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The Effects of Field-Based Learning on the Knowledge, Behaviors and Practices of Teachers and Students

Mary Jo Kosco

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The Effects of Field-Based Learning on the

Knowledge, Behaviors and Practices of Teachers and Students

(TITLE)

BY

Mary Jo Kosco

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
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ABSTRACT

The outdoor environment has the potential to serve as a teeming laboratory with numerous opportunities for students to study various science-related phenomena and processes. However important teachers deem outdoor experiences in science, they also bear doubts about their abilities to teach in these natural surroundings. Providing teachers with the training necessary to teach using field-based activities would help develop and strengthen the teachers' and consequently their students' interest in science, their background knowledge of basic science concepts and processes and possibly affect their behaviors towards the environment. This study was designed to measure the extent science teachers' field-based learning experiences affected their pedagogical effectiveness, the frequency of their field offerings and their students' attitudes, knowledge and behaviors relating to science and environmental education. The subjects of the study were middle school and secondary education teachers (N=100) and middle school and secondary level students (N=270). The teachers participated in a program entitled PLAN-IT EARTH (Pairing Learners And Nature with Innovative Technology for the Environmental Assessment of Resources, Trends and Habitats). They took part in an intense weeklong residential workshop during the summer pertaining to training techniques and activities that focused on field-based teaching techniques and innovative instructional strategies. The program design was based on a developmental framework of exploration, concept introduction and application exercises. The teachers answered a preliminary survey before beginning their training. These data were compared with questionnaires filled out after the training and five months into

the program (February and March of a regular school year). Randomly selected portfolios, which all the teachers in the program were required to keep, were viewed and evaluated. Interviews were also conducted with randomly selected teachers (n=5). The middle school and secondary students completed instruments which measured their attitudes towards science, learning methods their teachers implemented, their favorite subject areas and their feelings about learning in the outdoors. Randomly selected students (n=7) were also interviewed about their favorite methods of learning science and how their perceptions of education and the environment. Results indicated that a high percentage of teachers utilized a large number of the teaching methods indicated on the survey. There was a higher ranking of "extensive" use of teaching methods on the posttest than were on the pretest. Teaching in the outdoors and using field trip excursions were both high ranking methods. It was concluded based on the results of the survey that teachers incorporated teaching in the outdoors more frequently after their training. Also concluded by student surveys and student interviews, was that field-based activities fostered positive attitudes about the environment and the educational means on how to improve their surroundings. Students involved in the study overwhelmingly rated science as their favorite subject and ranked field trips/field activities as their most preferred method of learning.

DEDICATION

To the many wonderful individuals who have influenced me,
my most supportive Mother and Father,
Sister and Brothers
and blessed Grandparents.
Thank you.

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This project would not be complete if it weren't for the efforts and accomplishments of many individuals. I am appreciative of many different people for their support, guidance, knowledge and patience throughout not only this paper but also for getting me this far. This is only the beginning of my educational pursuits and I have many to thank for supporting these efforts.

I have been very fortunate in my life--with the people I have encountered and the occurrences I have experienced. I am most thankful for my ever-supportive mom, Dolores, whose love and encouragement has been unsurpassed. For the passion of knowledge and academia held dear to my father, Richard, I am also forever grateful. The value of education is very important and held in high esteem in my family of educators. Thank you Theresa, for being not only the greatest sister, but also a true friend to me. To my accomplished and dedicated brothers, Ken and Mike, I thank you both for your ever enduring sense of humor and consistent encouragement. I am also very grateful to my four extraordinary grandparents who have consistently showered me with love and support since the day I was born. I owe thanks to my dear friend Alicia, with whom I have shared many adventures and learned many life lessons alongside of--thank you for sharing your love of the road with me. And to my best friend, Jerry, thank you.

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Special appreciation goes out to the remarkable faculty and staff with whom I was able to work and learn while at Eastern Illinois University; especially those in the Early Childhood, Elementary and Middle Level Education department.

VITA

EDUCATION

1997-1998	Eastern Illinois University Charleston, IL M. S. Education: Elementary Education, Reading
1992-1996	Eastern Illinois University Charleston, IL B. S. Education: Elementary Education
1988-1992	O'Fallon Township High School O'Fallon, IL

PROFESSIONAL EXPERIENCE

April 1998	Presenter at National Science Teachers' Association Convention, Las Vegas, NV
1997-1998	Graduate Assistant Eastern Illinois University, Charleston, IL
1996- Present	Substitute Teacher Cathedral Grade School, Belleville, IL
1996-Present	Substitute Teacher Carl Sandburg School, Charleston, IL
Fall 1996	Student Teach 4th Grade Carl Sandburg School, Charleston, IL

HONORS & ACTIVITIES

1997-Present	Phi Delta Kappa
April 1998	Distinguished Graduate Student Award
April 1998	Enviro-Thon Judge
1997-1998	History Fair Judge
1997-1998	Graduate Student Advisory Council (Treasurer)
April 1997	Thomas Drury Scholarship Recipient
October 1997	Eco-Meet Judge
1993-1997	Special Olympics Volunteer
1993-1997	Red Cross Volunteer

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CHAPTER ONE

INTRODUCTION

IMPORTANCE OF THE STUDY

Teachers everywhere are surrounded by the most valuable resource available to the science curriculum—the natural physical environment. However, many teachers fail to recognize the outdoors as a tool for learning. Why don't more teachers open their doors so students can use concrete learning experiences to help them attain higher levels of conceptual understanding? Teachers have cited lack of knowledge and experience with this technique as critical reasons for this omission. In a study conducted by Simmons (1998) it was found that teachers believed that it was important to provide experiences in the field as part of the curriculum. The teachers felt that their students would enjoy these outdoor experiences while benefiting in science education within these natural settings. However, with this enthusiastic attitude came doubts about their abilities to teach in natural surroundings. The teachers in this study stressed the need for additional training before taking their students outdoors to learn environmental education.

Traditionally, teachers have had few opportunities to participate in courses that are field-based, especially since methods courses rarely include a field component. Since research suggests that teachers teach how they were taught, it is not surprising that this approach to instruction is so seldom used. Training, however, could assist in the development and strengthening of teachers' and consequently their students' interest in science and their background knowledge of basic science concepts, scientific methodology and investigative processes through environmental, field-based learning experiences. Also through the training, teachers can deal with possible barriers such as safety/hazards, resource needs, and additional management concerns. Training can address apprehensions teachers may have about field-based learning by presenting strategies to overcome potential impediments such as lack of funding or administrative support. Teachers must use distinct skills and knowledge in order to make their students' experiences in natural areas beneficial to their education and this requires preparation and commitment. Research shows that educators believe in the effectiveness of outdoor education, but need the proper training in order to utilize it effectively (Smith-Sebasto, 1998). It is proposed that teachers who are trained in field-based instruction will have a more enthusiastic attitude about using field trips effectively and, consequently, they will utilize field-based learning to a greater degree with their students.

Studies indicate that learning is more personal and relevant when the students' surroundings serve as the learning environment. The National Science Education Standards (1996) recommend that youth should be familiar with the world and should recognize its diversity and unity. Involving students in the scientific process will not only foster a better understanding of their environment but will also develop and nurture a sense of stewardship and community involvement. It is vital in our era for citizens to acquire the environmental literacy necessary to act responsibly towards our surroundings. The outdoor environment has the potential to serve as a teeming laboratory with numerous opportunities for students to study various science-related phenomena and processes. The Standards acknowledge that "the classroom is a limited environment" and efforts should be taken "to extend the science program beyond those confines". The Standards further state that the physical environment in and around the school is a valuable resource and can be used as a living laboratory. Yet, teaching directly in the natural environment is a strategy that only a relatively limited number of educators employ. This is especially perplexing since teachers ranked field instruction as being an important and valuable method for teaching science yet indicated that it was not used in their teaching (Lisowski & Disinger 1991). In order to adopt this instructional strategy, teachers need to develop the expertise and confidence necessary to incorporate field-based learning in their classrooms by experiencing it firsthand.

Without a working knowledge of how to create opportunities for students to be involved in science investigations, teachers often resort to doing little more than providing a course of factual information rather than facilitating an environment where students are able to construct their understandings of science. The utilization of field-based learning presents students with activities where they are more likely to see science as relevant and applicable in their lives. Learning in the outdoors has been proven to enhance the educational experience for students, however as mentioned above, a majority of teachers do not employ this method. Will teachers who have training and experience in field-based learning be more likely to implement outdoor experiences than teachers without this training and experience? Further study is necessary to determine the effects of field-based learning on teacher effectiveness, the frequency of field trip implementation and on student behaviors relative to environmental education.

STATEMENT OF THE PROBLEM

To what extent do science teachers' field-based learning experiences affect their pedagogical effectiveness, the frequency of their field offerings and their students' knowledge, attitudes and behaviors relating to science and environmental education?

HYPOTHESIS

Appropriate statistics were used to test the acceptance of the following hypotheses:

1. There are significant changes in the pedagogical effectiveness of science teachers after they are trained in field-based instruction.
2. There are significant changes in the frequency of field offerings for students after teachers are trained in field-based instruction.
3. There are significant differences in the student behaviors, knowledge and attitudes about science after they take part in field-based learning activities.

DEFINITIONS OF TERMS

Active Field Trips- an excursion stressing specific criterion and learning objectives which usually involves prior and follow-up activities

Anxiety Measures- an amount of doubt or concern

Confidence Measures- an amount of self-assurance

Constructivist Perspectives- an educational view where learners give up naïve theories and misconceptions about science and construct new theories by experiencing scientific phenomena through hands-on, inquiry-based activities

Environmental Education (EE)- the exploration of attitudes and values, and the development of knowledge and skills, so that people can both individually and collectively take an active role in decision-making concerning the total environment

Environmental Literacy- the capacity to perceive and interpret the relative health of environmental systems and to take the appropriate actions to maintain, restore or improve these systems

Field-Based Instruction- activities applied to develop an understanding of the immediate environment

Field-Based Learning- refer to field-based instruction

Field Excursions- experiences for the purpose of first-hand observations with accompanying activities

Field Trips- refer to Field Excursions

Interdisciplinary Teams- a group of teachers who participate or cooperate in two or more subject areas

Middle School- grades five through eight

Non-Structured Field Trips- an excursion where no specific criterion are stressed

Orientation Activities- additional appropriate instructional supports to enhance the educational impact of a field trip

Outdoor Education- field-based instruction conducted in the natural environment

Passive Field Trips- refer to Non-Structured Field Trips

Pedagogical Effectiveness- when an educator learns about and utilizes a variety of methods such as problem solving/critical thinking, cooperative learning, individual/group projects, action learning and outdoor education to meet the needs of every individual they teach

Pedagogical Experiences Survey (PES)- an instrument to measure the changes in pedagogical effectiveness in science teachers

Secondary Level- grades nine through twelve

Student Science Behaviors Survey (SSBS)- an instrument to measure student behaviors and the frequency of field offerings in science

Traditional Field Trips- refer to Non-Structured Field Trips

Values Clarification- teaching and helping people to become aware of their principles/standards and how to act upon them

Whole Process Approach- using a variety of activities and strategies to teach concepts

ASSUMPTIONS

The following assumptions will underlie this study:

1. The middle school and secondary level teachers (N=100) involved in this study will be properly trained and have experience in a field-based instruction program.
2. The Pedagogical Experiences Survey (PES) will be a valid and reliable instrument to measure the changes in pedagogical effectiveness in science teachers involved in this study.

3. The PES will be given to the subjects before they take part in the training and again approximately five months after returning to their classrooms.
4. Interviews performed with a random sample of middle and secondary school teachers will be a valid and reliable instrument to measure pedagogical effectiveness.
5. The evaluation of randomly selected portfolios developed by participating middle school and secondary level science teachers will be valid and reliable means to measure pedagogical effectiveness and frequency of field offerings.
6. The middle school and secondary level students (N=270) in the study will be randomly selected from students who have taken part in field-based instruction activities for approximately five months.
7. The Student Science Behavior Survey (SSBS) will be a valid and reliable instrument to measure student behaviors and the frequency of field offerings in science.
8. Interviews performed with a random sample of middle and secondary school students will be a valid and reliable instrument to measure student behaviors.
9. The students and teachers will complete the measurement instruments conscientiously.
10. The students and teachers in the study will represent geographically diverse schools of varying populations from the Midwestern state of Illinois.
11. Field-based instruction is worthy of research and investigation.
12. Assessing the changes in pedagogical effectiveness of teachers who utilize field-based instruction is worthy of research and investigation.

13. Assessing the behaviors, attitudes and knowledge of those students who have experienced field-based instruction is worthy of research and investigation.

DELIMITATIONS

The following delimitations will underlie this study:

1. The study will be limited to 100 middle school and secondary level science teachers.
2. The teachers involved in the study will be limited to those who have been properly trained in a field-based instruction program.
3. The study will be limited to 270 middle school and secondary level students.
4. The students involved in the study will be limited to those who are part of a science class that utilizes field-based learning.
5. The students and teachers involved in the study are exclusively from the Midwestern state of Illinois.
6. The measurement of the frequency of field trips utilized by the teachers will be limited to the PES, SSBS and analyses of the logs and portfolios.
7. The instrument that will measure the changes in pedagogical effectiveness in science teachers will be limited to the PES and the evaluations of randomly selected logs and portfolios.
8. Measurement data in the study will be limited to the following: interviews with randomly selected students; interviews with randomly selected teachers; evaluation of portfolios; evaluation of logs; the PES; and the SSBS.

LIMITATIONS

The following limitations will underlie this study:

1. The use of teachers from the Midwest limits the generalizability to other geographical areas such as the Northeast.
2. The use of middle school and secondary level teachers and students limits the generalizability to elementary school teachers and students.
3. The use of teachers who have received training in field-based teaching strategies limits the generalizability to teachers who have only received training in cooperative learning techniques.
4. The frequency of structured field trips offered limits the generalizability to the amount of nonstructured field trips.
5. The study measures pedagogical effectiveness, which limits the generalizability to measuring pedagogical attitudes.
6. The study measures student behaviors in science, which limits the generalizability to measuring student behaviors in math.

OVERVIEW

This thesis contains five chapters.

Chapter One provides a rationale for the study; problem statements; hypotheses; definitions; assumptions; delimitations; and limitations.

Chapter Two includes a review of the literature which is reported in four sections. These focus on: field trips and field-based instruction for students; field trips and field-based instruction for teachers; pedagogical effectiveness; and student attitudes, knowledge and behaviors relating to the environment.

Chapter Three consists of the research design and procedures. They address the areas of: overall design; population; instrumentation; and statistical analysis.

Chapter Four reviews the study's results. Five sections are reported and include: descriptive statistics on students; descriptive statistics on frequency of field activities; descriptive statistics on teachers; qualitative data; and hypotheses.

Chapter Five contains a summary, conclusions and recommendations.

CHAPTER TWO

REVIEW OF LITERATURE

This chapter will review literature related to field-based learning experiences for both teachers and students, pedagogical effectiveness and students' knowledge, attitudes and behaviors relating to environmental education. The studies are divided into four sections: field trips and field-based instruction for students; field trips and field-based instruction for teachers; pedagogical effectiveness; and students' environmental knowledge, attitudes and behaviors.

FIELD TRIPS AND FIELD-BASED INSTRUCTION FOR STUDENTS

This section of the Review of the Literature will focus on the effects of field trips and field-based instruction on students.

Schellhammer (1935) investigated the knowledge gains of two groups of high school biology students in a study lasting one year. Experimental and control groups were established with the experimental group participating in a field excursion. Posttests were given to both groups and the knowledge gains were significant with only the experimental group. The groups were reversed (control group became experimental group and vice versa) and a new unit was taught following the same procedures. Results were consistent in that the new experimental group that had the field trip showed more significant gains than the new control group.

Atyeo (1939) conducted a study in which he compared the results obtained from the use of the excursion technique with those of other teaching methods. He showed that with an increase in excursions there was a corresponding increase in investigating the phenomena associated with the experience. He demonstrated that the excursion technique was superior to class discussion for teaching material requiring comparisons and knowledge of concrete objects.

Benz (1962) conducted an evaluation on the effectiveness of field trips in achieving informational gains in a unit on earth science. Four classes of ninth grade students (N=109) participated in the study. The experimental groups went on excursions to geological sites while the control groups remained in the classroom and viewed the content through slides. Based on pretest and posttest results, Benz concluded that, first, superior pupils tended to profit more from field trips than students with average to less than average ability, and, second, that field trips contributed to the understanding of scientific principles.

Mason (1980) developed a survey to measure the status of earth science fieldwork in Virginia secondary schools. A questionnaire was sent to secondary school teachers (N=335) whose teaching responsibilities were at least 50 percent in earth science. Results from usable questionnaires (N=207) indicated that over 60 percent of the 1974-75 Virginia teachers conducted at least four field trips a year and only 17 percent failed to take any field trips whatsoever. There were a few teachers (n=25) in the study with field programs that could be classified as highly active (at least 27 hours devoted to fieldwork). Most of the teachers (n=147) were conducting field programs classified as moderately active (up to 27 hours devoted to fieldwork).

Finally, there were some teachers (n=35) who had inactive programs with no fieldwork. Results of the open-ended items on the questionnaire showed that teachers were interested in devoting more time to planning and utilizing field trips in their classrooms. They showed a significant preference for spending more time learning better ways to plan and conduct field activities.

Falk and Balling (1981) reported three studies of attitudes toward and effects of science education field trips. The first study involved fifth and sixth grade students (N=425) who took part in outdoor science activities in one of three types of settings. Results showed that when the number of available examples of concepts to be learned and setting novelty were both maximized, more learning took place. Students reported positive feelings about their experience. They were also observed to be spending over 90% of the field trip time on-task with assigned activities. A second survey measured the attitudes and perceptions toward field trips of a nationwide sample of teachers, administrators, college methods instructors, and nature center professionals. All four groups held positive attitudes toward field trips. The final study demonstrated the significant influence of certain factors associated with field trips upon learning and behavior. The overall results indicated that educators viewed science field trips as important and that field trips had clear cognitive and affective benefits. Results also showed that certain characteristics of learners and the field trip setting influenced student attitudes, behaviors, and learning.

Mackenzie and White (1981) conducted a study to measure the effect of fieldwork in geography on long term memory structures. The study involved eighth and ninth grade students (N=141) from Australia. One group took part in an excursion which stressed processing meaning of phenomena observed and experienced during the field trip. The second group participated in a traditional (passive) excursion. The third group participated in the same geography course but did not go on an excursion. An achievement test was given to all students following the completion of the unit and again twelve weeks later. Results indicated that the students who participated in either form of excursion out-performed students who did not go on one. The study also showed that the students involved in the field trip which stressed knowledge and idea processing outperformed students who participated in the passive field trip.

A study was conducted by Kern and Carpenter (1986) to evaluate the effects of field activities on student learning using two sections of a college laboratory course in earth science. One section involved primarily classroom activities that utilized a laboratory manual. Field-oriented activities were employed in the second section. Comparison of the two classes at the conclusion of the term revealed almost identical levels of lower-order learning (recall). However, higher-order skills were demonstrated to a greater degree with the field-oriented section, indicating an enhanced ability to apply the acquired information.

Haynes et al. (1987) conducted a study to determine the effect of field trips with prior and follow-up activities in comparison with field trips without these activities. The Peabody Picture Vocabulary Test (PPVT) was used to assess urban black preschool children (N=52) after they took six weekly field trips to places such as the zoo and museums. The experimental group of students (N=26) took part in activities such as discussion of the trips before and after, drawing pictures about the experiences, and acting out what they had observed on the trips. Items were selected on the PPVT that matched concepts experienced on the trips. Results showed that the children exposed to the structured field trips were more successful with the selected PPVT items than were the children participating in the non-structured field trips.

In 1987, Lisowski completed a study to determine students' conceptions of ecological concepts and the influence of field instruction strategies on students' understanding and retention of these concepts. The independent groups (N=3) of secondary students took part in a seven-day field program. Results were measured by the Student Ecology Assessment (SEA) prior to, during, and four-weeks after the field program. Posttest gains were exhibited through combining background data, instructional emphasis rating scores, SEA concept subscores and total scores into multiple regression analysis. All groups significantly increased their posttest scores and exhibited retention of the targeted concepts. The effectiveness of the field program was apparent in that the specific concepts emphasized were learned and retained. The results of this study showed the successful effects of learning in a field study.

A study to measure the impact of travel on geographic competency was conducted by Bein (1990). Indiana college students (N=3000) were administered a geography skills test in an introductory geography course. Geographic ability in the area of map skills, place name location, physical geography, and human geography were measured by the use of The National Council for Geographic Education Competency-Based Geography Test, Secondary Level, Form D. Geographic skills were correlated with the subjects' age, sex, ethnicity, past travel experience, and past geographic education. Results indicated a strong correlation between increased travel experiences and knowledge of geographic skills.

Gilbertson (1990) investigated the effect of outdoor education on children's knowledge and attitudes toward the environment. This study measured the change in environmental literacy in sixth grade students after taking part in one of four levels of outdoor education activities. The researcher wanted to find the relationship between the change in environmental literacy to the type of program students took part. A non-equivalent control group design was used. The programs ranged from simple outdoor trips led by teachers to residential centers providing up to weeklong instruction. Throughout the programs, participants gained outcomes such as better student-teacher relationships, improved self-concept and a positive attitude toward the natural world. Data showed that, overall, students were more knowledgeable of environmental issues than ecological concepts. The students who attended the residential training were more environmentally literate than the other students. It was found that when their outdoor experiences lasted longer, more learning took place.

Howard (1995) interviewed high school students (N=13) to measure the influence of outdoor education on curriculum integration. Students were taught by the same teacher all semester and earned credits in science, English, physical education, and life skills. Outdoor education encompassed over one-third of the students' school time. The interviews were administered at the beginning, middle, and end of the semester. The results indicated that students felt connected to and united with their work for the reasons which follow: the whole process approach, experimental learning, and the authenticity of the experience. Throughout the semester students experienced increased responsibility, greater challenges and an increased sense of community within their class. Findings also revealed that through the utilization of outdoor education, students were given opportunities to enhance self-awareness, increase self-esteem and acquire a positive sense of nature.

In 1996, a study was designed by Nelson to distinguish changes in the sixth grade students' (N=429) level of environmental literacy. The Children's Attitudes Toward the Environment Scale (CATES) was utilized as a pretest and posttest to measure environmental literacy. The students were divided into two experimental groups and two control groups based on the scheduled dates they were attending the residential environmental education programs. The students in the two experimental groups attended accredited residential environmental education programs. One experimental and one control group took the pretest and the posttest, while the other two groups only took the posttest. Nelson reported that the students who had attended the residential outdoor education programs showed significant increases on affective, cognitive and somewhat on behavioral items scored. Overall, this data inferred that students who participated in residential outdoor education programs had higher levels of environmental literacy.

In 1998, Simmons completed a study to determine what motivated teachers to use various nature settings for Environmental Education (EE). The study focused on the teachers' (N=59) personal comfort levels and their judgement of educational affordances, as well as their perceptions of potential barriers. The subjects involved in the study were elementary school teachers who primarily taught urban minority children in the Chicago metropolitan area. The four sets of photographs that were used to portray possible natural settings to teach EE were as follows: rivers, ponds and marshes; deep woods; county park; and urban nature. The photos of each setting were displayed and an 83-item questionnaire accompanied them. Questions probed to determine the benefit and barrier factors such as the appropriateness of teaching setting; teacher confidence; worries; need for training; hazards; and difficulty of teaching EE. Results deemed that the deep woods and rivers, ponds and marshes were viewed as the most appropriate settings for teaching EE. Overall teachers felt a moderate sense of confidence in their ability to teach EE in any of the four settings, however they expressed a higher need for training in the same two settings viewed as most appropriate. Teachers believed that it was important to provide nature experiences as part of the curriculum, that their students would enjoy these experiences and that these experiences would be beneficial to students' education. Along with these beliefs came the teachers' concern for their preparation. Before taking part in these outdoor experiences, the teachers believed they needed proper training to teach in natural settings.

FIELD TRIPS AND FIELD-BASED INSTRUCTION FOR TEACHERS

This section of the Review of the Literature will focus on the effects of field trips and field-based instruction on teachers.

Braverman and Yates (1989) conducted a study to explore whether the educational impact of a zoo visit could be enhanced through orientation activities provided before the trip. The subjects were 4-H extension agents. The experimental group was either presented a lecture with slides or given a packet of orientation reading materials. After the groups visited the San Diego Zoo, they were given a test of knowledge, values, and attitudes about the zoo. Outcomes indicated that changes in attitudes and values related to the zoo were not affected by the orientation. However, the orientation sessions did increase the teachers' effective use of the zoos in the area of knowledge gain.

Elks (1989) designed a study to increase the utilization of a forest in an environmental science curriculum for elementary students. Teachers were surveyed to determine why an Environmental Education (EE) center at a local forest was not being used. It was found that coordinating resources, conducting countywide planning and holding inservice training removed the obstacles that were voiced by the teachers. Teachers who participated in the inservice training at the center felt confident teaching the necessary concepts. Students, likewise, increased their EE knowledge and showed greater interest after visiting the forest.

Eash et al. (1990) measured the effects of a three-week summer workshop sponsored by the National Science Foundation (NSF) and seven seminars held the following school year on the learning environments of high school biology and chemistry teachers' (N=40) classes. The subjects took field trips to ten industries and agencies to observe applications of basic science. After these experiences, the teachers developed teaching modules for their classroom curricula. The activities were augmented with lectures, demonstrations, and presentations by visiting scientists. Results were gathered by a learning environment measure called Our Class and Its Work. Data collected focused on the ability of an inservice program to stimulate effective teaching approaches relative to theories and concepts in the secondary biology and chemistry curricula. The assessment also focused on the ability to create curriculum units from industrial and societal applications of conceptual and syntactical science using a variety of teaching strategies to meet a range of student abilities. Finally, the assessment intended to measure the ability of the workshop to provide lesser-prepared teachers an opportunity to create enriched curriculum units and develop effective teaching strategies. Results of the evaluation indicated that the program improved the science education of participants, stimulated positive student attitudes and greater student achievement. After experiencing field trips that focused on the application of basic science, the teachers were able to develop teaching modules for their classroom curricula. Hence, evidence was provided indicating that field trips were influential in the instructional improvement efforts of the participating teachers.

Romero (1992) conducted a study to measure attitudes and practices of workshop participants (N=71) regarding aerospace education. An interview questionnaire was used to investigate the practices adopted by educators to teach aerospace concepts. An opinionnaire was also designed to investigate the attitudes of educators towards aerospace education. The study found that participation in the workshops was significantly related to positive attitudes and practices regarding the teaching of aerospace concepts. Results also indicated that there was no significant correlation between attitudes towards aerospace education and sex, age, teaching experience, educational preparation, teaching level, or size of the community. Participants of the workshop agreed overwhelmingly that the field trips they experienced were essential in providing an enhanced educational experience.

To determine the effectiveness of conservation education strategies in use at zoological parks, nature centers and related locations utilized in Columbia, South America, Gutierrez de White & Jacobson (1994) implemented and compared several program formats. A zoo workshop in wildlife conservation targeting elementary teachers (n=10) was designed, evaluated and contrasted with existing programs. A second group of teachers (n=6) preceded their zoo visit with a 15-minute slide show featuring native endangered species. The students in the third group took part in the zoo visit only treatment lead by their teachers (n=7). Finally, the teachers (n=11) in the control group completed the pretests and posttests with out taking their students to the zoo. Randomly selected fourth grade students (N=1015) from classrooms of the above mentioned teachers (N=34) from Cali, Columbia completed a pretest and posttest questionnaire. The questionnaires were completed by students before teachers took part in the training program and again three months later after training and zoo visits were completed. Teachers who took part in the zoo workshop were introduced to ecological concepts and local conservation issues using adapted educational activities which stressed hands-on experiences and the use of a variety of materials. The teachers visited the zoo and then evaluated the activities that were given at the workshops, modified them and designed their own appropriate activities to use in their classrooms and at the zoo with their students. Data showed that the students whose teachers took part in the training program conveyed greater cognitive learning and a positive attitude shift toward wildlife conservation, compared with the other three treatments. No effects on knowledge or attitude scores were found for the other groups' treatments. Results confirmed the researchers' initial hypothesis that favorable attitudes toward conservation were fostered in young children by improving their teachers' knowledge of conservation-related topics.

PEDAGOGICAL EFFECTIVENESS

This section of the Review of the Literature will focus on the strategies that contribute to the instructional effectiveness of a teacher.

Harris et al. (1982) designed a study to determine the relationship between the personality characteristics and self-concepts of preservice teachers (N=110) and their humanistic vs. authoritarian orientations toward pupil control. Results indicated that the humanistically oriented educators were emotionally stable, realistic, happy-go-lucky, and imaginative. They also tended to be outgoing, relaxed, venturesome, inner-directed, self-assured, and high in self-concept. The teachers with authoritarian orientations were easily affected by feelings, conscientious, practical, and shy. They also tended to be tense, reserved, frustrated, unlikely to compromise, and low in self-concept. It was found that a humanistically oriented teacher was more effective in the classroom.

Steer (1984) completed a study to measure the characteristics and competencies of effective middle and junior high school teachers. He developed a 38-item questionnaire which focused on the characteristics and competencies of effective middle and junior high school teachers. The items were gleaned from the various studies that he had investigated over the preceding 15 years. The survey was sent out to members (N=500) of the National Middle School Association. Results from the useable questionnaires (N=160) indicated that the most effective middle and junior high school teachers were those who genuinely liked and respected people. They also were committed to working with "transescents" (young people in transition from childhood to adolescents). They enjoyed listening and talking with students and assisting in the healthy development of their self-concepts. These characteristics described effective middle and junior high teachers.

Zielinski and Bernardo (1989) conducted a study to measure the effects of a ten-day summer inservice program on secondary science teachers' stages of concern, attitudes, and knowledge of selected science technology and society (STS) concepts and the impact of these three attributes on students' knowledge. Results were gathered using a modified pretest and posttest control group design. The experimental group was given a pretest prior to the ten-days of instruction and a posttest at the end. The experimental group then implemented a ten-day STS unit into their classroom, gave a pretest and posttest to their students. A pretest and posttest was also given to the control group. The experimental groups' knowledge and attitudes were evaluated using instruments created by the researchers. Their concerns were significantly changed in the following areas: awareness; informational; consequence; collaboration; and refocusing. Their attitudes were significantly increased in a positive direction compared to the control group. It was found that an intensive inservice program of considerable duration was effective in assisting teachers in reducing their stages of concerns, increasing their content knowledge, and their approach tendencies toward STS topics.

Lasley et al. (1990) examined middle school teachers' (N=6) classroom management strategies and their prevention methods for misbehaving students. The misbehavior was coded according to four categories: activity type; form of misbehavior; teacher response to misbehavior; and student response to teacher's desists (a specific teacher action directed at stopping a student's misbehavior). Three classrooms were rated as effectively managed and three as ineffectively managed. The effective teachers were those who permitted the fewest misbehaviors and were the most successful in stopping the misbehavior once it occurred. Results showed that the most effective methods used by teachers were nonverbal cues and rule reminders. Results also indicated that teachers who changed classroom activities and varied their lessons from day to day could prevent more misbehaviors than those who did not.

Hadfield and Lillibridge (1991) conducted a study to measure the improvements of rural elementary teachers' (N=39) confidence in science and mathematics following an inservice workshop. The six-day summer workshop focused on student participation, hands-on activities, and improvement of attitudes toward the teaching of science and mathematics. Results indicated a significant improvement in the knowledge of the content areas as measured by a pretest and posttest. There were also noted improvements in the confidence measures, as well as significant decreases in anxiety measures. Follow-up visits held several weeks after the workshop indicated that subjects had disseminated their new techniques and materials and were still enthusiastic about the instruction they received. Therefore, it was believed that the intense interaction with the new techniques learned in the workshop contributed to the instructional improvement of these elementary teachers.

Gorham (1993) completed a study to evaluate middle school students' (N=22) comments regarding "good" teachers to determine whether the students employed consistent, distinct criteria for evaluation. The students were interviewed individually to determine their perceptions of good teachers. Instruction, personality, and classroom management were the areas where the teacher' efficacy was distinct to the students. The results of the study indicated that students were actively assessing teachers with consistent criteria. These students were able to evaluate the characteristics of an effective teacher.

A study completed by Husband and Short (1994) investigated the relationship between teachers' perceived levels of empowerment in middle level education interdisciplinary teams and departmentally organized programs. It also measured the differences in teachers' perceptions of the six identified subscales of empowerment: decision-making, professional growth, status, self-efficacy, autonomy, and impact. The study involved teachers (N=309) from middle and junior high schools (N=16). Teachers (n=154) in departmentally organized programs were compared to teachers (n=155) on interdisciplinary teams. The results indicated that teachers working on interdisciplinary teams perceived themselves to be significantly more empowered than the departmentally organized teachers on all six scales of empowerment. The collaborative work environment where norms for collegiality existed was fostered within the interdisciplinary approach. The teachers experienced greater decision-making ability, self-efficacy, and confidence. Teachers working within the camaraderie of the interdisciplinary approach had a more effective influence in the classroom than teachers in departmentally organized programs.

STUDENTS' ATTITUDES, KNOWLEDGE AND BEHAVIORS RELATING TO THE ENVIRONMENT

This section of the Review of the Literature will focus on the effect of environmental education on students' attitudes, knowledge and behaviors.

This study was conducted to measure the effectiveness of ten hours of Environmental Education (EE) instruction on fifth grade students' (N=53) attitudes towards the environment by Jaus (1982). Students were from two different elementary schools within the same school district. They were from lower to middle socioeconomic backgrounds and were considered to be equivalents in their educational coursework, textbooks and materials. One fifth grade class received 40-minutes of daily EE instruction for 15 consecutive days. Lessons consisted of topics such as the Earth'' resources, air pollution, water pollution, noise pollution, conservation of the biotic and abiotic environment and the balance of nature. The other fifth grade class did not receive any EE instruction. Following the treatment, both groups answered a questionnaire which measured their attitudes toward the environment. Results deemed that the experimental group possessed significantly more positive attitudes toward the environment than did the control group. Three days after the attitude measurement was administered, the control group was taught the same EE instruction the experimental group had received. After completion of the instruction, students answered the questionnaire again. The retest scores were nearly identical to the scores of the experimental group who received the instruction first. Findings showed that the fifth grade students in this study had similar positive attitudes toward the environment going into the EE instruction; and the lessons they were taught increased these positive attitudes.

Garver (1984) used questionnaires to survey what types of Environmental Education (EE) programs and courses were available to students in the schools (N=36) in a region of Ohio. Consistent with E.P. Hart's key standards of EE, the schools surveyed had programs which were interdisciplinary, multilevel, and had values clarification activities. The programs focused on current and future issues and were involved with the community. Activity participation, a team approach to teaching and learning, and an individual learning approach were all fostered within the schools surveyed. Field studies were incorporated to further enhance the students' comprehension of EE. The programs stimulated positive student-teacher relationships, personal accountability, and group interaction.

Metro et al. (1984) completed a study with fifth grade urban students (N=269) from Chicago. A questionnaire was created to record their past experiences, opinions, and ideas concerning a forest environment. It was found that most students had visited an urban or rural forest and had a positive learning experience. The students who had not visited a forest thought they would enjoy it. Black students reported more perceived danger in both the forest environment as well as in their own neighborhood.

Schwartz (1988) designed a study to assess whether Environmental Education (EE) instruction caused students to have a positive attitude towards the curriculum. Participating in the study were an experimental group of students in intermediate classrooms (n=14) who were involved in ten-to-twelve EE activities and a control group of students from other classrooms (n=14) who received no such instruction. Activities used with the experimental group came from programs such as Project Learning Tree, Project WILD, and Outdoor Biology Instructional Strategies (OBIS). Several field-based activities were included. A pretest and posttest were given to both groups. Posttest results indicated that students in the experimental group approached science and social studies with a more positive attitude.

Seever (1993) provided an evaluation of Nowlin Environmental Science Magnet Middle School after its second year of full operation. Evidence of the magnet theme (environmental science) was seen through site and classroom visits. Likewise, student participation in field trips and a recycling project were documented. A questionnaire for students showed increased positive perceptions about their program. Parents and teachers completed a different questionnaire which revealed a dramatic increase in positive perceptions compared to a previous study.

A study was designed by Leeming et al. (1997) to assess whether environmental attitudes and knowledge of children in grades one through seven who were involved in pro-environmental activities changed relative to children not involved in these types of programs. Also under investigation were the children's level of influence on their parents' environmental attitudes and knowledge. The Caretaker Classroom Program was initiated by a major daily metropolitan newspaper to encourage elementary school classes to engage in pro-environmental activities. Participating classes (n=16) agreed to take part in a minimum of eight environmentally relevant activities during the course of an academic year. The control classes (n=19) were from the same schools, however they did not take part in the Caretaker Program. Both groups were given the Children's Environmental Attitude and Knowledge Scale (CHEAKS) to obtain pretest and posttest measures of the students' environmental attitudes and knowledge. The pretests were given between late October through late December; while the posttests took place in late May. At the time of the posttest the children were given an envelope to take home to their parents; it contained a letter explaining the study, the parent questionnaire, a behavior checklist and a postcard to be signed and returned which committed their family to pro-environmental behaviors. Teachers were also asked to name up to ten students from each class who were the most environmentally aware and most interested in environmental issues. They were to also name up to ten students on the other end of the spectrum—those who were the least interested in or concerned about the environment. Data established that participation in the Caretaker Program resulted in more positive attitudes toward the environment. The children rated high by their teachers showed the largest increase in pro-environmental attitudes and those rated low displayed the smallest increase. Students in the experimental group scored just slightly higher than the control group on the knowledge scale of the CHEAKS. Questionnaires returned by the parents (n=486) indicated that parents of the experimental children reported a significantly greater change both in their own awareness of environmental issues and in their performance of pro-environmental behaviors during the past year than did parents of control children. Also, a significantly higher amount of commitment postcards were returned by parents of the experimental group than by the parents of the control group. Overall, data proved that the Caretaker Program to be successful in affecting the attitudes and behaviors of participating children and their parents toward the environment.

A study was conducted by Smith-Sebasto (1998) to assess the University of Illinois Cooperative Extension Service (UICES) educators' preparation to infuse Environmental Education (EE) concepts, their attitudes toward EE and the extent to which they are infusing EE concepts into their programs. A questionnaire was used to collect data from participating educators (N=188). When asked, educators (n=110) reported they were not currently presenting programs about the environment or environmental issues while 78 educators reported they were. When the educators were asked why they did not include environmental issues in their programs, 68.8% agreed (strongly agree and agree combined) that they did not have enough knowledge or background to include this their program. Results indicated that the subjects assessed the three most valuable cognitive-domain education methods to be observations, outdoor teaching strategies and problem solving/critical thinking. The three methods they most often utilized were lectures, observations and audiovisuals. The affective-domain education methods deemed most valuable were action learning, sensory or awareness activities and values analysis. These three along with behavior modification were the actual methods most frequently used by the educators. Of the participants, 99 subjects agreed (strongly agree and agree combined) that it was important to include environmental education in their programs so participants' levels of environmental responsibility may increase. The subjects cited reasons such as not enough program time and not enough knowledge/background for not involving their participants in environmental action strategies.

SUMMARY OF THE LITERATURE REVIEW

This review of the literature indicated that field trips were an extremely effective role in students' learning. When field trips were utilized, students' learning increased, as well as their attitudes and behaviors. Studies revealed that effectively implemented, active field trips increased the students' success more so than did passive field trips.

However, there has been limited research conducted on the impact of field trips and field-based instruction on classroom teachers. From the available research, evidence was found indicating that field trips were an essential part of their learning experience. The studies proved that there were increased knowledge acquisition and increased levels of confidence in teaching the necessary concepts when field trips were part of teachers' training.

In the realm of pedagogical effectiveness, research revealed that effective middle school and secondary level educators were viewed as those with humanistic characteristics who enjoyed the students with whom they worked and who sincerely wanted to help their students. Research indicated that teachers who attended intensive workshops and inservice training developed an increased confidence in themselves and in their teaching partly because of the knowledge gain in that subject area or concept. The teachers felt more at-ease with the material taught in the workshops so they felt fewer tendencies about teaching these topics in their classrooms. The experience of an intense training program led to the development of new ideas and concepts that teachers tended to adopt in their classrooms.

Finally, data indicated that students' attitudes, knowledge and behaviors were positively affected by environmental education (EE). The studies deemed that students in grades one through twelve held positive perceptions about the environment after they took part in some type of EE training, workshop, classes or activities. Several students involved in the studies showed pro-environmental attitudes going into the EE activities; these students displayed greater awareness of environmental issues as well as a dramatic increase in positive perceptions after they were involved in EE programs. Not only were students' environmental attitudes and behaviors affected, but their parents' environmental attitudes and behaviors increased as well. Also revealed was the increase of the knowledge in parents whose children were involved in pro-environmental activities. Data that measured the students' knowledge were limited; however those studies revealed an increase of knowledge when environmental issues affected areas close to home.

CHAPTER THREE

RESEARCH AND DESIGN PROCEDURES

Procedures involved in this study are reviewed in this chapter, which is subdivided in four sections: overall design; population; instrumentation; and statistical analysis.

OVERALL DESIGN

Experimental research was conducted to determine if science teachers' field-based learning experiences affected their pedagogical effectiveness, the frequency of their field offerings, and their students' behaviors. The subjects of the study were middle and secondary school teachers (N=100) and middle and secondary students (N=270). The program in which the teachers participated was entitled PLAN-IT EARTH (Pairing Learners And Nature with Innovative Technology for the Environmental Assessment of Resources, Trends and Habitats).

This project was a collaborative effort of scientists, environmentalists and educators representing the following groups: science teachers from school districts throughout Illinois; scientists from the Illinois Department of Natural Resources; science coordinators from the Illinois State Board of Education and the Illinois Regional Offices of Education; educators from the Environmental Education Association of Illinois and the teachers who developed the Curriculum Modules on ecosystems; and science and science education professors from four universities.

PLAN-IT EARTH operated for three years with instructional cycles beginning in the summer and continuing throughout the school year. Data which measured this program was gathered in February and early March, six months into the first school year, so the results were limited and did not include what took place in late March, April and May, which were the designated times to complete field work. Data displayed in this study revealed work completed by teachers and students beyond the program guidelines.

The subjects participated in an intense weeklong residential workshop during the summer pertaining to training techniques and activities that focused on field-based teaching techniques and innovative instructional strategies. The program design was based on a developmental framework of exploration, concept introduction and application experiences. Each session began with exploration exercises including but not limited to inquiry based science investigations that were conducted directly in the physical environment; problem solving scenarios; questions for exploration; and data collection and analysis techniques. Concept introduction sessions followed these exercises. Science content clarification and updating occurred through a blend of direct instruction, cooperative learning exercises, laboratory and computer exercises.

Interwoven in the sessions was information related to the guiding principles contained in The Benchmarks of Science, The National Science Education Standards and NSTA Pathways to the Science Standards. Teachers were immediately provided with sufficient time to rework and transfer their learnings, thus ensuring that application occurred. Individually, teachers reflected and responded in their journals and developed contributions to add to their portfolios which described the week's work. It was a goal to engage teachers in developing alternate forms of assessment and to be involved in reflective and communication activities such as journal writing and portfolio development. In teams, teachers planned how to incorporate the activities, information and experiences in their personal curriculum as well as in their district's Science Curriculum Plan.

There were also eight monthly follow-up sessions held during the school year for all participants. These sessions focused on: expanding science content; new science methodologies; science instruction updating; mentoring techniques; technology usage; and dissemination strategies. A continuous networking system for sharing was established with a home page on the World Wide Web, newsletters designed specifically for the project, and special sessions at the annual state science conventions. The final component of the program was the implementation of field-based instruction by the teachers for their students. The students were required to submit data on an established basis demonstrating what they have learned in the outdoors.

Each year PLAN-IT consisted of the above mentioned activities. Some of the structural ideas on which this program was based were also included in the sessions. These included the following: constructivist perspectives; technological applications; leadership development; equity attention; the Science-Technology-Society (STS) approach; cooperative strategies; questions strategies/science as inquiry; hands-on activities; and authentic assessment.

During the summer program, the basic principles of ecology, research methodology and field techniques were introduced daily and further developed throughout the program. However, the specific ecosystem that the participants monitored changed each year. The first year focused on forests and streams, the second concentrated on the wetlands and prairies while the final year will address soil and urban systems.

Initially, the program provided teachers with the necessary content background and instructional methodology needed for conducting field investigations and monitoring projects. The inclusion of monitoring projects in the science program provided students with a model of scientific research, allowed for concept applications and provided students with opportunities for responsible environmental stewardship--since action and community involvement components were at the core of the program. A major emphasis in PLAN-IT was to call attention to the contributions that could be made by scientifically literate and concerned citizens. The concept of the "Citizen Scientist" was infused throughout the program. Involvement of citizens in the scientific process would not only foster a better understanding of their environment but also would develop and nurture a sense of stewardship and community involvement.

Data measuring the changes in pedagogical effectiveness and frequency of field offerings was obtained through four instruments. The Pedagogical Effectiveness Survey (PES) was used to measure changes in the pedagogical effectiveness of the science teachers (N=100) who took part in the program (Appendix A). These data were collected five months into the first year of the program. Training occurred in the summer of 1997 and the PES was administered in February and early March 1998. Before training, the subjects completed a similar survey about their knowledge and experience of science (Appendix B). A random selection of portfolios and logs kept by the participating subjects were reviewed and evaluated to measure the quality of their programs. The PLAN-IT EARTH participant portfolio format gave the teachers a structure to follow when completing their portfolios (Appendix C). Included in the portfolios were collections of the teacher's work during the initial months of the program. Randomly selected teachers were also interviewed to solicit the accounts of their utilization of field-based education and its effectiveness (Appendix D).

There were two instruments used to measure the students' attitudes, knowledge and behaviors, as well as the frequency of their field offerings. The middle and secondary school students (N=270) involved in the study were members of science classes that utilized field-based learning. The data were gleaned through survey research as well as personal interviews of randomly selected students (Appendix D). The Science Student Behavior Survey (SSBS) was used to measure the frequency of field offerings and student behaviors such as environmental responsibility and student attitudes (Appendix E). The data collected measured the effects of field-based learning on these students after their teachers took part in the PLAN-IT EARTH training.

POPULATION

Experimental research was conducted to determine if science teachers' field-based learning experiences affected their pedagogical effectiveness, the frequency of their field offerings, and their students' behaviors. The middle and secondary school teachers (N=100) involved in this study were selected from a group of teachers within the Midwestern state of Illinois. Subjects represented schools of geographic and ethnic diversity (suburban, urban and rural areas). The subjects participated in a program which helped them develop and apply a variety of activity-based lessons and investigative techniques to enhance the teaching of science in the outdoors. Throughout the program, the teachers took part in several field trips to directly learn the fundamental ecological concepts and techniques necessary to monitor ecosystems. To measure the effectiveness of the program, the data were obtained through the Pedagogical Effectiveness Survey (PES). The PES was used to measure the changes in pedagogical effectiveness and the frequency of field trips utilized by the science teachers who took part in this field-based learning program both before and after the training. Data were also obtained after the teachers were trained and were in the initial months of the program. Interviews and the randomly selected portfolios and logs were also analyzed.

The middle and secondary school students (N=270) involved in this study were selected from a group of students from varying regions of Illinois. Subjects represented the geographic and ethnic diversity (suburban, urban and rural areas) within the state. Tables 22 through 24 provide background information on the students involved in the study. They were students whose teachers participated in a field-based program. The Science Student Behavior Survey (SSBS) was used to measure the frequency of field offerings for students after the program was implemented for five months. Data also measured student behaviors such as attitude and environmental responsibility. Interviews were conducted with randomly selected students to collect additional data on their attitudes, behaviors and the field trips they have experienced.

INSTRUMENTATION

Experimental research was conducted to determine if science teachers' field-based learning experiences affected their pedagogical effectiveness, the frequency of their field offerings, and their students' behaviors. Data on all middle and secondary school teachers (N=100) were obtained through the Pedagogical Effectiveness Survey (PES) and the analyses of portfolios and logs. A survey similar to the PES was administered before the subjects took part in the workshop and then the PES was given five months after the workshop. The PES results were compiled after the teachers completed the initial training and during the first months of the project. This survey contained a list of ten activities both school- and personally-related. The subjects were asked to mark the box that appropriately described their attitudes about taking part in each activity. The second half of the survey contained nine pedagogical techniques utilized by effective teachers. Subjects were asked to mark the box which most accurately measured how often they implemented each component. The data from the PES were analyzed to determine if the teachers who took part in the program and applied field-based learning experiences had enhanced their teaching of science. The analyses of the randomly selected logs and portfolios measured the number of field trips taken as well as the methodology teachers used to teach science in their classrooms. Portfolio components such as student assessments, presentations or workshop experiences and resource personnel contact charts were reviewed and analyzed. Finally, interview questions which pertained to subjects such as the time teachers spent out of school doing nature-related activities and their views on the benefits and barriers of field-based instruction were evaluated and analyzed.

The Science Student Behavior Survey (SSBS) was developed to collect data from middle and secondary school students (N=270). This survey contained 15 items which included the subject's gender, age and the geographical location of the school he/she attended. The students' answers projected their attitudes about environmental education and learning in the outdoors. It also elicited the students' record of the frequency of field offerings in their science classes during the initial stages of program implementation. Student behaviors were measured with questions relating to their conceptual attitudes about science and field-based education. These data were collected after students had been in classes whose teachers were trained in field-based techniques. Randomly selected students were interviewed for additional data that helped measure changes in their behaviors such as environmental responsibility and attitudes about science. These subjects were asked to share both the good and bad experiences they had with learning in the outdoors. They were also asked whether or not they spent free time outside of school doing nature-related activities, and if so, in what types of activities did they take part.

The initial draft of the Student Science Behavior Survey (SSBS) was reviewed by faculty members from Eastern Illinois University's Education Department. The ideas and suggestions given by these individuals were incorporated into the second draft. Both surveys were then jury reviewed by randomly selected students and teachers. The surveys were modified based on the suggestions given by the teachers and students.

STATISTICAL ANALYSIS

Statistical analysis procedures were conducted at the testing services facility of Eastern Illinois University. Statistical Package for the Social Sciences (SPSS) was the statistical package used to correlate and compare frequencies obtained by the surveys.

CHAPTER FOUR

RESULTS

DESCRIPTIVE STATISTICS--TEACHERS

The Pedagogical Effectiveness Survey (PES) recorded the attitudes teachers had about taking part in specific activities. Teachers also indicated how frequently they implored nine different teaching methods in their classrooms. Frequencies and/or percentages related to items on the PES are provided in Tables 1 through 18.

Teacher Activities/Experiences

Table 1 reports that a very high percentage of teachers, 91 percent, enjoyed traveling with only one individual indicating that it is an activity he/she would rather not do.

Table 1
TRAVELING PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
91%	8%	1%	100

Exploring the outdoors was rated as an activity the teachers enjoyed doing by 88 percent of the teachers. They seemed to enjoy activities which they were more actively involved comparable to their students. A passive activity such as watching a nature show did not receive as high of a percentage, 70 percent, as the more actively involved activities. These percentages are reported in Tables 2 and 3.

Table 2
EXPLORING THE OUTDOORS PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
88%	10%	2%	100

Table 3
WATCHING NATURE SHOW PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
70%	28%	2%	100

Using computers was an activity that 62 percent of teachers enjoyed doing. Perhaps the teachers surveyed enjoyed exploring the internet or utilizing e-mail but they would rather not analyze their budget or do their taxes on the computer. None the less, just over half of the teachers indicated that they enjoy using computers; this data is found on Table 4.

Table 4
USING COMPUTER PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
62%	34%	4%	100

The teachers preferred attending workshops over membership in organizations or going to conventions. Only 41 percent indicated that they enjoyed belonging to organizations; while 71 percent reported that they enjoyed attending workshops. Comments written on some surveys noted that when teachers presented at the conferences they enjoyed going more than if they were only attending. Tables 5 through 7 report these findings.

Table 5
ATTENDING WORKSHOP PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
71%	24%	5%	100

Table 6
GOING TO CONVENTION PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
57%	34%	9%	100

Table 7
BELONGING TO ORGANIZATION PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
41%	52%	7%	100

Teachers enjoyed trying new teaching techniques, 82 percent indicated; and 70 percent implied that they enjoyed personal goal setting. These two activities relate directly to a teacher's self-improvement which is very important to pedagogical effectiveness. These percentages are revealed in Tables 8 and 9.

Table 8
TRYING NEW TEACHING TECHNIQUE PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
82%	18%	0	100

Table 9
PERSONAL GOAL SETTING PERCENTAGES

Enjoy Doing	It's OK	Rather Not Do	N
70%	29%	1%	100

Teaching Methods

Percentages from the pretest and posttest deemed that teachers used many of the methods of teaching more often after their training than before. Portfolios also revealed the variety of methods teachers implemented.

Rubrics for papers, presentations, models and other forms of alternative assessment were displayed in the randomly selected portfolios (Appendices F & G). Teachers encouraged the students to use graphic organizers and maps as well as a variety of other assessment options to display the work they completed in the field (Appendix H). Some groups of students made graphs which displayed the types of trees and plants they encountered during their wilderness watch. They used computers, personally created illustrations, cutouts and others materials to create various graphs that showed the number of described species from the area students explored. The portfolios contained guidelines for a variety of alternative assessment activities implemented by the subjects (Appendices I & J). Samples of various lessons were also found in the portfolios (Appendix K).

Cooperative learning was implemented by many of the teachers for program activities. When students did the Forest Watch monitoring and the various experiments, they primarily worked in teams. Students were expected to present findings to the rest of the class in an oral presentation using visual aids. Some teachers created rubrics so students were clearly aware of what was expected. Each group was also expected to create a model of their environmental monitoring protocol. At the end of each class period, students evaluated their team members for group work and effort. This is an important part of cooperative learning because students needed to understand that not only was their role in the group important, but the work and relations of all the group members made their team a success. Peer evaluations from cooperative learning groups allowed students to take more ownership of their efforts and share this with their peers (Appendix L).

Questions on both the pretest and posttest referred to cooperative learning, teaching in the outdoors, field trip excursions, alternative assessment, internet applications, environmental issue analysis and resource personnel assistance. Teachers utilized cooperative learning extensively 20 percent more after their training. The frequency of implementing alternative assessment also increased after teachers received training.

One teacher's high school students created children's books with vivid illustrations about various animals, plants and wildlife of Illinois. The books varied from factual nonfiction works to cartoons and fictional stories about animal characters and the endeavors they faced. They then shared these books with local elementary students. The high school students had to be well informed about Illinois wildlife and the environment to write their stories and then discuss them with each other and, also with young children. Students were extremely knowledgeable about their subject because they had to do the research for their books and then they read and shared each others' work. These high school students became teachers, took ownership of their learning and became experts on their subjects.

Another group of students created scrapbooks about the ecosystems, prairie and wetlands. They illustrated and labeled the various parts of the ecosystems and created books out of them. One student remarked, "I enjoyed illustrating and describing each part of the system, I had to really know it to make this book. It was fun to do and different."

The use of internet applications increased greatly with 15 percent of the teachers using it more frequently now than before they were trained. The extensive utilization of resource personnel assistance went from 1 percent to 11 percent; while the frequent use rose to 43 percent from 22 percent. Tables 10 through 16 report the change in percentages between those pretest and posttest questions.

Table 10
COOPERATIVE LEARNING COMPARISONS

	Extensive	Frequent	Minimal	Not At All	N
Pretest	14%	53%	27%	6%	88
Posttest	34%	50%	15%	1%	100

Table 11
ALTERNATIVE ASSESSMENT

	Extensive	Frequent	Minimal	Not At All	N
Pretest	7%	46%	35%	12%	99
Posttest	14%	45%	37%	4%	100

Table 12
TEACHING IN THE OUTDOORS

	Extensive	Frequent	Minimal	Not At All	N
Pretest	4%	26%	57%	13%	88
Posttest	11%	43%	41%	5%	100

Table 13
FIELD TRIP EXCURSIONS

	Extensive	Frequent	Minimal	Not At All	N
Pretest	8%	20%	58%	14%	88
Posttest	10%	35%	52%	3%	100

Table 14
INTERNET APPLICATIONS

	Extensive	Frequent	Minimal	Not At All	N
Pretest	8%	27%	46%	19%	88
Posttest	12%	42%	36%	10%	100

Table 15
ENVIRONMENTAL ISSUE ANALYSIS

	Extensive	Frequent	Minimal	Not At All	N
Pretest	5%	39%	43%	13%	94
Posttest	18%	42%	35%	5%	100

Table 16
RESOURCE PERSONNEL ASSISTANCE

	Extensive	Frequent	Minimal	Not At All	N
Pretest	1%	22%	51%	26%	88
Posttest	11%	43%	43%	3%	100

More than 75 percent of the teachers used open-ended investigations extensively or frequently in their classrooms. Activity-based lessons had a very high percentage of implementation by the teachers' surveyed. Nearly 90% of the teachers used this method either extensively or frequently. Tables 17 and 18 report the percentages of these findings.

Table 17
OPEN-ENDED INVESTIGATIONS

	Extensive	Frequent	Minimal	Not At All	N
Posttest	19%	57%	20%	4%	100

Table 18
ACTIVITY-BASED LESSONS

	Extensive	Frequent	Minimal	Not At All	N
Posttest	41%	48%	10%	1%	100

DESCRIPTIVE STATISTICS—TEACHERS & STUDENTS

The PES, SBSS and the analyses of portfolios and logs all revealed the frequency that teachers in the program utilized field activities. Since data were collected during the initial months of the project, there were no indications as to how many additional outdoor experiences took place in late March, April and May. Those were the designated months for monitoring sites, so activities before March were beyond the program expectations. In order to determine any increase in field-based activities, student and teacher surveys were correlated. These percentages appear in Tables 19 through 21.

Frequency of Field Activities—Teacher Surveys and Portfolios

Portfolios and logs kept by teachers indicated what types of field activities they planned and how frequently. Many of the teachers took students outside of class time to visit monitored sites and set up necessary equipment. Since the designated time for monitoring was late March, April and May, teachers who took students outdoors before March went beyond the program expectations. Tables 19 and 20 report the percentages and frequencies of field activities utilized by teachers.

When pretest and posttest surveys were compared, there was an increase in the frequency that teachers reported employing field trips and outdoor education in their instruction. As shown in Table 20 the percentage of teachers who indicated that they frequently teach in the outdoors increased 17 percent after the initial stages of implementation. Only 5 percent of the teachers had not yet utilized teaching in the outdoors. Occurrences of field trip excursions increased as well after teachers participated in training. Fewer teachers indicated that they did not use field trip excursions at all and more reported using them more frequently; Table 19 shows these percentages and frequencies.

Table 19
TEACHERS' UTILIZATION OF FIELD TRIP EXCURSIONS

	Extensive	**Frequent**	**Minimal**	**Not At All**	**N**
Pretest	8%	20%	58%	14%	88
Posttest	10%	35%	52%	3%	100

Table 20
TEACHERS' UTILIZATION OF TEACHING IN THE OUTDOORS

	Extensive	**Frequent**	**Minimal**	**Not At All**	**N**
Pretest	4%	26%	57%	13%	88
Posttest	11%	43%	41%	5%	100

Frequency of Field Activities—Student Surveys

Surveys were collected in early March, but up to that point 46 percent of the students had taken one to three field trips in their science classes. These results are provided on Table 21.

Table 21
HOW MANY FIELD TRIPS HAVE YOU TAKEN IN YOUR SCIENCE CLASSES THIS YEAR?

	0	**1-3**	**4-6**	**7-10**	**11+**	**N**
%	25%	46%	14%	7%	8%	100%
n	67	125	37	19	22	270

DESCRIPTIVE STATISTICS--STUDENTS

The Student Science Behavior Survey (SSBS) was designed to obtain information on selected characteristics, behaviors and attitudes of the participating students. Frequencies and/or percentages related to items in the SSBS are provided in Tables 22 through 30.

Student Characteristics

Characteristics which described students in the group included gender, grade level and the geographic region of the schools they attended. Students involved in the study were in grades six through twelve. A higher percentage of the subjects were from secondary level schools while only 16 percent were from middle schools. The schools these students attended were located in suburban, urban or rural areas. Gender was evenly represented however most of the students were from rural schools. The frequencies of those characteristics are summarized in Table 22 through 24.

Table 22
GRADE LEVEL OF STUDENTS IN THE GROUP

	6th	**7th**	**8th**	**9th**	**10th**	**11th**	**12th**	**N**
%	1%	10%	5%	6%	16%	36%	26%	100%
n	3	27	14	15	42	98	71	270

Table 23
GENDER OF STUDENTS IN THE GROUP

	FEMALE	**MALE**	**N**
%	49%	51%	100%
N	132	138	270

Table 24
GEOGRAPHIC REGIONS OF SCHOOLS STUDENTS ATTEND

	SUBURBAN	**URBAN**	**RURAL**	**N**
%	23	23	54	100%
n	61	61	148	270

Student Attitudes

Students' attitudes toward science and environmental education as expressed in selected items on the SSBS are reported by percentages in Tables 25 through 27.

Table 25 indicates that 94 percent of the students surveyed responded that they enjoyed learning directly in the environment.

Table 25
DO YOU ENJOY LEARNING DIRECTLY IN THE ENVIRONMENT?

	YES	**NO**	**N**
%	94%	6%	100%
N	253	17	270

When students were asked to list their three favorite subjects in school over the last three years, science was ranked more often than any other subject. Following science, mathematics and English were the other two most favorite subjects. Sometimes students listed more than one type of science as their favorite subjects (example list: chemistry, biology, Algebra). Overall, the science courses were identified more frequently than the other subjects in the curriculum. Table 26 provides all of the percentages and frequencies.

Table 26
STUDENTS' FAVORITE SUBJECTS IN SCHOOL

	SCI	**MA**	**ENG**	**SS**	**O**	**PE**	**ART**	**TE**	**FL**	**P/S**	**MU**	**BU**	**N**
%	29%	18%	12%	12%	6%	5%	5%	4%	4%	2%	2%	1%	100%
n	238	145	101	97	47	40	39	34	29	15	14	11	810

(SCI = Science; MA = Mathematics; ENG = English; SS = Social Studies;
O = Other; PE = Physical Education; ART = Art; TE = Technical Education;
FL = Foreign Language; P/S = Psychology/Sociology; MU = Music; BU = Business)

Methods of learning where students took an active role and were directly involved were consistently ranked higher as preferred methods of learning science. Five methods of learning science were listed on the survey for students to rank one, two, three, four and five. One designated their most preferred method of learning about science and five their least preferred.

Students overwhelmingly indicated that taking part in field activities was their most preferred mode of learning science with 77 percent of them ranking it number one. Activities such as group projects/reports in class (50 percent ranked it number two) and doing research on a computer (46 percent ranked it number three) also received high ratings by a large percentage of students. When activities were passive and did not involve the students directly, they were more often ranked as being least preferred. For instance, activities such as listening to teacher lecture (40 percent ranked it number four) and working with the science textbook in the classroom (44 percent ranked it number five) were given low ratings by a high percentage of the students. The findings on preferred methods of learning science are reported in Table 27.

Table 27
STUDENTS' PREFERRED METHODS OF SCIENCE INSTRUCTION

	Method 1	**Method 2**	**Method 3**	**Method 4**	**Method 5**
Median	1.00	2.00	3.00	4.00	5.00
% at Median Rank	77%	50%	46%	40%	44%
N	270	270	270	270	270

Method 1 = Taking part in field trips/field activities
Method 2 = Doing group projects/reports in class
Method 3 = Doing research on a computer
Method 4 = Listening to your teacher give a lecture
Method 5 = Using your science textbook in class

Student Behaviors—Environmental Responsibility

Students' behaviors and environmental responsibility as expressed in selected items on the SSBS are reported by percentages in Tables 28 through 30.

A large percentage of students reported that they shared the information they had learned about the environment with their family and/or friends. Some students wrote directly on the survey that they told their friends what they learned more often than they told their families.

One activity students shared with their family and friends was mapping out the lives of the scientists with whom they worked from the Illinois Department of Natural Resources. With the name of the scientist in the center of a piece of poster board (plus some students drew their scientists), students mapped out the lives of their scientist and the path he/she took to become a scientist. Students interviewed the scientists and asked questions such as: where they went to college, why they went there, what they majored in, what internships and jobs they held, what hobbies they had and other background questions. This helped the students to answer the questions, "Who are scientists and what do scientists do?" When they completed this project they realized that a scientist can be anyone and it corrected the stereotypes they previously held. After this, students interviewed each other and made "life maps" about the past, present and future of their lives. Students took this very seriously and set some spectacular life goals. Their teacher was extremely pleased with the discussion that took place between peer about their future in science and environmental education. The percentages and frequencies of this question are indicated in Table 28.

Table 28
DO YOU SHARE INFORMATION YOU HAVE LEARNED ABOUT THE ENVIRONMENT WITH YOUR FAMILY AND/OR FRIENDS?

	YES	**NO**	**N**
%	83%	17%	100%
N	225	45	270

Table 29 reports student responses affirming their participation in science related activities. This could have included activities such as: belonging to the Ecology Club, visiting a Nature Center or going hiking. The percentage of students who were affirmative in their response was not very much higher than those who responded negatively. Many students indicated directly on the survey that they would like to take part in these types of activities more but either they did not have the time or else these types of activities were not available in their schools/neighborhoods.

During the interviews, the students also conveyed feelings of enthusiasm towards outdoor activities completed on their own time with family and/or friends.

One high school class went door-to-door throughout their community with surveys about water-use and their area's water tables. During this experience students informed community members about the dangers of pesticides and fertilizers to their water supply. This was an excellent example of the concept of the "Citizen Scientist" which was infused throughout the program. Involvement of citizens (especially young citizens) in the scientific process not only fostered a better understanding of their environment but also developed and nurtured a sense of stewardship and community involvement.

Another student shared experiences he had with an after school program called the "Trailblazers." This group met weekly and completed a variety of environmental activities. They sent out a bulletin every two months to inform the school and the community about their upcoming activities and projects. Over the last few years, this group had raised enough money to add the following items to their school grounds: a prairie; a butterfly garden; a bird sanctuary with a multitude of feeders; a small pond; and this year, a gazebo and walkway around the pond.

Table 29
DO YOU PARTICIPATE IN ANY SCIENCE RELATED EXTRACURRICULAR ACTIVITIES?

	YES	NO	N
%	55%	45%	100%
N	149	121	270

When students were asked if they felt better prepared to help improve nature and their surroundings as a result of their science classes, 77 percent of them responded that yes, they did feel prepared. One student shared experiences of a monthly ritual his family took part in to help clean up their community. They took various routes around their town and collected garbage, cans and other items which littered the area. What started out as a Boy Scout project carried on into a family's personal quest for a trash-free environment.

During another interview, a student revealed how he expanded his involvement with the school's recycling program into his community. After he helped organize and run his high school's very successful program, he was chosen to be on a city council committee to incorporate a citywide environmental awareness project. He served on the committee and helped city members make environmentally literate decisions about their community's environmental issues. As this student heads off to college, he hopes to study environmental biology or environmental law and he "owes this decision to all the great experiences given to me throughout high school." Supportive findings are presented in Table 30.

Table 30
DO YOU FEEL BETTER PREPARED TO HELP IMPROVE NATURE AND YOUR SURROUNDINGS AS A RESULT OF YOUR SCIENCE CLASSES?

	YES	**NO**	**N**
%	77%	23%	100%
N	207	63	270

QUALITATIVE DATA—TEACHERS

Teacher Interviews

Teachers (n=5) were randomly selected to answer questions about the benefits and barriers of teaching/learning in the outdoors. These are comments made by the teachers who were interviewed.

"Students love learning in the outdoors because it is a real experience for them. To see these students outside in the environment where many of them have never been before, doing things like catching insect specimens which they didn't think they could do when we started. However, as they get used to experiences they learn more about them; understand what we are doing and they enjoy the entire learning experience. They are also excited about us learning together—teacher and student. Since the environment is ever changing, the experience is never the same. Nothing is better to see kids learning when they don't realize they are learning."

"Like many teachers in the program, I made presentations to the school board to request funding to further our involvement in the program. A presentation was also given to faculty to pique their interest and gather more support for the program.

Many of the teachers made presentations on their involvement in the program at conferences at the local, regional, state and national levels."

"Students in my class seem to be enjoying all of the aspects of this program. They see that we are all learning together and we are all teaching each other as well. They recognize the real-life aspect of this program and feel important that their work is being used by the state. They take ownership of their work, their findings and in turn their learning because it is personal and it is relevant. They work very hard and they enjoy it very much at the same time. It is great!"

"Many of these students have gotten their interests and curiosities piqued and now they want to do things on their own to better the environment. Because of their involvement in this program, students realize they can help the environment through recycling, encouraging their parents to choose better pesticides, not littering, conserving water, conserving power and by spreading the word about those things to others as well. We can all help and this is empowering."

QUALITATIVE DATA—STUDENTS

Student Interviews

Students (n=7) were randomly selected to answer questions about learning in the outdoors and outdoor activities they took part in during time outside of school. These are comments made by students who were interviewed.

"We are all girls and we really got into this stuff. It's a hands-on experience and we use all of our senses. In fact we plan to cook-up cattails before this year is over. It is a continuous learning experience because our teacher is learning with us.

We teach our teacher, we teach each other, and we teach ourselves. We are actually in the streams, touching the water and critters, we feel the environment."

"We're concerned with what is put on the lawns of our community because it affects each of us. The chemicals go through the water cycle and eventually come out the tap and contaminate our bodies. It is up to me to educate my parents about the poisonous chemicals they put on our lawns and pollute our ground water. I get involved and go to city meetings to encourage people to learn how to protect our water source."

"There is nothing bad about learning outdoors! It is all really great! We get out of the classroom and do real stuff. Now I know about all the beautiful forest surrounding my town; now my friends go hiking on the trails a lot."

"What we are doing is really important because the state uses the information we give them for their studies on Illinois environment. Education becomes powerful because we can help the earth. We can tell our parents and other people what they are doing to hurt the environment and how they can help. We can help our community make better decisions that will in turn help our environment."

"The classes at our school that do work in the outdoors and take field trips are the most popular classes to take—they are everyone's favorites. The class gets close and we get to know their teacher outside of the classroom. We work together out in the field on teams so we all have a role."

Student Surveys

These are comments written on the surveys by students when asked, "What was your favorite part about taking field trips?"

The activities we do are the best part, especially when they are hands-on.

Learning about things I didn't know and how I can help with them.

Experiencing something I have not seen before.

I was learning things and I didn't even realize I was learning them.

The first hand water testing, we get in the water and really do experiments.

We learned a lot about the different kinds of trees, the different kinds of bark that trees have and how to identify them.

I learned about the trees in the woods and why it is bad for them to be overrun by foreign species of trees.

Being able to relate what we learned with an actual situation.

Knowing it was all real and the data would be used.

They allow us to go out and learn more about plants, trees and our environment; I was able to go home and teach my parents things such as how to tell the difference between a red oak and a white oak.

I know now I can help the environment and this is important for kids my age to volunteer and help the world around us.

We must help our environment, look at all our earth gives us, every thing we need and more, it's the least we can do for our earth.

Actually experiencing the different types of organisms that were in the river.

It was fun!

We learn about our wonderful environment and how we can help it.

We go outside with animals and stuff and we interact with nature.

We work to help our environment while learning more about it.

Get to interact with others in our class and new people too and discuss different topics.

Getting to learn in groups, with friends is fun!

You get the chance to know your teacher better.

Getting out of the boring lectures and being with friends while learning visually.

Learning about the environment and different scientific stuff.

I learned I don't have to be in a classroom to learn, I can be anywhere.

I enjoyed getting away from the norm, it stays in my head better when it's different.

We saw things we couldn't see in the classroom.

Being with classmates and teachers away from school.

Meeting new people and learning about new things; we get to do their job for awhile.

I go to different places I have never been and do hands-on stuff.

Actually seeing what we learn helps me learn it better and understand what's going on.

I like talking to my teachers outside of school.

It's cool going out to the forest and doing real experiments.

The experience of hands-on out in the field and I get to meet people and form my own personal network for the future.

The cooperative work and the abundance of knowledge that I acquire through it all.

I learned about my surroundings and saw beautiful areas I never knew were right near me.

I learned that there is a Japanese tree invading the trees in our woods and it is not good.

Getting fresh air, in nature, with my friends.

Taking water samples and learning about the Galena River which is right by my house.

We did research outside and got to ride a pontoon boat. I wish we could go outdoors more.

Going on a hike at Rush Creek when we did a tree count.

Everything!

HYPOTHESES

Data resulting from the analyses of the study were employed in the acceptance or rejection of the hypotheses. Statements follow for each of the hypotheses.

Hypothesis One

Hypothesis One: There are significant changes in the pedagogical effectiveness of science teachers after they are trained in field-based instruction.

The Pedagogical Experiences Survey (PES) was created so teachers could indicate the level of satisfaction they experienced when taking part in a variety of activities. Also revealed on this instrument was the frequency which teachers employed a variety of teaching methods in their classrooms. A similar survey on teaching methods was given to teachers before they took part in the PLAN-IT EARTH program training. When percentages from the pretest and posttest were compared, all of the numbers increased pertaining to how often teachers use these methods. There was an increase in how often teachers used alternative forms of assessment with their students.

In the randomly selected portfolios that were reviewed, a variety of ways that teachers had assessed their students was highlighted. Activities to meet the needs of all types of student learners were apparent in these portfolios. Cooperative learning and group activities allowed students to share their knowledge with their peers and teach as well as learn from one another. There was an increase of teachers indicating extensive use of cooperative learning, teaching in the outdoors, field trip excursions, alternative assessment, internet applications, environmental issue analysis and resource personnel assistance. Some of the increases were greater than others, but all the modes were reported to be utilized more often after training than before. Supporting evidence based on the percentages from the results of the PES, analyses of portfolios and teacher interviews, Hypothesis One is accepted.

Hypothesis Two

Hypothesis Two: There are significant changes in the frequency of field offerings for students after teachers are trained in field-based instruction.

Results from the Student Science Behavior Survey (SSBS) revealed that nearly 50% of the students took one - three field trips in their science classes during the initial months of the program. One-fourth of the students reported that they had not taken any field trips. Since this study was done five months into the program and the specified time for field work was designated for April and May, the results indicate what teachers offered beyond the monitoring period. A high percentage of teachers indicated that they taught using the outdoors either frequently or minimally. It is projected that these numbers could easily increase if teachers were surveyed again in June. However, the percentages from pre and posttest surveys collected showed that teachers utilized the methods of teaching in the outdoors and field trip excursions more often after their program training. The frequency of teaching in the outdoors went up over 25% and the utilization of field trip excursions increased by

17%. Therefore, evidence based on the comparison of the pretest and posttest results of the teacher surveys, Hypothesis Two is accepted.

Hypothesis Three

Hypothesis Three: There are significant differences in the student behaviors, knowledge and attitudes about science after they take part in field-based learning activities.

The SSBS was developed as a means to collect data about students' attitudes, behaviors and background in science and environmental education. Items from the instrument pertained to information such as the students' most preferred ways of learning science, their three favorite subjects in school, how many field trips they took in their science classes and how they felt about those experiences and about learning in the outdoors. Students overwhelmingly ranked field trips and field activities as their most preferred method of learning science. Some students had not been outdoors or on any field trips yet, however, they were greatly anticipating these experiences. Many of the students who experienced field activities in their science classes could not wait to get outside again. Over 90% of the students indicated that yes they do enjoy learning directly in the environment. Many students, 83 percent, also reported that they shared information they have learned about the environment with their family and/or friends. Students surveyed also ranked science as their favorite subject over the last three years. Based on the SSBS results and student interviews, Hypothesis One was accepted.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In this chapter a summary of the study is provided, conclusions are drawn and recommendations for further study and practice are made.

SUMMARY

This study was conducted to determine if science teachers' field-based learning experiences affect their pedagogical effectiveness, the frequency of their field offerings and their students' behaviors, knowledge and attitudes.

MAJOR CONCLUSIONS

The findings of this study allow the following conclusions to be drawn:

1. Improvements in pedagogical effectiveness were evident after teachers were trained in field-based techniques.
2. Involvement in a field-based training program enhanced teachers' methods of science instruction.
3. Teachers who are trained in field-based programs were more likely to incorporate outdoor experiences in science instruction.
4. Students' positive perceptions of science, enjoyment of science classes and the desire to apply information learned through science classes had been enriched by their experiences in field-based learning.

RECOMMENDATIONS FOR FURTHER RESEARCH

The findings and insights derived from this study support the following recommendations for further research:

1. A follow-up study should be conducted in two years, following the completion of the PLAN-IT program to determine the long-term effects of teacher training in field-based learning.
2. Further experimental research which will survey scientists, environmentalists and other educators involved in the program could indicate their direct effects of this program.
3. Further experimental research which will survey administrators, parents and school board members is needed to analyze their foreseen benefits and barriers of field-based learning and its effect on their students, children and community members.
4. A case study should be conducted on ten teachers to determine the effectiveness of the participation of a field-based instruction workshop on the frequency of field trips utilized in the classroom and changes in pedagogical effectiveness.
5. A case study should be conducted on ten students to determine changes in their attitudes, behaviors and knowledge relating to the environment due to receiving science instruction in the outdoors.

6. A comparative study should be conducted to investigate the frequency of field trips utilized in elementary schools with the frequency of field trips utilized in middle schools.
7. A similar study should be conducted to investigate the impact of field experiences on particular populations of students, specifically students with special needs or with behavior disorders.
8. Replicated studies should be conducted in various socioeconomic settings such as inner cities or wealthy suburbs.
9. Replicated studies should be conducted in states other than Illinois, such as Montana, Alabama, and Vermont.
10. A cross-cultural experimental study could indicate whether a field-based learning workshop done in Illinois had a similar result in another country such as Germany.
11. Further experimental research is needed to determine whether a larger population (N=500) would demonstrate the same results of increased frequency of field trips and improved pedagogical effectiveness.

RECOMMENDATIONS FOR PRACTICE

The findings and insights derived from this study support that the following measures be taken for its implementation in practice:

1. It is suggested that teachers be given the opportunity within their first three years of teaching to attend a workshop on field-based instruction, paid for by their school district.

2. It is suggested that preservice teachers be required to takea three-week unit on field-based learning and demonstrate mastery of the major concepts. At least half the time must be actual field trips and field oriented programs.
3. It is suggested that school administrators provide teachers with release time bi-quarterly to develop and prepare field trips, field study activities and programs for their students.
4. It is suggested that science teachers be allotted two days per quarter to observe and evaluate other teachers using field-based instruction.
5. It is suggested that school administrators allow teachers to take at least five field trips or field-based investigations each year.
6. It is suggested that the board of education allocate the funds necessary to equip the school with materials needed to create natural surroundings for that area's environment (ie. a variety of trees, plants, flowers, and shrubs; bird feeders; weather tools and devices).
7. It is suggested that adequate funding be set aside for each classroom to be used specifically for field trip purposes (ie. transportation, fees).
8. It is suggested that the district invest in specific books and materials for field-based learning activities and lessons for teachers to checkout.
9. It is suggested that the school principal take part in at least one field trip or field activity per class each year.
10. It is suggested that interested parents attend field-based learning workshops so they can be more effective chaperones.

11. It is suggested that at least one parent of each student in the classroom be required to assist with at least on field trip or field activity per year.

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Appendix A

PRE-TRAINING TEACHER SURVEY

... Perceptions, Understandings... ndicate the level of your understanding of the followin

	Extensive	Moderate	Little
Benthic Macroinvertebrates			
Dichotomous Keys			
Canopy Cover			
Topographic Maps			
Biodiversity of Illinois			
Invasive Species			
Transect Studies			
DBH			
Dendrochronology			
Duff			
Animal Sampling			
Compass Use			
Bioindicators			
Native Species of Illinois			
Stream Substrate			
Watersheds			
Stream Habitats			
Riparian Zones			
Nonpoint Sources Pollution			
Habitat Assessment			

Participant Perceptions, Experiences... Please indicate the level of your experience and use of the following:

	Extensive	Frequent	Minimal	Not At All
Cooperative Learning				
Teaching in the Outdoors				
Field Trip Excursions				
Alternative Assessment				
Interdisciplinary Teaching				
Internet Applications				
Environmental Issue Analysis				
Resource Personnel Assistance				
GIS Applications				
Team Teach...				

Appendix B

PEDAGOGICAL EFFECTIVENESS SURVEY (PES)

Since last summer's program involvement you have been introduced to various new experiences about learning and teaching in the outdoors. With this in mind, please respond to the following as thoroughly and honestly as you can. Thank you for your input!

	ENJOY DOING	IT'S OK	RATHER NOT DO
Traveling			
Watching Nature Shows			
Exploring Outdoors			
Using Computers			
Teaching Other Teachers			
Trying New Teaching Techniques			
Attending Workshops			
Going to Conventions			
Belonging to Organizations			
Personal Goal Setting			

	EXTENSIVE	FREQUENT	MINIMAL	NOT AT ALL
Cooperative Learning				
Teaching in the Outdoors				
Field Trip Excursions				
Alternative Assessment				
Open-ended Investigations				
Internet Applications				
Environmental Issue Analysis				
Activities-based Lessons				
Resource Personnel Assistance				

Appendix C

PLAN-IT EARTH PARTICIPANT PORTFOLIO FORMAT

PLAN-IT Earth
Participant Portfolio Format

Instructions:

1. Label the tabs of standard letter-sized file folders with the titles of the portfolio components (see below). Make sure your name is also on each folder tab.

2. Place the appropriate documents in the folders.

3. Organize the folders in the order given below.

4. Place the folders in a standard 12" expandable pocket folder.

5. Print your name and school on the front of the expandable folder in the upper right-hand corner.

Portfolio Components:

I. DNR Data Forms

II. DNR Resource Personnel Contact Chart

III. Site Assistance Schedules

IV. Networking Activities Chart

V. Presentations and Workshops Chart

VI. PLAN-IT Lesson Plans

VII. Student Assessment Documents

VIII. Miscellaneous

Resource Personnel Contact Chart

Teacher ______________________ School ______________________

Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact

Networking Activities Chart

Teacher ______________________________ School ______________________________

Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact
Date Purpose	Contact

Presentation / Workshops Chart

Teacher ______________________________ School ______________________________

Date Audience Description of Event
Date Audience Descriptions of Event
Date Audience Description of Event
Date Audience Description of Event
Date Audience Description of Event
Date Audience Description of Event

Appendix D

STUDENT AND TEACHER INTERVIEW QUESTIONS

INTERVIEW QUESTIONS

Teacher

*Could you tell me about any benefits of implementing field-based instruction?

*Have there been any barriers? What are some examples?

*Do you spend your own time outside of school in the outdoors doing nature-related activities?

Yes = What types of activities do you do?

No = Why not? Any particular reasons?

Student

*Tell me the good, the bad and the ugly about learning outdoors.

*Do you spend your own time outside of school in the outdoors doing nature-related activities?

Yes = What types of activities do you do?

No = Why not? Any particular reasons?

Appendix E

STUDENT SCIENCE BEHAVIOR SURVEY (SSBS)

Your ideas are important. Please share your ideas about science by answering the questions below. Thank you!

1. Do you enjoy learning directly in the environment? Yes No

2. Do you share information you have learned about the environment with your family and/or friends? Yes No

3. Do you participate in any science-related extracurricular activities such as an Ecology Club or visiting nature centers or hiking? Yes No

4. Do you feel better prepared to help improve nature and your surroundings as a result of your science classes? Yes No

5-9. Listed below are a variety of ways to learn about science. Please rank them with 1 being your most preferred and 5 being your least preferred way of learning science concepts and skills.

- ☐ Using your science textbook in the classroom
- ☐ Listening to your teacher give a lecture
- ☐ Doing research on a computer (ie. Internet, CD-ROMs)
- ☐ Taking part in field activities/field trips
- ☐ Doing group projects/reports in class

10. Over the last three years, what have been your three favorite subjects in school? _

_____________________ _____________________ _____________________

11. During the 1997-1998 school year, how many field trips have you taken in your science classes?

☐ None ☐ 1-3 ☐ 4-6 ☐ 7-10 ☐ 11or more

12. What was your favorite part of these field trips? ______________________________

____

13. What school do you attend? ____

14. Please mark your current grade level. ___

☐ 6th ☐ 7th ☐ 8th ☐ 9th ☐ 10th ☐ 11th ☐ 12th

15. What is your gender? ☐ Female ☐ Male

Appendix F

ORAL PRESENTATION AND MODEL RUBRIC

GROUP NAME: ____________________

PROTOCOL ____________

PRESENTATION: 100 PTS.

UNDERSTANDING: 50 PTS

Terminology : 20 pts. _____

Explanation: 30 pts. _____

Answering questions: 5 pts. _____

PRESENTATION: 30 PTS.

Smooth & flowing: 5 pts. _____

All participate : 10 pts. _____

Grammar : 5 pts. _____

Eye contact : 5 pts. _____

Use of Notes : 5 pts. _____

VISUAL AIDS : 20 PTS.

Uses model: 15 pts. _____

Other : 5 pts. _____

TOTAL _______

MODELS: 100 PTS.

Completeness: 40 pts. _____

Attractiveness: 25 pts. _____

Neatness : 25 pts. _____

Group effort: 10 pts. _____

TOTAL _______

COMMENTS:

Appendix G

ORAL PRESENTATION AND MODEL OF PROTOCOL RUBRIC

Oral Presentation of Protocol

Demonstrates complete understanding of the protocol - how, what,what it evaluates.
Uses appropriate terminology.
Gives a clear and complete explanation of the protocol.
Presentation is smooth and flowing.
All members of group participate.
Uses model of protocol effectively.
5 Uses other visual aids - diagrams, board, overhead, etc.
Correct grammar is used.
Eye contact is made and sustained.
Students refer to notes, but does not read.
Audience questions are skillfully handled.

Demonstrates adequate understanding of the protocol.
Uses most terminology.
Gives an adequate explanation of the protocol.
Presentation is not as smooth and flowing as the 5.
All members of group participate.
4 Uses model of protocol.
Uses other visual aids, but not as completely.
Correct grammar is used.
Eye contact is made , but intermittently.
Students refer to notes, but does not read.
Audience questions are answered.

Demonstrates adequate understanding of the protocol.
Uses some terminology.
Gives a superficial explanation of the protocol
Presentation is not smooth and flowing.
Some members of group do not participate.
3 Uses model of protocol.
Little or no visual aids.
Presentation is matter of fact, lacking enthusiasm and style.
Lapses in correct grammar.
Eye contact is made, but intermittently.
Students reads some of the notes.
Audience questions are superficially addressed.

Demonstrates lack of understanding of the protocol.
Little use of terminology.
Very little explanation of the protocol.
Presentation is not smooth and flowing.
2 Some members of group do not participate.
Uses model of protocol very little.
No visual aids.
Presentation is sloppy, little organization.
Poor grammar.

Some eye contact.
Most of presentation is read from notes.
Audience questions are poorly answered.

Demonstrates very little if any understanding of the protocol.
Presentation lacks basic information.
Presentation lacks focus and organization.
Grammar is poor.
1 Only one member participates.
Does not refer to model of protocol.
No visual aids are used.
Minimal or no eye contact.
The presentation is read entirely from notes.
Does not take or answer audience questions.

Protocol Model

Model contains all features required.
Model contains all features specific to that protocol.
5 Model is attractive - appears to have all features in scale with each other, colors are appropriate.
Model is neatly done - no glue or tape showing, edges neatly cut, features are firmly attached and properl placed.

Model contains all features required.
Model contains all features specific to that protocol.
4 Model is attractive but not quite as creative as the above.
Model is neatly done but not quite as neat as the above.

Model contains most of the features required.
Model contains most of the features specific to that protocol.
3 Model has some features out of scale,colors not appropriate.
Model not neatly done - glue showing, rough edges, trees falling over.

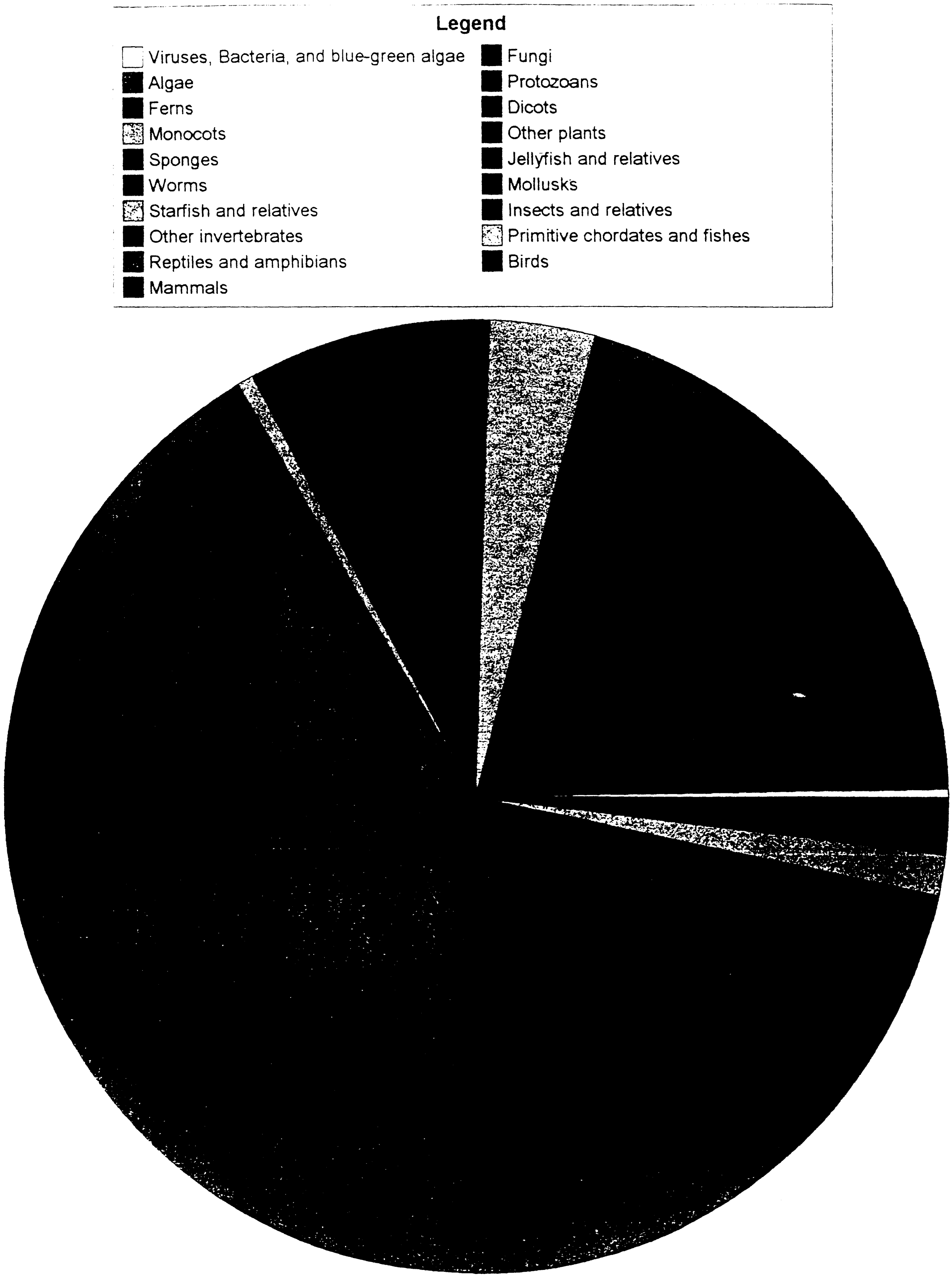
Model does not contain all required features.
2 Model lacks some features specific to protocol.
Model lacks attractiveness.
Model is not neat, sloppily put together.

Model does not contain required features.
Model not specific to protocol.
1 Model very unattractive.
Model is very sloppily put together.

Appendix H

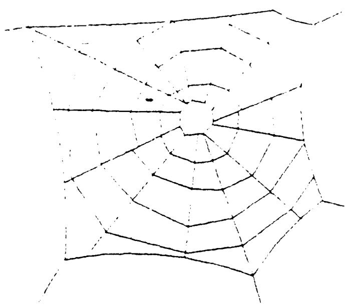
STUDENT GRAPH

Number of Described Species on Earth



Appendix I

GUIDELINES FOR ALTERNATIVE ASSESSMENT



ALTERNATIVE ASSESSMENT

FOR TIMBER PROJECT

*Research the career of a forester and create a poster about a forester's job And the background needed to become one

* Make a leaf collection with at least 12 leaves. Identify the leaf, describe the leaf and the tree, and its habitat.

* Create a shoe box diorama of the forest. Include the canopy trees and label them, sub-canopy trees and label them, saplings, seedlings, and down debris. Also include animals, insects etc.. That live in each habitat of the forest.

ALTERNATIVE ASSESSMENT FOR PRAIRIE PROJECT
Student is to do all the following:

1. READ THE BOOK

SEASONS OF THE TALLGRASS PRAIRIE

After reading the book, the student is to design a poster on seasons on the prairie. The poster is to be divided into four sections and labeled for each season. COLOR POSTER

2. Design a book cover entitled Disturbance Sensitive Plants. Then draw a picture of each plant and color it and report on the plant. Include information like the plants appearance, leaf shape, flower, etc...Each page of the booklet will have a different plant on it. Half the page is to be the plant and the other half is to be the report.

PLANTS:

1. Pale Coneflower
2. Leadplant
3. Green Milkweed
4. White Prairie Clover
5. Prairie Dropseed
6. Closed Gentian

3. Construct a booklet on Grasses of the Prairie. Include a cover and the same type of information as the plants of the prairie.

1. Big Bluestem
2. Little Bluestem
3. Indian Grass
4. Switch Grass

Appendix J

GUIDELINES FOR ALTERNATIVE ASSESSMENT ACTIVITY

Forest Module Assessment

Group:____________________ ____________________

____________________ ____________________

1. Read the town history and examine the data pages.

2. Discuss the viewpoints of the following: commercial development, small industry, local nature club, local farmer, or an idea the group chose. You may want to gather more information on the chosen topic such as going to the internet, magazines, interviews, etc.

3. Decide as a group the option the County Board should develop for the town.

4. Make sure in your action plan you include the how this decision would impact the surrounding communities, industry, jobs, people from Lieberville, surrounding farmland, quality of life, economics, and the environment. What are the pros and cons of each viewpoint and situation? How does this view point impact the community and its people? What impact will this decision have on native species, alien species, vegetative complexities, canopy condition, animal species, human use, economics, and the future use of this site?

5. Write an action plan for the County Board on your decision. Explain in detail and prepare visuals to be used for the oral presentation to the class.

6. In your action plan describe in detail how the forest area would look 25 years in the future if the County Board follows your recommendations. Also include what affect your plan had on Lieberville and the surrounding area in Carson County.

Action Plan

What does the data tell us?

What other information do we need to gather?

Write a step by step plan your goup thinks the City Council should follow and explain why your goup thinks they should follow your plan.

How will this plan affect commercial development, small industry, local nature groups, local farmers, farmland, surrounding communities, industry, jobs, the citizens of Lieberville, quality of life, economics, the environment, etc? Make sure you include pros and cons.

If your plan is followed how will this 750 acres look in 25 years and what will the surrounding area and community look?

Appendix K

SAMPLE ACTIVITIES FOR STUDENTS

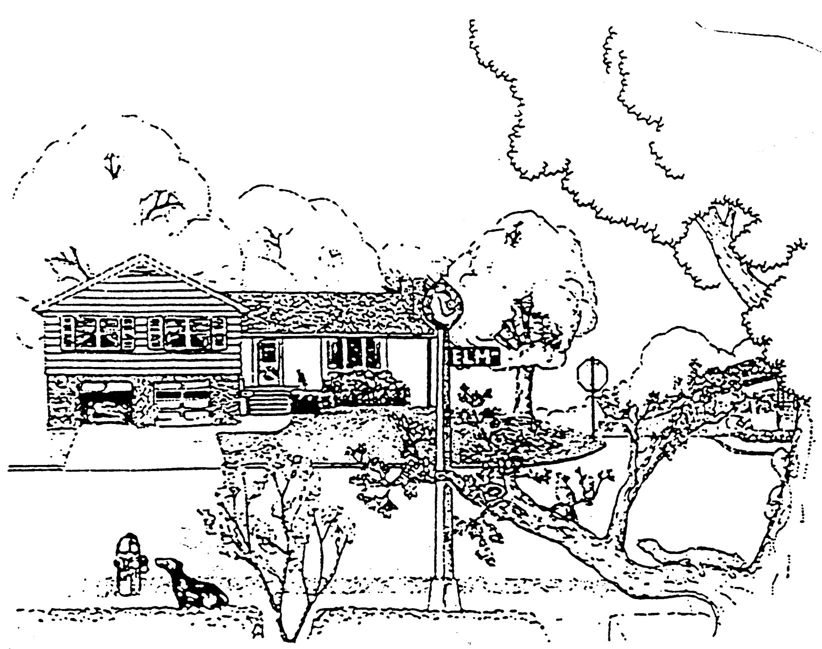
Why Are Forests Important?

1. They provide watershed protection.
2. They protect against excessive soil loss. The annual erosion of cropland is 7 tons/acre while that of forests is 1.6 tons/acre.
3. 61% of the state's native plants are found in Illinois forests.
4. 75% of the wildlife habitat is found in forests.
5. Forests are major recreation sites for the renewal of human physical and spiritual well-being.
6. Urban forests provide temperature modification, energy conservation, reduction of air, noise, and water pollution, hide unpleasant views, and have major psychological benefits.
7. Forests reduce global warming by trapping carbon dioxide.
8. Forests are necessary for timber production.
9. Forests provide fuel - 43% of the trees harvested in the state are used for firewood.

Student Page 3: Common Street Trees Found in Illinois*

Good (+1)	Intermediate (0)	Poor (–1)
Honey Locust (thornless)	Eastern Hemlock	Gingko
Willow Oak	Bald Cypress	Norway Spruce
Pin Oak	Mimosa	Blue Spruce
Crabapples	Tree of Heaven	Serbian Spruce
White Oak	Buckeye	Firs
Red Maple	Tulip Tree	Larch
Arbor Vitae	Eastern Redbud	Coffee Tree
Blue Beech	Sweetgum	Black Locust
Ironwood	Other Oaks	Holly
Norway Maple	Basswoods	Sassafras
Swamp White Oak	Dogwood	White Mulberry
	Black Walnut	Hawthorns
	Catalpa	White Birch
	Bur Oak	American Elm
	White Ash	Beech
	Bradford Pear	Hackberry
	Sycamore	Silver Maple
		Sugar Maple
		Black Cherry
		Green Ash
		Scotch Pine
		Red pine
		Austrian Pine
		Eastern White Pine

*If a tree is not on the list, consider it to be in the Poor category.



Student Page 2: Field Data—Urban Forest

Name ______________________

	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5
Species:	________	________	________	________	________

	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5
X = Suitability for an urban environment					
(+1) Good	____	____	____	____	____
(0) Intermediate	____	____	____	____	____
(−1) Poor	____	____	____	____	____
Y = Physical condition of tree					
(+1) Healthy (green leaves, no wounds, no yellow or brown leaves, few broken or dead branches)	____	____	____	____	____
(0) = Moderately healthy (mostly green leaves, a few yellow or brown leaves, no wounds, some broken or dead branches)	____	____	____	____	____
(−1) = Unhealthy (yellowish or brown leaves, one or more wounds, many broken or dead branches)	____	____	____	____	____
Z = Location of tree					
(+1) Growing in an open area with pavement >4 m away	____	____	____	____	____
(0) = Growing 2–4 m from a paved area	____	____	____	____	____
(−1) = Growing <2 meters from a paved area	____	____	____	____	____

Health Index Value (THIV or FHIV) = 1X + 3Y + 2Z

Health Scale

−6 −5	−4 −3	−2 −1 0 +1 +2	+3 +4	+5 +6
Very Unhealthy	Moderately Unhealthy	Intermediate Health	Moderately Healthy	Very Healthy

Student Page 3: Determining Forest Health

Name ______________________________

Model for Determining Forest Health Index Value

Variables	Rating
Lichen Monitoring	
>100 lichens in circular plot 30 m in diameter	+1
40–100 lichens in circular plot 30 m in diameter	0
<40 lichens in circular plot 30 m in diameter	–1
Tree Regeneration Monitoring	
>75% of seedlings and saplings same genus as witness tree	+1
30–75% of seedlings and saplings same genus as witness tree	0
<30% of seedlings and saplings same genus as witness tree	–1
Tree Damage Monitoring	
< 25% of trees >12.5 cm dbh with wounds	+1
25–50% of trees >12.5 cm dbh with wounds	0
>50% of trees >12.5 cm dbh with wounds	–1

Forest Health Index Value (FHIV) = 1X + 2Y + 3Z
FHIV = 1( ) + 2 ( ) + 3 ( )
FHIV =

Health Scale

–6 –5	–4 –3	–2 –1 0 +1 +2	+3 +4	+5 +6
Very Unhealthy	Moderately Unhealthy	Intermediate Health	Moderately Healthy	Very Healthy

Student Page 3: Analysis and Discussion Name ______________________________

After completing a master tally for your group and another for the class, answer the following questions. Use the reverse side of the page for longer answers.

1. What is the dominant tree (occurs most often) in the canopy for
   - a. Your group ______________________
   - b. The class ______________________
2. What is the dominant tree in the understory for
   - a. Your group ______________________
   - b. The class ______________________
3. How many sapling trees were found in
   - a. Your group ______________________
   - b. The class ______________________
4. What effect do the saplings have on the forest?

5. Is this forest a traditional oak-hickory or maple-beech forest? Other type?

6. What is the average diameter size of the following trees found by the entire class?

a. Oak ____________	b. Hickory ____________	c. Maple ____________
d. Beech ____________	e. Elm ____________	f. Cottonwood ________
g. Pine ____________	h. Ash ____________	i. Other ____________

7. Was your plot part of a deciduous or a coniferous forest?

8. Hypothesize which trees will be dominant in the canopy and understory in 40 years.

9. How could the canopy affect the understory growth?

10. How might the understory structure affect the flowering plants, ferns, and mosses?

Student Page 3: Dandy Data

Name ______________________

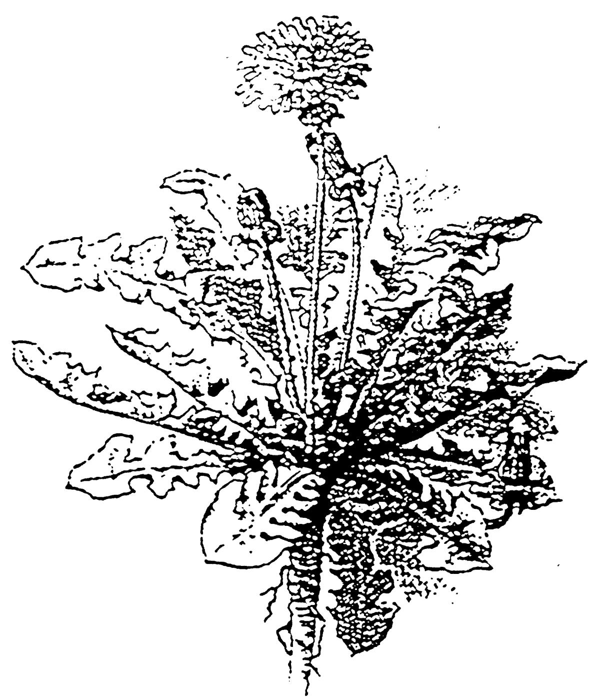
1. Your job is to estimate a population of dandelions based on the sample census technique. Your team will be given a square-meter frame and assigned an area of a field in which to conduct your census. Before we begin, we need to determine the area (how many square meters) are in this field. We will use the metric tapes to determine the length and width of the field; then we will compute its area.

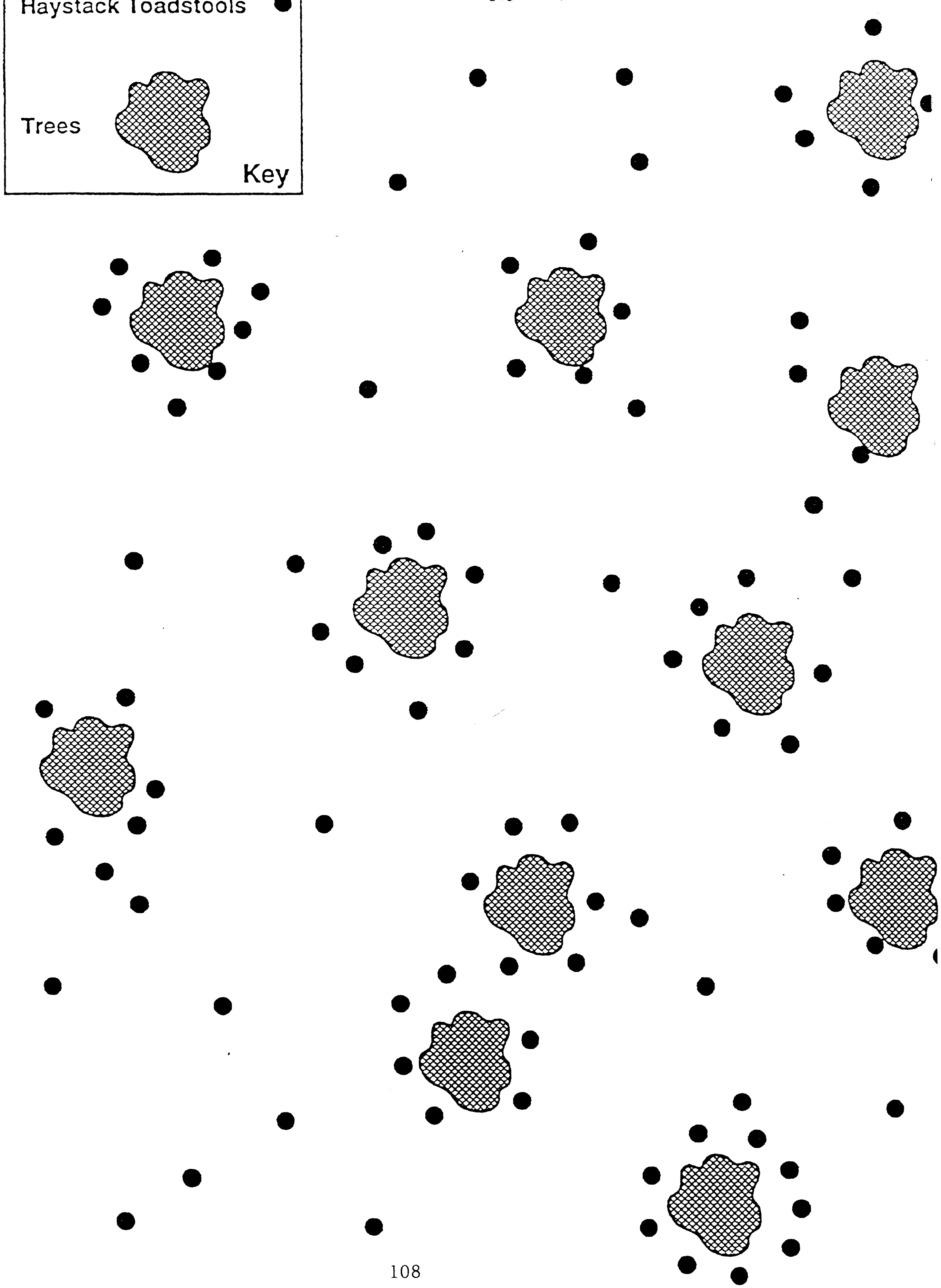
2. Randomly select a square meter on the field by tossing the plastic square over your shoulder or blindly tossing it. Count the dandelion plants within the square meter. Do NOT count flowers because a single plant may have more than one flower. Count each green, leafy plant from which the flowers are emerging. Record this information below. Make five replications in your assigned area, randomly selecting a new square meter each time.

3. Return to the classroom to figure the average dandelion population in your five replications. Compute the average population in a square meter of the entire field by totaling the averages of each team and dividing that number by the number of teams. You now have a class average per square meter. To estimate the total dandelion population in the field, multiply the class average by the number of square meters in the field.

Dandelion Data

Replication	Dandelion Count
1	____________
2	____________
3	____________
4	____________
5	____________
Total	____________
Average	____________
Total estimate for field	____________




Haystack Toadstools
Trees
Key

Student Page 2: Haystack Mushroom Census

Name ______________________

	Random Plots			
	Square	Circular	Rectangular	Plots along a Transect
Plot 1	______	______	______	______
Plot 2	______	______	______	______
Plot 3	______	______	______	______
Plot 4	______	______	______	______
Plot 5	______	______	______	______
Total	______	______	______	______
Average	______	______	______	______

1. Was our census a true census or a sample census? Differentiate between the two types of census.
2. What was the smallest average population count? Which plot shape was used?
3. What was the largest average population count? Which plot was used?
4. Count the entire population of haystack toadstools. Were our census figures close to the actual number?
5. Which plot shape seems to give the most accurate census? Which sampling method (random plots or transect plots) seems to provide the more accurate census?
6. What observations can you make about plots with no or few toadstools? What observations can you make about the presence of trees and the presence of toadstools? Why are replications important?

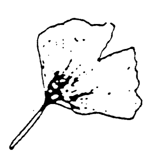
Student Page 2: What Tree Is That?

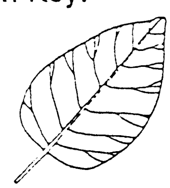
Name ____________________

Use the key to identify the three unknown trees whose leaves are shown below.

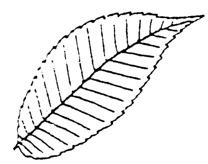
1. Leaves alternate 2
   Leaves opposite or whorled 7
2. Leaves simple 3
   Leaves compound 6
3. Leaves fan-shaped with notch at tip . . . . gingko
   Leaves not fan-shaped, lacking notch at tip 4
4. Leaves entire . . . . magnolias
   Leaves lobed or toothed 5
5. Leaves lobed . . . . oaks
   Leaves toothed . . . . elms
6. Leaflets small . . . . honeylocust
   Leaflets large . . . . yellowwood
7. Leaves whorled . . . . catalpa
   Leaves opposite 8
8. Leaves simple 9
   Leaves compound 10
9. Leaves palmately lobed . . . . maples
   Leaves entire . . . . dogwoods
10. Leaves palmately compound . . . . buckeyes
    Leaves pinnately compound . . . . ashes

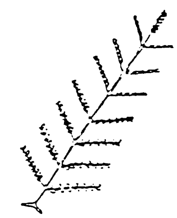
Leaf Types Used in Key:


fan-shaped


entire

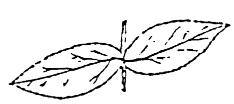

lobed


toothed


small leaflet


large leaflet

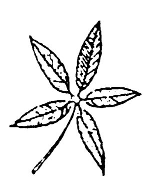

whorled


opposite

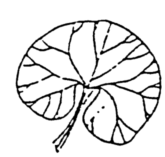

compound


palmately lobed

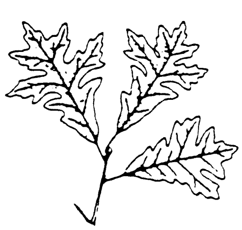

leaves alternate

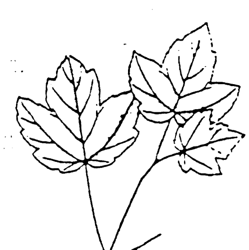

palmately compound


pinnately compound


simple

Unknowns:

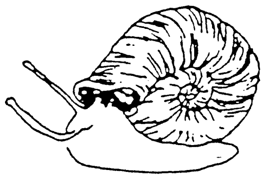


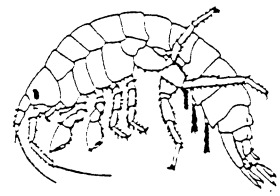


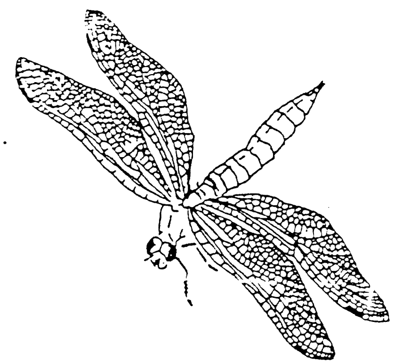
Student Page 1: Aquatic Macroinvertebrate Key

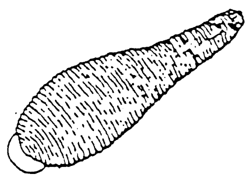
Name ______________________________

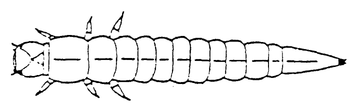
Below are drawings of five organisms and a key. Use the key to identify these animals.

A. 

C. 

E. 

B. 

D. 

1. legs absent . . . . go to 2
   legs present . . . . go to 3
2. protective shell present . . . . snail
   protective shell absent . . . . leech
3. wings present . . . . dragonfly
   wings absent . . . . go to 4
4. three pairs of jointed legs . . . . beetle larva
   more than three pair of legs . . . . scud

A. ____________ B. ____________ C. ____________ D. ____________ E. ____________

Questions to think about:

1. For which group of animals would it be easier to write a key, all the mammals found in Illinois or all the rodents found in Illinois? Explain your choice.

2. Is it easier to write a key to organisms that are very different from each other or to organisms that are very similar? What difficulties would you encounter in each case?

3. If you were to write a key to all the mammals found in Illinois, what kind of information would you need to create a useful, accurate key?

Appendix L

COOPERATIVE LEARNING EVALUATION FORM

Date______________ Name__________________

TEAM EVALUATION FORM FOR GROUP WORK

AT THE END OF EACH CLASS, USE THE FRONT AND BACK AS RELEVANT

Team Name___________________

A. The individual comes to the group prepared for group work.
B. The individual completes all individual tasks for the group on time and with quality.
C. The individual participates in a constructive way.
D. The individual encourages others to participate in a constructive manner.
E. The individual is an active listener.
F. The individual supports his/her position in a strong and thoughtful manner.
G. The individual disagrees in an agreeable manner.
H. The individual can reach compromises.
I. The individual shares the responsibility of helping the group get the job done a according to directions and on time.
J. The individual promotes positive human relations in the group.

LIST NAMES IN ALPHABETICAL ORDER. (Abbreviations are fine)
RATE YOURSELF AND TEAM MEMBERS.

+ = Yes **X** = Partially -- = Not Evident

Team Members:	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**

Do you have any comments you would like to make regarding the team?