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Effects of in-service training on elementary teachers pertaining to science achievement and attitudes toward environmental science

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CHAPTER I. INTRODUCTION

Following the Russian conquest of space in 1957, great strides were taken in American education to strengthen a number of areas. Foremost in this action was the National Science Foundation which provided innumerable in-service institutes for secondary school teachers, particularly in the fields of science and mathematics. The primary objective of these institutes was the improvement of subject-matter competence.

Orr and Young (32) found that 32 percent of all secondary science and mathematics teachers in the United States had attended some type of institute sponsored by the National Science Foundation. Another 13 percent had applied but had been rejected. Schlessinger (47) concluded that this program represented what was probably the most massive effort ever made for in-service education.

It has only been in the past few years that in-service training in science has been made available to elementary teachers. There is considerable support for developing programs of this nature. The National Commission on Teacher Education and Professional Standards included the following in their statement of policy (28, p. 12):

> Even with skillfully contrived and carefully administered pre-service programs in teacher education, changing demands, deepening understanding of the qualities of learning and of teaching, and a constantly enlarging body of materials of instruction require each member of the profession to add continually to his knowledge, his skill, and his understanding.

Following visits to 260 primary classrooms in 100 schools clustered in and around the major cities of 13 states, Goodlad noted (19, p. 61):

> Public schooling is probably the only large scale enterprise in this country that does not provide for systematic updating of the skills and abilities of its employees and for payment of the costs involved.

Busch (6) found that one main difficulty encountered by teachers of elementary science was their lack of preparation in using their immediate environment. She felt that the teacher needed help in two ways: bringing available outdoor resources to his attention and helping him to use these resources in the best way possible.

Since the decade following Sputnik, the emphasis on subject-matter competence has been supplemented by concern for the affective dimensions of teaching. Not only is in-service education seen as a way of adding to pre-service education and keeping abreast of the expanding world of knowledge, but it is also viewed as a means of emphasizing methods of science, increasing teachers' understanding of students' interests and abilities, and developing new attitudes, ideas, and skills (37, 42, 59).

The activities of in-service education include workshops, preparing curriculum guides, consultant demonstrations, professional meetings, visitations, reading of professional materials, staff meetings, action research, summer school, and many more. Schaaf (46), Lingren (25), and others agree, however, that in-service training for individual teachers should be related to some important, current, local problem which is

of real interest to those who will engage in the activity.

There are numerous institutions and organizations which can perform in-service activities. The National Education Association (39) lists county, city, state, and national governments; local schools; professional associations; and institutions of higher education. That the local schools should play a vital role in in-service training has been noted by Piltz (37, p. 12):

> Beginning teachers, teachers new to the school, and teachers lacking sufficient background need help; and the school must provide a variety of ways to help them improve, keep up to date, experiment with new methods, and find the best activities for helping children learn.

How teachers feel about a subject area or about teaching a subject area may be more important than subject-matter competence. Dressel observed that (11, p. 47):

> Studies generally show that although there is a positive correlation between the amount of factual knowledge acquired through science training and the ability to exhibit some scientific attitudes, teaching subject matter alone does not produce significant changes in attitude nor measurably train in scientific method.

Davis reiterated this feeling when he stated (10, p. 122):

> We must convince science teachers by clearcut evidence that teaching science for the sake of knowledge alone is not enough.... We doubt that we can make advances in teaching science methods and attitudes without a good background of knowledge. But we feel that teaching knowledge alone is not enough and that we are neglecting many opportunities to give pupils the real values of science instruction.

Carin and Sund (8) and Potter (38) agree that one of the most important aspects in the development of scientific thinking in children is the teacher's attitude.

Unfortunately, attitudes are not easy to change and little has been done to create such changes. Through questionnaires and follow-up interviews, Soy (49) found that prospective elementary teachers arrived at college with their feelings about science firmly established. In addition, little happened at college to promote positive feelings toward this area. As a researcher who has developed several attitude measures, Dutton (13) discovered that once attitudes were developed, they were very difficult to change. He advocated that continued efforts be made to change negative teacher attitudes through in-service instruction during the school year. Lewis (23) believed that a diversified in-service training program would increase teachers' feelings of security in their ability to teach science.

Concerning the relationship of the school administrator to in-service training, Turner (58) described the efforts of central office personnel as ineffective, irrelevant, inappropriate, inconsequential, and inferior. At the same time, he found that these administrators were lamenting the lack of teacher expertise and the inadequately trained individuals emerging from teacher training institutions. Schaaf conceptualized this relationship in the following manner (46, p. 20):

> If it is true that the improvement of instruction is the major reason for school administration as a profession,

> it follows that in-service education broadly conceived is a continuous task that can never be completed.

And Rubin has added (45, p. 14):

> ...in-service education is virtually useless if the objectives of the training program are not valued and rewarded--if with nothing more than esteem--by the power structure of the school.

Regrettably, there has been little scientific evidence to serve as a guide for the administrator. In assessing the general trends and practices of in-service education in the United States, the National Education Association (39) found that nearly all programs have some form of subjective evaluation, but very few have well-organized statistical evaluations. Similarly, Harris and Bessent (20) noted that in-service education for many years centered on the idea that the needs of teachers should be primary to all efforts. They also found, however, that careful evaluations of a program in progress and at its termination were rarely undertaken to determine the degree to which these needs were being met.

If the school administrator is to aid in improving instruction at the local level, it is imperative that he be aware of the effects of the in-service programs being utilized. Not only must subject-matter competence be evaluated but also attention must be given to changes and development of attitudes and interests.

Statement of the Problem

The problem for this study was to determine what changes, if any, occurred in the achievement and attitudes of elementary teachers following an in-service program in environmental science. A second problem for consideration was to ascertain the degree of relationship between these changes and academic and personal characteristics of these teachers. Finally, an attempt was made to investigate the implications that such relationships, if found, might have for school administrators.

More specifically, this research attempted to answer the following questions:

1. Was there a difference in the science achievement of elementary teachers who have been involved in an environmental science in-service program (experimental group) and the science achievement of elementary teachers who did not receive this training (control group)?
2. Did the experimental group teachers display attitudes toward environmental management concepts which are different from the attitudes of the control group teachers?
3. Did the experimental group teachers exhibit attitudes toward teaching environmental science which are different from the attitudes of the control group teachers?
4. Was there a relationship between the achievement and attitudes of these teachers and their age, grade level taught, amount of teaching experience, and formal academic science preparation?

In light of the statistical analyses needed to determine answers to the above questions, it was necessary to consider these inquiries in a null form. This form was based on the premise that no differences existed between groups with regard to achievement and attitudes and that no relationships were present between achievement and attitudes and the personal and academic characteristics of the teachers.

Definition of Terms

The elementary teachers included in this study were all of the first, third, and fifth grade classroom teachers within the Ames Community Schools who were involved with teaching elementary science.

Teacher achievement was defined as the raw scores of the teachers on Part II, Principles, of the Test of Science Knowledge, which was administered to the teachers prior to the beginning of the in-service program and again following its completion.

Attitudes toward environmental management concepts and attitudes toward teaching environmental science were interpreted as summated rating scores gained by the teachers on an instrument constructed by the author and which was administered both before and after the in-service program.

The in-service program in environmental science was defined as the training sessions and field experiences provided by Project ECO of the Ames Community Schools for selected elementary teachers. Included in the program were three one-half day workshop sessions with the

Coordinator and Associate Director of Project ECO as well as three field experiences with students and the two Project administrators. This program was conducted during the 1971-1972 school year.

Age referred to the teacher's age on September 1, 1971.

Grade level taught meant the major grade level assignment of the teacher for the 1971-1972 school year.

Amount of teaching experience was defined as the total number of years, to the nearest whole year, that the teacher was employed as a classroom teacher. Student teaching experience was not included.

Formal academic science preparation was defined as the number of semester hours (to the nearest full hour) in science courses and science teaching methods courses earned by the teachers at institutions of higher learning.

Sources of Data

Data concerning personal and academic information about the teachers were obtained from a personal data sheet completed by the teachers and verified through records maintained in the Personnel Office of the Ames Community Schools. Permission for the use of these records was obtained from the Director of Personnel of the Ames schools. Paper and pencil instruments were administered to the teachers in order to obtain measures of their understanding of scientific principles and their attitudes toward environmental management concepts and toward teaching environmental science.

Delimitations of the Study

This study encompassed only the 11 elementary schools within the Ames Community Schools. The subjects were all of the first, third, and fifth grade classroom teachers who teach elementary science in their respective grades at these schools. Generalizations drawn from this study should be limited to the population sampled or cautiously applied to other elementary classroom teacher populations which closely resemble those included in this research.

A further limitation was the length of the study. The pre-tests were administered to the teachers during September of 1971 and the post-tests were completed during April and May of 1972.

The in-service program herein was restricted to three one-half day training sessions for each teacher as well as three field experiences for each teacher and his students. The field experiences ranged in length from one-half day to a full day.

Organization of the Study

CHAPTER I is an introductory chapter presenting a background for the problem and stating, delimiting, and defining the problem. CHAPTER II is a selected review of the literature relating to this problem. The methods and procedures used to gather and analyze the data are described in CHAPTER III. The findings of the study are set forth in CHAPTER IV, and CHAPTER V contains a summary, conclusions, implications, and recommendations for further research.

CHAPTER II. REVIEW OF RELATED LITERATURE

This review of literature has focused on five topics related to the problem being studied. In order of their discussion, they were: the Science Training of Elementary Teachers; Teacher Attitudes Toward Science; the Effects of Teacher Attitudes on Students; the Effects of In-service Education on Teachers; and Constructing Attitude Measures.

Science Training of Elementary Teachers

It has often been stated that elementary teachers are not as well prepared for teaching science as they are for teaching the other academic areas. Several studies conducted during the last 20 years support this contention.

In a survey of the literature in 1953, Mallinson (26) found that elementary teachers in two-thirds of the states might teach without completing any college science courses. Although many elementary student teachers considered themselves competent to teach science subject matter, their test scores in general science did not support their impression. In addition, their cooperating teachers often lacked adequate science backgrounds which resulted in ineffective student teaching experiences in science.

Bryant (5) in 1963, Dubins and Chamberlain (12) in 1963, and Newton and Watson (29) in 1968 conducted national studies of the science requirements for elementary teachers. Bryant surveyed 225 member

institutions of the American Association of Colleges for Teacher Education (AACTE). His study revealed that the science requirements ranged from none to 45 quarter hours with an average of nearly 18 quarter hours. When requirements existed, they generally consisted of survey courses in the biological and physical sciences. Little standardization was evident among institutions.

Dubins and Chamberlain looked at four-year schools which were accredited by a regional accrediting agency, a state university, or a state department of education. They found that the science requirements for elementary teachers ranged from none to 27 quarter hours. Over one-half of these institutions require one year or less of science preparation. Only three percent of the schools require the equivalent of two years of science with laboratory work.

In a two-year study funded by the United States Office of Education, Newton and Watson examined the science education programs of 725 institutions across the nation. Their findings were similar to those of the two previous studies. Science requirements ranged from none to 30 quarter credits. Biology was the course most often required with physics a distant second, and chemistry and earth science appearing infrequently.

Two recent studies have been more encouraging. O'Toole and Chesin (33) in 1969 compared the science preparation of present elementary teachers and senior elementary education students in Pennsylvania. They discovered that 100 percent of the prospective teachers were completing at least nine credits in science, while only 72 percent of the

present teachers had done so. In addition, nearly three times as many of the prospective teachers were completing a science cognate of 18 or more science credits.

At Wisconsin State University (Platteville) where elementary education students are required to take nine semester hours of science, Oberlin (31) in 1969 administered the Stanford Achievement Test (Science) to all of the elementary education seniors. He found that three-fourths of the teachers scored at or above the tenth grade level with the lowest falling at the seventh grade level. However, no significant correlation was detected between the number of science credits completed by the teacher and the test scores. Neither was a relationship noted between the areas of science studied and the test scores. No attempt was made to determine the students' attitude toward science which might have been related to test scores.

In 1960 the American Association for the Advancement of Science and the American Association of Colleges for Teacher Education (1) developed recommendations for the science training of elementary teachers. They suggested that teachers in general elementary education complete 16 semester credits in science--eight in biological science and eight in physical science. For a cognate area in science they recommended a compilation of 28 semester hours in science. The findings listed above reveal that these recommendations have not been followed to this time.

Teacher Attitudes Toward Science

In the last decade considerable attention has been given to the attitudes of teachers toward science. Schwirian (48) developed the Tri-S Scale (Science Support Scale) composed of 60 Likert-type statements relating to science. She administered this instrument to 191 elementary teachers in the Midwest and compared the results with their personal and academic characteristics. A significant difference was found in relation to the number of college science courses completed. Inverse relationships were detected with regard to age, highest degree held, and years of teaching experience. However, when age was held constant, the differences in the latter two characteristics were no longer present.

Schwirian concluded that examining the effects of the amount of higher education, the years of teaching experience, and the nature of this experience was the same as examining the effects of age. Even the type of institution attended and the number of hours in college science did not entirely escape the effects of age. In essence, age appeared to be the major source of variation in attitudes toward science.

In an attempt to ascertain why elementary teachers were reluctant to teach science, Victor (60) surveyed 106 elementary teachers in one Illinois city. The principal conclusion was that lack of familiarity with content and material was the greatest factor. Loss of prestige due to inadequate knowledge was considered to be a related factor. Most

of those surveyed were women who felt men were better suited to teach science. Other reasons given were the lack of time and the pressures for teaching other areas.

Dutton and Stephens (14) constructed an attitude scale of 20 statements of feelings about science. The instrument was administered to 266 prospective elementary teachers at the University of California, Los Angeles. Their general feelings were favorable toward science, but they did not consider it an area to be pursued independently and displayed a disliking for mice, worms, and small crawling things. They did have good impressions of simple experiments, field trips, and the opportunities for doing creative work.

In a survey of 529 upperclassmen majoring in elementary education at the University of Northern Iowa, Soy (49) found that only seven percent had selected science as a field of concentration as compared to 40 percent who selected language arts and 31 percent who selected social studies. The reasons given for not selecting science included a lack of interest, the difficulty of science courses, and a lack of high school science background. Only 33 percent considered science one of the three areas in which they felt best prepared to teach, even though 60 percent felt science was the most interesting subject to the students. Soy concluded that elementary education teachers come to college with established strengths in language arts or social studies and continue in these areas rather than developing others.

Effects of Teacher Attitudes on Students

School administrators have long been aware of teacher attitudes. They have felt that "good" attitudes would provide an atmosphere conducive to learning as well as high staff morale. However, in 1963 Stern (52) found meager direct evidence that teacher attitudes were significant for student learning. He did determine that the investigations of teacher attitudes on student learning had been limited in number and scope. He also noted that students had been found to internalize teachers' interests.

Probably the most notable study of teacher attitudes and pupil perceptions was conducted by Torrance (57). The purpose of his study was to determine the relationship of instructor attitudes and perceived instructor attitudes to attitudes and behavior of trainees. The subjects involved were 428 aircrewmen who were undergoing a survival training course and their instructors. The aircrewmen were indoctrinated by the instructors as to the uses of the emergency ration "pemmican." The instructors were expected to express positive attitudes toward "pemmican" despite what their true sentiments might have been. Subsequently, this ration was used as the major component of their diet during a seven-day exercise.

Following the seven-day period both verbal and nonverbal behaviors were noted. The former consisted of hedonic ratings and expressed intentions to use the ration in future emergencies. The nonverbal behaviors included records of how many bars of "pemmican" were eaten by each subject, and whether or not the food made them sick. Also, at this time the subjects gave their perception of their instructor's opinion of "pemmican" and the instructors were asked to express their actual opinion

of the ration.

It was found that the number of bars eaten and becoming sick were not related to the perceived instructor opinion. However, they were related to the actual opinion of the instructors. The conclusion was made that one's verbalized attitudes may follow more closely his perceptions of the instructor's attitude, but his acutal behavior reflects more the instructor's actual attitude.

These findings had great implications for teacher education. First, teacher education institutions must attempt to develop in students those attitudes which they are expected to develop in their pupils. Second, school administrators who ask teachers to develop certain attitudes in their pupils should seek first to develop those attitudes in the teachers.

Two studies conducted during the 1930's produced some interesting findings. Following a supervisory program, Von Eschen (61) discovered a positive change in teacher-pupil relationship but detected no significant differences in social attitude and interest in teaching on the part of the teachers. The pupils of these teachers gained in silent reading ability, basic study skills, and social studies achievement. Rostker (43) found that teachers' social attitudes and their attitudes toward teaching were significantly correlated with teaching ability. Also significantly related to teaching ability were the teachers' intelligence, their knowledge of subject matter, and their ability to diagnose and correct pupil mental maladjustment.

An investigation of the influences of teachers' attitude toward science, their degree of authoritarianism, and their attitude toward

desirable teacher-pupil relations on the science information and scientific attitudes of pupils was conducted by Bixler (3). His subjects were 62 fifth and sixth grade teachers and their 1,481 students in a California school system. All pupils gained significantly in science information, and there was a tendency, although not significant, for more positive changes to be associated with more favorable teacher attitudes. Teacher attitudes did significantly affect pupil attitudes; teachers with a more favorable attitude toward science produced a greater change in pupils' attitude. The authoritarianism of teachers and their attitudes toward teacher-pupil relations was not found to be related to changes in the students' science information or scientific attitude. This study was limited by the instruments used. The validity of the Fascism-Scale and the Minnesota Teacher Attitude Inventory has been questioned in this type of research. The ceiling of student tests may have been the cause for students with lower intelligence quotients revealing greater gains in achievement and attitude.

Phillips (36) directed a longitudinal study of the relationships between teacher attitude and student attitude and achievement in mathematics. He measured the attitudes and achievement of 306 entering seventh graders along with the attitudes of their arithmetic teachers in grades four, five and six. Favorable and unfavorable attitudes were arbitrarily determined by selecting those above the median score as favorable and those below the median score as unfavorable. It was found that the attitude toward arithmetic of the student's most recent teacher was related to the student's attitude but not to his achievement. The teacher attitudes encountered by the students for the preceding

two and three years were significantly related to both the student's achievement and attitude. The more favorable the teacher attitude, the more favorable the student attitude and the higher the student achievement.

A nonstatistical survey conducted by Steinbrook (51) contrasted the local success records of elementary teachers with some of their personal and academic characteristics. His data were obtained from evaluation forms in personnel files, college records, classroom visitations, and questionnaires completed by the teachers. The 77 respondents were nontenure elementary teachers randomly selected within a school district. The teachers were arbitrarily classified as successful and unsuccessful in a manner similar to that of Phillips mentioned above. One of his findings was that successful teachers had more wholesome and constructive attitudes toward children and toward professional activities and responsibilities. Unfortunately, success was also highly related to number of years of experience, a fact which removed most of the credibility of the other findings.

Effects of In-service Training on Teachers

Evaluation of in-service programs has attended to both the cognitive and affective dimensions of the participants. A number of these appraisals have been concerned with National Science Foundation (NSF) programs.

Parker (34) surveyed the high school teachers who had participated in eight NSF summer institutes in Louisiana. One-fourth displayed an

increased interest in professional organizations and scientific publications. More than 99 percent felt they were better teachers. Over 91 percent of their principals believed these teachers were more enthusiastic and were better teachers.

A comparison of three methods of in-service education was conducted by White, Raun, and Butts (64). The three year-long programs, all at the elementary level, included: 1) an NSF program carrying college credit and meeting weekly for a three-hour session; 2) a week-long pre-school workshop plus six one-day visits by workshop consultants to the participating schools; and 3) a released-time plan which met for 11 half-day sessions. A form of the semantic differential was used to measure teacher attitudes; science competencies of the teachers were assessed by the Teacher Process Measure. The findings revealed that teaching experience and grade level taught had no effect on competency. However, the amount of previous science training was favorably associated with attitude change. The teachers in the pre-school workshop had the greatest gain in competence; this was believed due to the condensed period of training.

Subsequently, Butts and Raun (7) directed another study of the NSF program described above. Using a semantic differential they found that teacher attitudes do change when they are involved in an in-service course directed toward an increased competence in the processes of science. Those teachers with few or no formal courses in science displayed more positive attitudes, a contradiction to results of their

earlier study. They determined that these attitude changes were not related to teaching experience which confirmed one of their previous findings.

Joan Zurhellen (66) evaluated attitude changes of science teachers during a year-long NSF institute concerned with the Earth Science Curriculum Project. The subjects were 20 instructors and 75 teacher-participants. The measuring devices used included the Minnesota Teacher Attitude Inventory, the Teaching Situation Reaction Test, the Edwards Personal Preference Inventory, The Rokeach Dogmatism Scale, a semantic differential scale, and the Perceived Problems Inventory. The instructors were subjected to five of these instruments on one occasion and to four of the instruments at four other times during a nine-month period. The teachers received all six of these instruments on one occasion and were subjected to five of them at three other times during the same nine-month period. The findings did not reveal any definite trends in attitude change nor were there any significant correlations between attitude measures and physiological and personality variables. There was little indication of the type of teacher most likely to experience positive change.

Two findings might point to weaknesses in conducting such extensive testing. First, the only positive change occurred between the pre-test and the first post-test. This gain measured over a two-week period could be the "Hawthorne effect" due to beginning a new experience. Second, there was an overall decline in attitudes during the nine months.

Whether this was an actual decline in attitude or simply less careful and honest responding to repeated testings could not be determined.

Pettersen (35) developed a physical science program for elementary teachers in Hammond, Indiana. In-service sessions of two hours were held weekly for nine weeks. This training included demonstrations, actual experiments, question and answer sessions, and peer teaching. Forty teachers volunteered for inclusion in this program and were split into experimental and control groups of equal size. The experimental group received the in-service training; the control group did not. The teachers' interest in science, understanding of science, and general content knowledge were measured utilizing standardized instruments. No differences were found in science interest among the groups or within groups. Both groups exhibited significant gains in general content knowledge and an understanding of science. Pettersen concluded that all of these teachers benefited from teaching and working with the units.

A somewhat unique study was designed by Mork (27) in natural science education at the elementary school level. Some teachers served as their own control during the first year and then as the experimental group during the second year. In addition, other teachers served as a control group for both years. Monthly in-service meetings dealt with objectives, content, methods, and materials of instruction. Mork prepared a science test for students which served as both pre-test and post-test. This test was based on three objectives: ability to recognize superstitions and misconceptions; ability to apply science

principles; and familiarity with basic facts, concepts and vocabulary.

All experimental groups revealed significant gains in science test scores during both years. This was also true in over half of the control groups. All of the in-service groups indicated numerically superior results during the experimental year. However, in only one case was this significant when pre-tests and intelligence were held constant. Mork did reject his null hypothesis on these findings, but this would appear to be a questionable decision.

In-service training has also been implemented in other academic areas. Henry Zurhellen (65) attempted to determine changes in the attitudes of teachers during an in-service program in classroom communications skills. His subjects were 101 elementary and secondary teachers from the Appalachia area. The in-service course utilized the verbal and nonverbal classroom communications skills techniques developed by Flanders and by Galloway and French. Evaluative measures were administered at the beginning and again at the end of the three-month program.

A negative attitude change toward students was detected by the Minnesota Teacher Attitude Inventory. The Teaching Situation Reaction Test revealed a negative shift in attitude toward youth and classroom situations. No significant change in self-concept was measured by the semantic differential and there were no significant differences in the scores of the Edwards Personal Preference Inventory. A questionnaire developed by Zurhellen did reveal significant differences in the subjects'

estimates of the effects of the program on their own lesson planning and classroom behavior. Zurhellen felt that numerous physical problems encountered in conducting his program may have biased the results. Also to be considered is the extensive testing conducted within a relatively short period of time. It was interesting to note that the only information of value to the local school administrator was that obtained from the questionnaire prepared by Zurhellen.

A three and one-half year diagnostic study of the language arts program in a Utah school district was made by Eggert (16). Teachers pursued one objective of the language arts curriculum; those aiming at the same objective held group meetings. Eggert assessed change in 108 curriculum practices through teacher self-evaluations, principal evaluations, supervisor evaluations, and visitor evaluations.

The principals felt that the teachers became more objective, developed greater understanding of children, increased in experimental behavior, were working to change their roles, and were reading more professional publications. The teachers considered the greatest gains to be an increased skill in teaching and the innovations of successful classroom practices, increased understanding of children, and a growth in group skills.

Todd (56) evaluated an in-service math education course at the University of Virginia in terms of understandings of math and attitudes toward math as held by teachers. His subjects were 34 prospective teachers and 253 practicing teachers, most at the elementary level. Utilizing Glennon's A Test of Basic Mathematical Understanding and

Dutton's Attitude-toward-Arithmetic Scale, Todd found significant increases in both understanding and attitudes. Understanding and attitude were correlated .36 at the initial testing and .30 at the final testing; these correlations were significant at the .01 level.

In New York, Thompson (54) examined the relationship which existed between a family-life in-service program and the teachers' attitudes towards teaching the factual knowledge of the topic. The training consisted of four two-hour sessions on sexuality and family living conducted by two health education specialists. The subjects were 60 elementary teachers who were assigned to one of four groups in a Solomon four-group research design. Thompson constructed a knowledge test of 50 multiple choice items and an attitude survey containing 50 statements about sex and family to which agree-disagree responses were made. No significant differences between any of the groups were indicated on either of the two measures. Thompson concluded that this treatment had produced no effect on the subjects.

Ridley (40) attempted to measure both cognitive and affective changes with a single instrument. She developed 90 items, 66 affective and 24 cognitive, relating to the utilization of the knowledge and skills of home economics in obtaining gainful employment. This instrument served as both a pre-test and a post-test for 49 home economics teachers in a three-week seminar at Florida State University. More change was detected in the cognitive area than in the affective. Ridley recommended that the evaluation of cognitive and affective areas be kept separate.

An attempt to relate attitudinal changes to critical thinking, openness to change, originality and ideational fluency, and the factors of formal education, teaching experience, and sex was made by Stanley (50). His subjects were 30 teachers who had requested to be on the staff of an experimental school and had agreed to participate in an in-service program. Evaluative instruments included a semantic differential for assessing attitudes, the Watson-Glaser Critical Thinking Appraisal, the Rokeach Dogmatism Scale, and the Consequences Instrument. The in-service program consisted of twelve meetings of approximately three hours in length which were held during the school year. Small group and team activities were additional components. The objectives of the program were: self-direction for pupils; small group interaction for pupils; large group instruction for pupils; and team teaching organization for teachers.

There were significant positive changes in attitude but there were no significant changes in any of the other variables measured. Neither were there any significant multiple correlations of these variables resulting in the absence of a predictive value for the study.

Interaction analysis has been used by several investigators to determine the effects of in-service education on teacher behavior in the classroom. Carline (9) found that new behaviors could be "trained-in" but previously obtained behaviors could not be "trained-out." La Shier (22) determined that teacher talk was reduced very slightly while student talk dropped from 29 to 19 percent. A proportionate

increase was found in the time spent in silence or confusion. Similarly, Roberson (41) detected little change in the indirect-direct ratio of teacher influence.

Constructing Attitude Measures

The following discussion was not an attempt to examine all of the work which has been done in the area of attitude measurement; entire textbooks have been devoted to this subject. Instead, a brief assessment was made of some of the major contributions in this area. In addition, reviews of some recent research studies involving attitude scale construction were included.

Two of the most influential works in this field were those of Thurstone (55) in 1929 and Likert (24) in 1932. The methods which they developed have become the most widely used.

Thurstone defined attitude as the sum of a person's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specific topic. To him opinion was the verbal expression of attitude and the vehicle by which attitudes could be measured. He recognized that measurement errors did exist between the opinion expressed and the actual attitude. To minimize these errors, attitude scales should be utilized only in those situations where one could reasonably expect people to tell the truth about their opinions.

In later studies Getzels (17, 18) substantiated these findings.

He found that discrepancies between covert and overt levels of reaction were maximal for socially conflicted objects of inquiry and minimal for socially neutral objects.

One of Likert's main objectives was to resolve the specificity-generality argument. Proponents of the specificity theory defined personality as a composite of many independent habits. Since attitudes were dependent upon stimuli and since combinations of stimuli were infinite, the number of attitudes a person possessed was infinite. Generality adherents theorized that personality was composed of general factors which made for effective prediction from behavior in one situation to behavior in a different situation.

Utilizing several different scales, Likert studied attitudes toward international relations, race relations, and economic conflict. He found that assigning numerical values to responses produced scales with reliabilities highly correlated with reliabilities computed through more elaborate methods. In addition, scores on different types of items could be added together to obtain a total attitude score rather than considering each item separately. Correlations among the scales which Likert used indicated the presence of a general factor in international relations, race relations, and economic conflict.

With regard to the validity of attitude scales, Likert noted (24, pp. 32-33):

> In many cases it would seem reasonable to conclude that since our daily behavior in these areas is largely verbal, the verbal responses would be valid indices of other habits....

> Of course, it cannot be sufficiently emphasized that the reactions on an attitude test are no more meaningful than the situation in which the attitude test was given. If the situation is such as to elicit the honest cooperation of the subject,...we can feel that we have a valid measure of his attitude....

Concerning the construction of attitude measures, he proposed four basic guidelines: 1) construct the statements so that those with different attitudes will respond differently; 2) use concise and clear wording; 3) be sure that the modal response falls in the middle of the possible responses; and 4) reverse the response continuum when possible.

Edwards (15) has compiled a compendium of information on techniques of attitude scale construction which includes those of Thurstone and Likert. The six major scaling methods which he discussed were paired comparisons, equal-appearing intervals, successive intervals, summated ratings, scalogram analysis, and scale discrimination.

Some interesting comments were made by Edwards concerning the use of the summated rating scale (15, p. 157):

> If, in terms of research, our interest is in comparing the mean change in attitude scores as a result of introducing some experimental variable,...then the lack of knowledge of a zero point should cause no concern. Similarly, if our interest is in comparing the mean attitude scores of two or more groups, this can be done with summated-rating scales as well as with equal-appearing interval scales. Or if we wish to correlate scores on an attitude scale with scores on other scales or with other measures of interest, this can also be done without any reference to the zero point on the favorable-unfavorable continuum.

As noted in the Encyclopedia of Education Research (2), attitude measurement is not an end in itself. Its purpose is usually to provide

information pertaining to the motives of individuals or groups in specific situations in order to better understand behavior dynamics. With respect to the measurement of scientific attitude, Davis (10) stated that "The ultimate aim is not testing but improved teaching."

In 1966 Blankenship (4) evaluated the effectiveness of four methods of determining science teacher attitudes toward a new biology program. The four methods included an attitude scale, peer ratings, instructor ratings, and a follow-up questionnaire. He found that the attitude scale and the peer ratings each effectively identified 75 percent of those who were identified as possessing a favorable attitude when all four measures were used. When these two measures were combined, they identified 96 percent of those having a favorable attitude. The other two measures were less effective.

In attempting to measure the scientific attitudes of elementary teachers in 1970, Weinhold (62) developed a pool of items consisting of statements containing at least one element of Ebel's Scientific Attitude. The statements were masked so that the responses would be an indirect measure. Validity of the items was determined by a panel of judges. Three types of responses were elicited: multiple choice; agree-disagree; and enough evidence-not enough evidence. Reliability of the measure was computed to be .80. Weinhold concluded that a paper and pencil test could be constructed with sufficient reliability for group measurement of scientific attitude. He recommended that the Likert-type items be utilized in developing future instruments.

In 1970 Johnson (21) developed an instrument for testing teachers' feelings of adequacy toward teaching selected sex education objectives. He compiled a list of sex education objectives which were evaluated by a panel of judges. The resulting list of 52 objectives was submitted to 315 teachers. They were asked to respond to the question "Do you feel adequate to employ various learning activities to provide the experiences necessary for your students to attain the following objectives in sex education?" Responses were on a five-point agree-disagree scale. The reliability of the measure was found to be .98 by utilizing the Spearman-Brown prophecy formula.

Summary

In general, pre-service education for elementary teachers has not included preparation in science which was consistent from institution to institution. Requirements ranged from none at all to 45 quarter credits of formal science training. However, a recent study in Pennsylvania revealed that elementary education students in that state were obtaining more science credits than had practicing elementary teachers. At Wisconsin State University it was found that three-fourths of their prospective elementary teachers scored at or above the tenth grade level on the Stanford Achievement Test (Science). Although these latter findings are encouraging, they do not provide any assistance to those teachers now in elementary classrooms. Guidelines for the science preparation of elementary teachers have been developed. However, there

is no indication that these recommendations are being followed by teacher training institutions.

College students who major in elementary education generally do not have strong science backgrounds or interests. For this reason they do not become involved in science study beyond that which is required and are reluctant to teach science once they enter the classroom. This occurs despite the finding that these teachers realize science is one of the most interesting subjects to their students. There is some evidence that teacher attitudes and interests in science are related to age. However, the high correlation between age, years of teaching experience, and the type of teaching experience raises questions as to which of these variables has been significant in the development or breakdown of these attitudes and interests.

Little research has been conducted on the effects of teacher attitudes on students. A landmark study was performed by Torrance (57) during Air Force survival training courses. He found that a student's verbalized attitude may coincide with his perceptions of the instructor's attitude, but his actual behavior may reflect more the instructor's actual attitude. The implication was that teachers must possess an attitude if they hope to convey it to their students. There is evidence which indicates that student achievement and attitudes vary directly with teacher attitude. However, there are questions concerning the applicability of the instruments used to measure attitudes as often they were not designed with this purpose in mind.

Investigations of the effects of in-service training on teachers have resulted in mixed findings. Changes in teacher attitudes were generally positive but in some cases they were nonexistent or even negative. The same was true of the teachers' gain in content knowledge. In some instances relationships were detected between these changes and the academic and personal characteristics of the teachers; in other cases they were not present. The type and scope of the in-service program, the measurement instruments utilized, and the extent of the evaluation were all variables which contributed to these differing results. In addition, attempts to measure changes in the classroom behavior of teachers due to in-service training have not produced significant results.

Significant contributions have been made by Thurstone (55), Likert (24), and Edwards (15) in attitude measurement. They agree that the situation in which attitudes are assessed is as important as the type of instrument used. In constructing attitude measures, it is important to produce discriminating items and to use clear and concise wording. Recent studies have revealed that reliable attitude instruments can be constructed utilizing Likert-type responses and a summated rating scale. The purpose of attitude measurement is to provide information which will allow a better understanding of behavior dynamics. In education this purpose should be improved teaching and learning.

CHAPTER III. METHODS AND PROCEDURES

In order that readers of this study may better understand the findings which will follow in CHAPTERS IV and V, it is necessary to provide a description of the setting in which this research was conducted. The first two sections of this chapter describe the Environmental Curriculum Opportunity (Project ECO) and the teacher in-service program, the component of Project ECO upon which this study has centered.

The remainder of the chapter describes the methods and procedures that were used to gather and analyze the data required for the study. Included are the following topics: selection of the sample; construction of the attitude instrument; selection of the cognitive instrument; collection of the data; and treatment of the data.

Environmental Curriculum Opportunity

During the 1970-1971 school year, staff members of the Ames Community Schools began development of a proposal for a program intended to broaden and enrich activities related to the understanding and preservation of the environment. They were assisted in this endeavor by several community agencies and organizations as well as staff members from Iowa State University and the Iowa State Department of Public Instruction. This proposal was submitted to the Division of Curriculum of the Department of Public Instruction and subsequently

received funding through Title III of the Elementary and Secondary Education Act of 1965 (Public Law 89-10).

The Environmental Curriculum Opportunity (Project ECO) was designed to encompass all grade levels and was to be implemented over a three-year period beginning with the 1971-1972 school year. The major emphasis was to develop a controlled system that provided for learning outside the classroom. Student awareness of the complexity of the environment was a prime concern.

In order to provide for this awareness, the following components were developed:

1. An outdoor, living "laboratory" on a school site. This consisted of plants and terrain indigenous to central Iowa. An elementary school site was selected for this component.
2. A student transportation unit. This unit was a bus which provided space for 30 students and a mini-science laboratory. It served as a link between the classroom and various sites in the greater community.
3. A mobile laboratory for use at major ecological sites. This unit was a renovated semi-trailer which included equipment to support on-site student investigations in various environments.
4. Teacher in-service training. The main focus of this component was to increase teacher skills, awareness, and

appreciation of environmental education.

The decision to develop these components rather than selecting other alternatives was based on a careful appraisal of the needs of the local school system. It was decided that environmental education was a vital curriculum need and that support of this need could be provided by allowing teachers and students to be outdoors to view the natural environment. Project ECO had four major goals which were to be achieved through utilization of these components: 1) Use the natural environment as a teaching device. 2) Use community resources in science education. 3) Provide opportunity for study in a variety of field locations. 4) Supplement the local district science education program.

Curriculum activities were developed for this project during the summer of 1971. Involved in this undertaking were two elementary teachers, two junior high school teachers, three high school teachers, and the Coordinator and the Associate Director of Project ECO. The activities were centered around the topics of water, soil, air, plants, and animals. Each activity was accompanied with suggestions regarding the appropriate grade level, the background needed, the specific ECO objective, the anticipated outcome, the procedure, the materials needed, and suggested evaluation. A compilation of these activities was provided for each of the subjects in this study.

Teacher In-service Program

The teacher in-service program was coordinated with the three seasons which occurred during the school year: fall, winter, and spring. The Coordinator and the Associate Director of Project ECO were responsible for the planning and implementation of this program which consisted of two parts.

The first portion involved 12 clock-hours of instruction relating to the curriculum of Project ECO. This instruction was comprised of three, one-half day sessions at which time the teachers were released from their classroom duties to attend the in-service meeting. Three meetings were held for the teachers at each grade level. Each session consisted of an exploration of activities which were appropriate for the field experiences as well as a brief visit to the outdoor location where the teacher would be studying with his students. In addition, a concerted effort was made to obtain both the needs and opinions of the teachers relating to this curriculum. Discussion periods and brief questionnaires were designed for this purpose. Brief descriptions of the in-service meetings included in this study can be found in Appendix A.

The second portion of the program included the field experiences of the teacher with his students. The teacher and his class spent from one-half day to a full school day in the field at one of several ecological sites near Ames. Each class went to the field in the fall, in the winter, and again in the spring. Whenever possible, each class was involved on a separate day. In a very few cases, two classes were

in the field on the same day. Appendix B contains a complete schedule of these field trips.

A few days time was normally allowed between the in-service meeting and the beginning of the field trips for each grade level. This enabled the teacher to prepare materials and ready his class for the upcoming excursion. The Project ECO staff aided in this preparation by providing materials and general information regarding field procedures and techniques.

Selection of the Sample

As was previously mentioned, implementation of Project ECO was to occur over a three-year period. At the elementary level, grades one, three, and five were selected as the first-year targets of the program.

One three-unit elementary school, whose site was one of the major components of Project ECO, was not included in the selection process. The staff and students at this school were involved in developing this component and thus would have provided bias to either the experimental or control groups. The 6 first, third, and fifth grade teachers at this school were included as a special experimental group to this study.

First grades from five of the ten remaining elementary schools were randomly selected for inclusion in the first-year program. This selection was made within the following stratification: two of four

one-unit schools; two of four two-unit schools; and one of two three-unit schools. As a result nine first grade classes and their teachers were included in the program during the 1971-1972 school year. A similar procedure was used to select nine third grades and nine fifth grades. The selection of schools at each grade level was independent of the selection at the other two grade levels. The experimental and control groups within these ten elementary schools are revealed in Table 1.

This selection provided 27 classes of students and their teachers. Because one teacher was responsible for all of the fifth grade science in the three-unit school, only 25 teachers were included. These 25 teachers were designated as the experimental group for this study.

The remainder of the first, third, and fifth grade teachers who taught elementary science at their respective grade levels were assigned to the control group. One teacher was also responsible for all of the fifth grade science in the three-unit school in this group. Thus, the total number of teachers in the control group was also 25. These 25 teachers did not receive the in-service instruction and were not involved in field trips with their students within Project ECO.

Construction of the Attitude Instrument

In a study of fundamental concepts for environmental management education, Roth et al. (44) found that such concepts could be formed by utilizing practicing scholars. He contacted scholars in 40 disciplinary

Table 1. Elementary experimental and control groups for Project ECO[a], 1971-1972

School	1st Grade	3rd Grade	5th Grade
One-unit			
School A	C	C	C
School B	C	E	C
School C	E	C	E
School D	E	E	E
Two-unit			
School E	C	E	C
School F	C	C	C
School G	E	E	E
School H	E	C	E
Three-unit[b]			
School I	C	E	E
School J	E	C	C

C = Control group E = Experimental group

[a] Ames Community School District, Ames, Iowa.

[b] A third three-unit school was not included in either the experimental or control groups.

areas which included the sciences, humanities, and social studies. An original list of 89 concepts for grades K-16 was collected from literature relating to wildlife management, plant ecology, water management, soils, political science, economics, sociology and cultural anthropology. This list was revised and expanded to 157 items upon review by 67 Wisconsin scholars who represented the 40 disciplinary areas mentioned above. A second evaluation resulted in a final list of 128 concepts.

These concepts were then submitted to a national panel of 699 scholars in the same 40 disciplinary areas. Ratings were received from 350 of the panel. Of the 128 concepts, 111 were judged acceptable by over 90 percent of the respondents. Only one concept received less than 80 percent acceptable ratings.

In constructing an attitude instrument for the subjects of this study, this writer subjected these 128 concepts to ratings by ten individuals familiar with both the objectives and the curriculum of Project ECO. Included were two elementary teachers, two junior high school teachers, two high school teachers, the Director of Elementary Education, the Director of Curriculum, and the Coordinator and the Associate Director of Project ECO. These individuals were asked to rate each concept according to its value in the curriculum of Project ECO. The possible responses were: essential, highly desirable, desirable, satisfactory, and unacceptable (Appendix C). These responses were given numerical values of 5,4,3,2, and 1 respectively.

A mean score for each concept was computed; the maximum possible mean score was 5.0 and the minimum possible mean score was 1.0. An arbitrary level of 3.5 was predetermined as the cut-off point. Concepts receiving a mean rating of 3.5 or higher were included in the attitude instrument; those falling below 3.5 were omitted. Clarifying revisions were made in some of the selected concepts as suggested by the raters.

The resulting 67 concepts were randomly ordered and separate response sheets were constructed (Appendix D). Teachers were asked to respond to each concept in two ways. First, what degree of importance did they place on the teaching of the concept to their students? The possible responses were essential, desirable, undecided, of little importance, and not important. Second, did they feel adequate to employ various learning activities, including field trips, in order for their students to develop an understanding of the concept? The possible responses were very adequate, adequate, undecided, inadequate, and very inadequate.

In this form the instrument was administered to 48 elementary teachers in two nearby school districts on a trial basis. Reliability estimates were computed for this trial administration using the Cronbach-Alpha Formula. The reliability coefficients ranged from .94 to .97. However, it was apparent that the response forms influenced the subjects to develop a pattern which placed most of their responses at the upper end of the two five-point scales. Therefore, the format of the

instrument was altered.

The subjects were asked to respond to each concept in the two ways mentioned previously. Each concept was then followed by two seven-point rating scales which contained no zero point. These scales were designated as important-not important and adequate-inadequate continuums respectively. If the subjects were unable to reach an opinion on the concept, they were allowed to indicate so by marking a No Opinion response which was not included in the seven-point scale. A personal data sheet requesting the subjects' age, teaching assignment, number of years of previous experience, and the number of credits of formal science training was developed and attached to the front of the instrument. A set of instructions for completing the instrument was also included. This form of the instrument along with the personal data sheet and the instructions can be found in Appendix E.

Selection of the Cognitive Instrument

In addition to the attitude assessment, some measure of the subjects' cognitive abilities was desired. A test of scientific principles and methods was deemed more appropriate than a test of basic factual information. This decision was supported by the fact that elementary teachers in general have limited science backgrounds. In addition, the purpose of the in-service program was not intended to increase the subjects' factual knowledge as much as it aimed at producing a general understanding of scientific principles.

The instrument selected was Part II of the Test of Science Knowledge (TOSK). This test was constructed by the staffs of the Earth Science Curriculum Project and the Psychological Corporation (53) to provide an estimate of student background in general science at the ninth-grade level. Part II (Principles) is composed of 50 multiple-choice items which attempt to measure the subjects' grasp of scientific principles, methods, and procedures and which are relatively free of specific factual knowledge. Included are such matters as hypothesis formation, generalizations from observations, experimental methods, measurement, and methods of collecting data.

Norms for this test had been established on the performance of over eight thousand students in grades eight through twelve. The Kuder-Richardson Formula 20 was used to compute reliability estimates. A reliability coefficient of .83 for Part II was based on 740 cases selected at random from all ninth grade students who took the test. Correlation coefficients of .64 and higher were found between Part II and the Differential Aptitude Tests which measure general scholastic ability.

Collection of the Data

Pre-tests were administered during September of 1971. The attitude survey was given to all 56 subjects on September 3. Part II of the Test of Science Knowledge was administered to the experimental groups at their first in-service session. The control groups were tested on

an individual building basis at scheduled dates throughout the month.

Post-tests were administered in late April and in May as the experimental groups completed their third in-service meeting and field experience. Both instruments were given at the same time. The control groups were included in these testing sessions.

Following the pre-tests, the personal data provided by the subjects were checked and completed through review of personnel files in the Ames Community Schools. The major verifications pertained to age, years of previous experience, and the number of science credits earned in college.

Responses to the attitude survey were recorded on the instrument and later transferred to machine scored answer sheets. The subjects responded to Part II of the Test of Science Knowledge directly onto machine scored answer sheets.

Treatment of the Data

There were four basic purposes for analyzing the data obtained in this study: to describe the experimental and control groups utilizing personal and academic characteristics and test scores; to determine the degree of difference, if any, which existed between the experimental and control groups with regard to these attributes; to evaluate the amount of change which occurred between the pre-tests and the post-tests within the experimental and control groups; and to determine relationships which existed between the various attributes

of these groups.

The personal data sheet attached to the attitude instrument produced four items of personal information for each subject. Included were age, grade level assignment, years of teaching experience, and the number of semester credits earned in college science courses. A fifth item, the number of college science courses taken, was obtained from individual transcripts in the personnel files of the Ames school district.

For each subject, there were three pre-test scores and three post-test scores. One of these was the raw score on Part II of the Test of Science Knowledge. The other two scores were summated rating scores for the two rating scales in the attitude instrument. For each individual the numerical ratings for the 67 concepts were summed on each of the two rating scales. With the seven-point rating scale, the possible scores ranged from 67 to 469.

Each of the personal information items, with the exception of grade level assignment, was analyzed for measures of central tendency. This analysis included computation of the mean, the variance, and the standard deviation for each item within each group. The t statistic (63) was used to evaluate differences in the means between the experimental and control groups for each item. The five percent and one percent levels of significance were chosen for rejecting the null hypotheses that there were no significant differences in the means.

Each of the test scores was also analyzed for measures of central

tendency within the experimental and control groups. The t statistic was again utilized to assess mean differences between the experimental and control groups for both the pre-tests and the post-tests. A similar analysis was made between the pre-tests and the post-tests within the experimental and control groups.

Product-moment correlation coefficients were computed between all possible pairs of the 11 items mentioned above. Included were the five personal information items, the three pre-test scores, and the three post-test scores. The product-moment correlation coefficient is an expression of the degree of relationship between two variables (30).

In an effort to find a relatively small number of variables which will explain other variables, partial correlations were computed. A partial correlation coefficient is the degree of relationship expected between two variables when one or more other variables are held constant (30). In this study partial correlations were used to determine the relationship between two attributes, i.e., age and attitude score, of the experimental and control groups when these groups were placed on an equal basis with regard to a third attribute, i.e., grade level taught.

The analysis of covariance technique (63) was also employed to evaluate the data collected on the 11 variables. This technique is particularly useful in educational investigations as it allows the researcher to equate the independent variable groups with respect to one or more variables which may relate to the dependent variable. In this study, the dependent variables were pre-test scores and post-test scores recorded on the three measurement instruments by the experimental

and control groups. The independent variables or covariates included grade level assignment, age, experience, number of college science courses completed, and number of semester credits earned in college science courses. Pre-test scores were included as a covariate only in assessing the effects of the treatment on post-test scores. As a result of this technique, the test scores of the experimental and control groups were compared on the basis that they were equal on the covariate items.

Data for the 11 items listed above were also obtained for the six teachers from the special experimental group who were not included in either the experimental or control groups. Measures of central tendency were computed. These measures were compared with those of the experimental and control groups on a nonstatistical basis.

CHAPTER IV. FINDINGS

To answer the questions posed in CHAPTER I, data pertaining to 11 variables were obtained for the 56 first, third, and fifth grade teachers included in this study. These teachers were divided into an experimental group of 25, a control group of 25, and a special experimental group of six teachers.

Personal and academic data for the subject were obtained from the personal data sheets attached to the attitude instrument and from personnel files of the Ames school district. Included were age, grade level assignment, years of teaching experience, number of college science courses completed, and number of semester credits earned in college science courses. In addition, both pre-test scores and post-test scores were procured from the subjects on three measures: Part II (Principles) of the Test of Science Knowledge (TOSK); the importance scale of the attitude instrument; and the adequacy scale of the attitude instrument.

Measures of central tendency and variance of these variables were computed. Comparisons were made between the experimental and control teachers on these variables utilizing the t statistic. Pre-test scores were compared with post-test scores on the three measures using the correlated t-test.

Correlations between each possible combination of two variables were computed in order to determine the degrees of relationship which existed. First-order partial correlations were calculated to

ascertain the relationship between two variables when a third variable was held constant.

Analysis of covariance was used to equate the experimental and control groups on the variables of grade level assignment, age, experience, number of college science courses completed, and number of credits earned in college science courses. Differences between the two groups on pre-test scores and post-test scores were then evaluated.

The special experimental group was described on the basis of the 11 variables. Nonstatistical comparisons were made with the experimental and control groups.

Comparison of the Experimental and Control Groups

Each group was comprised of nine first grade teachers, nine third grade teachers, and seven fifth grade teachers. The experimental group teachers ranged in age from 22 to 59 years while the range of the control group teachers was from 23 to 52 years. Only one of the control group teachers was over 40 years of age; in the experimental group six teachers exceeded that age with four between the ages of 56 and 60. The respective mean ages for the experimental and control groups were 35.6 and 29.4. This difference of 6.2 years was significant at the .05 level. Table 2 contains the age distributions of these two groups as well as the means and the t statistic value.

The experimental group teachers averaged 10.8 years of teaching

Table 2. Ages of the experimental and control group teachers

Age (years)	Experimental Group (N = 25)	Control Group (N = 25)
21 - 25	6	9
26 - 30	6	6
31 - 35	3	7
36 - 40	4	2
41 - 45	1	0
46 - 50	1	0
51 - 55	0	1
56 - 60	4	0
Mean	35.6	29.4
t	2.19*	

*Significant at the .05 level.

experience while the control group teachers had an average of 6.1 years of experience. The difference of 4.7 years was nearly significant at the .05 level. Only one of the control teachers had more than 15 years teaching experience. In the experimental group seven teachers had taught for more than 15 years; two of these had been teaching for more than 35 years. Frequency distributions of the years of teaching experience, means, and the t statistic value for the two groups are represented in Table 3.

Table 3. Years of teaching experience of the experimental and control group teachers

Years of Teaching Experience	Experimental Group (N = 25)	Control Group (N = 25)
0 - 5	12	14
6 - 10	4	6
11 - 15	2	4
16 - 20	3	0
21 - 25	2	1
26 - 30	0	0
31 - 35	0	0
36 - 40	2	0
Mean	10.8	6.1
t	1.98	

There were no significant differences in the two groups with regard to the number of college science courses completed and the number of semester credits earned in college science courses. The experimental teachers had completed from two to nine college science courses with an average of 4.8. The number of courses for the control group teachers ranged from two to 12 with a mean of 5.0. The control teachers had also earned slightly more credits in the science courses with an average of 15.2 semester credits; the average number of credits earned by the experimental teachers was 14.0. Data relating to these two

items are illustrated in Table 4 and Table 5.

Table 4. Number of college science courses completed by the experimental and control group teachers

No. of college science courses completed	Experimental Group (N = 25)	Control Group (N = 25)
1 - 2	2	2
3 - 4	10	10
5 - 6	9	7
7 - 8	3	3
9 - 10	1	2
11 - 12	0	1
Mean	4.8	5.0
t	0.45	

The control group scored higher than the experimental group on the pre-test of the 50-point TOSK. The former averaged 36.7 while the latter attained a mean score of 33.4. This difference of 3.3 points was not significant at the .05 level. Conversely, the experimental group scored higher on the pre-tests of both the importance and adequacy scales. On the importance scale, their average scores (342.0) exceeded that of the control group (286.2) by 55.3 points, a difference which was significant at the .01 level. A difference of 30.7 points was found between the mean scores of the experimental teachers (303.4)

Table 5. Number of semester credits earned in college science courses by the experimental and control group teachers

No. of Semester Credits	Experimental Group (N = 25)	Control Group (N = 25)
Under 10	9	5
11 - 15	9	13
16 - 20	4	4
21 - 25	2	1
26 - 30	1	1
Over 30	0	1
Mean	14.0	15.2
t	0.66	

and those of the control group (272.7) on the adequacy scale. This difference was nearly significant at the .05 level.

The control teachers again scored higher on the post-test of the TOSK (38.9 vs. 35.0). The difference of 3.9 points approached significance at the .05 level. As in the case of the pre-tests, the experimental teachers scored higher on both the importance and adequacy scales administered at the completion of the in-service program. On the importance scale, the difference was 42.6 points (368.7 vs. 326.1). A difference of 41.3 points (363.5 vs. 322.2) was noted for the adequacy scale. In both cases these differences were significant at the .05 level.

Table 6 represents a comparison of the pre-test and post-test scores of the experimental and control groups.

Table 6. Comparison of pre-test and post-test scores of the experimental and control group teachers

	Experimental Group (N = 25)	Control Group (N = 25)	Mean Difference	t
Pre-tests				
TOSK (Part II)	33.4	36.7	3.3	1.52
Importance Scale	342.0	286.2	55.8	2.90**
Adequacy Scale	303.4	272.7	30.7	1.90
Post-tests				
TOSK (Part II)	35.0	38.9	3.9	1.88
Importance Scale	368.7	326.1	42.6	2.25*
Adequacy Scale	363.5	322.2	41.3	2.42*

*Significant at the .05 level.
**Significant at the .01 level.

Comparison of Pre-test and Post-test Scores within Groups

In order to assess any changes which occurred in the subjects during the in-service program, comparisons were made between the pre-test scores and post-test scores on the three measures utilized

in this study. Since the pre-test scores and post-test scores were positively correlated for each measure, the most general form of the t-test was used.

Within the experimental group, gains were noted on all three measures. An increase of 1.6 points on the TOSK (35.0 vs. 33.4) was significant at the .05 level. Scores on the importance scale rose from 342.0 to 368.7, a gain of 26.7 points. This difference was not significant. The largest increase within either group was found on the adequacy scale within the experimental group. The increase of 60.1 points (363.5 vs. 303.4) was significant at the .01 level.

Score increases were also detected for all three measures within the control group. In each instance the gains were significant at the .01 level. Scores on the TOSK rose 2.2 points from 36.7 to 38.9. The respective gains for the importance scale and for the adequacy scale were 39.9 and 49.5. A comparison of pre-test scores with post-test scores within the two groups is contained in Table 7.

Correlation of the Variables

Product-moment correlations were computed for each possible combination of two variables in order to determine what degrees of relationship existed among the 11 variables observed in this study. These correlations were calculated by utilizing the data for the 50 subjects in the experimental and control groups. A matrix of these correlations can be found in Appendix F.

Table 7. Comparison of pre-test and post-test scores within the experimental and control groups

	Pre-test	Post-test	Mean Difference	Correlated t
Experimental Group (N = 25)				
TOSK (Part II)	33.4	35.0	+ 1.6	2.76*
Importance Scale	342.0	368.7	+26.7	1.78
Adequacy Scale	303.4	363.5	+60.1	4.01**
Control Group (N = 25)				
TOSK (Part II)	36.7	38.9	+ 2.2	2.93**
Importance Scale	286.2	326.1	+39.9	4.06**
Adequacy Scale	272.7	322.2	+49.5	4.42**

*Significant at the .05 level.
**Significant at the .01 level.

The variable of grade level assignment was found significantly related to only one other variable. A correlation coefficient of .48 was noted between grade level assignment and pre-test scores on the importance scale. This coefficient was significant at the .01 level. The correlation of .27 between grade level assignment and pre-test scores on the adequacy scale was nearly significant at the .05 level. The correlations between grade level assignment and post-test scores of these two scales did not approach significance.

Age and years of experience were highly correlated with a

coefficient of .88. Age was negatively correlated at the .01 level with both pre-test and post-test scores on the TOSK. The respective coefficients were -.58 and -.59. A correlation of .30 between age and post-test scores on the importance scale was significant at the .05 level; a correlation of .27 between age and post-test scores on the adequacy scale approached significance at this level.

Years of teaching experience, which was highly correlated with age, was also highly negatively correlated with pre-test scores and post-test scores on the TOSK. The coefficients between experience and these two sets of scores were -.38 and -.41 respectively. These relationships were to be expected because of the high age-experience correlation.

Significant correlations were noted between the respective pre-test scores and post-test scores of the three measures. Pre-test and post-test scores on the TOSK had a correlation of .91. A correlation of .61 was found between pre-test scores and post-test scores on the importance scale and these two scores for the adequacy scale were correlated at .42. All three of these correlations were significant at the .01 level. In relation to the control group, these correlations were an indication of test-retest reliability.

A correlation of .57 was computed between pre-test scores on the importance scale and pre-test scores on the adequacy scale. Similarly, the post-test scores on these two scales were correlated .69. This indicated that the subjects tended to rate the importance of the concept and their adequacy in teaching the concept at the same level.

Table 8 reveals the correlations among the pre-test scores and the post-test scores of the three instruments used in this study. Correlations above .36 were significant at the .01 level and those above .28 were significant at the .05 level.

Partial Correlations of the Variables

In order to determine if a variable had a significant part in explaining the correlation between two other variables, partial correlations between selected variables were computed. In essence, correlations between two variables were recalculated when a third variable was held constant.

Grade level assignment was significantly correlated with pre-test scores on the importance scale and approached significance with pre-test scores on the adequacy scale. Thus, grade level assignment was partialed from the correlation of pre-test scores on the importance scale with pre-test scores on the adequacy scale. The correlation coefficient of .57 was reduced to a .44 partial correlation which remained highly significant. Grade level assignment was not a significant factor in

Table 8. Correlations[a] among pre-test and post-test scores of the TOSK and of the importance and adequacy scales

	TOSK Pre-test	TOSK Post-test	Importance Pre-test	Importance Post-test	Adequacy Pre-test	Adequacy Post-test
TOSK Pre-test	100					
TOSK Post-test	91**	100				
Importance Pre-test	-11	-10	100			
Importance Post-test	-12	-10	61**	100		
Adequacy Pre-test	15	23	57**	30*	100	
Adequacy Post-test	-08	-04	43**	69**	42**	100

[a]All correlations were multiplied by 100 to remove the decimal.

*Significant at the .05 level.

**Significant at the .01 level.

the relationship of these two sets of scores.

Grade level assignment was also partialed from the correlation between pre-test scores and post-test scores on the importance scale. The original product-moment correlation of .61 was lowered to .60. A similar partialing of the correlation between pre-test scores and post-test scores of the adequacy scale did not significantly change this relationship. None of the above correlations were significantly changed when grade level assignment was held constant.

It was previously noted that age was highly negatively correlated with both pre-test scores and post-test scores on the TOSK. When age was partialed from the correlation between pre-test scores and post-test scores on this instrument, the coefficient of .91 was reduced to .86. These two variables remained highly correlated when age was held constant.

Age was also found to be significantly correlated with post-test scores of the importance scale. The correlation between age and post-test scores on the adequacy scale approached significance. The correlation between pre-test scores and post-test scores on the importance scale were recomputed holding age constant. This correlation was lowered only one point. Similarly, holding age constant when recalculating the correlation between pre-test scores and post-test scores on the adequacy scale did not produce a significant change. It appeared that age did not significantly affect the relationships between other variables.

Analysis of Covariance

Another technique used for assessing differences between test scores of the experimental and control groups was analysis of covariance. This technique compensated for differences in the two groups with regard to grade level assignment, age, experience, number of college science courses completed, and number of semester credits earned in college science courses.

There was no significant difference in pre-test scores or in post-test scores on the TOSK when analysis of covariance was utilized. In-service training was not associated with higher scores on the TOSK when the experimental and control groups were equated on the five variables listed above.

Significant differences between the experimental and control groups were detected on pre-tests of the importance scale and the adequacy scale respectively. The experimental teachers scored significantly higher on the pre-tests of these two measures when the two groups were equated on the five covariates. Descriptions of these covariance analyses are shown in Tables 9 and 10.

Previous findings based on the use of the t statistic revealed that a significant difference existed only between pre-tests of the importance scale. When the two groups were equated on the five covariates, the differences between pre-tests of the adequacy scale also became significant.

Adjusted means for the two scales are presented in Table 11 and

Table 9. Analysis of covariance. Effect of in-service training on pre-test scores of the importance scale with covariates of grade level assignment, age, experience, number of college science courses completed, and number of credits earned in college science courses

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	49	260,499		
Covariates	5	87,124		
Adjusted total	44	173,375		
Treatment	1	33,365	33,365	10.25**
Residual	43	140,010	3,256	

**Significant at the .01 level.

Table 10. Analysis of covariance. Effect of in-service training on pre-test scores of the adequacy scale with covariates of grade level assignment, age, experience, number of college science courses completed, and number of credits earned in college science courses

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	49	168,087		
Covariates	5	27,875		
Adjusted total	44	140,212		
Treatment	1	15,583	15,583	5.38*
Residual	43	124,629	2,898	

*Significant at the .05 level.

Table 11. Adjusted means of pre-test scores on the importance and adequacy scales

	Importance Scale		Adequacy Scale	
	Adjusted	Unadjusted	Adjusted	Unadjusted
Experimental Group	317.42	342.00	286.48	303.40
Control Group	310.75	286.20	289.35	272.70

illustrate the effects of the covariates on the respective means. It was observed that the experimental and control group means were similar when the covariates were held constant.

Previously, it was demonstrated that the experimental group scored significantly higher than did the control group on the post-tests of both the importance scale and the adequacy scale when the t statistic was used. However, when the two groups were equated on the five covariate items, these differences were no longer significant. It was noted that the mean differences of 42.6 points and 41.3 points were not significant for the post-tests while a difference of only 30.7 points was significant for the pre-tests. This was due to correlations between the post-tests and the covariate items being larger than the correlations between the pre-tests and the covariate items. The resulting F values presented in Tables 12 and 13 did approach significance at the .05 level.

Adjusted means for pre-test scores and post-test scores on the importance and adequacy scales were computed. However, these adjustments

Table 12. Analysis of covariance. Effect of in-service training on post-test scores of the importance scale with covariates of grade level assignment, age, experience, number of college science courses completed, and number of credits earned in college science courses

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	49	237,340		
Covariates	5	43,862		
Adjusted total	44	193,478		
Treatment	1	12,986	12,986	3.09
Residual	43	180,492	4,197	

Table 13. Analysis of covariance. Effect of in-service training on post-test scores of the adequacy scale with covariates of grade level assignment, age, experience, number of college science courses completed, and number of credits earned in college science courses

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	49	195,917		
Covariates	5	23,632		
Adjusted total	44	172,285		
Treatment	1	14,228	14,228	3.87
Residual	43	158,057	3,676	

were all one point or less and were not presented.

Respective pre-test scores were then included as a sixth covariate for each measure. The subsequent covariance analysis of differences between post-test scores resulted in F values which were clearly non-significant. When the experimental and control groups were equated on pre-test scores as well as on the original five covariates, these two groups did not differ statistically on post-test scores. This finding was not unexpected due to the high correlations between pre-test and post-test scores on the respective measures.

Description of the Special Experimental Teachers

Due to the involvement of one of the elementary schools with a major component of Project ECO, the first, third, and fifth grade teachers of that school were not included in either the experimental or the control groups. However, data for the 11 variables were obtained for these six teachers and were compared on a nonstatistical basis with those of the experimental and control group teachers.

The special experimental group was comprised of two first grade teachers, three third grade teachers, and one fifth grade teacher. The mean age of 32.5 years fell between those of the experimental and control groups. These teachers averaged 6.5 years of teaching experience which placed them slightly above the control group but well below the experimental group teachers. With regard to the number of college science courses completed and the number of semester credits earned

in college science courses, these six teachers ranked well above the other two groups. The special group averaged 6.2 courses and 17.2 semester credits. This difference was caused primarily by two teachers who had a combined total of 20 courses and 54 semester credits.

Pre-test and post-test scores on the TOSK were 31.5 and 31.7 respectively. Both of these scores were lower than those earned by the experimental and control groups. Similarly, the gain of only 0.2 points from pre-test to post-test was much lower than either of the other groups.

These six teachers scored higher on both the importance and adequacy scales than did either the experimental or the control group teachers. This was true for both pre-test and post-test scores. However, their gains from pre-test to post-test (8.2 points on the importance scale, 29.8 points on the adequacy scale) were considerably below those of the other two groups. Table 14 presents the mean values of ten variables for these six teachers along with comparable averages for the experimental and control group teachers. A comparison of pre-test and post-test scores within these three groups appears in Table 15.

Summary

The experimental group was found to be significantly older than the control group. The experimental teachers also exhibited a greater number of years of teaching experience; however, this difference was not significant. The two groups were identical with respect to grade

Table 14. Mean values of ten variables for the experimental, control, and special experimental teachers

Variable	Experimental Group (N = 25)	Control Group (N = 25)	Special Experimental Group (N = 6)
Age (years)	35.6	29.4	32.5
Years of teaching experience	10.8	6.1	6.5
No. of college science courses completed	4.8	5.0	6.2
No. of semester credits earned in college science courses	14.0	15.2	17.2
TOSK pre-test	33.4	36.7	31.5
Importance pre-test	342.0	286.2	362.5
Adequacy pre-test	303.4	272.7	338.2
TOSK post-test	35.0	38.9	31.7
Importance post-test	386.7	326.1	370.7
Adequacy post-test	363.5	322.2	368.0

level assignment and did not differ greatly on the number of college science courses completed or on the number of semester credits earned in college science courses.

The control teachers scored higher than the experimental teachers on both the pre-tests and the post-tests of the TOSK. These differences were not significant. Conversely, the experimental group scored higher than the control group on both the importance scale and the adequacy

Table 15. Comparison of pre-test scores with post-test scores for the experimental, control, and special experimental teachers

Teachers	Pre-test	Post-test	Difference
Experimental (N = 25)			
TOSK (Part II)	33.4	35.0	+ 1.6
Importance scale	342.0	368.7	+ 26.7
Adequacy scale	303.4	363.5	+ 60.1
Control (N = 25)			
TOSK (Part II)	36.7	38.9	+ 2.2
Importance scale	286.2	326.1	+ 39.9
Adequacy scale	272.7	322.2	+ 49.5
Special experimental (N = 6)			
TOSK (Part II)	31.5	31.7	+ 0.2
Importance scale	362.5	370.7	+ 8.2
Adequacy scale	338.2	368.0	+ 29.8

scale of the attitude instrument. This was true for both pre-test scores and post-test scores. For the pre-tests the difference on the importance scale was highly significant; differences for the post-tests were significant at the .05 level.

Differences between pre-test scores and post-test scores on the three instruments within the two groups were compared using the correlated t-test. All comparisons revealed score increases from pre-test

to post-test. The gain on the TOSK for the experimental group was significant at the .05 level; a highly significant increase was observed on the adequacy scale for this group. Increases on all three measures within the control group were significant at the .01 level.

Grade level assignment was positively correlated with pre-test scores on the importance scale. When grade level assignment was held constant, no significant change in correlations between other variables was detected.

As expected, age and experience were highly correlated. Both of these variables were negatively correlated with pre-test scores and post-test scores on the TOSK. The older the teacher, the lower was his score on the TOSK. Age was also found to be significantly related to post-test scores on the importance scale. However, holding age constant did not significantly alter the correlations between other variables.

Pre-test scores were significantly correlated with post-test scores for all three measures. Pre-test scores of the importance scale and of the adequacy scale were positively correlated with each other. Post-test scores of the two scales were also correlated. Teachers were inclined to rate the importance of the concept and their adequacy in teaching the concept at the same level.

Analysis of covariance revealed that the experimental and control groups differed on the pre-tests of the importance and adequacy scales when the personal and academic variables were used as covariates. However, there were no significant differences on either the pre-tests or

the post-tests of the TOSK or on the post-tests of either the importance scale or the adequacy scale. This indicated that in-service training had no effect on scores of the TOSK when the personal and academic variables were held constant. Also, the effect of in-service training on the attitudes of the subjects was evident at the beginning of this study but was no longer significant at the end of the year.

The special experimental group of six teachers was similar to the experimental and control groups with regard to personal and academic variables. Their scores on the TOSK were lower for both the pre-test and post-test administrations. Initially, they scored considerably higher on the pre-tests of the importance and adequacy scales. However, their gain scores were much lower on these two scales than were those of the experimental and control groups.

CHAPTER V. SUMMARY

Elementary teachers have often been berated for their aversion to the area of science, both in their college preparation and in later teaching activities. Research has revealed that there are few college science requirements for the developing teacher and that these requirements are not consistent from one institution to another. At the same time, elementary teachers are reluctant to teach science due to their feelings of inadequacy and the subsequent loss of prestige which they feel they would suffer. Also, the great majority of elementary teachers, who are women, are of the opinion that men are better suited to teach science.

Attempts are being made at the college level to insure greater science preparation for future elementary teachers. Nevertheless, this will not aid those teachers who are now in the classroom and who do not have adequate preparation in science. Hopefully, the public school administrator can assist his teachers in this regard through in-service training. It is important, however, that the administrator be aware of the effects of in-service training on the attitudes of teachers as well as on their knowledge of content and methods. The meager evidence which is available does indicate that teacher attitudes and interests do have an effect on student learning and student attitudes.

The purpose of this study was to determine what changes, if any, occurred in the achievement and attitudes of elementary teachers during an in-service program in environmental science. The subjects

were 25 first, third, and fifth grade teachers who were randomly selected for inclusion in the Environmental Curriculum Opportunity (Project ECO) of the Ames (Iowa) Community Schools. A control group of 25 first, third, and fifth grade teachers was used for comparison. A special experimental group of six teachers was also observed as a part of this study.

The in-service program included three one-half day training sessions for the teachers. These sessions included an exploration of activities appropriate for field study and brief field trips to the outdoor locations where the teacher would be studying with his class. Each training session was followed in succeeding days by a field trip for the teacher and his students. One field trip was completed in each of the three school-year seasons (fall, winter, spring); the trips ranged in length from one-half day to a full school day.

Personal and academic information was obtained for the experimental and control teachers. Included were grade level assignment, age, experience, college science courses completed, and semester credits earned in college science courses. The teachers were subjected to three paper-and-pencil measures. The Test of Science Knowledge (TOSK) was used to determine their understanding of scientific principles. A second instrument consisting of two rating scales attempted to assess their attitudes toward selected environmental management concepts and toward teaching these concepts. All three measures were administered before the in-service training began and again following its completion.

The t statistic, product-moment correlation, partial correlation,

and analysis of covariance were statistical techniques used to evaluate the data obtained on the above items. The experimental group was older and had more years of teaching experience than did the control group. Scores on the TOSK did not differ greatly between groups. The experimental group scored considerably higher than the control group on both the importance and adequacy scales. This was true for both the pre-tests and the post-tests.

Score increases from pre-test to post-test existed for all three measures within the two groups. Five of six gain scores were significant when the correlated t-test was utilized.

Few strong correlations were noted between personal characteristics and scores on the three measures. Age and experience were highly negatively correlated with scores on the TOSK. The older the teacher, the lower was his score on this instrument.

Pre-test scores of the importance scale were positively correlated with pre-test scores of the adequacy scale. This was also true for the post-test scores of the two scales. There was a definite relationship between the teacher's rating of the concept and his rating of his adequacy in teaching the concept.

Analysis of covariance was used to hold the personal and academic variables constant while comparing scores on the three measures. It was found that in-service training had no effect on scores of the TOSK when these variables were held constant. The experimental group scored significantly higher than the control group on pre-tests of

the importance and adequacy scales. However, at the end of the year, these differences, although relatively high, were no longer statistically significant.

The special experimental group of six teachers was similar to the experimental and control groups with regard to personal and academic variables. Initially, the special group scored higher on the pre-tests of the importance and adequacy scales. However, their gain scores were much lower than those of the other two groups.

Conclusions

In the presentation of the problem in CHAPTER I, four questions were posed. Following is a restatement of those questions with conclusions derived from the findings previously reported.

1. Was there a difference in the science achievement of elementary teachers who have been involved in an environmental science in-service program (experimental group) and the science achievement of elementary teachers who did not receive this training (control group)?

The control group scored slightly higher than the experimental group on the Test of Science Knowledge. The differences were not significant. There was no difference in science achievement of the two groups.

2. Did the experimental group teachers display attitudes toward environmental management concepts which are different

from the attitudes of the control group teachers?

The experimental teachers scored significantly higher than the control group on the importance scale. Increases in scores on this scale were evident for both groups. Although the experimental teachers scored higher than the control teachers on the importance scale, their gain in attitude score from pre-test to post-test was not nearly as great.

3. Did the experimental group teachers exhibit attitudes toward teaching environmental science which are different from the attitudes of the control group teachers?

The experimental group also scored higher than the control group on the adequacy scale. Both groups exhibited large gains from pre-test to post-test. The experimental teachers did display attitudes different from those of the control group. However, the changes in their scores from pre-test to post-test were similar.

4. Was there a relationship between the achievement and attitudes of these teachers and their age, grade level taught, amount of teaching experience, and formal academic science preparation?

Analysis of covariance was used to hold constant these personal

and academic characteristics of the subjects. The two groups remained similar in science achievement. However, significant changes were noted with regard to the attitude scales. The effect of in-service training upon the attitudes of the teachers was evident at the beginning of the study but was no longer significant at the end of the year. There was a relationship between these variables and attitude scale scores. Age and experience were observed to have the greatest effect; the other variables were minor contributors. The slight change of some differences from nonsignificant to significant and vice versa indicates that the effect of the covariates was not as great as could be inferred from the statistics.

Discussion

Some of the findings reported earlier were not unexpected. The negative relationship of age and scores on the TOSK is indicative of two things: 1) Older teachers have been away from formal science training and testing for a longer period of time. 2) Science education has improved in recent years giving the younger teacher an added advantage. When age and experience, the major contributors in the covariance analysis, were held constant, differences between the experimental and control groups for the TOSK were clearly nonsignificant. The in-service training did not produce significant gains in the teachers' grasp of scientific principles.

This, too, is not surprising as the thrust of the in-service program

did not focus on the cognitive area. Instead, the major concern was involving teachers in field experiences in order to develop a willingness to work with and an enthusiasm for outdoor education.

Since the attitude scales contained no zero or base point, it was not unusual that the pre-test scores for the two groups were quite dissimilar. However, it should follow that the teachers in the experimental group would exhibit greater gains in attitude as measured by the the two attitude scales. Personal observations by this writer also would lead to this assumption. One experimental teacher, who was most critical of the program through the first half of the year, asked to be considered for a full time position with Project ECO during the 1972-1973 school year. Following the completion of the first year of Project ECO, two other teachers from the experimental group commented on the effects of the in-service training. They both felt that it had given them added confidence in dealing with all facets of science and had indicated so by marking the adequacy scale very high.

Nevertheless, the data do not support these conclusions. The experimental group scored higher than the control group on the pre-tests of the two attitude scales and they also scored higher on the post-tests of the two scales. The differences between the two groups in each case were of approximately the same magnitude; on one scale the difference increased and on the other scale the difference decreased. The differences were significant or nonsignificant depending upon the statistical technique used. Regardless of the technique employed, the differences approached significance.

There are three possible explanations for not finding greater attitude gains on the part of the experimental teachers. The first is that the in-service training had no effect upon the experimental teachers which was different from that experienced by the control teachers. Subjective evaluations, such as the observations of this writer, would not agree with this conclusion.

A second explanation is that the attitude instrument did not measure what it intended to measure. Thus, this instrument was not a valid index of attitudes toward environmental science concepts or the teaching of these concepts. The findings could not then be used in evaluating the effects of the in-service program upon these attitudes. Since this was the first use of the attitude instrument, this possible explanation must stand until further research can be conducted.

A third explanation is contained within the design of the study. Due to the random selection of teachers from three grade levels at ten different schools, nearly every school included both experimental and control teachers. The chance was great that information and ideas presented in the in-service sessions would spread to the control teachers. Not only could this occur from teacher to teacher but also through the students who were involved in the field experiences.

Closely associated with this possible contamination effect was the subtle competition which exists among teachers. Each teacher knew whether he was a control or an experimental teacher. The control teachers were generally aware of what was occurring within the

experimental group. The desire to provide their students with opportunities similar to those experienced by the experimental groups may have caused them to work harder in the science area than they would have done without the presence of Project ECO.

It is interesting to compare all three groups on the assumption that a common base for attitude did exist on these scales. The special experimental group initially scored higher on the attitude scales than did either the experimental or control group. This special group had previous contact with Project ECO and was under the administration of a principal who was very active in science and had played a large part in initiating the district-wide environmental project. It was only natural that their initial attitude scores were higher than those of the other two groups.

This special group was omitted almost entirely from the first-year activities of Project ECO. Undoubtedly, there were some feelings of disappointment by these teachers and their principal. It would follow that these teachers would exhibit the smallest score changes on the attitude scales and they did.

Meanwhile, the experimental teachers, demonstrating the "halo" effect of being the recipients of a special program, scored higher on the pre-tests of the attitude scales than did the control group. As the experimental teachers were being involved in the in-service sessions and field trips with their students, the control teachers were listening

and observing. This exposure plus the desire to provide equal science opportunities for their students urged the control teachers into more science activities. At the end of the year, it would be expected that the experimental and control teachers would both reveal greater increases in their attitudes toward science and toward teaching science than were observed in the special experimental group. The findings support this statement.

Limitations of the Study

A major limitation of this study was the possible contamination of the control group. The desire to be informed and involved on the part of the control teachers along with available means of communication provided too many opportunities for the exchange of information pertaining to the in-service training.

A second limitation was the length and extent of the program. Three in-service sessions and three field trips in a nine-month period may not have been sufficient to develop significant changes in achievement and attitudes.

A third limitation was the manner in which the evaluation of this program was presented to the teachers. The teachers were not informed of their assignment to experimental or control groups until their return to school in late August. Within one week they had been subjected to an attitude survey and informed that an additional test would follow. At that time this writer sensed that the teachers were opposed

to the project and the evaluation primarily because of their lack of information. During the course of the year, a major attempt was made by the project administrators to develop and maintain open lines of communication with the teachers. Nonetheless, it is impossible to determine the impact of the teachers' initial impressions upon their scores on the achievement and attitude measures.

Another limitation was the attitude instrument. The validity of this measure could be questioned with regard to the objectives of the in-service component. In addition, there was no base data for comparison with the findings obtained herein. This study may furnish base data for future research with this instrument.

Implications for School Administrators

One caution is extended to school administrators relating to a teacher's age. This study and others have found that older teachers do not score as well on cognitive measures, both initially and after training. However, the findings herein would indicate that the older teachers were as receptive to the new program as were the younger teachers. This writer would add that many of the younger teachers were as resistive to the training as were the older teachers. As Thurstone (55) noted, attitudes are the sum of a person's preconceived notions, ideas, fears, threats, and convictions. The number of these which exist in any one individual does not appear to be a function of age.

Two additional suggestions which this writer would make to school

administrators regarding in-service training are not necessarily derived from the direct findings of this study. Rather, they stem from observations made during the implementation of this particular in-service program.

First, the administrator must be alert to the widespread effects of instituting in-service training. Who will be included and who will be excluded? How will this selection affect staff morale? Will curricular changes be necessary? How will scheduling be affected? What is the role of the building principal? All of these questions and more must be considered; each local situation will require its own solution.

Second, lines of communication must be maintained between teachers and administrators. As mentioned earlier by Rubin (45), the objectives of the program must be evident to the teachers as well as to those implementing the program. Teachers must know why such training is valued and how it fits into their schema of teaching. At the same time, administrators must be apprised of the opinions and attitudes of their staff members. If the lines of communication are open to all, in-service training can be a flexible and useful means of improving instruction.

Recommendations for Further Research

The high correlation between the two scales of the attitude instrument suggest that as much information could be gained by using only one rating scale. This would be preferred over administering two lists

of concepts, each with a different rating scale. Teachers are somewhat wary of "tests" of any kind and their attention span does not appear to be significantly longer than that of students. The adequacy scale presented in this study seems to be more susceptible to attitude changes than does the importance scale.

The lack of a zero-point on the attitude scales was previously mentioned as a limitation of the study. An approximation of such a base might be possible by revising the rating continuum. For this study the adequacy scale contained seven points with "adequate" and "inadequate" placed at opposite ends. A suggested change would be to place "inadequate" at one end and "very adequate" at the opposite end. "Adequate" could then appear at the center of the scale. If subjects were instructed to consider the "adequate" rating as one which most teachers would have, perhaps a more normal distribution of ratings would occur.

In order to remove the possible contamination effect described earlier, some provision should be made for utilizing a control group which could have little or no contact with the program being evaluated. An obvious choice would be teachers in another school district who have similar personal and academic characteristics but who are not involved in a similar treatment.

Although the personal and academic characteristics observed in this study did not have a significant bearing upon the findings, other variables should be investigated in future studies. Included among these might be type of teaching experiences, recency of teaching experience, and academic ability.

Further studies using this type of attitude survey are needed to determine if this instrument is a valid and reliable measure. The data obtained in this study can be used as a basis for comparison.

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APPENDIX A. DESCRIPTION OF THE IN-SERVICE MEETINGS FOR PROJECT ECO

First Grade

Fall (September 3, 1971)

Pre-test: Part II, Test of Science Knowledge

Jerry Dunn, Associate Director: approach to be used in the project, objective of Project ECO

Suggested activities: tree identification, leaf prints, map reading, measuring

Field trip: Brookside Park, Ames

Winter (October 27, 1971)

Jerry Dunn, Associate Director, and Ken Frazier, Coordinator: slide presentation of first field trip in September, solicitation of suggestions for improvement

Suggested activities: film on conservation or wildlife, water safety, fishing, cook-out, study of animal homes, counting plants and animals, games for recess

Field trip: McFarland Lake (located north of Ames)--cancelled due to rain and impassable roads

Spring (May 17, 1972)

Ken Frazier, Coordinator: discussed previous field trip to McFarland Lake, solicited suggestions for improvement

Suggested activities: tour of Iowa wildlife display, nature trail--animal and plant identification, cook-out, recreation activities, observation games during ride to and from park

Field trip: Ledges State Park, Boone

Third Grade

Fall (October 11, 1971)

Pre-test: Part II, Test of Science Knowledge

Suggested activities: study of micro-organisms in the pond, observing designs in nature, collecting seeds and plants, bird watching and nest identification, soil sampling

Field trip: Izaak Walton League Park, Ames

Winter (November 30, 1971)

Suggested activities: observation of terracing activities, bird watching, insect collecting, snail population studies, animal tracking, advantages and disadvantages of animal control, cook-out, visit to beaver dam, map reading and interpretation, weather study--wind, temperature, barometric pressure

Field trip: Hickory Grove Park, Colo (accompanied by Bob Pinneke, Story County Conservationist)

Spring (March 7, 1972)

Suggested activities: observation skills for trip to and from outdoor site, tree identification, tree ring study, increment boring, bird watching, water sampling, study of exposed moraine, study of area history

Field trip: Don Williams Lake and Holst Forest, Boone (accompanied by Ed Grafton, Extension Forester, Iowa State University)

Fifth Grade

Fall (September 13, 1971)

Pre-test: Part II, Test of Science Knowledge

Suggested activities: collecting water and plant samples, microscopic study of algae and microscopic animals, photography, casting animal tracks, collecting rock, coal, shale, and clay, observation of striations in cutbank

Field trip: State 4-H Camp, Luther

Winter (November 12, 1971)

Ken Frazier, Coordinator: slide presentation of fall field trips of fifth grade classes, review of problems and suggestions brought forward by teachers

Suggested activities: water sampling, animal tracking, bird watching, plant collecting, insect and spider collecting, classifying rocks in exposed gravel, rock sawing, area history via epitaph interpretation, tombstone rubbings

Field trip: McFarland Lake, Peterson's gravel pit, and Pleasant Hill Cemetery

Spring (April 5, 1972)

Suggested activities: sorting and grading gravel, graphing, fossil collecting, study of layering in soils, bird watching, water sampling, track casting, rock collecting

Field trip: Preston's Branch and Hallett Construction Co. gravel pit

APPENDIX B. SCHEDULE OF FIELD TRIPS OF PROJECT ECO

Date	School	Grade	Place visited
Sept. 13 PM	G	1	Inis Grove Park
Sept. 14 AM	H	1	"
PM	H	1	"
Sept. 15 AM	J	1	"
PM	J	1	"
Sept. 16 AM	J	1	"
PM	D	1	"
Sept. 17 AM	C	1	"
PM	G	1	"
Sept. 20	H	5	State 4-H Camp
Sept. 21	H	5	"
Sept. 22	I	5	"
Sept. 23	I	5	"
Sept. 24	I	5	"
Sept. 27	C	5	"
Sept. 28	G	5	"
Sept. 29	G	5	"
Sept. 30	D	5	"
Oct. 25	E	3	Izaak Walton Park
Oct. 26	E	3	"
Oct. 27	G	3	"
Oct. 28	G	3	"
Oct. 29	B,D	3	"
Nov. 2	I	3	"
Nov. 3	I	3	"
Nov. 4	I	3	"
Nov. 8	C	1	McFarland Lake
Nov. 9	D	1	"
Nov. 10	J	1	"
Nov. 11	J	1	"
Nov. 12	J	1	"
Nov. 15	H	1	"
Nov. 16	H	1	"
Nov. 17	G	1	"
Nov. 18	G	1	"
Nov. 19	D	5	McFarland Lake
Nov. 22	G	5	"
Nov. 23	G	5	"

Date		School	Grade	Place Visited
Nov.	24	C	5	McFarland Lake
Nov.	29	I	5	"
Nov.	30	I	5	"
Dec.	1	I	5	"
Dec.	2	H	5	"
Dec.	3	H	5	"
Dec.	6	I	3	Hickory Grove Park
Dec.	8	I	3	Des Moines Historical Museum
Dec.	9	I	3	" " " "
Dec.	13	D	3	Hickory Grove Park
Dec.	14	G	3	"
Dec.	15	G	3	"
Dec.	16	E	3	"
Dec.	17	E	3	"
Dec.	20	B	3	"
Mar.	13	B	3	Don Williams Lake
Mar.	14	I	3	"
Mar.	15	I	3	"
Mar.	16	I	3	"
Mar.	27	E,E	3	"
Mar.	28	G	3	"
Mar.	29	G	3	"
Mar.	30	D	3	"
Apr.	10	I	5	Preston's Branch
Apr.	11	C	5	"
Apr.	12	I	5	"
Apr.	13	D	5	"
Apr.	14	I	5	"
Apr.	17	H	5	"
Apr.	18	H	5	"
Apr.	19	G	5	"
Apr.	20	G	5	"
May	22	J,J	1	Ledges State Park
May	23	J	1	"
May	24	G,G	1	"
May	25	H,H	1	"
May	26	C,D	1	"

APPENDIX C. INSTRUMENT FOR RATING THE 128 ORIGINAL CONCEPTS

DIRECTIONS

Enclosed is a list of concepts related to environmental management. As an indication of their relative importance, we are requesting your reaction to each concept. Please indicate your opinion of the worth of each concept as it relates to Project ECO by placing a check in the appropriate space. Following are explanations of the ratings:

Essential---a concept essential to Project ECO at the elementary level

Highly Desirable---a concept highly desirable to Project ECO at the elementary level

Desirable---an important, but not critical, concept to Project ECO at the elementary level

Satisfactory---a concept meaningful to Project ECO but not pertinent to the elementary program

Unacceptable---a concept which does not pertain to Project ECO (is not related to the current objectives)

1. Living things are interdependent with each other and their environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

2. Natural resources are interdependent and the use or misuse of one will affect others.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

3. The natural environment is irreplaceable.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

4. Man has been a factor affecting plant and animal succession and environmental processes.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

5. The interaction of environmental and biological factors determines the size and range of species and populations.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

6. Energy is supplied to an ecosystem by the activities of green plants.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

7. The earth and life on it are greatly affected by the atmosphere.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

8. Pollutants and contaminants are produced by natural and man-made processes.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

9. Safe waste disposal, including the reduction of harmful and cumulative effects of various solids, liquids, gases, radio-active wastes, and heat, is important if the well-being of man and the environment is to be preserved.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

10. An organism is the product of its heredity and environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

11. All living things, including man, are continually evolving.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

12. Man is influenced by many of the same hereditary and environmental factors that affect other organisms and their populations.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

13. The form of life present depends upon the coincidence of the life needs and their availability in an environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

14. The rate of change in an environment may exceed the rate of organism adaptation.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

15. A diverse biological community or culture perpetuates diversity within the gene pool.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

16. Organisms and environments are in constant change.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

17. Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles; inorganic materials and energy become part of organic materials and are subsequently broken down into simpler substances and energy as a result of the operation of organic systems.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

18. At each successively higher level on an energy pyramid, the organic mass is reduced due to metabolic and energy transfer losses occurring at each exchange.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

19. Succession is the gradual and continuous replacement of one kind of plant or animal complex by another and is characterized by gradual changes in species composition.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

20. In any environment, one component like space, water, air or food may become a limiting factor.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

21. The carrying capacity of an ecosystem is the level at which a population can be sustained at an acceptable level of nutrition.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

22. Most resources are vulnerable to depletion in quantity, quality, or both.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

23. The nonrenewable resource base is considered finite.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

24. The rate of use of a nonrenewable natural resource is dependent upon supply and demand, availability of substances, and technology.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

25. The rate of renewal of an exhaustible natural resource is usually extremely slow.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable.

26. The renewable resource base can be extended by reproduction, growth, and management.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

27. Geological processes like erosion and deposition modify the landscape.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable.

28. The economy of a region depends on the utilization of its natural, human, and cultural resources and technologies over time.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

29. Natural resources, water and minerals in particular, are unequally distributed with respect to land areas and political boundaries.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

30. Minerals are nonrenewable resources.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

31. Mineral conservation involves the utilization of all known methods of using the minerals of the earth's crust that will cause them to serve more people for a longer time.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

32. Soil is classified as a renewable resource, but, because it may take a few years to thousands of years to be "renewed," it is more practically termed a depletable resource.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

33. Maintaining, improving, and in some cases restoring soil productivity is important to the welfare of people.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

34. Soil productivity can be maintained by utilizing known agronomic, mechanical, and chemical processes.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

35. Water is a reusable and transient resource, but the available quantity may be reduced or quality impaired.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

36. The amount of precipitation that becomes available for use by man varies with topography, land use, and applied management practices.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

37. Water supplies, both in quantity and quality, are important to all levels of living.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

38. Plants are renewable resources.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

39. Green plants are the ultimate sources of food, clothing, shelter, and energy in most societies.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

40. Animal populations are renewable resources.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

41. Wildlife is considered to be a public resource.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

42. Management of habitat is considered to be an effective technique of wildlife management when the desire is to increase numbers of particular populations.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

43. A rapid turnover of individuals making up a population of most wildlife species exists whether or not the species are exploited.

__Essential __Highly Desirable __Desirable __Satisractory __Unacceptable

44. Wildlife populations are important economically, esthetically, and biologically.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

45. Nonmigratory small game wildlife populations cannot be stock-piled; when hunting mortality replaces natural mortality--the resource is utilized.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

46. Migratory wildlife populations can be stockpiled for short periods of time.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

47. Hunting regulations are useful in maintaining and restoring populations as well as in distributing the game harvest.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

48. Wildlife refuges, undisturbed natural areas, and preserves may be of value in protecting endangered species and perpetuating the gene pool.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

49. Increasing human populations, rising levels of living, and the resultant demands for greater industrial and agricultural productivity promote increasing environmental contamination.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

50. The culture of a group is its learned behavior in the form of customs, habits, attitudes, institutions, and lifeways that are transmitted to its progeny.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

51. Man has psychobiological and biosocial needs.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

52. Man is a high animal form because of his ability to reason.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

53. Man's biological life requirements for growth and development are relatively constant.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

54. Reduction of environmental stresses from excessive to optimum levels result in a feeling of well being.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

55. A satisfactory level of physical, psychological and social health for man depends upon an optimum level of environmental stress.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

56. Environmental management involves the application of knowledge from many different disciplines.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

57. Natural resources affect and are affected by the material welfare of a culture and directly or indirectly by philosophy, religion, government, and the arts.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

58. The political and economic strength of a country is, in part, dependent upon its access to domestic and foreign resources and international relationships.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

59. The relationships between man and the natural environment are mediated by his culture.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

60. Social and technological changes alter the interrelationships, importance, and uses for natural resources.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

61. The distribution or location of resources in relation to population, technological, and economic factors are critical to problems of resource conservation and use.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

62. Modern man affects the structure of his environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

63. Resource depletion can be slowed by the development and adoption of alternatives.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

64. Supply and demand, in relation to values held by society, determine what is a resource and its economic values.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

65. Mineral resources form the base of the cultural pyramid for modern man.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

66. Conservation policy is determined by the interaction of science and technology; social and political factors; and esthetic, ethical, and economic considerations.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

67. The more efficient use of some resources is the result of technical and marketing improvements.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

68. Man's need for food, fiber, and minerals increases as populations expand and levels of consumption rise.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

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69. Increased population mobility is changing the nature of the demands upon some resources.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

70. As populations increase competition for the use of water increases resulting in a need for establishing water use priorities.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

71. Multiple use is a practice in which a given land area functions in two or more compatible ways.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

72. Zoning is a practice in which land uses are prescribed based upon value judgments regarding the needs of society.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

73. Conflicts emerge between private land use rights and the maintenance of environmental quality for the general public.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

74. Choices between needs (essentials) and wants or desires (nonessentials) are often in conflict.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

75. Consumption practices are constantly being expanded by our ability to produce and create wants and markets, which affect the rate of resource use.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

76. Increasing population and per capita use of resources have brought changed land to man or resource to population ratios.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

77. An increase in input (capital, labor, resources) will produce a proportionate increase in production or benefits up to a limit defined as the margin of diminishing returns.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

78. The management of natural resources to meet the needs of successive generations demands long-range planning.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

79. Raw materials and energy supplies are generally obtained from those resources and places where they are available at least cost, usually in short economic terms.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

80. Goods and services are produced by the interaction of labor, capital, natural resources, and technology.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

81. Individuals tend to select short-term economic gains, often at the expense of greater long-term environmental benefits.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

82. Economic efficiency does not always result in conservation of a natural resource.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

83. Conventional benefit-cost analyses do not always result in sound conservation decisions.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

84. Ready transportation, growing interest, money surpluses, and increased leisure time combine to create heavy pressures on existing recreation facilities and demands for new ones.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

85. A sound natural resource policy is dependent upon a flexible political system, pragmatically appraising and reappraising policies and programs in terms of their effect upon the public interest and in light of scientific knowledge about the natural resources.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

86. A knowledge of the social, physical, and biological sciences and humanities are important for environmental understanding.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

87. Man has ability to manipulate and change the environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

88. Knowledge of the social structures, institutions, and culture of a society must be brought to bear on environmental considerations.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

89. Individuals perceive different self-roles depending upon their position in the social and environmental context.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

90. Management is the result of technical and scientific knowledge being applied in a rational direction to achieve a particular objective.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

91. The management of natural resources is culture bound.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

92. Policies, including natural resource policies, come about as the result of interacting social processes: science and technology, government operations, private interests, and public attitudes.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

93. A cultural and time lag exists between the development of knowledge in science and technology and application of that knowledge to resource and environmental problems.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

94. Science does not cause nor become independent of the natural environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

95. Human resources include the physical and mental abilities which man is endowed and the knowledge he has generated.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

96. Options available to future generations must not be foreclosed.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

97. Environmental management has effects on individuals and social institutions.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

98. Man has moral responsibility for his environmental decisions.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

99. Man is continually developing an ethical base for making value judgments.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

100. There are sensory prerequisites to the appreciation of the cultural heritage.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

101. Man has the capability of improving society through sociology, psychology, and science.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

102. There are certain risks taken, and limitations experienced, when manipulating the natural environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

103. Family planning and the limiting of family size are important if overpopulation is to be avoided and a reasonable standard of living assured for successive generations.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

104. Man is developing the technical and sociological knowledge needed to control population growth, modify environments, and alter resource use patterns.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

105. Long-range planning for the use and allocation of natural and human resources is continually evolving.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

106. Historically, cultures with high technological development have used more natural resources than those with lower levels of technological development.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

107. As populations increase and/or as resource supplies decrease, the freedom of the individual to use the resources as he wishes decreases irrespective of the form of government.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

108. Public opinion constitutes a control over the use of conservation practices.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

109. Social values and mores influence personal conservation behavior.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

110. Conservation policies are often the result of group action.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

111. Government is the interaction of custom, rule, and law.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

112. Decisions in society are made through the interaction of countervailing power structures.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

113. A variety of institutional structures is involved in planning and managing the environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

114. In a democracy, a basic theory is that increasing restrictions on resource allocation and use are imposed by the consent or insistence of the people.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

115. Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

116. Individual citizens should be stimulated to become active in the political process.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

117. Conservation responsibilities should be shared by individuals, businesses and industries, special interest groups, and all levels of government and education.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

118. We have "legal" ownership of some resources like real estate and control over others during our lifetime, but ethically we are "stewards" rather than owners of the resource base.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

119. Man performs some tasks at a high physiological cost.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

120. Resources have a psychological impact on people.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

121. Emotional reactions can be elicited by exposure to physical objects and geometric forms.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

122. Architecture can be one of the positively persuasive influences in developing a congenial environment.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

123. An individual must develop his ability to perceive if he is to increase his awareness and develop environmental perspective.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

124. The need of man to turn inward for self renewal can be stimulated by his external esthetic experiences.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

125. Opportunities to experience and enjoy nature are psychologically rewarding to many and are important to mental health.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

126. Man has responsibility to develop an appreciation of and respect for the rights of others.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

127. Esthetic resources and recreational facilities of economic and non-economic value are becoming increasingly important in leisure-time activities.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

128. Outdoor recreation is an increasingly important part of our culture and our economy.

__Essential __Highly Desirable __Desirable __Satisfactory __Unacceptable

GPO 816-220-3

APPENDIX D. ATTITUDE SURVEY (TRIAL FORM)

Following is a trial form of an instrument designed to measure the attitudes of teachers toward the study of ecology. It is also intended to gain an understanding of elementary teachers' feelings of adequacy about teaching ecological concepts. Please feel free to make comments on either the instrument or the answer sheets if statements are unclear, poorly worded, or inadequate. However, please try to respond to each item as best you can.

The instrument is composed of 66 ecological concepts. You are asked to respond twice to each concept. First, what degree of importance would you place on the teaching of the ecological concepts to your students? The responses are essential, desirable, undecided, of little importance and not important. Second, do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an understanding of the concepts? The responses are very adequate, adequate, undecided, inadequate, and very inadequate.

Place an X or check mark in the appropriate square under each question for each concept. Note that the page numbers of the answer sheets correspond with the page numbers of the questionnaire. Please answer as honestly as you can. There need be no relationship between your two responses to a concept. You may feel that one concept is very important but that you are inadequate to teach it. The reverse may also be true.

Thank you for your cooperation.

1. The rate of change in an environment may exceed the rate of organism adaptation.

2. Social values and mores influence personal conservation behavior.

3. Soil is classified as a renewable resource, but, because it may take a few years to thousands of years to be "renewed", it is more practically termed a depletable resource.

4. Esthetic resources and recreational facilities of economic and non-economic value are becoming increasingly important in leisure-time activities.

5. Animal populations are renewable resources.

6. Conservation responsibilities should be shared by individuals, businesses and industries, special interest groups, and all levels of government and education.

7. Conservation policies are often the result of group action.

8. Man is influenced by many of the same hereditary and environmental factors that affect other organisms and their populations.

9. Opportunities to experience and enjoy nature are psychologically rewarding to many and are important to mental health.

10. Hunting regulations are useful in maintaining and restoring populations as well as in distributing the game harvest.

11. Outdoor recreation is an increasingly important part of our culture and our economy.

12. Public opinion constitutes a control over the use of conservation practices.

13. The earth and life on it are greatly affected by the atmosphere.

14. We have "legal" ownership of some resources like real estate and control over others during our lifetime, but ethically we are "stewards" rather than owners of the resource base.

15. Energy is supplied to an ecosystem by the activities of green plants.

16. In any environment, one component like space, water, air or food may become a limiting factor.

17. An individual must develop his ability to perceive if he is to increase his awareness and develop environmental perspective.

18. Living things are interdependent with each other and their environment.

19. The natural environment is irreplaceable.

20. Man manipulates and changes the environment.

21. The interaction of environmental and biological factors determines the size and range of species and populations.

22. Maintaining, improving, and in some cases restoring soil productivity is important to the welfare of people.

23. Plants are renewable resources.

24. Environmental management involves the application of knowledge from many different disciplines.

25. Wildlife is considered to be a public resource.

26. Natural resources are interdependent and the use or misuse of one will affect others.

27. Options available to future generations must not be foreclosed.

28. The management of natural resources to meet the need of successive generations demands long-range planning.

29. An organism is the product of its heredity and environment.

30. A knowledge of the social, physical, and biological sciences and humanities is important for environmental understanding.

31. Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles; inorganic materials and energy become part of organic materials and are subsequently broken down into simpler substances and energy as a result of the operation of organic systems.

32. The carrying capacity of an ecosystem is the level at which a population can be sustained at an acceptable level of nutrition.

33. Human resources include the physical and mental abilities which man is endowed and the knowledge he has generated.

34. Minerals are nonrenewable resources.

35. Wildlife refuges, undisturbed natural areas, and preserves may be of value in protecting endangered species and perpetuating the gene pool.

36. Man has been a factor affecting plant and animal succession and environmental processes.

37. Natural resources, water and minerals in particular, are unequally distributed with respect to land areas and political boundaries.

38. Succession is the gradual and continuous replacement of one kind of plant or animal complex by another and is characterized by gradual changes in species composition.

39. Man has responsibility to develop an appreciation of and respect for the rights of others.

40. Wildlife populations are important economically, esthetically, and biologically.

41. The form of life present depends upon the coincidence of the life needs and their availability in an environment.

42. Man's need for food, fiber, and minerals increases as populations expand.

43. The renewable resource base can be extended by reproduction, growth, and management.

44. Organisms and environments are in constant change.

45. Individuals tend to select short-term economic gains, often at the expense of greater long-term environmental benefits.

46. Soil productivity can be maintained by utilizing known agronomic, mechanical, and chemical processes.

47. The rate of renewal of an exhaustible natural resource is usually extremely slow.

48. Increasing human populations, rising levels of living, and the resultant demands for greater industrial and agricultural productivity promote environmental contamination.

49. Long-range planning for the use and allocation of natural and human resources is continually evolving.

50. Management of habitat is considered to be an effective technique of wildlife management when the desire is to increase or decrease numbers of particular populations.

51. Mineral conservation involves the utilization of all known methods of using the minerals of the earth's crust that will cause them to serve more people for a longer time.

52. Pollutants and contaminants are produced by natural and man-made processes.

53. Water is a reusable and transient resource, but the available quantity may be reduced or quality impaired.

54. Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

55. There are certain risks taken, and limitations experienced, when manipulating the natural environment.

56. Modern man affects the structure of his environment.

57. All living things, including man, are continually evolving.

58. Most resources are vulnerable to depletion in quantity, quality, or both.

59. Water supplies, both in quantity and quality, are important to all levels of living.

60. Environmental management has effects on individuals and social institutions.

61. Resource depletion can be slowed by the development and adoption of alternatives.

62. Geological processes like erosion and deposition modify the landscape.

63. Safe waste disposal, including the reduction of harmful and cumulative effects of various solids, liquids, gases, radio-active wastes, and heat, is important if the well-being of man and the environment is to be preserved.

64. Man has moral responsibility for his environmental decisions.

65. Green plants are the ultimate sources of food, clothing, shelter, and energy in most societies.

66. The amount of precipitation that becomes available for use by man varies with topography, land use, and applied management practices.

PERSONAL DATA SHEET

Name _____
Last First Middle

Soc. Sec. No. _____ Folder No. _____

Grade Assignment 1971-72	No. of Years Previous Experience	No. of Years Previous Experience In this District
K ___	K ___	K ___
1 ___	1 ___	1 ___
2 ___	2 ___	2 ___
3 ___	3 ___	3 ___
4 ___	4 ___	4 ___
5 ___	5 ___	5 ___
6 ___	6 ___	6 ___

Total Years of Teaching Experience _____

Academic Preparation:

Science Credits

	Quarter Hours	or	Semester Hours
General Science	_____		_____
Biology	_____		_____
Zoology	_____		_____
Botany	_____		_____
Earth Science	_____		_____
Physics	_____		_____
Chemistry	_____		_____
Field Science	_____		_____
Science Teaching Methods	_____		_____
Other	_____		_____

What degree of importance would you place on the teaching of the following ecological concepts to your students?

	Essential	Desirable	Undecided	Of little importance	Not important
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an understanding of the following concepts?

	Very adequate	Adequate	Undecided	Inadequate	Very inadequate
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

What degree of importance would you place on the teaching of the following ecological concepts to your students?

	Essential	Desirable	Undecided	Of little importance	Not important
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					

Do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an understanding of the following concepts?

	Very adequate	Adequate	Undecided	Inadequate	Very inadequate
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					

What degree of importance would you place on the teaching of the following ecological concepts to your students?

	Essential	Desirable	Undecided	Of little importance	Not important
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

Do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an understanding of the following concepts?

	Very adequate	Adequate	Undecided	Inadequate	Very inadequate
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

What degree of importance would you place on the teaching of the following ecological concepts to your students?

	Essential	Desirable	Undecided	Of little importance	Not important
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					

126

Do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an an understanding of the following concepts?

	Very adequate	Adequate	Undecided	Inadequate	Very inadequate
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					

What degree of importance would you place on the teaching of the following ecological concepts to your students?

	Essential	Desirable	Undecided	Of little importance	Not important
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					

Do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an understanding of the following concepts?

	Very adequate	Adequate	Undecided	Inadequate	Very inadequate
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					

What degree of importance would you place on the teaching of the following ecological concepts to your students?

	Essential	Desirable	Undecided	Of little importance	Not important
52					
53					
54					
55					
56					
57					
58					
59					
60					
61					
62					

Do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an understanding of the following concepts?

	Very adequate	Adequate	Undecided	Inadequate	Very inadequate
52					
53					
54					
55					
56					
57					
58					
59					
60					
61					
62					

What degree of importance would you place on the teaching of the following ecological concepts to your students? 129

	Essential	Desirable	Undecided	Of little importance	Not important
63					
64					
65					
66					

Do you feel adequate to employ various learning activities, including field trips, in order for your students to develop an understanding of the following concepts?

	Very adequate	Adequate	Undecided	Inadequate	Very inadequate
63					
64					
65					
66					

APPENDIX E. ATTITUDE SURVEY (FINAL FORM)

PERSONAL DATA SHEET

Name _____
Last First Middle

Soc. Sec. No. _____ Folder No. _____

School _____ Age _____

Grade Assignment 1971-72	No. of Years Previous Experience	No. of Years Previous Experience In this District
K ____	K ____	K ____
1 ____	1 ____	1 ____
2 ____	2 ____	2 ____
3 ____	3 ____	3 ____
4 ____	4 ____	4 ____
5 ____	5 ____	5 ____
6 ____	6 ____	6 ____

Total Years of Teaching Experience _____

Academic Preparation:

Science Credits

	Quarter Hours	or	Semester Hours
General Science	_____		_____
Biology	_____		_____
Zoology	_____		_____
Botany	_____		_____
Earth Science	_____		_____
Physics	_____		_____
Chemistry	_____		_____
Field Science	_____		_____
Science Teaching Methods	_____		_____
Other	_____		_____

INSTRUCTIONS

You have been selected as a participant in a research study relating to the teaching of ecology at the elementary level. Please be assured that the results of this study will be used only for research. No evaluation is intended which would reflect upon your promotion or salary increase. Although your name, social security number, and folder number are needed to follow the results through computer analysis, none of the test results will become a part of your personnel file in the Ames Community Schools.

One task which you are to fulfill is completion of the following attitude survey. The instrument is composed of 67 concepts. You are asked to respond to two questions about each concept:

1. What degree of importance would you place on the teaching of the concept to your students at your respective grade level? The responses range from not important to essential on a 7-point scale. Please circle a number which best describes your rating.

2. How capable do you feel to employ various learning activities, including field trips, in order that your students can develop an understanding of the concept? In other words, considering your experience and education, how would you rate your ability to present this concept to your students? The responses range from inadequate to adequate on a 7-point scale. Please circle a number which best describes your perception of your adequacy in teaching this concept.

Sample:

The management of natural resources is culture bound.

Importance	1 (2) 3 4 5 6 7	10
	Not Important-----Important	No Opinion
Your capability	1 2 3 4 5 6 (7)	10
	Inadequate---------Adequate	No Opinion

If you feel that this concept is relatively unimportant, circle a number on the lower end of the scale as shown. Do not circle two numbers. If you feel that you are quite capable of teaching this concept, circle a number toward the upper end of the scale as shown.

Please note that the number ten (10) has been included for your use if you cannot conceive an opinion for an item. However, this should be used only in rare cases; please attempt to rate each item on the seven-point scale if at all possible.

Since there are 67 concepts, it would seem doubtful that the majority of them could be considered essential to your grade level. Therefore, some should be rated important while others will probably be considered of little value.

Similarly, your perception of your ability to teach these concepts will probably vary considerably. Please answer as honestly as you can. There need be no relationship between your two responses to a concept. You may feel that one concept is very important but that you are not very adequate to teach it. The reverse may also be true. Remember that this is not an examination. There are no right or wrong answers.

Thank you for your cooperation.

1. As populations increase competition for the use of water increases, resulting in a need for establishing water use priorities.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

2. Social values and mores influence personal conservation behavior.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

3. Soil is classified as a renewable resource, but, because it may take a few years to thousands of years to be "renewed," it is more practically termed a depletable resource.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

4. Esthetic resources and recreational facilities of economic and non-economic value are becoming increasingly important in leisure-time activities.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

5. Animal populations are renewable resources.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

6. Conservation responsibilities should be shared by individuals, businesses and industries, special interest groups, and all levels of government and education.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

7. Conservation policies are often the result of group action.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

8. Man is influenced by many of the same hereditary and environmental factors that affect other organisms and their populations.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

9. Opportunities to experience and enjoy nature are psychologically rewarding to many and are important to mental health.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

10. Conflicts emerge between private land use rights and the maintenance of environmental quality for the general public.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

11. Outdoor recreation is an increasingly important part of our culture and our economy.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

12. Public opinion constitutes a control over the use of conservation practices.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

13. The earth and life on it are greatly affected by the atmosphere.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

14. We have "legal" ownership of some resources like real estate, but ethically we are "stewards" rather than owners of the resource base.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

15. Energy is supplied to an ecosystem by the activities of green plants.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

16. In any environment, one component like space, water, air or food may become a limiting factor.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

17. An individual must develop his ability to observe and understand he is to increase his awareness and develop environmental perspective.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

18. Living things are interdependent with each other and their environment.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

19. The natural environment is irreplacable.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

20. Man manipulates and changes the environment.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

21. The interaction of environmental and biological factors determines the size and range of species and populations.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

22. Maintaining, improving, and in some cases restoring soil productivity is important to the welfare of people.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

23. Plants are renewable resources.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

24. Environmental management involves the application of knowedge from many different disciplines.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

25. Wildlife is considered to be a public resource.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

26. Natural resources are interdependent and the use or misuse of one will affect others.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

27. Environmental decisions available to future generations must not be limited by our actions today.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

28. The management of natural resources to meet the need of successive generations demands long-range planning.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

29. An organism is the product of its heredity and environment.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

30. A knowledge of the social, physical, and biological sciences and humanities is important for environmental understanding.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

31. Biological systems are described as dynamic because the materials and energy involved are parts of continuous cycles; inorganic materials and energy become part of organic materials and are subsequently broken down into simpler substances and energy as a result of the operation of organic systems.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

32. The carrying capacity of an ecosystem is the level at which a population can be sustained at an acceptable level of nutrition.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

33. Family planning and the limiting of family size are important if over population is to be avoided and a reasonable standard of living assured for successive generations.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

34. Minerals are nonrenewable resources.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

35. Wildlife refuges, undisturbed natural areas, and preserves may be of value in protecting endangered species and perpetuating the gene pool.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

36. Man has been a factor affecting plant and animal succession and environmental processes.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

37. Natural resources, water and minerals in particular, are unequally distributed with respect to land areas and political boundaries.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

38. Succession is the gradual and continuous replacement of one kind of plant or animal complex by another and is characterized by gradual changes in species composition.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

39. Man has responsibility to develop an appreciation of and respect for the rights of others.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

40. Wildlife populations are important economically, esthetically, and biologically.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

41. The form of life present depends upon the coincidence of the life needs and their availability in an environment.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

42. Man's need for food, fiber, and minerals increases as populations expand.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

43. The renewable resource base can be extended by reproduction, growth, and management.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

44. Organisms and environments are in constant change.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

45. Individuals tend to select short-term economic gains, often at the expense of greater long-term environmental benefits.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

46. Soil productivity can be maintained by utilizing known agronomic, mechanical, and chemical processes.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

47. The rate of renewal of an exhaustible natural resource is usually extremely slow.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

48. Increasing human populations, rising levels of living, and the resultant demands for greater industrial and agricultural productivity promote environmental contamination.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

49. Long-range planning for the use and allocation of natural and human resources is continually evolving.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

50. Management of habitat is considered to be an effective technique of wildlife management when the desire is to increase or decrease numbers of particular populations.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

51. Mineral conservation involves the utilization of all known methods of using the minerals of the earth's crust that will cause them to serve more people for a longer time.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

52. Pollutants and contaminants are produced by natural and man-made processes.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

53. Water is a reusable and transient resource, but the available quantity may be reduced or quality impaired.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

54. Individual citizens should be stimulated to become well informed about resource issues, problems, management procedures, and ecological principles.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

55. There are certain risks taken, and limitations experienced, when manipulating the natural environment.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

56. Modern man affects the structure of his environment.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

57. All living things, including man, are continually evolving.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

58. Most resources are vulnerable to depletion in quantity, quality, or both.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

59. Water supplies, both in quantity and quality, are important to all levels of living.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

60. Environmental management has effects on individuals and social institutions.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

61. Ready transportation, growing interest, money surpluses, and increased leisure time combine to create heavy pressures on existing recreation facilities and demands for new ones.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

62. Geological processes like erosion and deposition modify the landscape.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

63. Safe waste disposal, including the reduction of harmful and cumulative effects of various solids, liquids, gases, radio-active wastes, and heat, is important if the well-being of man and the environment is to be preserved.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

64. Man has moral responsibility for his environmental decisions.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

65. Green plants are the ultimate sources of food, clothing, shelter, and energy in most societies.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

66. The amount of precipitation that becomes available for use by man varies with topography, land use, and applied management practices.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

67. Man is developing the technical and sociological knowledge needed to control population growth, modify environments, and alter resource use patterns.

Importance	1 2 3 4 5 6 7 Not Important-----Important	10 No Opinion
Your capability	1 2 3 4 5 6 7 Inadequate---------Adequate	10 No Opinion

APPENDIX F. CORRELATION MATRIX[a] FOR THE 11 VARIABLES OF THE 50 SUBJECTS

Variables[b]	1	2	3	4	5	6	7	8	9	10	11
1	100										
2	-11	100									
3	-03	88	100								
4	24	-10	-12	100							
5	18	-10	-10	88	100						
6	20	-58	-38	23	24	100					
7	48	13	02	19	15	-11	100				
8	27	-11	-17	25	15	15	57	100			
9	18	-59	-41	22	18	91	-10	23	100		
10	18	30	19	17	14	-12	61	30	-10	100	
11	05	27	20	16	13	-08	43	42	-04	69	100

[a] All correlation coefficients were multiplied by 100 to remove the decimal.

[b] 1. Grade level assignment; 2. Age (years); 3. Years of teaching experience; 4. Number of college science courses completed; 5. Number of semester credits earned in college science courses; 6. Score on the pre-test of the Test of Science Knowledge (TOSK); 7. Summated rating score on the pre-test of importance scale; 8. Summated rating score on the pre-test of the adequacy scale; 9. Score on the post-test of the Test of Science Knowledge (TOSK); 10. Summated rating score on the post-test of the importance scale; 11. Summated rating score on the post-test of the adequacy scale.