test is obtained, thus allowing even slight differences in the variance between the treatment categories to be found significant. That is to say, the previous knowledge of the classes is treated as a nuisance variable which hides the influence of the treatment on the posttest score. For a more complete discussion on the uses of analysis of covariance, see Fennessey (1968, pp. 10-15).

Because analysis of covariance is a combination of linear regression and analysis of variance, the data must meet the assumptions of both procedures. These assumptions, given by Steel and Torrie (1960, p. 309) for the analysis of covariance model, are: (1) the X's (pretest scores) are fixed and measured without error, (2) the regression of Y (posttest scores) on X after removal of block and treatment differences is linear and independent of treatments and blocks, and (3) the residuals are normally and independently distributed with a zero mean and a common variance. In regards to this study, assumption (1) above is a basic requirement for the use of linear regression. Assumption (2) refers to the requirement that the regression of the pretest on the posttest be homogeneous for all treatment categories and increases or decreases posttest scores by a constant factor. Assumption (3) deals specifically with the appropriateness of the data as they relate to the use of the "F" and "t" statistical tests. While the assumption of normality is not required for estimating the components of the variance of the adjusted posttest score, randomization is a prerequisite (Steel and Torrie, 1960, p. 309). Since the project's research design involved the random assignment of treatments to classes, this final requirement was satisfied by the design used. In addition to these assumptions, a secondary requirement must be met in order to provide a satisfactory frame of reference for the interpretation of test results; that is, the covariate must be independent of the experimental treatments.

In the following paragraphs, a step-by-step summary of the analysis is presented, with the first two steps involving an evaluation of the appropriateness of the data collected for the analysis of covariance procedure used, and steps 3 and 4 dealing with the actual analysis of those data as related to the primary objective of the study.

<u>Step 1</u>. Step 1 of the analysis was conducted to obtain mean class pretest and posttest scores. This was accomplished through the use of the SPSS (Nie and others, 1975) descriptive statistical program, CONDESCRIPTIVE. The data are presented in Table 1. For clarity and relevance

Table 1. Observed Class Mean Pretest and Posttest Scores by Block and Treatment

	Block												Observed Treatment Mean Scores		
	1			2			3			4					
Treatments	X[a]	Y[b]	N[c]	X	Y	N	X	Y	N	X	Y	N	X	Y	N
Control	12.39	13.08	26	13.28	12.68	25	12.47	12.90	30	11.91	10.67	21	12.51	12.33	102
Field Trip	13.79	14.85	24	12.85	15.77	27	10.72	11.62	29	11.76	15.10	21	12.28	14.34	101
Slide Presentation	12.68	15.88	25	13.68	15.00	22	13.08	14.17	12	11.25	11.94	16	12.67	14.28	75
Combined Program	11.76	13.60	25	11.87	15.91	23	13.20	14.67	30	11.80	14.70	20	12.16	14.72	98
Observed Block Mean Scores	12.66	14.35	100	13.92	14.84	97	12.36	13.34	101	11.68	13.10	78	12.41	13.91	376

[a] Observed class mean pretest score.

[b] Observed class mean posttest score.

[c] Number of respondents.

to the analysis strategy to follow, the data are arranged by treatment and block with the X's being the class pretest score, the Y'x representing their posttest score, and N equalling the number of students from which the calculations were based.

Step 2. The second analysis procedure relates directly to the secondary assumption discussed above which is to determine whether or not an interaction exists between the treatment categories and the covariate, i.e., the class mean pretest score. If these variables are not found to be independent, then the interpretation of the effects of the treatments on the adjusted posttest score will be restricted since such confounding would prevent the separation of their individual effects. The test for interaction was accomplished through the use of one-way analysis of variance (see Table 2) using the SPSS program, ONEWAY (Kim and Kohout, 1975) in which the class mean pretest score was defined as the dependent variable and the experimental treatments as the independent variable.

From Table 2, differences between treatments, while existing, were not found to be significant even when using the .2 level of significance. For the purposes of the analysis, treatment type and pretest scores are independent. This result is important as it demonstrates that from the standpoint of the assumption above, the data are appropriate

Table 2. Analysis of Variance of Observed Class Pretest Scores by Treatment

Source	df	Sum of Squares	Mean Square	F
Between Treatments	3	3.1255	1.0418	1.40*
Within Treatments	12	8.9279	.7440	
Total	15	12.0534		

*Not significant at the .2 level of significance.

for the analysis strategy selected, i.e., analysis of covariance.

The assumption of homogeneity of pretest/posttest regression coefficients for each treatment category was tested using a procedure outlined in Steel and Torrie (1960, p. 319). The examination involves the calculation of a new set of class means for both tests by subtracting the mean of each block from the observed class means so as to remove the effect of the blocking variable. Individual treatment pretest/posttest regressions can then be computed. For the test of equal regression coefficients, the null hypothesis is that there are no differences between regression coefficients. In this particular test, the F ratio value was .6527 which indicates that the null hypothesis cannot be rejected. As related to Assumption 2 above, the regression coefficients are homogeneous for each treatment category.

Step 3. Step 3 of the analysis was directed at the primary objective of the study, that of evaluating the collective effects of the methods of instruction. As discussed previously, class mean posttest scores were adjusted for pretreatment differences through a regression process with the resulting adjusted mean posttest scores being used in the analysis of variance. The analysis of covariance procedure utilized for the project is described by Steel and Torrie (1960, pp. 311-317) as it is specifically developed for the randomized complete-block research design. Data for the analysis are presented in Table 3.

Table 3. Analysis of Adjusted Class Mean Posttest Scores Utilizing Analysis of Covariance

Source of Variation	df	Sum of Products X, X	X, Y	Y, Y	Y Adjusted for X df	SS	MS	F
Total	15	11.58	9.33	39.04				
Blocks	3	3.42	4.78	8.15				
Treatments	3	.64	-1.33	13.75				
Error	9	7.52	6.00	17.14	8	12.35	1.54	
Treatments + Error	12	8.16	4.67	30.89	11	28.22		
Treatments Adjusted					3	15.87	5.29	3.44*

*Significant at the .10 level with 3 and 8 degrees of freedom.

Based upon the results shown in Table 3, when pre-treatment differences in knowledge of the subject matter are removed and the effects of the neighborhood from which the class belongs is considered, significant differences ($p = .10$) between treatment categories remain. In other words, at least one method of instruction did have an effect.

Because the data in Table 3 contain both analysis of variance and covariance calculations, associated tests utilizing the data can be computed. Two such statistics are the test of the blocking variable on posttest scores and the gain in efficiency by the use of design selected. The effect of blocking was tested using analysis of variance and the statistic was found to be $F = 1.42$, which is not significant at the .10 level. Therefore, no significant differences between blocks were demonstrated so that the assignment of treatments could have been made without regard to neighborhood characteristics, but that this may not have been the case had the research involved an analysis of the effects of such socioeconomic variables as income, respondent mobility or parental educational levels.

While not being a significant factor, the use of blocking can be evaluated as to the relative increase in precision it provides over a completely randomized design. This analysis, using a procedure discussed by Steel and Torrie (1960, p. 142) involves the calculation of a precision factor ($E_e(CR)$) with the equation:

$$E_e(CR) = \frac{n_b\ E_b + (n_t + n_e)\ E_e}{n_b + n_t + n_e}$$

in which E_b and E_e are the block and error mean squares and n_b, n_t, and n_e are the block, treatment, and error degrees of freedom respectively. For the data presented in Table 3, the equation translates into:

$$E_e(CR) = \frac{3\ (2.72) + (3 + 9)\ (1.90)}{3 + 3 + 9} = 2.064$$

The increase in precision is found by the equation:

$$\frac{E_e(CR)\ (n_1 + 1)\ (n_2 + 3)}{E_3(RB)\ (n_2 + 1)\ (n_1 + 3)} \text{ X } 100$$

where $E_e(RB)$ represents the mean square error for the randomized complete block design and n_1 and n_2 are the degrees of freedom for error for the randomized complete block and completely randomized design respectively. By substitution, the equation becomes:

$$\frac{2.064\ (9 + 1)\ (12 + 3)}{1.90\ (12 + 1)\ (9 + 3)} \text{ X } 100 = 104\%$$

In this case, by blocking on neighborhoods, the efficiency of the analysis was increased by 4 per cent. As related to class knowledge and perception of the information presented in the experimental treatments, results suggest regional differences, while not being a critical factor, did make the analysis more sensitive. As a preventative measure, blocking was modestly effective in reducing error variation in the experiment and the gains realized seem to justify the use of the research design selected.

Step 4. Step 4 of the analysis dealt specifically with the effects of treatments as examined individually and involved two separate procedural states: (1) calculation of the adjusted posttest mean scores, and (2) comparison of individual adjusted treatment means using a pair-wise comparison test described by Steel and Torrie (1960, p. 316).

Calculated adjusted treatment mean values are as follows: (1) Control, 12.247; (2) Field trip, 14.441; (3) Slide presentation, 14.060; and (4) Combined program, 14.912. When these values are subjected to pair-wise comparisons shown in Table 4, the results indicate that all presentation treatments differed significantly from the control group at the .10 level, while no significant differences were demonstrated when comparing the three presentation treatment means together, i.e., contrasts 4, 5, and 6.

Results. Analysis Steps 1 and 2 indicate that no significant interaction existed between the pretest and the methods of instruction tested. While the results of this evaluation are intuitively obvious, since the pretest was administered prior to any presentation of the experimental treatments, it was necessary to evaluate the relationship between these variables so as to be able to determine the

Table 4. Pair-Wise Comparison Tests Between Adjusted Treatment Means

Contrast	Treatment Comparisons	Difference in Adjusted Means
1	Control vs. Field Trip	2.194*
2	Control vs. Slide Presentation	1.813*
3	Control vs. Combined Program	2.665*
4	Field Trip vs. Slide Presentation	.351
5	Field Trip vs. Combined Program	.501
6	Slide Presentation vs. Combined Program	.852

*Significant at the .10 level of significance.

appropriateness of the data for the analysis of covariance technique used. Because the results were nonsignificant, the determination was made that the data did meet the required assumptions.

Analysis Steps 3 and 4, dealing with the primary analysis objective, indicate that all three methods of instruction tested, when evaluated at the .10 level of significance, produced adjusted posttest mean scores which differed from scores made by respondents not receiving special instruction. When examining the effects of the treatments individually and then in combination, the field trip produced the largest single increase in performance and that the slide presentation, when added to the field trip, accomplished very little in the way of additional improvement. However, since no significant differences could be demonstrated between treatment presentations, any ordering in treatment effects becomes tenuous at best. The effects of the location and medium used to present the information of the general program were, for all practical purposes, equal in effectiveness. In regards to the primary analysis objective, no differences between the three methods of instruction could be demonstrated and the hypothesis of differences must be rejected.

The results of equal effectiveness between treatments bring into consideration a number of contributing factors, each of which is perceived to be important in explaining the conclusion drawn above. These factors can be divided into three general types: (1) problems associated with the unreliability of the evaluative instrument; (2) the learning level measured by the instrument itself along with several pertinent characteristics of the treatment presentations and analysis; and (3) other sources of variation not controlled, either through statistical measures or by the research design selected. Because an extended discussion has already been presented as to the reliability problem and the subsequent problems of interpretation (pp. 57-58), further discussion would be repetitive.

In general, however, unreliability tends to "blur" treatment effects by increasing the error in the measurement and lowers the sensitivity of the analysis. In regards to the last two factors listed above, each will be discussed in the paragraphs below.

In terms of factors uncontrolled for through the analysis of covariance technique used or by the employment of the randomized complete block research design, it appears that sources of variation due to teacher, class and student differences accounted for, at least in part, a high proportion of error in the measurement of treatment effects. In regards to teacher variation, wide differences in the way teachers were willing to participate in the research project were evident. While each expressed their cooperation, some were apparently more committed than others. A few teachers were very interested in environmental education and their classes seemed to absorb some of this interest. While teachers were instructed not to deviate from their regular classroom routine, variations in teaching programs could have had an effect on class attitudes and knowledge of the subject matter. When teachers did not exhibit a particular interest in the project, their lack of commitment was reflected in class attention and discipline during the actual presentation. In this regard, the field trip program, due to its outdoor location, increased discipline problems. When outside, classes seemed to associate the field trip with physical activity or recess and the behavior exhibited resulted in problems of maintaining class attention. The degree to which the teachers were willing to control their classes was an important factor in reducing disruptive activity. Some were forceful, instructing their classes to listen to what was said, while others relegated this responsibility to the researcher. The added pressure tended to create variability in the dialogue presented and ultimately resulted in an increased amount of experimental error.

Student variation in the form of differing academic ability such as reading and vocabulary skills as well as day-to-day fluctuations in respondents, also may have contributed to the error in measurement. While the teacher and class variations are possibly controllable through the use of random assignment of class members using single classes, student variables are more difficult to deal with. A possible solution would be to match students on a number of relevant variables; however, the loss of sample size must be considered.

The second area of variability presented above related the learning level measured by the test and basic characteristics of the presentations considered to be important factors affecting the conclusion drawn about treatment effects. In the section of the report discussing the objectives of the evaluative instrument, questions were said to measure student knowledge and recall about the subject matter presented in the general program. Bloom (1956, p. 18) describes learning of this type as cognitive learning. Test questions designed for this domain deal specifically with: (1) knowledge (the ability to recall information); (2) comprehension (the ability to comprehend what is being communicated and make use of the information); (3) application (the ability to use idea, principles, and theories in particular situations); (4) analysis (the ability to break down a communication into its components and organize them into clear ideas); (5) synthesis (the ability to put these components into a unified whole); and (6) evaluation (the ability to judge the value of the information, ideas, and procedures). Because of the large number of questions found to be unacceptable as determined by the test item analysis, the available questions designed to measure cognitive learning skills were limited. Also Kropp and Stoker (1966, p. 172) have determined that questions of the multiple choice format are not amenable to measure objectives of the last two levels listed above (synthesis and evaluation). He found that questions designed to evaluate these two levels were continually downgraded to the four lower levels of the domain, that is, analysis, comprehension, application, or knowledge. In reviewing the individual items on the project's instruments, questions seemed to universally deal with the two lower learning levels of knowledge and comprehension. Since these questions were taken directly from the dialogue of the general program rather than the concepts and ideas on which the program was based, the test appears to have measured what the classes heard rather than dealing with things which could be seen on both the projection screen and in the field. In terms of the results of the analysis, the modifying effects of the field trip and slide presentation did not aid or inhibit the classes from remembering the dialogue presented. In this case, each treatment type was equally effective.

The final contributing factor discussed above relating to the results of analysis Steps 3 and 4 deals specifically with characteristics of the research design, such as the unit of analysis used and presentation exposure. Because individual student responses were not measured, the sample size of the analysis was drastically reduced from 376 observations to a total of 16 class means. This loss of numbers required the treatment effects to be much greater in order to show significant differences between treatments. Because of the smaller number of observations, the sensitivity of the statistical analysis was reduced. While randomization of individual students was a possible alternative to using class means, the difficulty of such a procedure would have increased the complexity of the research project beyond all rational justification. For this reason, individual randomization was not employed.

In relation to presentation exposure, each individual presentation was of a one hour duration with the combined program lasting a total of two hours. These times were selected to approximate the exposure normally used in presentations given by resource agency personnel while in the classroom or at environmental education field excursion areas. Due to the relatively short time each class was subjected to the presentaiton, the amount of information, ideas and concepts presented may have approached the saturation point for the participating classes resulting, in part, to the lack of demonstrated differences between treatments. Because of time and monetary constraints imposed on the project, longer exposure times, while increasing the potential time for learning, were not considered to be appropriate based upon the objectives of the project.

In conclusion, each of the sources of variation discussed above was perceived to contribute to the lack of sensitivity of the analysis and limit treatment evaluation. While it is impossible to assign a specific contribution to the error in the measurement by each of these variables, except for the evaluative instrument subscales, all must be considered important and efforts to control for them should be developed prior to the initiation of future research endeavors (see Implications and Recommendations). The result of analysis Steps 3 and 4 are presented in Figure 4. For clarity, confidence intervals for the .10 and .05 levels have been computed. The lack of precise discrimination between treatment effects is represented by the high degree of overlap of these intervals. Treatment effects can best be estimated, however, by the adjusted posttest mean score with the performance of the treatment being subject to interpretation based upon the above sources of variation. While the combined program produced the highest scores followed, in turn, by the field trip and the slide presentation, these results can only be termed as trends and not in any way be considered substantiative.

Use of the Analysis Strategy Selected

In the introduction of this section of the report, the rationale for the statistical controls in the form of analysis of covariance were discussed. Because of the complexity of the statistical analysis strategy used, it is felt that an evaluation of the technique procedure in relation to the effectiveness of the covariance as a means of error control is in order. Steel and Torrie (1960, pp. 316-317) discuss a process in which the percentage gain in precision by analysis of covariance can be calculated. The evaluation is shown below.

1. The equation for the mean square error after adjustment is given by:

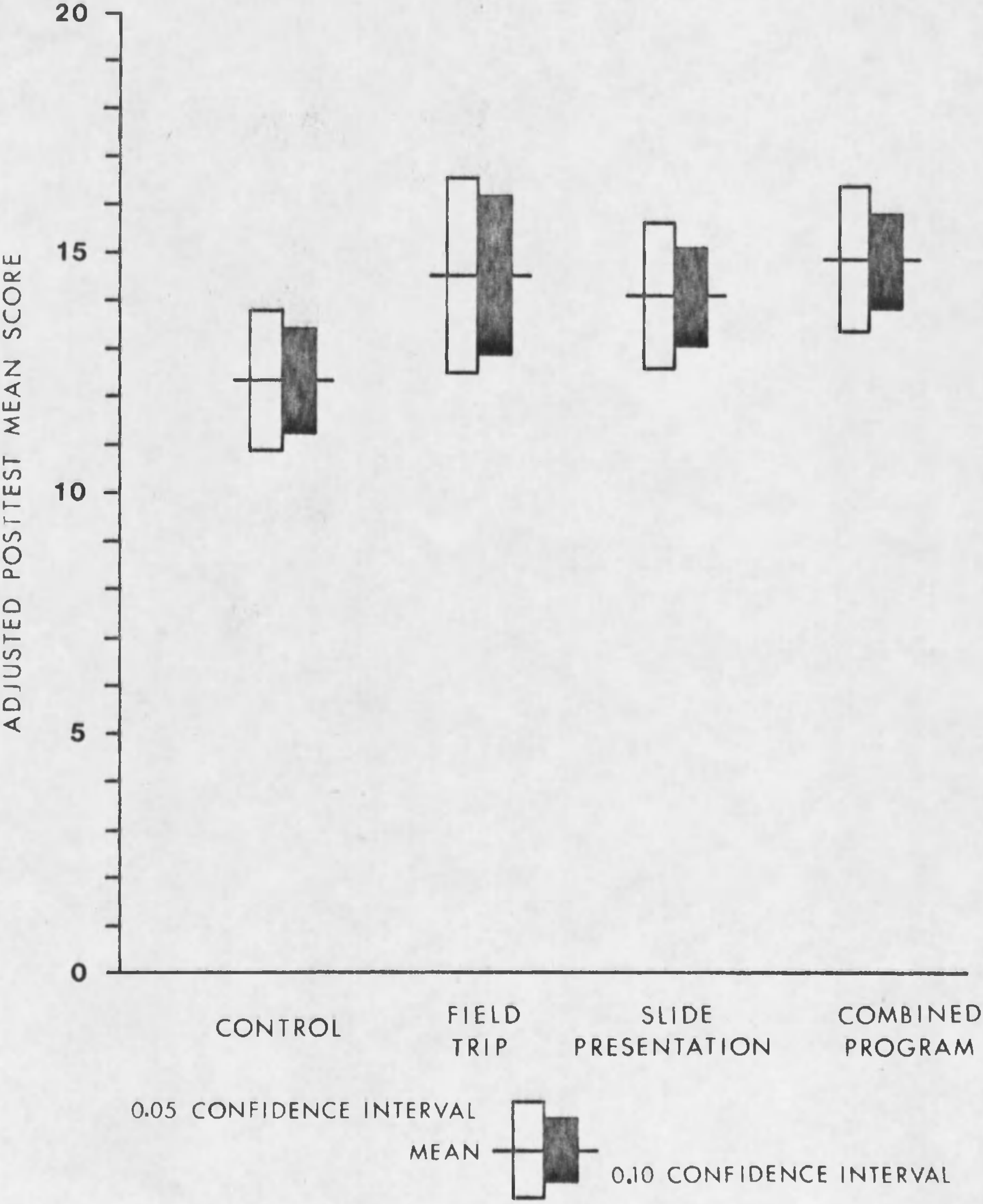

Figure 4. Adjusted Treatment Means with .10 and .05 Confidence Intervals

$$S_Y^2 \times [1 + \frac{T_{xx}}{(T-1)(E_{xx})}]$$

For the data presented in Table 3, the above equation translates into:

$$1.54\ [1 + \frac{.64}{(3)(7.52)}] = 1.58$$

2. The error mean square before adjustment is given by:

$$\frac{E_{yy}}{(r-1)(T-1)} = \frac{17.14}{9} = 1.90$$

3. The percentage increase in precision due to covariance is calculated as:

$$\frac{1.90}{1.58}\ (100) = 121\%$$

The 121 per cent value indicates that an increase in precision due to the strategy selected is 21 per cent. That is to say, if the study were to be repeated, it would require 121 replications without covariance to equal the precision of 100 replications with covariance or an improvement ratio of approximately 6 to 5. The technique selected did produce an increase in the precision and, therefore, the use of analysis of covariance as a means to reduce error, seems to be justified.

Analysis of Tape Recordings

The second objective of the study, as discussed in the introductory chapter of the report dealt specifically with an examination of the differences, if any, between the two general methods of instruction (the slide presentation and the field trip) as related to their potential to elicit student participation and interest in discussions. The data gathering technique used to assess these possible differences was tape recordings made of unsolicited questions and comments made by respondents to the researcher while the participating classes were in the field or in their own classrooms.

Since a major problem in education, as identified by McClelland (1972) is getting the attention of the audience, it was felt that by recording these responses, an indicator of the method's potential to stimulate interest and thought would be provided. McClelland (1972, p. 23) states, "Getting attention seems to be largely a function of exposing a person to stimuli which are moderately discrepant from expectation. That is, if what happens is fully expected, it is experienced as routine and boring. If it is totally unexpected, it is shocking, disorganized and experienced as unpleasant." Because the two methods tested are used primarily to provide experiences, the child or class would not ordinarily have, a measure of their potential to elicit interest was considered to be important in assessing treatment differences as related to other learning areas. While much of the dialogue recorded did not directly relate to the subject matter presented in the treatments, the data were easily collected and applicable to simple frequency analysis.

Initially, the examination of the tapes involved a review of the recordings in order to transcribe individual questions and comments into a written response list, which was then categorized by treatment type, into the final response list to be used for the analysis. If a series of responses were made at one time, only one response was recorded for that series so as to attempt to negate the synergistic effect of other questions and comments and avoid measuring responses keyed by student discussions. In total, the taped conversations lasted approximately 31 minutes. For the purposes of the study, only those questions and comments dealing with the subject matter of the presentation were transcribed. For example, questions such as "how does the weather thing know how hot or cold it is?" were retained as they relate directly to the concepts discussed. Questions such as "where is the bathroom?" or "what time is it?" were not used, because they provide no information regarding the uniqueness of the presentations and were not related to the evaluation under discussion. Through this process, the 31 minute tape was reduced to a final working total of 28 responses, with the complete response list being given in Appendix E.

The second and final step of the analysis was to subject the transcribed data to Chi-square analysis to determine if differences between the presentations, as related to the number of responses made during each type existed. In this case, the null hypothesis was that there were no differences between presentations. Since the total number of observed responses was 28, the expected number of responses for each treatment would be 14, i.e., half for each type of presentation. Observed frequencies for each presentation were 23 for the field trip and 5 for the slide program. For one degree of freedom, the test of independence is as follows:

$$X^2 = \frac{(23 - 14)^2}{14} + \frac{(5 - 14)^2}{14} = 11.57$$

Since the critical value at the .01 level of significance is 6.64, it is concluded that there is, in fact, a relationship between the methods of instruction and the number of responses made. Therefore, the null hypothesis of independence is rejected.

Results. The results of the analysis of the tape recordings suggest that differences in the methods of instruction did exist as related to their potential to elicit questions and comments about the subject matter. In this regard, the field trip presentation was the most effective of the two methods evaluated. While not identical to the results of the previous analysis, the findings are similar in that the relative effects of the slide presentation and field trip remain the same. Since no definitive statement about the comparative effectiveness of the methods could be made, due to the insensitivity of the evaluative instrument and other sources of variation, conclusions drawn at that time as to the ordering of treatment effects were termed trends or indications. With the addition of the findings of the second analysis, however, these trends appear to be more substantial.

In a previous section of the report concerning the primary analysis problem, discussions indicated that the evaluative instrument, while being developed to measure at all levels of the cognitive domain, actually included questions which were appropriate for only the four lower levels of the taxonomy, i.e., knowledge, comprehension, application, and analysis. Because a large number of questions were lost due to their level of difficulty and/or failure to discriminate, it became evident that the majority of the remaining questions measured only knowledge and comprehension, and to this end, neither method was shown to be statistically superior. How then do these two analyses, obviously measuring two different aspects of learning, support each other?

In the introduction of this report, the goals of environmental education, as developed at the Alliance for Environmental Education Conference (Schafer and Disinger, 1975, p. 7) were discussed. In general, these goals were aimed at developing desirable human behavior patterns in regards to the environment by helping to "develop" citizens who are knowledgeable and interested in ecological matters and who also possess favorable values, attitudes, and concern for environmental quality. In the opinion of the researcher, the key phrases to be emphasized in these goals are: (1) valuing process, and (2) environmental literacy. While the evaluative instrument did measure, to some degree, class cognitive skills as related to their knowledge and comprehension of the subject matter, class skills as related to a second learning domain or what Krathwohl, Bloom, and Masia (1964) termed the affective domain were not. This learning area deals with attitudes, appreciation and values and, according to Krathwohl et al. (1964), is made up of a continuum of five levels, which include: (1) receiving, or the level in which the subject is willing to become aware of what is said or what is seen; (2) responding, or when the subject is willing to respond to questions or act voluntarily; (3) valuing, in which the subject becomes involved and committed toward a cause or belief; (4) organization, or the level in which the subject attempts to involve others in a valued activity; and (5) characterization, the final stage in which the subject's philosophy of life is determined. While the tape recordings did not measure at all of the levels listed, it did, in conjunction with the evaluative instrument, examine both the receiving and responding levels. Admittedly, the recorded responses are not adequate to measure attitudes but, if affective learning theory is correct, they do provide an indicator of the methods of instruction's ability to stimulate the class, thereby providing a measure of their potential for affecting learning and possible attitude development. In this regard, Millward (1970, pp. 25-26), in his discussion of the affective domain, developed four dimensions of affective behavior. He states, "the first dimension might be referred to as an 'area of behavior transmission.' All potential ideas, cognitions and attitudes are received in this dimension." Some stimuli are received and rejected while others are retained and reinforced. The longer the stimuli is retained, the greater the potential for behavior change. Millward's second affective dimension relates to the degree to which the individual becomes committed and opinionated. Millward says of this dimension, ". . . there are strong indications that the individual is on the threshold of attitude formation--behavior becomes more consistent and less inclined to change." From this, ". . . beliefs and opinions are indicators of attitude--useful in forecasting attitude direction" (p. 25). The third and fourth dimensions relate directly to the development of attitudes and values and the formation of personal or group philosophies of life. The number of responses recorded is considered to be a measure of Millward's second dimension, and while it is acknowledged that attitude measurement is beyond the capability of both the evaluative instrument and the tape recordings, the potential for attitude formation may be measured by these two techniques. When compared, the methods did differ in the degree to which classes were willing to respond with the field trip being the most effective method, primarily due to the first-hand nature of the experience and the increased sensory stimuli provided. Tilden (1967, p. 50) has discussed this factor when dealing with children. He indicates that children love to examine things personally through all of their senses rather than relying solely on sight and sound. The field experience, unlike the slide presentation, offers the advantage of full sensory stimulation in a relatively natural context. While items such as plants and animals may be brought into the classroom to augment a slide program which in itself is designed to provide unusual experiences and stimuli, the potential for disorganization or lack of stimulation is high as McClelland (1972, p. 27) states: "It is a common observation that it is the people who make the slide shows, set up the equipment, worry about the conditions of projection, take the pictures, edit the sound tapes, etc., who genuinely participate and probably develop some achievement motivation in the process. Unfortunately, the audience ordinarily does not participate. It just watches and listens." If the purpose of the presentation is to provide information, that is, oriented toward cognitive skills, both methods are equally effective. If, however, the goal of the presentation is directed at affective objectives as well as information, the field trip appears to be superior due to its ability to elicit responses from classes, increase their interest, and make them more willing to participate in the learning experience. While many practical considerations must be evaluated when making the decision to commit resources to an environmental education program, the findings of the research suggest the field trip is the superior method.

CHAPTER 4

SUMMARY AND CONCLUSIONS

The primary objective of this study was to determine the comparative effectiveness of three methods of teaching environmental concepts in public schools with the methods being: (1) slide presentation, (2) field trip, and (3) a combined program consisting of both the slide presentation and the field trip. A secondary objective of the research was to examine the differences, if any, between the two general methods of instruction, i.e., the slide presentation and field trip, as related to their potential to elicit student participation and interest in discussions. The major concern of this second objective was to aid in the interpretation of the findings of the primary analysis objective. Although the intent of the researcher was to investigate these specific research problems in the context of a public school situation generalization of the results to natural resource agencies dealing in environmental education as well as schools was a major consideration. In the remaining sections of this chapter, the following topics will be discussed: (1) a summary of the procedures and presentation of the major findings, (2) a statement of conclusions based on the findings developed, and (3) implications and recommendations of the study as related to the selection process discussed in the introduction.

Summary of Procedures

The procedural steps of the research project are divided into five major phases:

1. Investigation of the district selected for study as related to the research design to be utilized.
2. Development of the slide presentation and field trip.
3. Development of the evaluative instrument.
4. Administration of the pretest, experimental treatments, and the posttest.
5. Analysis of the data collected.

In the following paragraphs, each of the research phases above will be discussed in greater detail.

Phase 1 of the research dealt specifically with the selection of the research design and analysis unit to be used for the study. Because the population residing within the boundaries of the Amphitheater School District contained a high degree of variation on such characteristics as income, racial and ethnic composition, and education, the decision to utilize the randomized complete block research design was made in order to separate the sample population into homogeneious subregions and, therefore, place the majority of inherent variation in the sample between blocks rather than within. Rationale used for blocking was local neighborhood characteristics, as schools in each local area are populated with children from that region. To maintain greater experimental control and provide increased cooperation between the district and the researcher, sixth grade classes taken in their entirety were selected as the unit of analysis. In total, 16 sixth grade classes composed of 376 students of the Amphitheater School District were used in the project with all classes being grouped into four sampling blocks of four classes each.

Research phase 2 dealt with the development of the method of instruction, i.e., slide presentation and field trip. The intent of the researcher was to prepare two identical presentations which differed only in the medium used to present the subject matter and in the location of the lesson. To accomplish this, a general program utilizing a number of concepts dealing with the theme, "man in the environment," was developed, with the concepts emphasized being taken from: (1) the Elementary Teachers Guide for Environmental Education (Hernbrode and Kennedy, 1974, p. 1), and (2) Robert Roth's (1970, pp. 65-74) Taxonomic List of Environmental Concepts. Upon completion of the general program, an intensive inventory of the selected field trip site at Tumamoc Hill Environmental Study Area was conducted. Once the proposed field trip route was determined, 72 color slides were photographed so as to illustrate the items and concepts contained on the route for the slide presentation treatment. The final step in the development of the methods of instruction was to prepare a dialogue which could be used for both treatment types. In total, each presentation required one hour with the combined program lasting two hours.

Phase three of the research involved the development of the primary evaluative instrument used to measure treatment effects with the source for test questions being the dialogue employed to present the general program. Once questions were prepared, each was reviewed by faculty members of the School of Renewable Natural Resources and the College of Education as to their readability and content. Through this review process, the initial total of 80 questions was reduced to a final list of 56 items which was then divided in half through a random process to make up the pretest and posttest. In addition to questions, the instrument also contained an instructional section in which information such as student names, ages, and sex were collected as well as providing a word list, arranged alphabetically and defined in simple terms to aid the respondent in answering the questions.

A second method of data collection utilized in phase three of the analysis was tape recordings made of unsolicited questions and comments made by respondents in order to evaluate each presentation type as to its potential to elicit student participation and interest in discussions.

Phase four of the project primarily consisted of the presentation phase during which all 16 participating classes were pretested, then subjected to their randomly assigned presentation treatment, and finally posttested. To allow for class rosters to stabilize, pretests were administered over a one-day period approximately two weeks after the beginning of the school year. Once completed, the presentation phase began with one block of four classes being taught each week over a period of one month. To control for any systematic improvement in the presentations, treatment assignment was varied at random for each block. Posttests were administered from three to five days after the assigned treatment was given with the time lag being designed to make all days of the week available for presentation dates.

Phase five of the research involved the analysis of: (1) the evaluative instrument as related to its reliability and test item quality, (2) the effectiveness of the methods of instruction as measured by class responses on the instrument, and (3) the frequency of recorded responses made by students while in the classroom or in the field. Of these evaluations, numbers two and three dealt specifically with the two objectives of the study. The analysis strategy for testing for treatment effectiveness was analysis of covariance in which pretreatment differences were controlled by regressing observed pretest mean scores on observed posttest mean scores with analysis of variance being conducted on the resulting adjusted posttest means. Individual treatment differences were examined using pair-wise comparison contrasts between adjusted treatment scores. In regards to the tape recording a review was made concerning the number of questions and comments made during each presentation type with the resulting data subjected to chi-square analysis.

Summary of Findings

The evaluative instrument used for the analysis of treatment effects was shown to have an overall reliability (coefficient alpha, Cronbach, 1951, pp. 297-334) of .70 with the pretest reliability being .45 and the posttest value being .63. Content validity of the instrument was determined through a review of the subject matter of the presentations and, for the purposes of the research, the instrument was found to be a valid measuring device.

In terms of the findings of the primary analysis objective, that of determining the differences in effectiveness of the slide presentation, field trip, and a combined program of both presentation types, the data collected from the evaluation instrument indicate the following:

1. The instrument, while being designed to sample from all levels of Bloom's (1956, p. 18) cognitive taxonomy, was determined to measure only learning objectives within the lower four levels; i.e., knowledge, comprehension, application, and analysis.

Cognitive objectives referring to synthesis and evaluation were not sampled as the format of the test was found to be inappropriate.

2. Mean scores for classes receiving the three methods of instruction were found to be statistically different from the group of classes not receiving instruction via the methods tested when evaluated at the .10 level of significance.
3. No statistically significant differences were demonstrated between the three methods of instruction tested, but in terms of their relative effects, the trends developed from the data indicate the combined program produced the highest adjusted posttest scores followed in order by the field trip presentation and slide program.

Findings of the second analysis problem dealing with the determination of the differences, if any, between the two primary teaching methods using tape recordings of unsolicited questions and comments made by class members about the general subject matter suggest:

1. While not measuring at all levels of the affective domain (Krathwohl et al., 1964), the tapes were measuring the two lower levels of the taxonomy; that is, receiving and responding and, therefore,

provided an indication of the methods' potential for learning in the affective domain.

2. Significant differences between the methods of instruction were found when evaluated at the .01 level of significance within the field trip program producing the highest number of responses.

Conclusions

As stated in the justification of this report, the primary reason for conducting this research endeavor was to aid school district administrators and natural resource agency personnel interested in environmental education in making objective decisions as to the use of slide presentations and field trips by comparing their relative effectiveness in teaching certain cognitive and affective learning skills. In terms of the findings of the project, the following conclusions, within the limitations of the data, are warranted:

1. Each method of instruction is equally effective in teaching cognitive learning objectives such as concepts, facts, and principles as they relate to environmental education and their use for such purposes is recommended.
2. The field trip program, due to its location and setting, increased classes' willingness to respond thereby possibly providing a greater potential for

affective learning development in the field of environmental education. For the affective objectives of receiving and responding the use of the field trip is encouraged.

Implications and Recommendations

How do the findings developed in this study aid school district and resource agency decision-makers in selecting the field trip and slide presentation as teaching methods for environmental education instruction? First, the study provides some information about each method's relative effectiveness in teaching basic cognitive learning skills such as the recall of facts, concepts, and terms. In this regard, both the field trip and slide program were found to increase test performance in these areas over scores obtained by classes not receiving such instruction. Results also indicate that both methods were approximately equal in their effectiveness as no significant differences in adjusted posttest mean scores could be demonstrated. For the purposes of providing a source of information, decision-makers would seem to be justified in their selection of either method used alone, as the combined program was not found to differ from the two primary teaching techniques. Concededly, however, the instruments used to evaluate method effectiveness did not cover all levels of the cognitive taxonomy and essentially measured what the students in each class heard. The location and medium used for instruction appear to have had no differential effect on learning. Also, since the evaluative instrument was administered shortly after the presentations, it is not known if long term improvements in learning have been achieved or if the gains demonstrated were only short term in nature. In terms of future research projects, if the instrument in the study is to be employed, revisions to improve its reliability and therefore its utility as a measuring device are necessary. In addition, an evaluation of question content should be carried out so as to be able to measure the upper levels of the cognitive domain. Kropp and Stoker (1966, p. 172) suggest an alternative to the multiple-choice test for examining the synthesis and evaluation levels with free answer or essay tests being the primary method of examination. While providing a means to test these levels, the time and subjectivity in scoring answers make them less desirable than the multiple-choice format and for this reason they were not used for the project. As a final comment on testing, follow-up examinations at longer time intervals might shed some light on each method's long term learning potential, thereby providing an indicator of the "carry over" in effectiveness to upper grade levels.

Second, findings suggest that potential differences between the methods tested exist as related to certain affective learning skills. While the method of evaluation was not a true affective instrument, marked differences in students' willingness to respond were found. The experiences presented in the field apparently subjected the classes to a greater amount of sensory stimuli, thereby increasing class participation in the learning experience. If the objective of the instruction is to be directed toward affective learning goals, the choice of some type of field experience over in-classroom instruction via slides is indicated. This does not mean, however, that special outdoor areas such as Tumamoc Hill Environmental Study Area would have to be developed as the outdoor excursion could take place on the school grounds as well as on local sites set aside for such purposes. In terms of future research, true affective instruments such as semantic differential or attitude scales (Likert, Thurstone, Guttman) should be developed so as to examine the effects of the methods on attitude formation and change. Wheatly (1975, pp. 409-413) outlines some promising examples which could be adapted to the subject matter presented in this study. In this way, a more definitive statement could be made about the comparative effectiveness of the methods of instruction in this second learning domain.

The results, while not being conclusive, do show promise in aiding decision-makers to cope with difficult decisions about environmental education, and more specifically to the use of the two techniques evaluated here.

Other recommendations suggested by the findings of the reeearch relate to the evaluation of the methods tested and the use of the in-classroom lecture; i.e., with no visual presentation. In doing so, questions concerning what the classes saw and what they heard might be resolved. A suggested method might involve a refinement of the evaluative instrument with special attention being paid to the improvement of questions developed so as to be able to discriminate between the dialogue presented and what was seen while in the field and on the projection screen.

As a concluding remark, research results presented here must be evaluated in relation to the overall environmental education program existing within school district curricula. Factors such as the degree of ease that the method of instruction can be included into the curriculum, instructor preferences, the intended audience, and fiscal considerations will all affect the overall outcome of the selection process. Because the primary purpose of the two methods tested is to provide educational experiences for the class that they might not ordinarily receive, their use can only be justified as a supplement to regular classroom instruction in environmental education. They should not be relied upon as the sole instructional technique. The intent of the researcher was to simulate, as closely as possible, the circumstances normally experienced by outside resource personnel when being asked to speak to a school class. The usual time of exposure to the subject matter, in most instances, is brief; that is, from one to two hours. The learning potential, much like the experience itself, is limited. The increase in class performance by the methods tested over the control group was approximately 2.7 points out of 28 questions or a 9.5 per cent improvement for the combined program, 2.2 points or 7.8 per cent for the field trip, and 1.8 points or 6 per cent for the slide presentation. These values, while being statistically significant, may not be significant in an educational sense, especially if utilized as the only instruction provided. As a supplement to other environmental education activities such as simulation games, personal inquiry, or class problem-solving projects, both methods can add to the learning atmosphere and help provide a context for study. With the goals of environmental education being to encourage children to become involved in environmental and resource conservation issues and to ultimately evolve a society willing to live according to basic ecological rules, the field trip and slide presentation have, and will continue to have, a place in the curriculum. The results of this study suggest that no one method alone can achieve these goals, so in terms of choices, the decision to rely on one method at the expense of the other should raise important questions in the minds of administrators, teachers, and managers about the quality and breadth of the environmental education instruction provided. The commitment to a curriculum-wide program is imperative (Brown, 1971); that is, one in which a variety of subjects and techniques are utilized to convey the ideas and concepts needed to make accurate observations and judgments about environmental matters. Dressel and Mayhew (1954) discuss the effect of isolated instruction and its relation to overall curriculum development. They found that gains in critical thinking skills attained through a single course of instruction are limited, but that when students are subjected to a curriculum-wide program, the gains observed become increasingly large. While this project did not deal with college programs such as the case for Dressel and Mayhew, similar results would seem to apply to the sixth grade children utilized here. Educators as well as resource agencies must develop comprehensive programs that utilize varied approaches to instruction. Included in these would be the two methods tested in this project.

Hopefully this study will serve as a first step for future research in environmental education and encourage educators, resource agencies, and students interested in environmental education to initiate studies aimed at evaluating their programs and methods so that objective decisions, based upon established research procedures can be made. John Hendee (1972, p. 22) emphasizes the importance of this first step in environmental education:

The traditional intuitive, subjective approach to environmental education is not good enough, and efforts have too long been dominated by folklore and possibly wishful thinking. Let's do the job right by establishing a high quality program of research commensurate with the importance of environmental education.

APPENDIX A

FIGURES OF PER CENT OF ALL FAMILIES WITH INCOMES BELOW $3,999 AND MINORITY ETHNIC COMPOSITION FOR EASTERN PIMA COUNTY

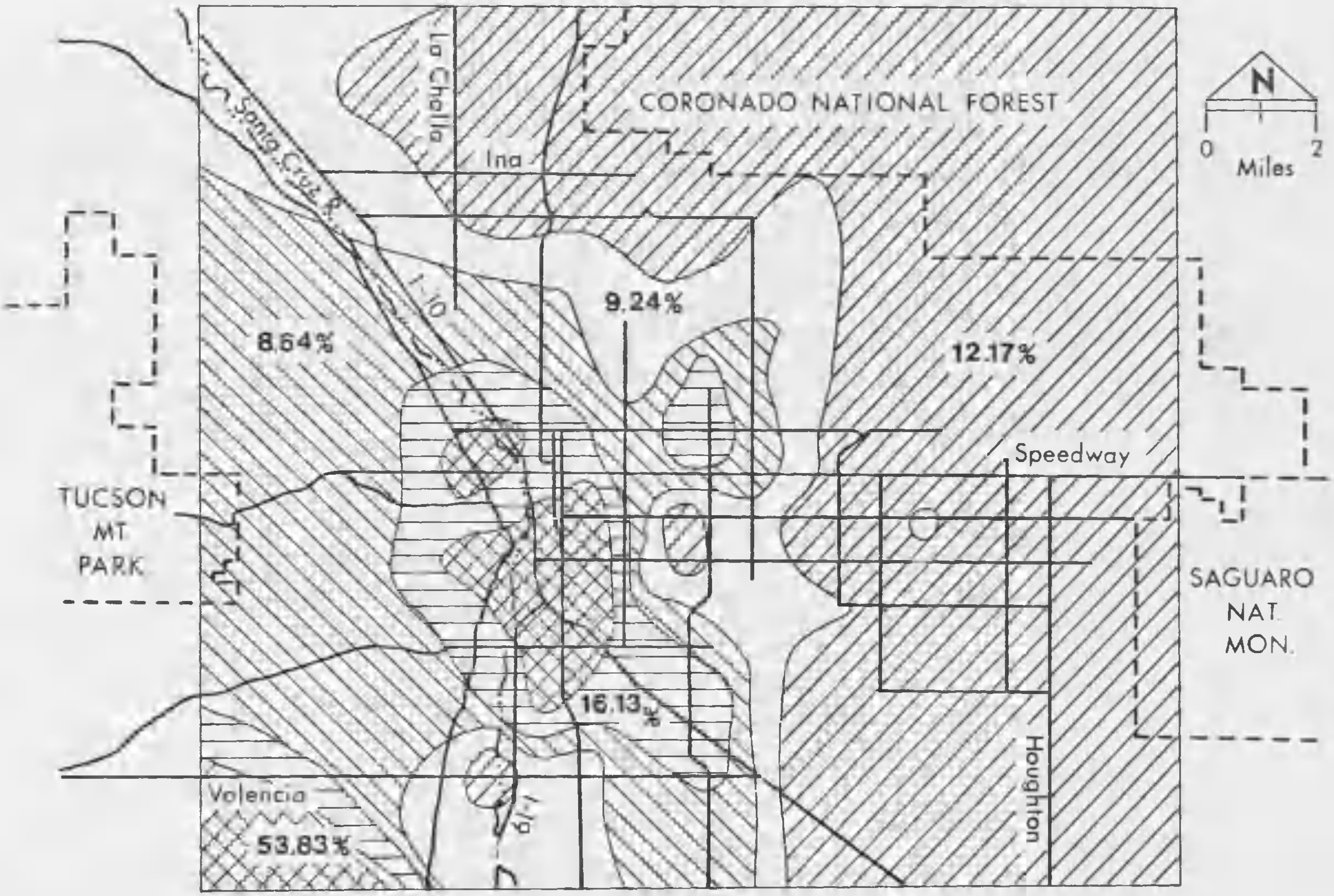

Figure A.1. Percentage of All Families with Income Below $3,999 -- Data obtained from Comprehensive Planning Process (1975, pp. 34-35).

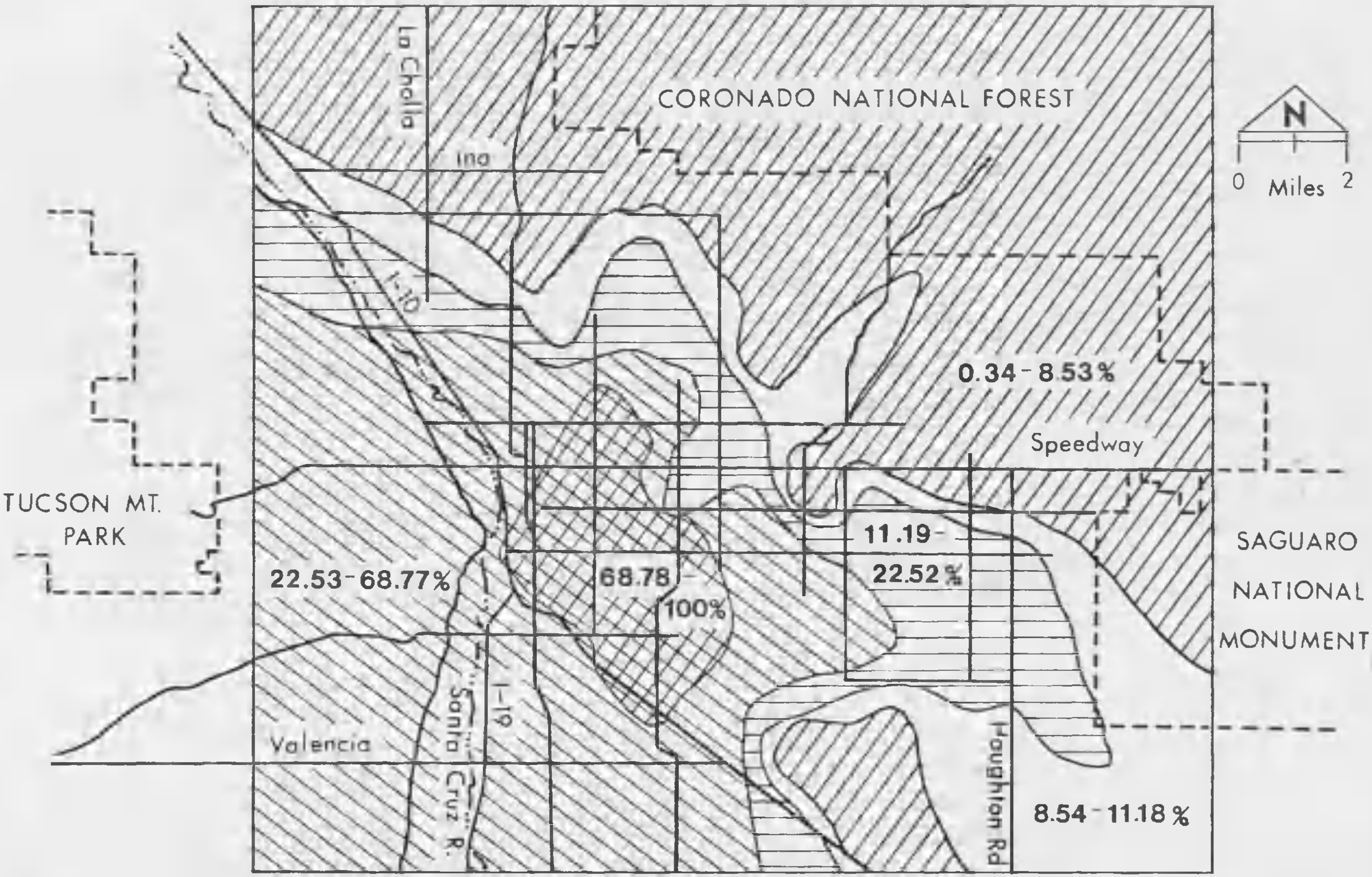

Figure A.2. Minority Ethnic Composition -- Data obtained from Comprehensive Planning Process (1975, pp. 36-37).

APPENDIX B

TREATMENT ASSIGNMENT SCHEDULE

Block Number	Pretest Date	Teacher[a]	Treatment Assignment[b]	Presentation Date	Posttest Date
1	Sept. 5	A	2	Sept. 8 (Mon)	Sept. 11 (Thu)
1	Sept. 5	B	1	Sept. 9 (Tue)	Sept. 12 (Fri)
1	Sept. 5	C	3a-slide	Sept. 9 (Tue)	
			b-field	Sept. 10 (Wed)	Sept. 15 (Mon)
1	Sept. 5	D	4	None	Sept. 15 (Mon)
2	Sept. 5	E	4	None	Sept. 22 (Mon)
2	Sept. 5	F	2	Sept. 15 (Mon)	Sept. 18 (Thu)
2	Sept. 5	G	1	Sept. 16 (Tue)	Sept. 19 (Fri)
2	Sept. 5	H	3a-slide	Sept. 16 (Tue)	
			b-field	Sept. 17 (Wed)	Sept. 22 (Mon)
3	Sept. 5	I	2	Sept. 22 (Mon)	Sept. 25 (Thu)
3	Sept. 5	J	3a-field	Sept. 24 (Wed)	
			b-slide	Sept. 25 (Thu)	Sept. 29 (Mon)
3	Sept. 5	K	1	Sept. 26 (Fri)	Sept. 29 (Mon)
3	Sept. 5	L	4	None	Sept. 29 (Mon)
4	Sept. 5	M	1	Sept. 29 (Mon)	Oct. 3 (Fri)
4	Sept. 5	N	2	Oct. 1 (Wed)	Oct. 6 (Mon)
4	Sept. 5	O	4	None	Oct. 6 (Mon)
4	Sept. 5	P	3a-slide	Oct. 2 (Thu)	
			b-field	Oct. 3 (Fri)	Oct. 6 (Mon)

[a]Due to the nature of the information obtained from the class, the names of the individual instructors participating cannot be divulged.

[b]The treatments were assigned in a random manner with the order of presentation for each block being as listed above. The treatments are: (1) slide presentation, (2) field trip, (3) combination of both the field trip and slide presentation, and (4) control.

APPENDIX C

PRETEST

This is to find out what you know about the desert. Your answers will not be graded. Please circle the number of the answer you think is best. If you do not know an answer, then guess.

My name is ____________________

I am _____ years old.

I had my last birthday _____ months ago.

I am a boy or a girl (circle one).

These are some words you might need to know to mark your answer. If you do not know a word, ask your teacher.

Adaptation (ăd ăp·tā shŭn) -- a change to help a plant or animal live.
Behavioral (bē hāv´yêr ăl) -- how something acts.
Climate (klī´mĭt) -- the weather over a large area.
Deals (dēlz) -- to do with.
Decomposer (dē´kŏm·pōz´er) -- a thing that eats dead things.
Ecosystem (ē kō sĭs´tĕm) -- the earth and all living things.
Energy (ĕn´ĕr jĭ) -- food or power.
Limiter (lĭm´ĭ·tĕr) -- a thing that controls.
Nonrenewable (nŏn rē·nū´ā´b'l) -- a thing that can not make itself.
Physical (fĭz´ĭ·kăl) -- how something looks or is made.
Product (prŏd´ŭkt) -- a thing that is made.
Renewable (rē·nū´a´b'l) -- a thing that can make itself.
Temperature (tĕm´pĕr·å´tūr) -- how cold or hot it is.
Transfer (trăns´fûr) -- to pass or give to another.
Weather (wĕth´ĕr) -- if it is raining, sunny, windy, hot, or cold.

1. Water is _____ in the desert.
   (1) not important
   (2) least important
   (3) just as important as other things
   (4) most important

2. If you dig up a cactus and move it to Mt. Lemmon, what may happen:
   (1) it will die because there are no other cactus living there
   (2) it will live just as well as in the desert
   (3) it will drop its leaves
   (4) it will die because it's cold

3. Ecosystems have parts that act on each other:
   (1) all of the time
   (2) only once
   (3) none of the time

4. Producers are:
   (1) animals
   (2) plants
   (3) soil
   (4) nonliving things

5. A herbivore eats:
   (1) meat
   (2) soil
   (3) dead plants and animals
   (4) plants

6. The three kinds of consumers are:
   (1) plant eaters, meat eaters, decomposers
   (2) plant eaters, seed eaters, soil eaters
   (3) meat eaters, decomposers, seed eaters
   (4) man, dogs, cats

7. Choose the right order for a food chain:
   (1) plant eaters, meat eaters, decomposers
   (2) meat eaters, plant eaters, decomposers
   (3) producers, consumers, decomposers
   (4) plant eaters, meat eaters, plants, decomposers

8. A parasite:
   (1) eats soil
   (2) kills its food
   (3) does not kill its food

9. If we put a bag over a branch of a tree, and we find water, the water comes from:
   (1) water in the air
   (2) the tree
   (3) the soil
   (4) rain drops

10. Trees and bushes:
    (1) help to hide animals
    (2) shade other plants
    (3) put water into the air
    (4) all of these
    (5) none of these

11. The water cycle deals with:
    (1) animals and climate
    (2) plants and climate
    (3) plants and animals
    (4) climate only

12. An escaper plant:
    (1) lives its life in one year
    (2) drops its leaves during hot weather
    (3) stores water in its body
    (4) moves to escape hot weather.

13. An evader plant:
    (1) lives its life in one year
    (2) drops its leaves during hot weather
    (3) stores water in its body
    (4) moves to evade hot weather

14. Escaper plants spend hot weather as:
    (1) leaves
    (2) seeds
    (3) roots
    (4) flowers

15. Which of these is a resister:
    (1) a tree
    (2) a bush
    (3) a cactus
    (4) an animal

16. The thorns on desert plants:
    (1) keep it from being eaten
    (2) are used to make flowers
    (3) are used to make clothes
    (4) help keep space between plants

17. Desert plants:
    (1) need little water
    (2) can live in cold climates
    (3) have no enemies
    (4) lose water to the air

18. The adaptations of animals are different from plants in that:
    (1) they also have behavioral adaptations
    (2) they do not use water
    (3) they are not in food chains
    (4) they are not different from plants

19. Which of these adaptations is behavioral:
    (1) skin color
    (2) long tails
    (3) growing hair
    (4) being active at night

20. The most important behavioral adaptations of man are:
    (1) his brain and hands
    (2) his eyes and ears
    (3) the things that he builds

21. If adaptations of living things are made to the ecosystem, this means that living things:
    (1) do not need the ecosystem
    (2) control their living area
    (3) fear their living area
    (4) are a product of their living area

22. We call the things that we take from the ecosystem:
    (1) man-made resources
    (2) natural resources
    (3) wastes
    (4) pollution

23. Choose the renewable natural resource:
    (1) coal
    (2) iron
    (3) animals
    (4) oil

24. Pollution is:
    (1) a man-made thing added to the ecosystem which has a bad effect
    (2) a man-made thing added to the ecosystem which has a good effect
    (3) a natural thing added to the ecosystem which has a good effect
    (4) a natural thing added to the ecosystem which has a bad effect

25. Many of the things man puts back into the ecosystem can:
(1) be eaten by decomposers
(2) not eaten by decomposers
(3) both 1 and 2
(4) not 1 or 2

26. The government:
(1) is not important in changing the ecosystem
(2) is important in changing the ecosystem

27. A good way we can make sure that the ecosystem is working well is to:
(1) learn what it needs
(2) make new resources
(3) use more resources
(4) do nothing

28. Conservation means:
(1) we must not use the ecosystem
(2) we must use the ecosystem
(3) we must use and take care of the ecosystem
(4) none of these

APPENDIX D

POSTTEST

This is to find out what you have learned about the desert in the last few weeks. Your answers will not be graded. Please circle the number of the answer that you think is best. If you do not know an answer, then guess.

My name is ____________________________

____

These are some words that you might need to know to mark your answer. If you do not know a word, ask your teacher.

Adaptation (ăd´ăp·tā´shŭn) -- a change to help a plant or animal live.
Behavioral (bē hāv´yẽr ăl) -- how something acts.
Climate (klī´mĭt) -- the weather over a large area.
Deals (dēlz) -- to do with.
Decomposer (dē´kŏm·pōz´ẽr) -- a thing that eats dead things.
Ecosystem (ē kō sĭs´tĕm) -- the earth and all living things.
Energy (ĕn´ẽr·jĭ) -- food or power
Limiter (lĭm´i·tẽr) -- a thing that controls.
Nonrenewable (nŏn rē·nū´ā´b'l) -- a thing that can not make itself.
Physical (fĭz´ĭ·kăl) -- how something looks or is made.
Product (prŏd´ŭkt) -- a thing that is made.
Temperature (tĕm´pẽr·ȧ´tūr) -- how cold or hot it is.
Transfer (trăns´fûr) -- to pass or give to another.
Weather (wĕth´ẽr) -- if it is raining, sunny, windy, hot, or cold.

1. The ecosystem is made of:
   (1) parts
   (2) parts that act on each other
   (3) parts that do not act on each other
   (4) none of these

2. The parts of the ecosystem are:
   (1) land and sea
   (2) soil and water
   (3) living and nonliving

3. The source of all energy for life is:
(1) sunlight
(2) wind
(3) falling water
(4) air

4. Plants make food:
(1) in the dark
(2) in the sunlight
(3) both 1 and 2
(4) at midnight

5. The nonliving part of the ecosystem is made of:
(1) things which have never lived
(2) things which are dead
(3) all of these
(4) none of these

6. The great limiter of all things is:
(1) soil
(2) trees
(3) living things
(4) climate

7. Large consumers are:
(1) all living things
(2) animals
(3) plants
(4) decomposers

8. A carnivore eats:
(1) soil
(2) plants
(3) dead plants and animals
(4) meat

9. A predator:
(1) kills its food
(2) does not kill its food
(3) eats plants
(4) eats soil

10. What thing is most important to desert plants and animals:
(1) temperature
(2) wind
(3) soil
(4) water

11. There are fewer meat eaters than plant eaters because:
    (1) there is less food for meat eaters
    (2) the desert is not a good place to live
    (3) the climate is too hot
    (4) none of these

12. Humidity is:
    (1) the low temperature of the day
    (2) water in a lake
    (3) water in the air
    (4) water in the soil

13. The thick skins of insects and snakes is an adaptation to:
    (1) let it hide in cactus
    (2) keep it from losing water
    (3) make it heavy

14. A resister plant:
    (1) drops its leaves during hot weather
    (2) stores water in its body
    (3) lives its life in one year
    (4) moves to resist hot weather

15. Man's food chains are:
    (1) short
    (2) long
    (3) slow
    (4) fast

16. Animals that live in holes do so:
    (1) to find food
    (2) to make soil hard
    (3) to save water and hide from hot weather
    (4) so that we can study them

17. A behavioral adaptation of lizards is:
    (1) cold blood
    (2) to have skin with scales
    (3) run fast across the sand
    (4) light-colored skin

18. There is a _____ of energy at each transfer along a food chain:
    (1) gain
    (2) loss
    (3) no change

19. Man's physical adaptations are:
(1) limited
(2) unlimited
(3) not important

20. Man ______ use the ecosystem:
(1) must not
(2) can not
(3) must

21. Natural resources are:
(1) renewable
(2) nonrenewable
(3) both 1 and 2
(4) not 1 or 2

22. Choose a renewable natural resource:
(1) oil
(2) steel
(3) coal
(4) plants

23. Choose a nonrenewable natural resource:
(1) oil
(2) animals
(3) plants
(4) timber

24. The changes that man makes in the ecosystem differ from changes in nature in that:
(1) man does not make changes
(2) the ecosystem does not change
(3) man makes fast changes
(4) man makes changes only in the city

25. If you keep plants on the soil, we may do all of these <u>but</u>:
(1) keep water in the soil
(2) keep soil in its place
(3) dry up wells
(4) make floods smaller

26. Man is:
(1) good to the ecosystem
(2) bad to the ecosystem
(3) not a part of the ecosystem
(4) both 1 and 2

27. If houses are built on a hill, what might happen to houses at the bottom of the hill:
    (1) it would make the hill look better
    (2) they might be flooded
    (3) floods would be smaller
    (4) nothing would happen

28. Man changes:
    (1) <u>to</u> the ecosystem
    (2) <u>no</u>thing
    (3) the ecosystem <u>to</u> <u>him</u>

29. Did you enjoy the slide talk or field trip:
    (1) yes
    (2) no
    (3) I did not have a field trip or slide talk

APPENDIX E

TABLE OF EASINESS PERCENTAGES, BISERIAL CORRELATION COEFFICIENTS AND PERCENTAGE RESPONSE RATES FOR EACH TEST ITEM ALTERNATIVE

Table E.1. Easiness Percentages, Biserial Correlation Coefficients and Percentage Response Rates for Each Test Item Alternative

Test Item	Test[a]	Easiness Percentage[b]	Biserial Correlation Coefficient	Item Alternative Percentage[c]					
				0	1	2	3	4	5
1	1	.64	.1402	0	7	7	21	64	0
2	1	.71	.2756	0	6	21	2	71	0
3	1	.84	.2122	0	84	8	7	0	0
4	1	.19	.1281	1	45	19	14	20	0
5	1	.37	.2734	1	22	8	33	37	0
6	1	.46	.3708	2	46	13	7	33	0
7	1	.27	.0947	1	29	21	27	22	0
8	1	.42	.1785	1	22	42	35	0	0
9	1	.11	.2903	1	33	38	18	11	0
10	1	.11	.3314	0	23	11	9	44	13
11	1	.10	.2309	1	10	30	24	35	0
12	1	.17	.1504	1	17	18	37	26	0
13	1	.24	.0710	1	17	24	28	29	0
14	1	.15	.0824	1	18	15	39	26	0
15	1	.49	.1983	2	8	14	49	27	0
16	1	.76	.4099	1	76	12	4	7	0
17	1	.05	−.0690	1	83	6	5	5	0
18	1	.47	.4086	2	47	15	18	19	0
19	1	.56	.3230	2	18	9	16	56	0
20	1	.19	.1190	2	63	16	19	0	0
21	1	.44	.3883	3	10	31	12	44	0
22	1	.66	.5120	3	13	66	8	10	0
23	1	.45	.1517	5	16	24	45	11	0
24	1	.73	.4521	2	73	8	5	10	0
25	1	.23	.0218	3	21	23	30	23	0
26	1	.73	.2417	3	24	73	0	0	0
27	1	.51	.3219	3	51	27	13	6	0

Table E.1.--Continued Easiness Percentages, Biserial Correlation Coefficients and Percentage Response Rates for Each Test Item Alternative

Test Item	Test[a]	Easiness Percentage[b]	Biserial Correlation Coefficient	Item Alternative Percentage[c]					
				0	1	2	3	4	5
28	1	.62	.4221	3	12	13	62	10	0
1	2	.61	.3347	1	19	61	8	11	0
2	2	.79	.2710	0	8	13	79	0	0
3	2	.50	.2558	1	50	3	9	37	0
4	2	.37	.2319	0	4	37	57	2	0
5	2	.17	.1625	0	46	24	8	17	4
6	2	.40	.3652	1	15	6	38	40	0
7	2	.25	.2046	2	32	25	16	26	0
8	2	.52	.4438	1	4	24	19	52	0
9	2	.67	.3375	1	67	15	13	4	0
10	2	.65	.3373	1	20	5	9	65	0
11	2	.40	.3434	0	40	11	18	31	0
12	2	.75	.5200	1	14	5	75	5	0
13	2	.74	.3651	0	20	74	6	0	0
14	2	.38	.1341	1	36	38	12	13	0
15	2	.27	.1927	1	27	48	14	10	0
16	2	.79	.5221	1	11	5	79	4	0
17	2	.37	.2836	2	27	16	37	18	0
18	2	.56	.0809	1	28	56	16	0	0
19	2	.57	.3081	2	57	36	5	0	0
20	2	.73	.3600	1	14	12	73	0	0
21	2	.31	.2823	1	26	31	31	11	0
22	2	.53	.3119	2	10	27	9	53	0
23	2	.42	.4407	2	42	29	13	15	0
24	2	.44	.3499	2	15	33	44	7	0
25	2	.21	.1509	2	29	22	21	26	0
26	2	.44	.3136	2	22	20	12	44	0

Table E.1.--Continued Easiness Percentages, Biserial Correlation Coefficients and Percentage Response Rates for Each Test Item Alternative

Test Item	Test[a]	Easiness Percentage[b]	Biserial Correlation Coefficient	Item Alternative Percentage[c] 0	1	2	3	4	5
27	2	.57	.2673	1	5	57	13	24	0
28	2	.51	.2856	1	37	11	51	0	0

[a]Pretest (1), posttest (2).

[b]Per cent of respondents who answered the test item correctly.

[c]Per cent of respondents who answered each multiple test item alternative, with 0, 1, 2, 3, 4, and 5 representing test alternatives and underlined percentage representing the correct response.

APPENDIX F

RESPONSE LIST OF QUESTIONS AND COMMENTS MADE BY PARTICIPATING CLASSES

Field Trip

1. How do you tell a baby saguaro cactus from a baby barrel cactus?
2. Why is there trash here?
3. Can we catch lizards?
4. What are the uses of clay?
5. Why are there animal tracks in the wash and not over here?
6. Now I know where to plant seeds so they will grow.
7. Can you drink the water in the bag?
8. I'm going to go home and try the bag-over-the-leaves trick.
9. Do you study herpatology? I like snakes and stuff.
10. I didn't know the water from the tree would be so clear.
11. Can we go up to the mine?
12. How does the weather thing know how hot or cold it is?
13. Would the branch die if the bag got full, or would the tree just put more water in the branch?
14. Why did the rock bubble and turn colors?
15. The desert is nice except for the trash and litter.

16. I got some rocks and found a bone!
17. Where does it escape to?
18. That paper is as old as me!
19. Why aren't there many lizards?
20. It was fun but I hoped to find some kind of animal other than ants and lizards.
21. Gee, it's hot out here!
22. Why did the owl go to the bathroom on Phil when he flew away?
23. What do vultures eat?

Slide Presentations

1. My brother and I saw that before when we hiked in the desert.
2. Why do animals live where it's hot?
3. The desert museum has cactus with holes in it like that. Woodpeckers made them.
4. Why do people experiment with animals? It seems cruel.
5. I heard of a man who drunk water from a cactus.

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