

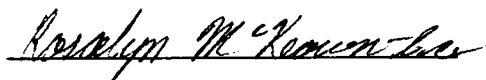
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I am submitting herewith a dissertation written by Kimberly S. Loomis entitled "The Effect of Using Level-3 Interactive Videodisc on the Environmental Knowledge and Attitude of Teacher Education Students." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Curriculum and Instruction.


E. Dale Doak, Major Professor

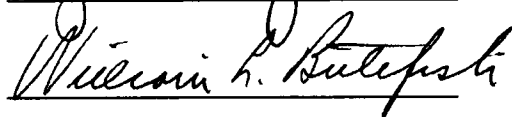
We have read this dissertation
and recommend its acceptance:











Accepted for the Council:


Associate Vice Chancellor
and Dean of the Graduate School

**THE EFFECT OF USING LEVEL-3 INTERACTIVE VIDEODISC
ON THE ENVIRONMENTAL KNOWLEDGE AND ATTITUDE
OF TEACHER EDUCATION STUDENTS**

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

Kimberly S. Loomis

August, 1992

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DEDICATION

This dissertation is dedicated with great love and admiration to my grandmother,

Mrs. Lucy Murray Loomis

I promised you, didn't I Nana?

to my parents,

Mr. A. Reeve Loomis, Jr.

and

Mrs. Marilyn Kern Loomis

I love you and owe you both so much.

and to my sister, my favorite person,

Mrs. Susan Loomis Kiley

How 'bout those Loomis girls?

ACKNOWLEDGMENTS

I would like to express my sincere thanks to my major professor, Dr. E. Dale Doak, for his guidance, patience, and friendship. I was fortunate to have been given the opportunity to work with such an exceptional professor and person. I would also like to thank my other committee members, Dr. William Butefish, Dr. Donald Dickinson, Dr. Rosalyn McKeown-Ice, Dr. John Ray, and Dr. Wilber Slawson. I appreciate and have grown from their involvement in my academic career and in my life. I have also received invaluable guidance and friendship from Dr. Laura M. Barden.

I would like to acknowledge the support, encouragement, and love from my dear friends, Christine Brooks Brown, Kathleen Burr, Sherri F. Davenport, Timothy B. and Diana Purser Dunaway, Ellen Gray, Jennifer L. Ladd, Julie K. Little, A. P. Lucy, Sara McNeil, Stacy Cummings Onks, L. Kim Pryor, S. E. Shellie, Sherri G. Smith, M. B. Tosh, and M. Roger White. Also, I have spent many stress-free hours with the people and beasts at the Marine Animals Complex at the Knoxville Zoo. Finally, I must acknowledge the joy given to me by my littlest stress-reliever, Rebecca Erin Dunaway.

ABSTRACT

Pre-service teacher education students were used as subjects to test the effectiveness of level-3 interactive videodisc (IVD) versus printed materials in environmental knowledge acquisition. The correlation of the amount of acquired knowledge to the degree of change in the environmental attitude of the subjects was also examined. Results of the experiment show no significant difference between the effectiveness of the instructional tools in knowledge acquisition as was measured by an instrument specifically designed for this experiment. Also, there was no significant correlation between knowledge gain and environmental attitude change. Initial and final attitude for each subject was assessed using an existing attitude test. It is proposed that the results of this experiment were not significant for two reasons. Information regarding the environment is presently very popular and one is considered to be "politically correct" if he or she is literate in environmental concerns. It is proposed that any method of environmental information presentation would attract some attention of the students. Also, the instrument used to measure environmental attitude examined general environmental attitude rather than attitude toward specific issues addressed in the instruction. It is proposed that no significant correlation between knowledge gain and attitude change was found since the specific issues addressed in the experiment were not measured by the attitude instrument. Future studies will involve content other than that of environmental issues and will utilize attitude tests developed with regard to the specific content offered in instruction.

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CHAPTER I

Introduction

In the end, we will conserve only what we love.
We will love only what we understand.
We will understand only what we have been taught.

--Baba Dioum, African ecologist

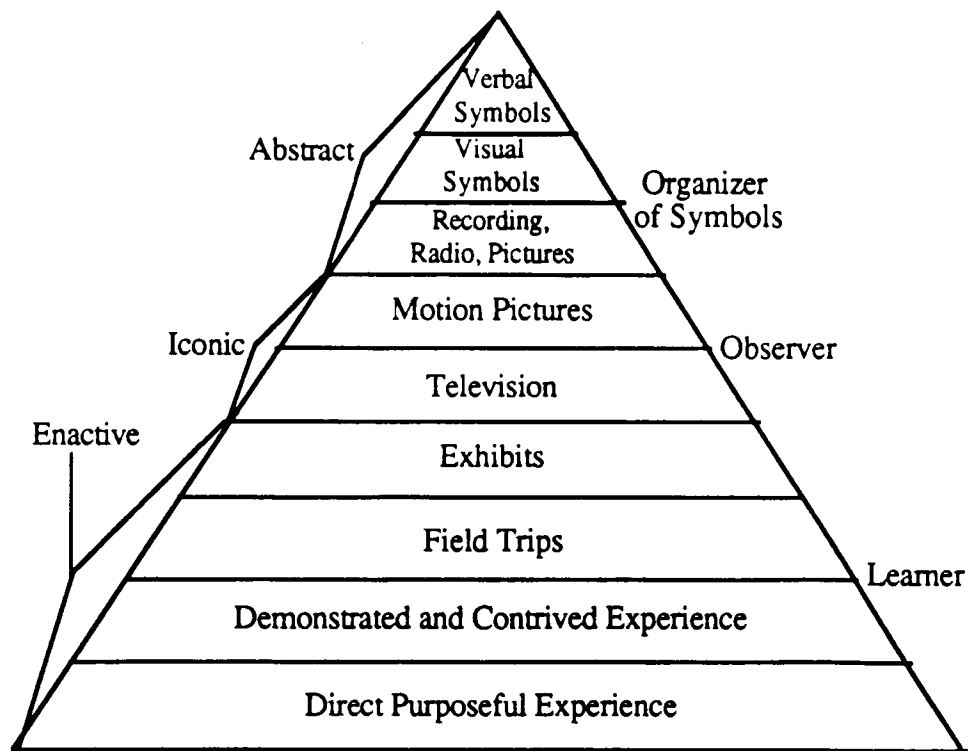
Much of the definition and goals of environmental education (EE) is embraced within these three lines. Conservation implies environmentally responsible behavior. Understanding implies knowledge, cognition, and awareness. The last line implies the importance of environmental education. The objectives of environmental education as described by the 1977 Tbilisi Intergovernmental Conference on Environmental Education include aspects of awareness, sensitivity, attitudes, skills, and participation (1988). Environmental education has been defined as education to produce

a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution (Stapp et al., 1969).

The ultimate goal of EE is to produce individuals who participate in environmentally responsible behaviors. Many researchers have tried to discover what influences an individual to behave in an environmentally responsible manner and their conclusions are varied. Traditionally, it has been thought that increasing an individual's knowledge about a subject will engender an attitude concerning the subject. Some research supports this proposition (Rokeach, 1978; Pettus, 1976; Nelson, 1970; Ramsey and Rickman, 1976). For example, increasing a student's knowledge about the California sea lion should engender a favorable attitude toward

the animal. This attitude then gives direction to the environmentally conscious behavior. Further research has established the existence and influence of other factors on behavior regarding the environment. These factors include environmental sensitivity, a knowledge of environmental issues, action strategies, and consequences of actions, personal involvement and commitment, skill in using environmental strategies, and locus of control (Hungerford and Volk, 1990). Although environmental educators have recognized the many influences, knowledge of ecology and a positive attitude continue to be accepted as important variables. The recognition of knowledge and attitude as a part of a basis that influences behavior has implications for environmental educators. They must search for effective instructional methods for promoting environmental knowledge acquisition and establish whether or not this method will also engender positive environmental attitudes.

Many instructional methods have been proven effective in knowledge acquisition. Edgar Dale organizes several of them in his "Cone of Learning" (Figure 1) with the most effective method for learning placed at the base of the cone (cited in Price, 1991). According to Dale, direct experience is the most effective instructional method to facilitate learning. Due to time constraints, safety considerations, and monetary factors, direct experiences for all students are sometimes not possible. For this reason, educators often turn to the use of other instructional methods. In Dale's "Cone of Learning", "demonstrated and contrived experience" is the next most effective instructional method. The use of simulations for instruction can be included in this category. Using simulations often allows educators to circumvent some of the limitations that may prevent learning by direct experience (Bork and Franklin, 1979).



Source: Price, Robert. V. 1991. Computer-Aided Instruction. California: Brooks Cole.

Figure 1: Dale's Cone of Learning

Several methods exist for presenting simulations in the classroom. Among the options for teachers are simulation games such as role playing and mock-debates, physical activities, and the use of instructional technology. Effective simulations have been presented using advanced technology such as computer-based and computer-assisted instruction, interactive videotapes, and interactive videodiscs. Interactive videodisc is a form of advanced technology currently receiving much attention as teachers are becoming aware of the attractive features of the videodisc and videodisc players. One may consider content information and simulations presented by interactive videodisc as an effective method of instruction for environmental educators who strive to achieve the goals of environmental education.

Problem

Two growing areas of interest and concern, not only for educators but for society in general, are environmental issues and advancing technology. The roles and responsibilities of education have been affected by society's entrance into the "Information Age" as new technologies find their way into our classrooms. Inside these rooms, as well as out in public, increased attention is being given to environmental concerns. Now, exposure to ecology is not limited to a few weeks of study in the biology classroom, but gained through national news reports of environmental disasters and in public rallies for environmental support such as Earth Day.

With advanced technology present in virtually every facet of society and the work place, and with the growing awareness and resulting popularity of environmental appreciation and concern, the public calls on educators to prepare future generations to be adept in using the technology and to be wise in using their earth. Educators are now wondering about and testing the effectiveness of computer-assisted instruction (CAI) and interactive videodisc (IVD) along with other technologies in achieving the objectives of environmental education. The effectiveness of different types of software--drill and practice, tutorial, laboratory probes, or simulations--must also be investigated so that the most appropriate program is used at the most appropriate time.

Many educators realize that instructional technology may cater to the preferences of today's learners. Pat Wright of Tele-Communications, Inc., and a former school principal, states that "in looking at ways to motivate our students, we realized we were dealing with kids accustomed to a Nintendo-MTV environment."

(Rudolph, 1991, pg. 31). Congruent with these thoughts is the following quote from an article in *The Computing Teacher* by educator Heidi Imhoff (1988).

"Our population is bombarded daily with state-of-the-art imagery instruction, thanks to advertising and video/television programming. We need that kind of instructional power in the hands of people trained to use it with intelligence and integrity---classroom teachers" (p. 29).

Research about CAI has only recently begun to accumulate in the literature while advances such as interactive videodisc have emerged in the technological world. Yet even without the support of a substantial research base, laser disc players are being purchased by schools that only a few years ago were putting their 16mm projectors in the media attic to be replaced by video cassette recorders. Videodisc players are causing excitement in the world of instructional technology because they offer a wide range of options in teacher and learner controlled interactive instructional strategies, especially when used in conjunction with a microcomputer. In addition, videodiscs use vivid images, motion, and sound for today's learners, already attuned to receiving information in this form from television and video games. There is an urgent need for research on the effectiveness and applications of IVD when one considers the cost of purchasing hardware and software as well as the implications for instruction.

Psychologists have long noted that people learn and remember images (LeBon, 1985, Loetsch, 1990). The videodisc caters to visual learning because it provides a wide variety of images for learners. The use of simulations in education has been shown to be effective in instruction as gains in achievement and problem-solving have been noted (Cox, 1980). From this information, it follows that using IVD simulations should produce gains in knowledge and learning. Research has also indicated a link

between knowledge acquisition and attitude toward the subject (Nelson, 1970; Ramsey and Rickman, 1976). Since it is an objective of environmental education to produce a generation with an awareness and an attitude of care and concern for their environment (Hendee, 1972), it is evident that IVD simulations may engender the knowledge acquisition that leads to environmentally aware attitudes and contributes to influencing environmentally responsible behavior.

Importance/Need of Study

Inferences can be drawn about the use of IVD in environmental education for teacher education students when the cited studies using IVD in other subject areas and in science are considered. However, with such limited research involving IVD, there is still much to be explored. Michael Hannifin (1985) has listed several propositions concerning IVD that need to be studied and evaluated. Hannifin's propositions include:

1. Since IVD instruction is more interactive than non-interactive video instruction, it should yield more gains in learning.
2. The type of interaction prescribed by IVD affects the amount and type of learning.
3. Learners become active as IVD programs include embedded questions that require learners to increase their efforts to learn.
4. The best learning takes place when questions are embedded throughout the instruction.
5. The questioning and feedback capabilities of IVD instruction increase comprehension and attention.
6. Guidance during IVD instruction is necessary in order for student control of instruction to be effective.

7. As interactivity increases, learning time increases.
8. Interactive video may not be appropriate for all learners in all situations and for all content areas.
9. Instruction is more effective as the speed of program access increases.
10. Favorable attitudes toward IVD are more attributable to the features of the instruction rather than the technology.
11. The interactive features of a lesson are not necessary for learning in well-designed instruction.
12. Program designs neglect the individual learning strategies brought to the instruction by the user.

It is clear that much research is needed to explore the various instructional strategies of the use of advanced technologies. This study can serve to approach some of these unanswered questions and hopefully provide a foundation for further research.

Many reports involving IVD are "how to" articles concerning instructional design, descriptive articles about the videodisc and/or the videodisc player, or anecdotal articles with no empirical basis. As mentioned earlier, excitement has gained IVD entrance into the schools without empirical research to validate its effectiveness. The proposed research will help to establish the effectiveness of IVD as an instructional tool. This information is imperative for educators seeking to effectively integrate IVD into instructional situations. Without it, there exists the opportunity to purchase expensive equipment and pay for potential never realized.

Many companies are becoming involved in videodisc instruction because of the new interest in IVD and the way it caters to a visually-oriented society of students. Not all of the companies are educational organizations. Lucasfilm and the National

Geographic Society have collaborated in the production of a geography disc. NOVA and Apple Computer developed a series of science videodiscs on animal behaviors, one of which will be used for this study. Also, ABC News Interactive and Optical Data Corporation has released a disc that explores issues in The Holy Land from different points of view (Brady, 1989). With so many media corporations involved, it is important for educators to explore the ways the discs can be used in teaching and then to determine which ways are most effective in specific situations. Marton (1989) cites the need for research before the general use of IVD. He stresses that the pedagogic application of the medium should be explored as he states that we should "concentrate on the man before the machine, no matter how marvelous the machine may be" (pg. 31).

Schools have been hesitant to incorporate interactive videodisc into their instructional methods. Among the reasons for this hesitation are the large initial investment required for hardware and software, skepticism about what could be another fad in education, the teachers' fear of being replaced by machines, and a reluctance to push aside already existing libraries of films, videotapes, and other audio-visual media (Beardslee and Davis, 1989). Recently however, IVD is finding its way into more schools. As the hardware is becoming less expensive, educators are realizing that the amount of information on one videodisc far surpasses that contained on many 16mm films or on many carousels of slides. Researchers must explore the effectiveness of the videodisc instruction at different levels of interactivity to justify the cost of hardware and software purchases.

Purpose

The specific purpose of this study was to explore the comparative effectiveness of the use of a level-3 interactive videodisc program. The chosen program contained environmental content information and a simulation game. Pre- and post-test instruments were used to measure the acquisition of environmental knowledge and the change of environmental attitude in teacher education students. This study also examined links between environmental knowledge and attitude based upon the gains in the pre- and post-test scores. An increase in knowledge accompanied by a significant shift in attitude would indicate a correlation between the two factors.

Hypotheses and Questions

The null hypothesis for this study was that there would be no significant difference in the mean scores on the knowledge post-test between subjects using the environmental interactive videodisc for instruction and subjects receiving instruction from printed materials. The alternate hypothesis was that the experimental group using the interactive videodisc would significantly outscore the control group subjects taught with the printed materials. The study also served to contribute to answering the question of the existence of a relationship between the amount of environmental knowledge a person has and his or her attitude concerning the environment by comparing the amount of knowledge gained from instruction to any shift in environmental attitude. The null hypothesis was that there would be no relationship between the two variables while the alternate hypothesis for the study was that a positive correlation would be found.

Assumptions

The measurement of attitude is a complicated task for which several assumptions must be made. First, it must be assumed that the subjects responded to the statements on the instrument honestly instead of responding in the manner that they feel is desired by the environmentally aware population. Being environmentally conscientious is currently "politically correct", a factor which may influence the subject. This study assumed that the respondents answered in a way that reflected their endorsement of the ecological situation presented. Also, it was assumed that the expressed initial attitudes were not so firmly grounded that they could not be changed by the instruction.

It was also assumed that the use of the technology itself did not significantly detract from the learning situation and that factors that may have negatively affected the learning situation were similar for the control and IVD groups.

Limitations

The study of instructional technology in schools is limited by the availability of hardware. In designing projects involving advanced technology, a researcher must consider not only whether or not the school has the necessary hardware but also how many units for student use are available. Most schools have only a few computers, at the most, a "lab-full" for a class of students working in pairs. Also, the computers are frequently outdated; they are not the models that can be used in conjunction with a videodisc player. Even if a school had a current-model microcomputer for every student, it is not feasible at this time for a school system to fund the purchase of a

videodisc player for every computer and a class set of all of the videodiscs to be used to create a fully equipped technological work station for each student in a class. In consideration of these constraints, it becomes necessary to design lessons to be used by small groups, perhaps in a rotation, or for large group presentations. These methods carry with them special considerations, advantages, and limitations. Group work has promoted achievement and interaction among students. The elementary methods classes involved in this study tended to be moderately full. The classes had to be divided into smaller groups for instruction as the technology set up lent itself best to small group or individual presentation and because only one IVD station was be available. This limitation is not uncommon in similar studies throughout the literature.

This research study was limited to the University where the advanced technologies needed were available. It can be argued that researching advanced technology that is not yet available in schools is not applicable to any place but the location in which it is studied. However, from literature cited above, it is clear that it is only a matter of time before this technology will be placed in the schools, and it is imperative that educators have relevant research to guide their practice. It is entirely appropriate for it to take place at the university level since this research focuses upon teacher education and future teachers. Other universities will likely have the same level of technology available as will classrooms in the future.

Delimitations

This study has been delimited to teacher education students for several reasons. It is hoped that by exposing future teachers to the technology and information about the environment, they will feel less intimidated and more enthused concerning them

both. This enthusiasm may promote increased use of the technology in the teachers' classrooms and added impetus to environmental education. Then, their students will benefit from the use of a new, attractive, effective instructional method and may also acquire the awareness of the environment that the teacher shows. In addition, as mentioned earlier, the technology to be used is more accessible at the university level than at local schools at this time.

The subjects using the interactive videodisc brought various levels of previous experience with the technology used in the experiment. No attempt to separate subjects on the basis of prior computer/videodisc experience was made however. While some individuals may be intimidated and distracted by the technology itself, it is likely that any population using instructional technology will consist of individuals with varied previous exposure. Therefore, the sample in this study was representative of the population in general.

Definition of Terms

The concept of "environmental attitude" is broad and varied. It has been given many definitions and components by various researchers and authors. This study accepts the definition offered by Rokeach (1978) as he interprets attitude as a set of long-lasting beliefs concerning a situation that determine the manner in which an individual may react. Rosenberg and Hovland (1960) list the three components of environmental attitude as cognitive, affective, and behavioral. Tendency toward these components can be inferred for individuals to an extent by measurable responses. It is the cognitive response that served as an indicator of environmental attitude in this research. Rosenberg and Hovland state that the cognitive response is influenced by an

individual's perceptions, concepts, and beliefs about the environment and is usually inferred from responses to verbal questions in printed form (pg. 3-4).

The experimental and control groups in this study were taught using the technology and by what has been referred to as "traditional" methods respectively. This research defines "traditional" methods as those that have been typically present in classrooms. These methods include lecture, questioning, small group activities, reading, and discussion. For the lessons involved in this study, students in the control group worked in small groups using written material to learn the same information presented on the videodisc to the experimental or IVD group. This procedure allowed the presentation of information to be as similar as possible for both groups.

The term "hardware" refers to any mechanical part of the technology. The microcomputer and videodisc player are hardware. Details about the hardware used in interactive videodisc programs can be found in Table 1. The written code or program that is the instructions for the computer and videodisc player is called "software" and is contained on eight 3 1/2 inch diskettes. As mentioned earlier, the interactive videodisc not only gives educators the ability to compete with the dramatic productions of television and the movies, but it allows teachers to surpass them by offering opportunities for presentation control and interaction. The versatility of the videodisc is evident in its many features. For example, each disc is capable of holding 54,000 frames of visual information on each side. The disc player can access these frames at the rate of 30 frames per second or it can play a single frame over and over allowing for high resolution still pictures. The user also has the option of viewing a motion sequence frame by frame. The access time to a specific frame or motion sequence is minimal, taking only a few seconds.

Table 1: Levels of Videodisc Interactivity

Level	Hardware Required	Presentation
0	videodisc player & monitor	nonstop playback
1	videodisc player & monitor, remote control	playback control, random frame & motion sequence access, scanning & frame by frame search
2	videodisc player w/built-in micro-processor, remote control, monitor	all of the above, branching via computer program on videodisc
3	all of the above plus micro-computer, system interface, operating software	level 1 capabilities w/complex branching, rapid answer processing & reinforcement
4	all of the above plus artificial intell.	expert systems simulations

Source: Phillip, John. (1988b). Videodisc's Impact on the Changing Needs of the Learner. Electronic Learning, October, 50, 52.

The videodisc player itself contributes to the versatility of instruction. It allows for various levels of interactivity ranging from use similar to a video cassette recorder to complex interactions utilizing artificial intelligence. The level-3 instruction in this study involved the use of a microcomputer in conjunction with the videodisc player. Table 1 describes in more detail the levels of videodisc interactivity.

CHAPTER II

Previous Research

Introduction

A review of research from environmental education and instructional technology is necessary to develop an understanding of previous and present propositions relevant to the research questions. The review will begin with an examination of the relationships between environmental knowledge, attitude and behavior. The display of responsible environmental behaviors by individuals is the ultimate goal of environmental education. The cited research will then establish a necessity for adequate environmental knowledge and attitude for the exhibition of positive environmental behavior as well as a possible link between knowledge about and attitude toward the environment.

With the need for environmental knowledge established, the review of the literature will examine methods for facilitating knowledge acquisition including direct experience and simulations. The use of simulations will be explored in more detail with a discussion of the effectiveness of certain instructional tools in presenting simulations to students. Of these methods, the literature cited will focus on advanced technology including computers and interactive videotapes and videodiscs.

Environmental Knowledge, Attitude, and Behavior

Knowledge and attitude have been included among the factors influencing behavior favoring the environment (Newhouse, 1990; Hungerford and Volk, 1990; Borden, 1984/85). Many researchers have examined the relationship between knowledge and attitude. Most researchers agree that knowledge about a topic does influence a person's attitude toward that topic although differing results and opinions emerge from their studies. Offering an intrinsic relationship between knowledge and attitude, Rokeach (1978) lists knowledge as one of the three components of attitude. The other two components are the taking of a position regarding the topic and the taking of an action in support of the position. It is evident how his components of attitude are congruent with the objectives of environmental education. These objectives have been stated by Hendee (1972). They are:

- a. to give facts about the environment,
- b. to develop awareness and concern for the environment
- c. to give students the necessary background to allow them to make appropriate environmental decisions and to take appropriate actions.

Hendee's objectives are not unlike the quote at the beginning of this proposal as they include the elements of appropriate action, understanding, and knowledge. Also, the objectives are similar to the three components of attitude given earlier by Rokeach. Other researchers agree that in order for students to attain attitudes of concern and appreciation toward the environment, knowledge must be gained (Pettus, 1976; Nelson, 1970; Ramsey and Rickman, 1976).

Recently, environmental education (EE) has moved past aspiring to merely instill a positive environmental attitude in individuals since a declared responsible attitude is not necessarily accompanied by responsible behavior. Although attitude is considered an extremely important influence on behavior (Newhouse, 1990), researchers are currently trying to isolate other determinants. Hines et al (1986/87) synthesized a model of environmental behavior that includes some of these other determinants. Their model is based on a meta-analysis of many studies. Hungerford and Volk (1990) constructed a behavior model based upon the Hines Model of Responsible Environmental Behavior along with the findings of other researchers (Figure 2).

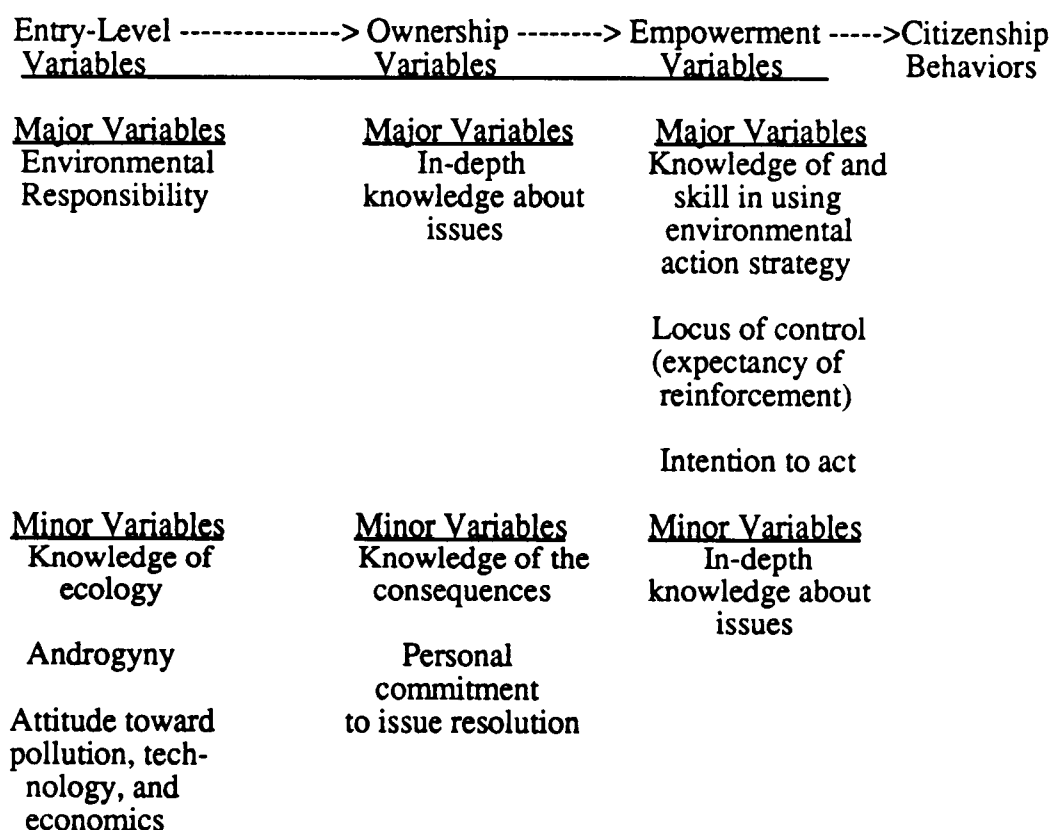


Figure 2: Behavior Flow Chart of Variables Involved in Environmental Citizenship
(Adapted from Hungerford and Volk, 1990.)

The two factors with which this research is concerned, knowledge and attitude, are categorized as minor entry-level variables. Hungerford and Volk note that entry-level variables are important predictors of behavior in that they are influential in decision-making. They state that although

research would indicate that knowledge does not, in itself, produce environmental behavior...it is an important variable when one considers the importance of ecological concepts in decision making (pg. 11).

Larry Gigliotti (1990) has identified another reason to promote environmental knowledge. He is concerned that while many claim to be environmentalists, they are driven by an emotion rather than knowledge-based commitment that focuses on the actions of others on the environment rather than on their own actions. It has been found by researchers that overall public environmental knowledge is low (Arcury and Johnson, 1987).

The two other variables defined by Hungerford and Volk in Figure 2 are ownership and empowerment variables. These two categories demonstrate how the objectives of EE have gone beyond knowledge and attitude. Ownership variables reflect the amount of personal control a person perceives him or herself to have while empowerment variables represent the degree of power a person feels he or she has in affecting a positive change through personal action. Hungerford and Volk discuss four levels of goals for EE that were developed in the 1980's. These goals were designed to include the ownership and empowerment variables in the model. They are as follows.

Goal Level I: The Ecological Foundations Level-To provide learners with adequate knowledge of ecology for future decision-making regarding environmental issues.

Goal Level II: The Conceptual Awareness Level-Issues and Values-To provide an awareness of how an individual's actions might affect the relationship quality of the environmental and quality of life and how these actions give rise to environmental issues that must be resolved through effective, informed decision-making and action.

Goal Level III: The Investigation and Evaluation Level-To provide learners with skills necessary to investigate environmental issues and evaluate actions toward the issues.

Goal Level IV: Action Skills Level-Training and Application-To guide learners in undertaking actions to sustain an equilibrium between the quality of life and quality of the environment. (from Hungerford and Volk, 1990, pg. 13.)

The first goal level relates to the concerns of this study in that it seeks to instill environmental knowledge in learners. This knowledge serves as a foundation on which to build environmentally literate citizens. Such citizens have a knowledge of ecology and attitudes of care and concern. They are capable of problem-solving and undertaking action suitable for a sustainable future. Newhouse (1990) supports on this contention as she states that, "knowledge of a problem is clearly a prerequisite to appropriate action." (pg. 27). Research has also established a link between attitude and behavior although the definite relationship has not been determined (Hungerford and Volk, 1990). Borden (1990) notes that several studies have determined that the attitude a person has toward pollution inspires that individual to act in a responsible manner.

Environmental educators realize that the amount of knowledge about the environment that an individual has is not the only influence on his or her attitude. Other factors playing a role in the concern and responsibility a person feels for the

environment include conditions surrounding the work and residential area, age, level of education, and cultural background (Pettus, 1976).

An individual's place of employment has been shown to influence his environmental attitude (Tichenor, 1972). The adoption of environmentally safe policies is expensive for employers. To meet these expenses, employees may have to be laid off. For this reason, an employee's attitude may be biased toward the action that would allow him to maintain his employment and the best employment conditions. The conditions of the residential area also serve to determine a person's environmental attitude. People who live in areas with an increased level of pollution tend to be willing to support actions and policies that will reduce the pollution level (Kronus and Van Es, 1972).

Studies have also indicated that factors such as age and level of education play a part in attitude formation. Stronck (1972) found that younger people saw technology as the cause of many environmental problems and felt that education of the public would lead to some solutions. Older persons saw apathy toward the environment as the problem and environmentally aware ordinances as the solutions. Other differences in environmental attitudes were noted by Smith (1973) who found that well-educated individuals were less likely to make personal sacrifices in favor of the environment. Smith proposed that this difference could be because the well-educated may not be as idealistic as those less-educated. Smith also pointed out that these well-educated people may not be as concerned for the welfare of others as was previously thought.

How people view personal responsibilities for the environment is in part determined by their cultural background and beliefs. A study involving black men

concluded that blacks felt that they had not reached the level of concern for environmental problems that whites had. They also felt that they would not reach this level of awareness until they are given opportunities to achieve a place in society that will allow more exposure to and identification with these problems. (Kreger, 1973).

While each of the factors above plays an important role in determining attitudes of environmental concern, an individual's support of the environment is influenced by the interactions of several if not all of the factors. A survey of Minnesota residents revealed that as residents acquired more information about local industrial pollution, their environmental support subsided due to their becoming aware of economic trade-offs (Tichenor et al, 1971). An environmental attitude survey of science and non-science majors conducted by Hoover and Schultz (1963) concluded that although the study of any one environmental factor may not in itself engender a supportive environmental attitude, having more knowledge of the subject could facilitate the learning of environmentally supportive attitudes. Both studies indicate that increasing knowledge about the environment does have an influence on environmental attitude.

Knowledge Acquisition

Experience

One assumes (one hopes) that with classroom education comes increased knowledge. Therefore, effective classroom instruction to environmental education objectives should result in increased environmental knowledge. This increase in environmental knowledge should result in a change of attitude in favor of the

environment. This sequence leads to a need for determining effective methods of instruction to ensure that knowledge is acquired. As mentioned earlier, Edgar Dale has listed the common modes of instruction in his "Cone of Learning" (Figure 1). At the base of this cone is learning by direct experience. Educators have consistently recognized the value of experience in education. Visich and Braun (1974) point out that every year in science classrooms and laboratories, students repeat the measurements and calculations of experiments that have been performed over and over by scientists and by other students. The purpose is not to find new scientific insights but to provide a direct experience that results in learning. Even though the data generated in classrooms and laboratories may be imprecise and may not be presented anywhere outside of a student notebook, the students have learned from their own experience with the activity.

There is no doubt that the experience of being in an outdoor setting will affect most individuals. While the effectiveness of an out-of-doors experience is readily demonstrated, this type of excursion is not available to all educators and their students. Not all school systems have diverse ecosystems or ecological situations nearby, nor do they have the money for field trips to get to such places. Also, although students may have the opportunity to study influences on the environment, many factors may prohibit this study. Among these factors are safety concerns, time requirements, and again, financial considerations.

Visich and Braun (1974) include the following in their list of factors that may prevent students from learning by direct experience:

1. Equipment not available and/or too expensive.
2. Equipment too complex or delicate.

3. Sample size available is too small to permit generalization.
4. Experimental technique is difficult.
5. Experiment has extreme time requirements.
6. Serious dangers to the student.
7. Opportunity to experiment directly is not available.
8. Variables that are difficult to measure.
9. Interference of factors other than the phenomenon under study.

Simulations

General Teachers struggle with the problem of how to provide a learning when any of the above obstacles for a direct experience exist. Some of these factors can be overcome by using simulations as an alternative to direct experience (Bork and Franklin, 1979). Edgar Dale's "next best" alternative to direct experience is represented on the second level of his "Cone of Learning" (Figure 1) which is labeled as "demonstrated or contrived experience". A simulation can be thought of as a demonstrated or contrived experience since it is a model of the real world in which only the factors of interest are selected to be manipulated and studied. Therefore, the model is more manageable and can be used for instructional purposes (McLean, 1973). Also, by using simulations, student focus is changed from trying not to make mistakes to learning from mistakes after the student formulates and tests his or her own ideas (Hansen, 1989).

The use of simulations has been shown to be effective in science classrooms in that they do provide students with another type of learning experience when a direct

experience is not possible. Simulations promote student involvement and interaction with others while learning is taking place (Maier and Veranzi 1984). This experience shows students that scientists (or environmental scientists, or even concerned citizens) are not isolated in their problem-solving and decision-making. By assuming different decision-making roles in a simulation, students can develop an appreciation of others, of the complexity of the problem, and of the consequences due to certain actions (Crawford and Purcell, 1974, g. 43). Learning to interact with others can serve a purpose in environmental education as one goal of environmental education is to show the student the inter-relatedness and connections among all the factors in the environment, human decision-makers included. This type of learning is also congruent with the four levels of goals discussed by Hungerford and Volk (1990). McLean (1973) notes that environmental problems "are the result of many contributing factors" and that students "are frequently unaware of this fact and of important relationships" (pg. 375). He states that simulation games are valuable instructional tools that help the student become aware of these relationships by applying what the students know to environmental situations presented in the simulations. Recalling a link between knowledge and attitude, McLean points out that "environmental attitudes are more often caught than taught" (pg. 376) and that a student is likely to "catch" an environmentally aware attitude by participating in an experience via a simulation. He also claims that the knowledge and attitude gained by this participation are more apparent than if the student had been taught and tested using traditional methods of instruction.

Because learning facts about environmental issues may not be enough to produce the desired environmental attitude, it could be that the added impact provided by the participation in an interactive simulation activity would benefit the outcomes of

the educational experience. It was the objective of this study to explore the effect of an environmental simulation on knowledge and attitude when presented using an interactive videodisc. Relevant research on this specific topic is not abundant. Therefore, it is necessary to explore the effect of simulations presented by other instructional strategies and in other subject areas. It has been assumed that research on the effects of video and computer-based instruction are somewhat generalizable to effects of the use of interactive videodisc as interactive videodisc represents a merging of these technologies (Hannifin, 1985).

Computer Simulations Computers are now a large part of our society. They can be found in businesses, schools, and in many homes. Students are motivated by the use of new technology in the classroom. As an instructional aid, the computer offers new experiences to the learner. It goes beyond textbooks, video cassettes, and slide presentations as it permits student interaction (Luehrmann, 1982). Recalling Dale's "Cone of Learning" (Figure 1), this interaction in effect moves students one step away from being an observer of symbols and one step closer to being a learner. John Bransford of Peabody College at Vanderbilt University notes that although direct experience is the most effective method of instruction, computer-controlled simulations can act as a "middle-step" between experiential learning and reading or lecture (personal communication, Spring, 1991). In a study involving interactive simulations, Kristina Hooper (cited in DeBloois, 1985) claims that the interaction with the computer can be equated to interaction with the learning environment and may thereby be treated like a direct experience by the learner.

One of the most popular ways of presenting a simulation is through computer assisted instruction (CAI). By simulating laboratory experiments on a computer, one

can transcend most if not all of the limitations listed earlier to learning by direct experience. The following represents some of the advantages of computer simulations cited by Eli Cohen (1980).

1. Equipment required for a computer simulation is safer to operate than real equipment.
2. The equipment is less expensive to operate.
3. The experience can be made available to a large group of people at one time.
4. The process of the simulation is not as space-consuming.
5. The time requirements for the simulation can be contracted or expanded easily.

So far, research has been cited that indicates that increasing knowledge about the environment affects attitude toward the environment and that an effective mode of instruction for increasing knowledge about the environment is simulation. Simulations can transcend the limitations to opportunities to learn by direct experience. Furthermore, the presentation of simulations by a computer carries with it not only the advantages of traditional classroom simulations, but also allows the presentation and manipulation of variables not otherwise readily accessible through models.

Among the cited effects of the use of computer simulations by students are the motivation to deal with real world problems by finding alternative solutions (Pager, 1982), increased ability in problem-solving skills used to deal with multiple processes (Ellinger and Brown, 1979; Rivers and Vochell, 1987), and the improvement of group interaction skills (Cox, 1980). The willingness to deal with real world problems is vital to future generations facing a myriad of environmental problems. Interaction and

problem-solving capabilities are necessary for an environmentally literate person to transform his knowledge into communication and action. These types of effects obviously have a place in teaching toward the objectives of environmental education. Other indications of CAI research include the reduction of learning time required (Kulik, Bangert, and Williams, 1983; Ebner, et al., 1984) and increased factual recall (Charp, 1981).

A fair amount of research has been conducted to assess the effectiveness of using computer simulations in science classrooms and laboratories. Along environmental lines, David Dunlop (1979) used the computer as an energy-environment simulator with which participants (who were classroom teachers) decided how much energy to produce and use. One objective of the study was to measure changes in energy-related attitudes after using the simulator. Dunlop found that elementary school teachers showed more of an attitude change than secondary school teachers. He concluded that this difference is probably due to the fact that the secondary school teachers had more knowledge of the topic than the elementary school teachers, thus the elementary school teachers had more knowledge to gain. If the change in attitude is related to a gain in knowledge, it seems plausible that the degree of change would be greatest with the group that acquired more knowledge. This proposition is what apparently happened with the elementary school teachers. Dunlop also concludes that these changes were due to the simulator as it was the only instructional method applied.

The same energy simulator was used another study by Cartwright and Heikkinen (1981). Its effects on attitudes were contrasted with the effects due to the use of a slide show presentation. It was found that students at lower cognitive levels

learned almost the same amount as students at higher cognitive levels when using the computer simulation. Similarly, a water resources management simulation program was used and evaluated by Amend and Arnold (1983). They found the program to be effective in disseminating information and in engendering concern for water as a resource. In these studies, the use of a computer-presented simulation had measurable effects on subjects' knowledge and attitude. The proposed study hopes to find similar valuable results concerning knowledge achievement and attitude enhancement.

In a more complex study, Fortner, Schar, and Mayer (1986) determined the effects of the use of computer simulations on students' knowledge of the environment and on their perceptions of environmental relationships. The researchers contend that if a student perceives a relationship among the variables of the environment, he is more likely to understand and appreciate the complexity of the world. They also state that the use of the computer as an instructional tool would help the students perceive these environmental relationships. In the study, students were divided into two groups. The experimental group used a series of three environmental simulations accompanied by worksheets and written background information on the topic and computer operations. The control group used traditional textbook material that covered the same course objectives as the computer simulation materials. The authors note that there was no significant effect on higher order thinking skills of the experimental group as was indicated by the perceptual survey. However, they do point out that this could have been due to the students' not understanding how the simulation related to any situation beyond itself. Also, since the simulation was an open-ended activity, there was no clear correct answer to the questions. This was frustrating to the students since most are accustomed to being rewarded with correct answers. To remedy this, the authors believe that more interaction between the student

and computer and between the students and the instructor is needed. The test of knowledge showed significant gains for the experimental group.

From the cited research, it can be determined that the use of computer simulations in environmental education classrooms does have an effect on knowledge. Effects on attitude toward the technology and the subject matter have also been shown.

Interactive Videotape and Videodisc Simulations One of the most attractive features of videotape and the videodisc to learners is its appeal to the need for images. From the encapsulated learning provided by the children's television program Sesame Street to the bursts of light, color, and sound, on MTV, our students have in effect been conditioned to expect visual presentations for learning and for maintaining attention. The development of interactive technology has responded to new insights as to how students learn. Such insights include the understanding that children respond to visual instruction and active cooperative engagement (Mageau, 1990). The need for visual stimulation for learning and remembering has long been recognized by psychologists and educators. Bernd Loetsch (1990) states that visual media surpasses traditional teaching methods because the human memory stores images that carry information and conviction. These images serve to "enhance motivation and thus reinforce the learning process" (pg. 183). Kristina Hooper (cited in DeBloois, 1985) asserts that pictorial information is remembered accurately based on results of her study involving the use of videodiscs. John Phillip (1988b) cites Mary Alice White of Columbia University's Teaching College as stating that students actually seek out information in the form of images. Undergraduate education students are taught by their professor that their students will respond to color in their learning. Many methods courses include the assignment of the development of bulletin boards and

other visual materials. The use of color is motivating to students and is appreciated by them. Loetsch also points out that the use of visual media lends itself well to group use. As the number of students in our classrooms gets larger and larger, teachers must have an effective method for presenting information. It has been noted that groups of people can think in terms of and are influenced by pictures and that even words are eventually transferred to memory in the form of images (LeBon, 1895). This contention is echoed by others in the field of technology and education. Mageau (1990) cites Walter Koetke, the director of Research and Development for Scholastic, Inc. He states that according to the research, with the combination of visuals and sound, teachers can "impact people's emotions, and since emotions are how memories are organized,..." it will "clearly have a big impact on learning" (pg. 27).

Overall, research regarding interactive videotape is positive (Hannifin, 1985). Learners react favorably toward the instruction and express interest in additional use of the technology (Manning, 1983). A study involving middle school science classes compared the use of interactive videotape, linear videotape viewing, and videotape viewing followed by class discussion. With regard to achievement as it is measured by pre- and post-test scores, the interactive group greatly outscored the other groups. The rate of participation and attention was greater in the interactive group ("Interactive Video," 1984). Similar gains in achievement were noted in a study comparing interactive videotape to the viewing of a 16mm film on the same content (White, 1989).

A step away from interactive videotape is interactive videodisc. Videodisc technology doesn't require special training for teachers as it is not really a new technology in itself, but one that is a combination of traditional instructional methods

and machines. In effect, IVD merges television and CAI. It surpasses the use of educational television in that the presentation can be teacher controlled in a nonlinear fashion with branching capabilities for review. To computer assisted instruction, it adds motion, color, and sound (Phillipo, 1988a). For further details about interactive videodisc, see the "Definitions" section of this paper.

Several authors have stated that the capabilities of the IVD lend themselves well to learning theory. Since IVD combines visual and verbal material, the learner is immediately able to make associations between the two as they are presented while forming his or her own perception of the information (Kumar, 1990). Jackendorff (1987) ascertains that this is the moment when conceptual learning takes place. The presentation design of IVD programs can also aid learners in chunking information. Chunking in turn facilitates storage and recognition of material (Kumar, 1990).

John Bransford and the Cognition and Technology Group at Vanderbilt University have explored using interactive videodisc to teach in congruence with cognitive theories (1990). They maintain that the dynamic visual presentations of the IVD allow students to "develop pattern recognition skill" and "form rich mental modes of the problem situations" (pg. 3). The Cognition and Technology Group also points out that these cognitive strategies are especially important to students who bring a low level of background knowledge to the lesson as some of the subjects for this proposed research will. In a study of science instruction conducted by Bransford et al. (1986), learners used information presented in the context of a popular movie to solve problems. A control group of students read the passages of information. Results indicated that the IVD group had better recall of the information and achieved more than the control group on post-tests. These results were probably due to the fact that

the IVD program provided a context for the learned information. Also, the IVD students were able to apply their recalled information to new situations. Bransford points out that by embedding information in "video-based 'macro contexts'" (pg. 20), students learn to integrate their knowledge across subject areas. This integration allows for a closer similarity between problem solving in the classroom and problem solving in the real world. Since environmental simulations on videodiscs allow the presentation of a macro-context, the implications for the production of knowledgeable problem-solvers through their use is hopeful.

As the excitement about the technology available has earned its acceptance, it has also hindered empirical research concerning the effectiveness of IVD. Considering research in various content areas and with various students, the use of IVD has shown effects on knowledge acquisition, mastery learning, retention, learning time, and attitudes toward the subject and toward the technology itself (Beardslee and Davis, 1989; Vadas, 1986). Since specific studies using IVD environmental simulations with teacher education students are few, it is advantageous to note studies involving the use of IVD in other subjects and at other levels of instruction so that some generalizations might be made. Qualitative and quantitative studies are discussed in the following paragraphs.

Research in other content areas has documented favorable effects of IVD use. Results in gains in achievement were reported by the GRAIN group (Group de Recherch sur l'Apprentissage Interactif) in Quebec using seven IVD programs they developed in various content areas (Marton, 1990). Qualitative results from student interviews indicate that after using the programs, the students felt that the technology held their attention and increased their participation. They expressed appreciation for

the versatility and the flexibility of the technology and felt that it should be made available to students in other courses. The professors using the programs thought that the use of the equipment was easy, that it decreased required learning time while it increased student participation, and that the technology was effective and adaptive.

A prototype on problem-solving in physical education showed other effects of IVD on knowledge and higher order skills. Qualitatively, comments made by students about the prototype note the feeling that the visual presentation of the information helped them to understand the concepts and that they had been able to develop and modify hypotheses. Learner control of the situation also appealed to the students using the technology. Students emphasized that the system inspired confidence by allowing them to organize and explore their own attitudes in relation to personal intuition and strategy (Marton, 1989). The comments by the students are not unlike those that environmental educators would hope to get from their students. Not only do they indicate appreciation for instruction by technology and an increase in knowledge, they also signify the type of thinking skills and attitudes that identify an environmentally literate citizen.

In science oriented fields, interactive videodisc technology has also been used by professors of chemistry at the University of Illinois (Jones and Smith, 1989). By using interactive videodisc, the professors overcame many of the obstacles to direct learning mentioned earlier that were present within their laboratory. They used the IVD program for a variety of purposes, including some outside of the laboratory. Lessons introducing content, supplementary laboratories, and the preparation of students for laboratories have all been approached by interactive videodisc instruction effectively. It was found that students using the videodisc achieved more than

students being taught traditionally (by lecture and reading assignments). Also, the technology was greeted favorably by the students. The developers have since integrated their lessons into high schools, community colleges, and universities with success.

A biology IVD tutorial was used with science majors and non-majors (Kumar, 1990). Taped recordings of conversations and questionnaires completed by students reported that the students attention level and interest was greater with IVD than lecture. Also, several non-science majors stated that their interest in science had increased. They reported an appreciation of the color and visual nature of the medium, the learner control, and the interaction. Comments of science majors were similar, however, the amount of learning that took place because of the instruction is in question. The comments of the subjects involved in this study are indicative of an environment that would facilitate the learning of environmentally aware attitudes.

Additional qualitative results were obtained from a study in which interactive videodisc simulations were used in introductory biology laboratories at the university level (Leonard, 1985). The IVD instruction involved simulations of selected laboratory exercises including motion sequences that were not included in information presented in the traditional instruction. Students enrolled in the introductory biology laboratories from three universities were divided into two groups. One group was involved in conventional laboratory instruction while the other received IVD instruction. The two groups completed the laboratory exercises in the same sequence at the same time with the same amount of time allotted for each lesson. After instruction, all students were given a questionnaire to assess "satisfaction with, interest in, and appraisal of the educational value of the activity" (pg. 5).

Results from the questionnaire indicate that the IVD groups had more positive responses concerning efficiency of instruction, level of attention, understanding of experimental instructions and results, confidence in carrying out instructions, and general satisfaction. Several measures had no significant difference between groups while in no measure did the conventionally instructed laboratory groups give more positive responses than the IVD instructed laboratory group.

Many comments for the IVD groups focused on the unique instructional options provided by the use of IVD. The cited options include learner control, visual presentation, and feedback. Also, relative to the use of simulations, students reports feeling at ease with the fact that they could manipulate variables easily and not have to repeat a long, tedious, involved laboratory exercise should an experimental error occur. The author of the study points out that IVD conducted laboratories are advantageous in certain situations but they would most likely not replace the direct learning experience only obtained from student participation in a traditional "wet" lab.

Leonard pursued this same line of research in a recent study (1992). College-level biology students were divided into two groups for laboratory activities. One group used the IVD for instruction while the other group received conventional laboratory instruction. achievement of the two groups was compared on laboratory quizzes, laboratory reports, and the laboratory final exam. Scores between the groups showed no significant difference between the IVD and conventional groups although the IVD groups finished instruction in approximately one-half the instructional time required by the conventional group laboratory group.

In a comparable empirical study with IVD in college level introductory biology laboratories, students using IVD significantly outscored traditionally taught students on post-tests and did so requiring an average of 37% less instructional time (Bunderson, Olsen, and Bailleo, 1981). A reduction in instructional time was also documented in a study by Doak and Loomis (in progress). High school biology classes at high and low instructional levels were divided into groups to be taught using IVD and traditional methods. It was found that students at both levels and using both types of instructions scored almost equally as well on the post-test. However, the IVD groups took a one-third to one-half of the time to complete their learning as did the traditionally taught students.

Conclusion

The literature cited establishes a necessity for environmental knowledge and a positive environmental attitude in the probable exhibition of an environmentally conscious behavior by an individual. It also proposes that there is a link between the knowledge an individual has about the environment and the attitude toward the environment. Among the instructional methods effective in inducing knowledge acquisition, the research noted indicates that simulations, including those presented by interactive videodiscs, are valuable teaching strategies.

CHAPTER III

Method and Procedures

Introduction

This research study was carried out at the University and used teacher education students as subjects for the experiment. All subjects were provided the same content information. The primary difference between the experimental and control groups was the method of information presentation. The experimental group received instruction from a level-3 interactive videodisc set-up and the control group received instruction from printed materials. Information regarding the subjects, materials, instruction, testing, and evaluation are outlined in this chapter.

Subjects

Thirty undergraduate teacher education students in two sections of elementary education methods classes participated as subjects in this experiment. Each subject was assigned to one of two instructional groups at random. One group received instruction from the IVD and the other group received traditional instruction from the use of printed materials. After omitting data from students who submitted invalid results or who missed any portion of the experiment, data from a total of 24 subjects, 13 in the IVD group and 11 in the traditionally instructed group, were analyzed.

Teacher education students were used as subjects in this research for several reasons. The equipment necessary for this research is difficult to find in public

schools at this time. Transporting the equipment is possible but risky in that some hardware is fragile and best not exposed to what may be rough travel. Also, since the hardware includes many separate pieces such as cables and connectors, it is possible if not probable that important components be left behind. Therefore, it was more convenient and secure with regard to equipment damage to conduct this research at the University. Additionally, the technicians intimately familiar with the equipment were immediately available should the computer or videodisc not work properly.

Pre-service teachers were chosen as subjects for this study because the researcher intends a career in teacher education. Some of these reasons stem from anticipated outcomes. By exposing future teachers to the technology, it is hoped that they will be less intimidated by computers and other hardware so that the technology will be accepted into classrooms as instructional tools. This in turn will expose students to the technology that will be present in their future, making the use of such innovations less intimidating to them. A similar line of reasoning follows with the information presented on the videodisc simulation. If the use of the simulation does produce an enthusiasm for the environment in pre-service teachers, it is hoped that as they cover environmental topics in their classrooms, their students will "catch" the enthusiasm, thus producing even more environmentally aware citizens.

Also, conducting the proposed study at the University allows access to the required equipment as school systems within acceptable traveling distance have not yet acquired the necessary hardware. Therefore, evaluating the effects of various instructional methods on teacher education students is of direct relevance to the current and future interests of the researcher.

Materials/Instruments

Pre- and Post-Test Instruments

Introduction The subjects completed an informed consent document (Appendix A) that described the objectives of the research and stressed that participation was strictly voluntary. An information sheet (Appendix B) was completed in order to obtain information about the subjects' current level of education and their perception of their own level of environmental knowledge and attitude. All of the subjects then completed a pre-test of environmental knowledge and current environmental attitude. (See Appendices C and D.) A parallel form of both the knowledge and attitude test was used as a post-test to be given to subjects at the end of the experiment. The use of parallel test forms was to lessen the possible pre- and post-test interaction which might result due to the relatively short amount of time between testing (1 week). More detailed descriptions of the instruments used follow.

Knowledge Test Because the purpose of this research was to examine the acquisition of specific content dependent upon two instructional methods, the knowledge test items were written by the researcher. The questions covered only the content information that the two instructional groups were expected to acquire by participating in the lesson. Twenty questions were derived directly from information contained in the content of the chosen lessons on the interactive videodisc. Two forms of the test were developed. The content of both forms was the same although the questions were worded differently and asked in a different order. Content validity was established by content area experts. Each form, A and B, was first piloted on teacher education students with the questions calling for free response answers.

Wrong answers given by the students were used to generate a pool of answer choices including the correct answers. Both forms of the revised test, including the answer choice pool, were piloted on teacher education students. Reliability for the revised instruments was established by using Kuder-Richardson Formula #20 (Leonard, 1992; Odubunmi and Balogun, 1991; Jackman and Moellenberg, 1990; Jones and Rowsey, 1990; Hall and McCurdy, 1990; Ross, Rakow, and Bush, 1980; Alesandrini, 1981). The calculated reliability coefficients for form A and form B of the test are .94 and .93 respectively.

Attitude Test To ascertain the current environmental attitude of the subjects, a revised version of the scale for the measurement of ecological attitudes developed by Maloney and Ward (1973) was used. The original 130 item instrument was revised by Maloney, Ward, and Braucht (1975) so that it finally contained 30 items. The scale consists of the four subscales labeled verbal commitment (a measurement of what a person says he or she is willing to do in favor of the environment), actual commitment (a measurement of what a person actually does with regard to the environment), affect (a measurement of the emotion a person relates to certain environmental issues), and knowledge (a measurement of a person's knowledge of specific environmental facts).

Maloney and Ward tested the validity of the shortened instrument as compared to the original scale by administering the test to Conservation Committee members of two chapters of the Sierra Club, a group of college students in lower division psychology courses, and a group of adults with less than 13 years of formal education. Results from a one-way analysis of variance for the original and shortened scales showed the F values to be "essentially the same" (p. 787). A calculation of Cronbach's alpha showed that the correlations between the original and shortened forms ranged

from .92 to .95 for the various subscales. In the discussion, Maloney, Ward, and Braucht state that the shortened form is more efficient at the expense of a slightly reduced but acceptable reliability. The calculated reliabilities for the affect, verbal commitment, and actual commitment subscales are .85, .81, and .89 respectively. The developers also note that the subscales of verbal commitment, actual commitment, and affect are more independent on the short form than on the original form and that the scales on the short form differentiate between the groups at the same level of significance. In addition, the short form is more internally consistent and more resistant to "possible systematic response biases" (p. 790). The fact that the scales have been shown to differentiate between groups with different ecological orientations was appropriate for this study since an objective involves the examination of the differences between initial and final orientations among the subjects. The knowledge subscale was not used since the researcher developed an instrument for the measurement of knowledge that is relevant to the content on the videodisc. Means for each of the three remaining subscales, verbal commitment, actual commitment, and affect, as well as a mean for the entire attitude test served to reflect the respondent's attitude toward the environment.

The statements contained in the actual commitment subscale reflect the actions already taken by the respondent that are consistent with an attitude appreciative of the environment. Because gaining more information about the environment should not affect a subject's answers to the actual commitment scale, an average score consisting of the subject's scores on the verbal commitment and affect subscale was also calculated and used for comparative purposes. Two forms of the instrument were used with the second form differing from the first only in the arrangement of statements.

Videodisc, Software, and Hardware

The videodisc used in this study was "Animal Pathfinders" by NOVA purchased from Scholastic for \$395. The videodisc is accompanied by eight 3.5 inch disks of HyperCard stacks. A Macintosh IIfx microcomputer and a Pioneer 6000 laser videodisc player with a monitor were used to present the information to the IVD instructional groups. (Figure 3.) "Interactive NOVA: Animal Pathfinders" is marketed as suitable for grades 5 through 10 and up and is designed for use as a part of biology or life sciences classes in which ecology, environmental issues, animal behavior, and migration are studied. The organization of the videodisc and accompanying software is based upon four formats: Overviews, Databases, Activities, and Resources. The Overviews format includes short video presentations on animals and animal behaviors and an hour long film called "The Mystery of Animal Pathfinders". The Database allows access to HyperCard stacks on specific animals, habitats, and behaviors. The program also includes three Activities that involve the student in a study of a specific animal or animal behavior. The Resources section allows the student to research, compile, design and present a report on a chosen topic. The presentation options include whole class, individual, paired, and small group activities. The accompanying teacher's guide (WGBH, 1990) contains twelve detailed

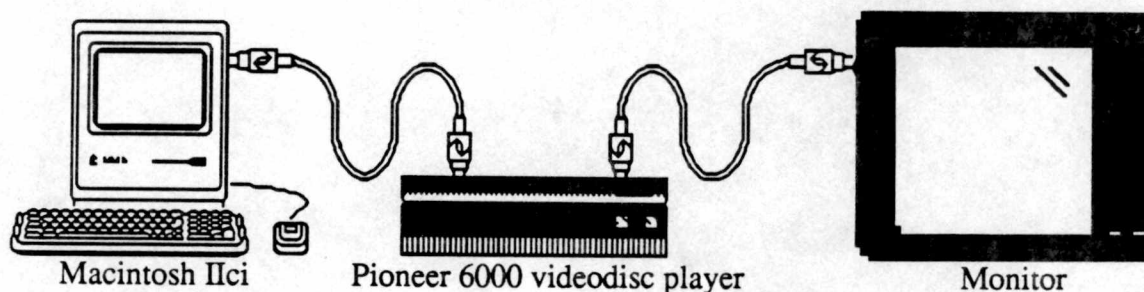


Figure 3: Level-3 Interactive Videodisc Set-Up

lesson plans involving lectures and demonstrations, guided inquiries, cooperative learning, independent research, and student-created multimedia reports that use the formats described above. These lessons become more difficult as they progress with the later lessons requiring more complex technical, thinking, and cooperative learning skills. The lessons chosen for the instruction in this study are quite advanced and were suitable for use with the subjects involved. The information on the videodisc and its accompanying software may be repurposed for teacher-designed lessons.

Methods

Pre-testing

The instruction carried out in this study took place over two class meetings with one week of time elapsing between sessions. In each class, the subjects were given an informed consent document to sign indicating their willingness to participate in the experiment (Appendix A). This document described the research project's purpose and methods and assured the subjects of confidentiality. It also assured the subjects that their participation in the study was strictly voluntary and that no penalty would result from the discontinuation of participation. The subjects also completed an information sheet (Appendix B) so that information could be obtained for future reference. To insure confidentiality, a random number written on colored paper was attached to each information sheet. The subjects were asked to keep and remember this number so that they could use it as identification on their pre- and post-tests. This number was never associated with the student's signatures on the informed consent documents. After filling out the information sheet, all subjects took the pre-tests on content knowledge (Appendix C) and environmental attitude (Appendix D).

After the experiment was completed, the information from the pre-tests was used to establish the previous environmental knowledge level and existing environmental attitude for each subject. The knowledge pre-test scores served as the data used to divide the subjects' scores into low level, middle level and high level groups. Comparing pre-test to post-test scores provided a measure of knowledge gained. This gain was compared to the shift in attitude indicated by a difference in attitude pre- and post-test scores.

Instruction

A short demonstration of how to interact with the technology was shown to all the subjects by the researcher. The demonstration included a one minute video segment entitled "How to Use Interactive NOVA" from the Overviews section of the "Animal Pathfinders" videodisc. The researcher then demonstrated the information seen on the video clip and asked for questions.

Grouping

The students in each of two elementary education methods courses participated as subjects in this study. Each subject in each class was assigned at random to one of two instructional groups after the demonstration. Each instructional group contained 8 to 10 subjects. The experimental group used the interactive videodisc for instruction while the control group used printed materials. It was necessary to instruct students in small groups of 4 to 5 due to the screen size of the computer and monitor on which the images from the videodisc were displayed. Therefore, the subjects in each of the two instructional groups were further divided into 4 subgroups. Two subgroups, each with

4-5 subjects were assigned to each instructional treatment so that there were two groups instructed by IVD and two groups instructed using the printed materials per class. (Figure 4.)

Subjects were assigned to subgroups at random using the colored paper on which the subject identification numbers were written. Those with numbers on blue or green paper were assigned to the two subgroups that would use the interactive videodisc. Numbers written on red or yellow paper assigned subjects to subgroups using the printed materials. There were a total of 13 subjects instructed by IVD and 11 subjects instructed by the printed materials representing both elementary methods sections.

Content Instruction

The groups being instructed were situated in adjoining classrooms with the researcher observing both groups. The only interaction between the researcher and the subjects was that of clarifying procedures. No content questions were answered. The videodisc and control group received the same information during Day 1 of instruction and participated in the same simulation game on Day 2. The only differences in instruction between the two groups was the method by which the information was presented. One group received their instruction entirely from the IVD program. The other group received their instruction entirely by reading printed materials. The details of the instruction provided for each group follows.

The instruction of one IVD and one control group took place at the same time. The subgroups not being instructed participated in activities unrelated to this research

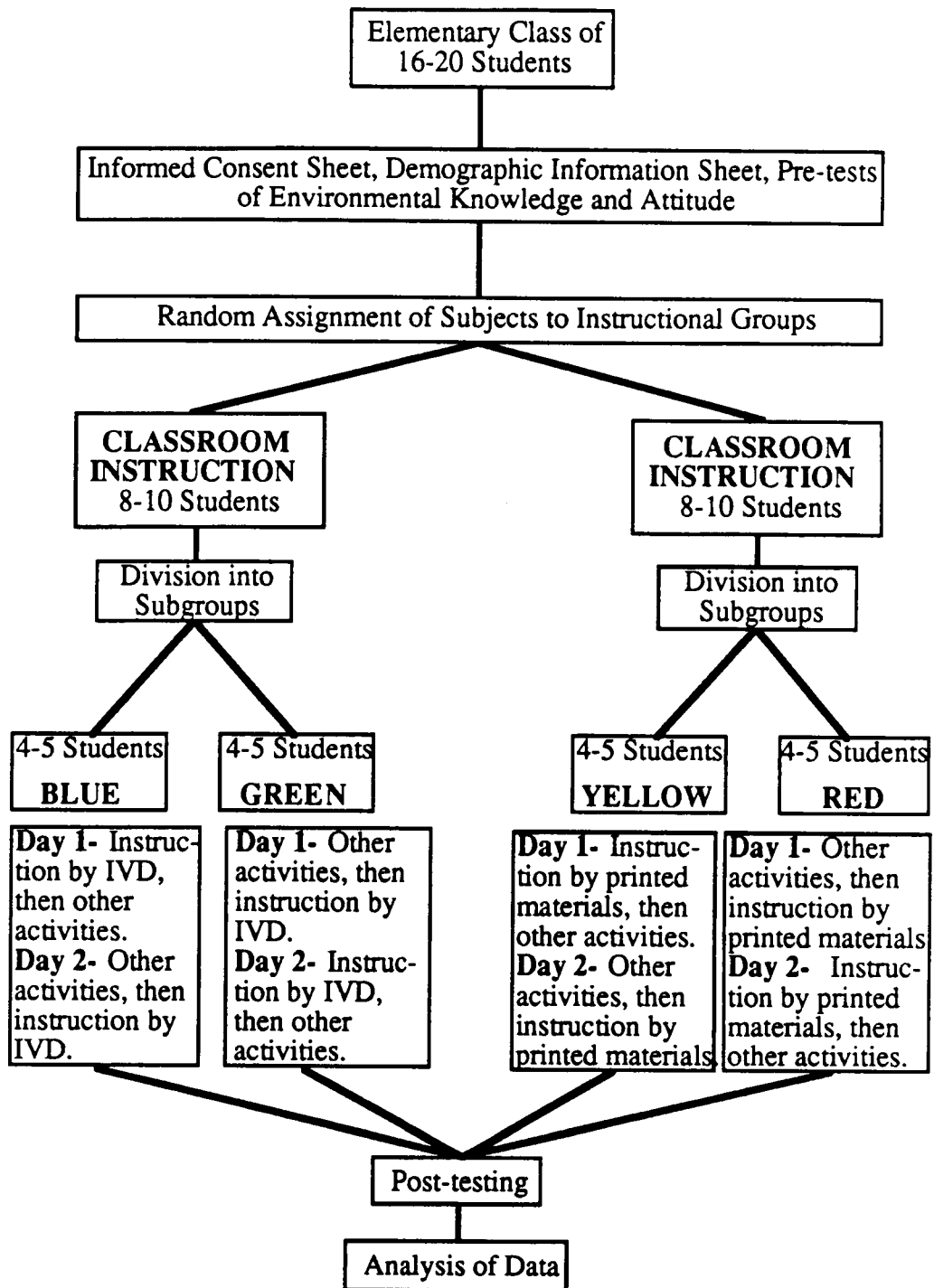


Figure 4: Grouping, Testing, and Organization of the Instruction of Subjects

with or planned by their regular instructors separate from the site of the experiment. The blue IVD and yellow control groups received instruction first on Day 1 of the experiment while the green IVD and red control groups engaged in the aforementioned activities. This procedure was reversed on Day 2 of instruction allowing the green IVD and red control groups to receive instruction first. (Figure 4.)

The subjects in the control group were told that they would be able to use the technology after the experiment was concluded. This was done to foster a positive attitude regarding the research. It was the researcher's hope to avoid any resentment felt by those receiving traditional instruction towards the instruction itself or towards those using the IVD by informing all subjects that they would be able to use the technology. This resentment might have caused the traditionally instructed individuals to not perform as well as they might have using IVD.

Day 1-IVD Group The two minute video segment entitled "Interactions" on the videodisc and the six cards in the HyperCard stack called "Interactions with Humans" were viewed on the computer by the blue videodisc group. The subjects then viewed the 29 card Theme Tour of the "Animal Pathfinders" Database entitled "Human Threats Theme Tour" and the 3 cards from the Database entitled "Loggerhead Turtles". It was possible for each member of the IVD group to read the textual information on the computer screen. The majority of the cards in the HyperCard stacks presented on the computer were accompanied by slides or motion sequences shown from the videodisc. After the instruction was completed by the blue IVD group, the green IVD received instruction in the same manner as the first IVD group.

Day 1-Control Group The same information was provided to the yellow control group by their reading a script of the video clip "Interactions" and six index cards of the textual information from the HyperCard stack "Interactions with Humans". The scripts for the instruction of the control group were taken directly from the text of the videodisc and HyperCard stacks with only slight modifications. Each member of the control group had his or her own set of index cards. The control group students were exposed to the same information as the IVD group as they read a total of 32 index cards making up the "Human Threats Theme Tour" and "Loggerhead Turtles" lessons. After the instruction was completed by the yellow control group, the red control group received instruction in the same manner as the first control group.

Day 2-IVD Group On the second day of instruction, the green IVD subjects participated in the Turtle Mystery simulation game on the "Animal Pathfinders" videodisc. This simulation game involves projects the subjects into a situation where they are investigative newspaper reporters with the assignment of discovering eight threats to loggerhead turtles. The subjects must investigate several scenes including offices, beaches, buildings, and the ocean. In each scene, the subject may explore objects, talk to people, and/or take some type of action. The game proceeds as the subjects discover clues to the threats and undertake actions to remedy the threat. Once the eighth threat is discovered the subjects return to the newspaper office to have the story published and thus win the game. As each threat is discovered, a short video segment is presented on the videodisc providing more information about the threat. The entire simulation is made up of several HyperCard stacks presented on the computer and eleven video segments presented on the videodisc monitor. The video segments include the information regarding the eight threats, a "Special Bulletin" playing on a television in a Florida diner, and two "video tapes" about loggerhead

turtles that the subjects may find in an office and in a library. The amount of time required for completion of the game is dependent on the decisions made by the players. Group decisions were made regarding actions to take in the simulation.

Day 2-Control Group The red control subjects played the Turtle Mystery simulation game by using index cards and scripts from the eleven video segments. Although the index card-based simulation contains all of the content and most of the processes of the HyperCard/videodisc-based simulation, it is not possible to emulate the level of interactivity obtained when using the microcomputer. However, it was the purpose of this research to examine the effectiveness of interactive videodisc technology as it compares to instruction by the use of printed materials. Interactive videodisc includes the interactivity provided by the computer along with the visual information provided by the videodisc. Providing the control group with the same level of interactivity or visual images would eliminate the treatment differences of the two groups and therefore negate the experiment itself. Only slight modifications had to be made to the videodisc material as it was transferred to the index cards. Only one set of index cards was used for the control group as not a lot of textual material was presented and group decisions were necessary. The scripts of the threats and other material from the videodisc were read aloud by one subject for the rest of the subjects in the control group. Essentially, the same information can be provided by using the index cards for instruction. The use of the index cards parallels the presentation of the information from the HyperCard stacks by the computer.

All students took the alternate forms of the post-tests of environmental knowledge and environmental attitude once instruction was concluded. Subjects took the alternate test forms as a post-test. The blue IVD and yellow control groups

received their instruction and took the post-tests after the green IVD and red control groups completed the post-tests.

Evaluation

Effectiveness of Instruction

The effectiveness of instruction was examined using measures of knowledge achievement. Pre- and post-test means of the IVD and control groups were compared using the Student's *t* test for significant differences. The gains from pre- to post-test scores on the knowledge and attitude tests were calculated by subtracting the pre- from the post-test scores and compared using the Student's *t* test. The average total time required by each instructional group to complete the lesson was obtained and used with the average points gained on the knowledge test to calculate the average learning productivity. This measurement was obtained by dividing the average gain in points by the time required to complete the lesson.

Attitude Change

The evaluation of attitude change was made by scoring the Likert scale responses of the subjects. Responses were scored as to their degree of endorsement of the environmentally favorable outcome with a score of 10 reflecting complete endorsement and 1 reflecting rejection. An average score for each subscale [verbal commitment (VC), actual commitment (AC), and affect(A)] was calculated along with an average for the whole attitude test. Also, an average of the verbal commitment and affect subscale scores was calculated since instruction would be expected to impact

these factors rather than the actual commitment of the respondent. A measure of attitude change was made by subtracting the pre- from post-test scores. This measure was compared to the gain from the pre- and post-test scores of knowledge by using Spearman's Rho correlation coefficient.

CHAPTER IV

Results

Introduction

The null hypotheses for this study were that no significant differences between the knowledge test means of the experimental (IVD) and control groups would be found and that there would be no correlation between the average amount of knowledge gained by a group and the average change in attitude of that group. The knowledge tests were scored on a percentage basis. A test containing no correct answers was given a score of 0% while a test containing correct answers to all twenty questions was given a score of 100%. Although the knowledge test scores are reported in this document without the percentage sign (%), it should be understood that these scores represent a percentage of items correct. The attitude test contained three subscales, each containing ten questions. A ten point Likert scale was used for each item on the attitude test with a response of "1" indicating disagreement and a response of "10" indicating agreement. Subjects were awarded points according to the degree that their response to each item indicated an agreement with a positive environmental attitude. For example, if a subject responded to the statement, "I have switched products for ecological reasons" by circling the number "10" on the scale, the subject would be given 10 points since agreement represents a positive environmental attitude. Likewise, if a subject responded to the statement, "I have never attended a meeting related to ecology" by circling the number "1" on the scale, the subject would be awarded 10 points since disagreement represents a positive attitude. To obtain a mean for each subscale, the sum of the points on each subscale was divided by ten. The sum of the three subscale scores was divided by three to obtain the mean for the whole

attitude test. The data were analyzed at the .05 level of significance using appropriate statistical tests and compared on several factors and the results expressed below.

Analysis of Data

Hypothesis 1

The first null hypothesis was that no significant difference would be found in the knowledge post-test scores of the experimental and control groups. The mean knowledge pre-test scores are 35.39 for the IVD group and 40.46 for the control group. The mean post-test scores are 70.39 and 66.82 for the IVD and control groups respectively. These scores were compared using the Student's t test, the results of which are recorded in Table 2. The calculated t values of 0.86 and 0.61 for the pre- and post-test means are less than the tabled t value of 2.07. Therefore, it can be determined that there were no significant differences between the knowledge post-test means of the two instructional groups. Therefore, there was not sufficient evidence to reject the first null hypothesis.

Table 2: t Test Comparison between Instructional Group Pre- and Post-test Means and Gains on the Knowledge Test

	IVD	Control	t values
Pre-Test			
Mean (%)	35.39	40.46	0.86
SD	12.33	16.65	
Post-test			
Mean (%)	70.39	66.82	0.61
SD	13.14	15.54	
Gains			
Mean (%)	35.00	25.91	1.70
SD	12.58	13.57	

It can also be noted from Table 2 that although the IVD group's knowledge pre-test mean was below that of the control group's, the IVD group's knowledge post-test mean surpasses the control group's post-test mean. The pre- to post-test gains on the knowledge test are shown in Table 2 along with the results of a t test that was performed to find significant differences in the gains. The t test calculation including the IVD group's average gain of 35.00 and the control group's average knowledge gain of 25.91 yielded a t value of 1.70. This value is less than the tabled t value. Although the IVD group's average gain in points on the knowledge test was greater than the control group's gain, the difference between the means was not found to be significant.

Hypothesis 2

The second null hypothesis examined in this study was that there would be no significant correlation between the gain in knowledge of the subjects and their attitude toward the environment. To examine this hypothesis, the gains on the knowledge test were compared to shifts in attitude. Any shift in attitude was assumed to be expressed by the difference between pre- and post-test scores on the whole attitude test and on the verbal commitment and affect subscales of the test. The subjects' scores were compared using Spearman's Rho correlation coefficient. The mean gains of the groups and the calculated coefficients are presented in Table 3.

Small positive correlations of 0.07 and 0.09 were found to exist between knowledge and attitude gains of the IVD group. Negative correlations of -0.34 and -0.11 were found between the knowledge and attitude gains for the control group. Overall, the calculated correlation coefficients were small, implying that the knowledge acquired by the subjects did not have a detectable impact on their attitude

Table 3: Correlation (Rho) of Knowledge Gains to Whole Attitude and Verbal Commitment (VC) and Affect (A) Subscale Gains

Instr. Group	Know. Gain (%)	Whole Att. Gain (pts.)	Correlation Coef.
IVD	35.00	0.23	0.07
Control	25.91	0.43	-0.34
Instr. Group	Knowledge Gain (%)	VC and A Gain	Correlation Coef.
IVD	35.00	-0.09	0.09
Control	25.91	0.32	-0.11

toward the environment as was measured by the attitude test. Therefore, there was not enough evidence to reject the second null hypothesis investigated in this study.

Other Analyses

Attitude Scores No significant differences were found to exist between the groups' scores on the average verbal commitment and affective scores as is shown in Table 4. The values of the calculated *t*'s were 1.92 and 1.26 for the pre-test and post-test respectively. These were less than the tabled *t* value of 2.07. However, there were significant differences noted between the pre- and post-test scores on the whole attitude test. The *t* value calculated for the pre-test was 2.70 and the *t* for the post-test was 2.51. Both calculated *t*'s are greater than the tabled *t* value. The IVD group began the experiment with an average whole attitude score that indicated a more favorable attitude (6.47) toward the environment than that of the control group (5.22). At the end of the experiment, both the IVD and the control group's whole attitude test scores had increased but the IVD group's whole attitude score of 6.58 remained significantly different from the control group's 5.65. Although the control group's gain on the whole attitude test and the average score on the verbal commitment and affect subscales was greater than that of the IVD group, these gains were not significant.

Table 4: t Test Comparison between Instructional Group Pre- and Post-test Means and Gains on Whole Attitude and Verbal Commitment (VC) and Affect (A) Subscale Scores

	IVD	Control	t values
Pre-Test			
Whole Att.			
Mean (pts.)	6.47	5.22	2.70*
SD	0.77	1.44	
VC and A			
Mean (pts.)	7.15	6.17	1.92
SD	0.91	1.53	
Post-Test			
Whole Att.			
Mean (pts.)	6.58	5.65	2.51*
SD	0.81	0.99	
VC and A			
Mean (pts.)	7.10	6.51	1.26
SD	1.22	1.07	
Gains			
Whole Att.			
Mean (pts.)	0.23	0.43	0.50
SD	0.73	1.24	
VC and A			
Mean (pts.)	-0.05	0.32	0.95
SD	1.02	0.91	

*p<.05

An analysis of covariance was performed on the whole attitude test scores of the IVD and control groups. Results gave an F value of 3.02. The tabled F value at the .05 level of significance is 4.32. Therefore, the difference between the adjusted means was not significant.

To further examine the level of knowledge gained and its relationship to attitude change, all subjects involved in the study were grouped according to points gained on the knowledge test. The subjects were assigned to high, middle, and low gains according to the difference in their pre- to post-test scores. Average gains for these groups are expressed in Table 5. The grouped data had a median and mode of 30, a mean of 30.83, and a standard deviation of 13.56. Subjects who had scores one

Table 5: Comparison of Level of Knowledge Gain and Verbal Commitment (VC) and Affect (A) Subscale and Whole Attitude Change

	Low Grp. n=4	Middle Grp. n=15	High Grp. n=5
Ave. Gain on Knowledge Test (%)	Mean = 13.75 SD = 2.50	Mean = 28.33 SD = 6.46	Mean = 52.00 SD = 5.70
Average Gain on VC and A (pts.)	Mean = 0.53 SD = 1.24	Mean = 0.13 SD = 0.97	Mean = 0.42 SD = 0.67
Ave. Gain on Whole Att. Test (pts.)	Mean = 0.56 SD = 1.25	Mean = 0.49 SD = 0.61	Mean = -0.39 SD = 1.19

standard deviation or below the mean were put in the low gain group. Scores of the subjects in this group ranged from 10 to 20 with an average knowledge gain of 13.75. All of the subjects with scores one standard deviation or above the mean were put into the high gain group. The scores of subjects in this group ranged from 45 to 60 with an average knowledge gain of 52.00. The remaining subjects with scores ranging from 25 to 40 were assigned to the middle gain group which had an average gain of 28.33. The average knowledge gains and average gains on the whole attitude test and the verbal commitment and affect subscales are listed in Table 5. It can be seen upon the examination of this data that the results on the whole attitude test are opposite as could be predicted when considering past research on knowledge and attitude. The greatest positive shifts on the verbal commitment and affect subscale (0.53) and on the whole attitude test (0.56) were exhibited by the low gain group. The middle gain group had the lowest gain, 0.13, on the verbal commitment/affect subscale score while the high gain group had the lowest average gain, -0.39, on the whole attitude test score. No discernible relationship between knowledge gain and shift in attitude is immediately evident with such diverse results. Although these results might indicate that those who learned less finished the experiment with a more positive attitude, the calculated average gains are small among all groups.

Learning Productivity The average gain in knowledge for each instruction group was used to calculate learning productivity. The percentage points gained by each instructional group were divided by the average total time required by each group to complete both days of instruction (Table 6).

Table 6: Comparison of Learning Productivity between Instructional Groups

Instr.Group	Gain (%)	Time (min)	Learning Prod. (Gain/Time)	t value
IVD	35.00	70.00	0.50	1.90
Control	25.91	75.25	0.34	

The learning productivity calculated for the IVD group was 0.50 points gained per minute of instruction. The control group's learning productivity value was calculated to be 0.34 points gained per minute of instruction. Also shown in Table 6 are the results of a t test for significant difference. Because the calculated t value of 1.90 is not greater than the tabled t value of 2.07, the learning productivity of both groups is not considered to be significantly different.

Conclusions

The analysis of the cited data does not provide enough evidence to allow the rejection of the null hypotheses. The use of the IVD and index cards as instructional tools was found to be equally effective as there were no significant differences between the knowledge tests means of the instructional groups. Also, there was no significant correlation found between the knowledge gained by the subjects of either group and their change in attitude toward the environment.

CHAPTER V

Summary, Conclusions and Recommendations

Summary

A group of elementary education methods students were selected and randomly assigned to one of two groups. One group (IVD) participated as the experimental group receiving instruction from a level-3 interactive videodisc. The control group received instruction from printed materials. The content of the instruction included information about human interactions with the environment and was the same for both groups. Both groups also participated in an environmental simulation game presented with the interactive videodisc for the IVD group and on index cards for the control group.

All subjects were given pre- and post-tests of environmental knowledge and attitude. Examination of the data collected from the instruments found that both methods of instruction were effective in promoting knowledge acquisition, but that neither method was more effective than the other. Also, the knowledge acquired by the participants did not affect their attitude toward the environment as no significant correlation was found between the points gained on the knowledge test and the points gained on the attitude test.

Conclusions

It can be concluded that the instruction provided to each of the groups involved was equally effective because there were no significant differences found between the means of the instructional groups. The fact that there was a gain in knowledge

demonstrated by all subjects indicates that learning did occur. However, the mode of information presentation did not distinguish significantly greater learning on the part of either group. It may be concluded that the information and/or the organization of the information was effective in promoting knowledge acquisition since the content on the index cards and on the videodisc was virtually identical. The primary difference in the instruction of the two groups was the interactive and visual elements provided by the level-3 interactive videodisc. These additional elements did not produce a significantly greater increase in knowledge for the IVD group. Therefore, the use of IVD in this instructional situation was no more effective than the use of the index cards as measured by the pre- and post-tests of knowledge and attitude.

Information regarding the environment is currently popular and accessible with celebrity endorsements on television and recycle bins conveniently located in many communities. It is reasonable, therefore, to suggest that the participants in this experiment would be accepting and attentive to the material presented in the lessons described in this study. The social popularity of the information given and the attentiveness it engenders may have contributed to the knowledge acquisition of the participants rather than the method by which it was presented.

Even though the IVD group gained more percentage points on the knowledge test than the control group did, the difference between the gains of the two groups was not significant according to the *t* test. However, the results may have been found to be significant if a larger sample of subjects was used. Also, significant differences between the knowledge test scores of the two groups may have been detected had this study not been limited to testing strictly factual recall. It could be that the use of the

interactive videodisc has an impact on retention, problem-solving, or other higher order thinking skills.

Environmental knowledge and a favorable attitude toward the environment have been recognized as important foundations of responsible environmental behavior (Hungerford and Volk, 1990). This study also examined the relationship between environmental knowledge and attitude. The specific knowledge acquired by the subjects involved in this experiment was not found to influence any significant attitude change toward environmental issues. Again, the added elements of interactivity and visuality provided by the interactive videodisc did not produce a positive shift in attitude in the subjects of the IVD group. In fact, the control group showed a greater shift toward a positive attitude than did the IVD group. This finding may suggest that reading the printed material influenced the subjects' environmental attitude to a greater degree than the use of the IVD. However, this suggestion cannot be confirmed since the gain in the control group's score was not significant according to the t test. The fact that no significant statistical correlation was found between the knowledge gained in this experiment and the subjects' attitude should not indicate that environmental knowledge is not necessary to an environmentally favorable attitude. It must be remembered that both environmental knowledge and a favorable attitude toward the environment are part of a foundation to an intention to participate in environmentally responsible behavior. The demonstration of this behavior is the ultimate goal of environmental education.

Recommendations

It may be that the subjects in the IVD groups would retain their acquired knowledge longer than the control group because of the visual nature of the IVD and because it has long been noted that people remember images (LeBon, 1895; Mageau, 1990). Future research with a design similar to the one in this study could include a second post-test at a later date. The administration of a second post-test would provide data regarding information retention. Considering the cited research regarding the retention of learning in images, it could be that those subjects taught with supplemental visual information would retain the content longer than those taught without the images. The second, later post-test would extend the study and serve to help validate this proposition.

This study involved two days of instruction to complete a lesson on human interactions with the environment. The experiment itself occupied only a short period of time within the semester of study. More conclusive results might have been obtained by extending the instruction as it is described within this study over a longer period of time. With the use of the instructional tools limited to such a short time, it is possible that the participants did not have adequate exposure to them for the impact to be made measurable by the instruments used. Increasing the exposure from the time it takes to complete a lesson to the time it takes to complete an entire unit might cause the impact of the instruction to become better defined and thus become more measurable. Of course, the ultimate test of the technology would be to use it with a group of students extensively throughout an entire course while another group received identical content by a different means of instruction. Then, the assignment, test, and course grades of the students could be compared and evaluated.

The absence of a detectable correlation between environmental knowledge and attitude toward the environment as was found in this study is not unique. It was surprising, however, that the added visual information presented to the IVD group did not seem to influence their affect subscale score or at least their verbal commitment score on the attitude test. The fact that no significant differences were found in this research might indicate that the questions that were asked did not give insight into the nature of learning that did occur as a result of IVD instruction. The environmental attitude test used was designed to establish a measure toward general environmental issues. An instrument designed to approach issues specifically addressed in the lessons included in this experiment may have detected a shift in the subjects' attitude toward those issues. This proposition may have important implications for any research designed to investigate the relationship between knowledge about a subject and attitude toward that subject, not just environmental educators.

Although the results of this study indicated no quantitative differences between the instructional groups, qualitative differences may exist. It was noted by the researcher that the subjects in the IVD group made many comments regarding the visual information presented by the videodisc. The comments included responses to pictures of pollution and animals affected by human encroachment and discussions about pollution and responsibility. Much of the content of their discussions was emotional, specifically related to the textual or pictorial information on the computer screen and/or videodisc monitor. The control group also made comments and discussed the information they read, although their responses were less involved and more brief than those of the IVD group.

Observing the IVD group during their instruction suggests that information regarding the learning produced and attitude change of the IVD and control groups could be obtained from interviews. All participants involved in a study similar to this could be shown pictures or slides relevant but not identical to the material presented during instruction after the instruction has been completed. Interviews and observations conducted during and after the presentation of the visual materials could yield information regarding the amount and kind of information that the participants recall. Also, participants could answer question about how they feel about what they saw and learned. The data from the interviews could be quantitatively and qualitatively analyzed.

Although the students in the control group of this study indicated satisfaction with their instruction, they were enthused when shown the presentation of the same material by the videodisc after the experiment was complete. Qualitative information concerning the participants' perceptions and attitudes regarding their mode of instruction, IVD or printed material, could also be obtained during the interview process. The reaction of the participants involved in this research to the technology, along with the comments of the IVD group subjects, is encouraging to educators. Further research should be conducted to investigate ways to transfer this enthusiasm into learning. Then, it would be interesting to ascertain if and to what degree this learning motivated students to participate in environmentally responsible behaviors.

This research was limited in that it was concerned with measuring the knowledge gained and the attitude shift by the participants but did not investigate other factors possibly affected by the instruction. These factors include problem-solving and critical thinking skills. The importance of these skills is frequently noted in

environmental education literature as well as in all areas of education. Future research with a structure similar to this study might involve additional evaluative instruments and/or activities designed to investigate changes in thinking skills resulting from the instruction. This research was also limited to a population of teacher education students. A vast number of student populations exists from which samples might be drawn for study. It cannot be assumed that one instructional tool will be equally effective for all populations in all learning situations. Studies have shown various results of the effectiveness of IVD instruction for groups of elementary, middle school, high school, college, learning disabled and gifted students. Researchers interested in investigating IVD instruction are presented with a vast number of opportunities that include many options concerning subject area, instructional group size, and population.

The fact that this study found no significant differences between the IVD and control groups should not negate the important findings of other research involving IVD. As discussed before, the content focus of the instruction is currently popular as society has entered the "Decade of the Environment". A possible reason for the almost equivalent gains in knowledge between the two instructional groups is that the information presented is popular and it is considered "politically correct" to be environmentally aware. Further research involving the presentation of information considered to be less attractive by the population selected for study may lead to more revealing conclusions concerning IVD instruction.

This study was designed to investigate the effectiveness of the IVD in environmental education. Both factors are currently important not only to educators but also to society. Research concerning interactive videodisc and other instructional technologies must continue since these tools are becoming increasingly prominent in

our nation's schools. Purchases are being made without adequate data to support them. As the educational technology is being accepted by teachers and administrators, they must be made aware of how and when to use it. It is no doubt important to utilize this technology in classrooms since our students will be expected to be skilled with computers and other technologies in the future. Research that involves all types of populations including pre-service and in-service teachers must be conducted and made available to those responsible for planning and utilizing educational technology in education.

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APPENDICES

APPENDIX A

APPENDIX A

THE EFFECT OF USING LEVEL-3 INTERACTIVE VIDEODISC ON THE ENVIRONMENTAL KNOWLEDGE AND ATTITUDE OF TEACHER EDUCATION STUDENTS

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(615) 974-8143

The study in which you are invited to participate involves research comparing instructional methods, namely, those of classroom activities versus interactive videodisc instruction. For a total of no more than 5 hours of instructional time that will take place within two class meetings, you will be asked to use one of the two instructional systems to learn about the environment. The instructional system that you are to use will be assigned at random. In addition, you will be asked to take a short test of environmental knowledge and attitude before and after instruction so that appropriate evaluations may be made. Since this study attempts to compare the effectiveness of the two instructional systems, it is important that you try your best no matter which system you use.

Participation in this study should offer you no risk beyond what you are normally exposed to in a classroom. You should benefit from your participation in that you may achieve a greater understanding of the environment and you will have the opportunity to use innovative instructional strategies.

At the beginning of the study, you will be given a number to use instead of your name on your pre- and post-tests of knowledge and attitude. This will insure confidentiality and still permit the categorization of data. The only time your name will be used is when you sign this consent form to indicate your willingness to participate. The consent form will not be associated with your tests at all. All forms and tests will be kept in the personal property of the researcher, Kim Loomis. (See address and phone number at the top of this page.) Only anonymous data will be viewed by others involved with the project and published in the research reports.

If you have any further question about the project, its outcomes, or related information, please feel free to contact the researcher. Your participation is entirely voluntary. You may discontinue participation in this study at any time without penalty. However, you must be present for the pre-tests, instruction, and post-tests in order to continue participation.

* * * * *

I understand all of the above and consent to participate in the described project.

(Signature)

(Date)

APPENDIX B

APPENDIX B

INFORMATION

Please supply the following information so that the data from this experiment may be categorized. Record the number attached to this sheet as your identification number. Please be sure to keep and remember this number to use as identification on your pre- and post-tests. Your scores on the tests and surveys will in no way affect any grade you will make in a University of Tennessee course. Your participation and cooperation are greatly appreciated!

1. Identification Number _____

2. Are you currently teaching? _____

If yes, how long have you been teaching? _____

What level? (Secondary or Elementary) _____

If secondary, what subject areas? _____

3. What is your current level of education? (Check all that apply and fill in major.)

_____ Bachelor's. Major: _____

_____ years beyond B. S. (Master's not yet attained.) Major: _____

_____ Master's. Major: _____

_____ years beyond Master's. (Specialist/Doctorate not yet attained.)

Major: _____

_____ Specialist's. Major: _____

_____ years beyond Specialist. (Doctorate not yet attained.)

Major: _____

_____ Doctorate. Major: _____

_____ Other. Please explain: _____

4. How would you describe your current level of knowledge about the environment?
(Circle one answer, please.)

Poor

Fair

Good

Excellent

5. How would you describe your current attitude concerning environmental issues?
(Check one answer, please.)

_____ In favor of the environment, whatever the issue.

_____ In favor of economics, whatever the issue.

_____ Somewhere in between the two statements above.

_____ Not sure.

APPENDIX C

APPENDIX C

Pre- and Post Test of Environmental Knowledge Form A

PLEASE CHOOSE ONE ANSWER FOR EACH QUESTION FROM THE LIST BELOW. THEN WRITE THE ANSWER IN THE BLANK.

Aerosol(s)	Egg Shells	Moss	Releasing animals
Algae	Feeding	Mother	Salt Marshes
Beaver	Fighting	(The) Moon	Scuba Diving
Bear(s)	Fish	Nuclear Plants	Sense of Smell
Biodegradable	Fishing	One Hundred	Shark(s)
Bird(s)	Food	One Thousand	Shells
Blubber	Forests	One or Two	Shelter
Breeding	Fungi	Organic	Skin(s)
Bright Sky	Global Warming	Pigeon(s)	Squirrel(s)
Counting Species	Habitat Destruction	Plant(s)	(The) Sun
Courting	Horns	Plastic	Ten
Crabs	Industry	Poisoning	Ten Thousand
Dams	Killer Whale	Pollution	Three
Decomposers	Loggerhead Turtle	Predation	Tide(s)
Detergents	Loss of Food	Providing Refuge	Tracks
Digestible	Lumber	Raccoon(s)	Trapping
Dirty Water	Man	Recyclable(s)	Tree(s)
Eagle(s)	Meat	Reefs	Tusks
Eggs	Migration	Reproduction	Whale Watching

- Besides hunting, name a specific reason for the extinction of the thousands of species that have been wiped from the earth. _____
- Materials that can be broken down quickly and used by living organisms are called _____.
- Regarding the Loggerhead turtle, in the United States, it is illegal to steal turtle eggs and sell turtle _____.
- Besides some pets and man, name another mammal that is direct threat to loggerhead turtle eggs. _____
- What is a reasonable estimation of the number of extinctions per *year*? _____
- Name a reason for the hunting of the California Sea Lion besides a demand for its fur. _____
- Baby loggerhead turtles find the ocean by following _____.
- Besides hunting, one reason that wolves disappeared from the western states of the U. S. is _____.

9. The effects of the destruction of _____ include the loss of a nursery for fish, a sanctuary for birds, and a barrier from storm damage.
10. Man-made products such as _____ are direct threats to loggerhead turtles.
11. What commercial activity has replaced the hunting of the gray whale?

12. Name an activity other than re-releasing animals that zoos participate in to help wildlife populations. _____
13. Name a source of the acid that can be found in acid rain and in ponds.

14. Massive growth of _____ triggered by phosphates and nitrates may be detrimental to ponds.
15. _____ is an example of a harmful interaction that can occur between animals of the same species.
16. Overfishing and _____ are threats to the pacific salmon.
17. _____ is an example of an animal whose existence may be easier because of human encroachment.
18. The effect of DDT on _____ aided in its being banned.
19. The only predator an adult loggerhead turtle may fall prey to is _____.
20. Rocky Mountain Elk are hunted mainly for _____.

Form A, page 2

**Pre- and Post Test of Environmental Knowledge
Form B**

PLEASE CHOOSE ONE ANSWER FOR EACH QUESTION FROM THE LIST BELOW. THEN WRITE THE ANSWER IN THE BLANK.

Aerosol(s)	Egg Shells	Moss	Releasing animals
Algae	Feeding	Mother	Salt Marshes
Beaver	Fighting	(The) Moon	Scuba Diving
Bear(s)	Fish	Nuclear Plants	Sense of Smell
Biodegradable	Fishing	One Hundred	Shark(s)
Bird(s)	Food	One Thousand	Shells
Blubber	Forests	One or Two	Shelter
Breeding	Fungi	Organic	Skin(s)
Bright Sky	Global Warming	Pigeon(s)	Squirrel(s)
Counting Species	Habitat Destruction	Plant(s)	(The) Sun
Courting	Horns	Plastic	Ten
Crabs	Industry	Poisoning	Ten Thousand
Dams	Killer Whale	Pollution	Three
Decomposers	Loggerhead Turtle	Predation	Tide(s)
Detergents	Loss of Food	Providing Refuge	Tracks
Digestible	Lumber	Raccoon(s)	Trapping
Dirty Water	Man	Recyclable(s)	Tree(s)
Eagle(s)	Meat	Reefs	Tusks
Eggs	Migration	Reproduction	Whale Watching

- Two reasons for the extinction of the thousands of species that have been wiped from the earth are hunting and _____.
- The term _____ refers to materials that can be broken down quickly and used by living organisms.
- With regard to the Loggerhead turtle, in the United States, it is illegal to steal turtle eggs and sell _____.
- Direct threats to loggerhead turtle eggs include man, some pets, and _____.
- What is a reasonable estimation of the number of extinctions per *day*? _____
- Besides a demand for its fur, one reason for hunting the California Sea Lion is _____.
- Baby loggerhead turtles follow _____ to the ocean after hatching.
- Hunting and _____ contributed to the disappearance of wolves from the western states of the U. S.

9. The effects of the destruction of _____ include the loss of a nursery for fish, a sanctuary for birds, and a barrier from storm damage.
10. An example of a man-made product that directly affects Loggerhead turtles is _____.
11. _____ has replaced the commercial losses of restrictions placed upon the hunting of gray whales.
12. Name an activity other than the breeding of endangered animals that zoos participate in to help wildlife populations. _____
13. Name a source of the acid that can be found in acid rain and in ponds. _____
14. Phosphates and nitrates may trigger the massive growth of _____ which is detrimental to ponds.
15. _____ is an example of a peaceful interaction between animals of the same species.
16. Name a threat to the pacific salmon besides overfishing. _____
17. The _____ is an example of an animal whose existence may be easier because of human encroachment.
18. DDT was banned due in part to its effect on _____.
19. _____ is the only predator of adult loggerhead turtles.
20. The Rocky Mountain Elk population suffers because they are hunted for _____.

Form B, page 2

APPENDIX D

APPENDIX D **ENVIRONMENTAL ATTITUDE** **Form A**

IDENTIFICATION NUMBER _____

Verbal Commitment	Disagree	Agree
1. I'd be willing to ride a bicycle or take the bus to work in order reduce air pollution.	1 2 3 4 5 6 7 8 9 10	
2. I would probably never join a group or club which is concerned solely with ecological issues.	1 2 3 4 5 6 7 8 9 10	
3. I would be willing to use a rapid transit system to help reduce air pollution.	1 2 3 4 5 6 7 8 9 10	
4. I'm not willing to give up driving on a weekend due to a smog alert.	1 2 3 4 5 6 7 8 9 10	
5. I'm really not willing to go out of my way to do much about ecology since that's the government's job.	1 2 3 4 5 6 7 8 9 10	
6. I would donate a day's pay to a foundation to help improve the environment.	1 2 3 4 5 6 7 8 9 10	
7. I would be willing to stop buying products from companies guilty of polluting the environment, even though it might be inconvenient.	1 2 3 4 5 6 7 8 9 10	
8. I'd be willing to write my congressman weekly concerning ecological problems.	1 2 3 4 5 6 7 8 9 10	
9. I probably wouldn't go house to house to distribute literature on the environment.	1 2 3 4 5 6 7 8 9 10	
10. I would not be willing to pay a pollution tax even if it would considerably decrease the smog problem.	1 2 3 4 5 6 7 8 9 10	

Actual Commitment

- | | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|----|
| 1. I guess I've never actually bought a product because it had a lower polluting effect. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2. I keep track of my congressman and senator's voting records on environment issues. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 3. I have never written a congressman concerning the pollution problems. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 4. I have contacted a community agency to find out what I can do about pollution. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 5. I don't make a special effort to buy products in recyclable containers. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 6. I have attended a meeting of an organization specifically concerned with bettering the environment. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 7. I have switched products for ecological reasons. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 8. I have never joined a cleanup drive. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 9. I have never attended a meeting related to ecology. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 10. I subscribe to ecological publications. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Affect

- | | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|----|
| 1. I feel people worry too much about pesticides on food products. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2. It frightens me to think that much of the food I eat is contaminated with pesticides. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 3. It genuinely infuriates me to think that the government doesn't do more to help control pollution of the environment. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 4. I feel fairly indifferent to the statement: "The world will be dead in 40 years if we don't remake the environment." | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

5. I become incensed when I think about the harm being done to plant and animal life by pollution.

1 2 3 4 5 6 7 8 9 10

6. I'm usually not bothered by so-called "noise pollution".

1 2 3 4 5 6 7 8 9 10

7. I get depressed on smoggy days.

1 2 3 4 5 6 7 8 9 10

8. When I think of the ways industries are polluting, I get frustrated and angry.

1 2 3 4 5 6 7 8 9 10

9. The whole pollution issue has never upset me too much since I feel it's somewhat overrated.

1 2 3 4 5 6 7 8 9 10

10. I rarely ever worry about the effects of smog on myself and family.

1 2 3 4 5 6 7 8 9 10

Form A, Page 1.

(From Maloney, Ward, and Braucht, 1975.)

ENVIRONMENTAL ATTITUDE Form B

IDENTIFICATION NUMBER _____

Verbal Commitment

Disagree

Agree

1. I would be willing to stop buying products from companies guilty of polluting the environment, even though it might be inconvenient.

1 2 3 4 5 6 7 8 9 10

2. I would probably never join a group or club which is concerned solely with ecological issues.

1 2 3 4 5 6 7 8 9 10

3. I'm really not willing to go out of my way to do much about ecology since that's the government's job.

1 2 3 4 5 6 7 8 9 10

4. I would not be willing to pay a pollution tax even if it would considerably decrease the smog problem.

1 2 3 4 5 6 7 8 9 10

5. I would be willing to use a rapid transit system to help reduce air pollution.

1 2 3 4 5 6 7 8 9 10

6. I'd be willing to write my congressman weekly concerning ecological problems.

1 2 3 4 5 6 7 8 9 10

7. I'd be willing to ride a bicycle or take the bus to work in order reduce air pollution.

1 2 3 4 5 6 7 8 9 10

8. I'm not willing to give up driving on a weekend due to a smog alert.

1 2 3 4 5 6 7 8 9 10

9. I would donate a day's pay to a foundation to help improve the environment.

1 2 3 4 5 6 7 8 9 10

10. I probably wouldn't go house to house to distribute literature on the environment.

1 2 3 4 5 6 7 8 9 10

Actual Commitment

- | | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|----|
| 1. I have switched products for ecological reasons. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2. I have attended a meeting af an organization specifically concerned with bettering the environment. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 3. I keep track of my congressman and senator's voting records on environment issues. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 4. I have never attended a meeting related to ecology. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 5. I don't make a special effort to buy products in recyclable containers. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 6. I guess I've never actually bought a product because it had a lower polluting effect. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 7. I have never joined a cleanup drive. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 8. I have contacted a community agency to find out what I can do about pollution. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 9. I have never written a congressman concerning the pollution problems. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 10. I subscribe to ecological publications. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Affect

- | | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|----|
| 1. It frightens me to think that much of the food I eat is contaminated with pesticides. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 2. The whole pollution issue issue has never upset me too much since I feel it's somewhat overrated. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 3. I feel people worry too much about pesticides on food products. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

- | | | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|----|
| 4. I become incensed when I think about the harm being done to plant and animal life by pollution. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 5. It genuinely infuriates me to think that the government doesn't do more to help control pollution of the environment. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 6. I'm usually not bothered by so-called "noise pollution". | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 7. I rarely ever worry about the effects of smog on myself and family. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 8. When I think of the ways industries are polluting, I get frustrated and angry. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 9. I get depressed on smoggy days. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 10. I feel fairly indifferent to the statement: "The world will be dead in 40 years if we don't remake the environment." | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Form B, Page 2.
(From Maloney, Ward, and Braucht, 1975.)

VITA

Kimberly S. Loomis was born in Waukegan, Illinois in 1963. She attended elementary school in Wood Dale, Illinois and moved to Rockford, Tennessee for her junior high school years. In 1981, she graduated from Cumberland County High School in Crossville, Tennessee.

After receiving a bachelor's degree in microbiology from East Tennessee State University, Ms. Loomis discovered her love for teaching as a graduate teaching assistant in the department of microbiology at the University of Tennessee at Knoxville. She spent two years teaching secondary science at North Cobb High School in Kennesaw, Georgia after receiving a master's degree in science education from UTK in 1987.

Ms. Loomis taught for one year at Robertsville Junior High School in Oak Ridge, Tennessee before becoming a full time doctoral student in 1989. Upon completion of her Ed.D., Dr. Loomis accepted a position as assistant professor of science education at Catawba College in Salisbury, North Carolina.