This is to certify that the

dissertation entitled

EFFICACY OF THE WORLD WIDE WEB IN
K-12 ENVIRONMENTAL EDUCATION

presented by

Kimberly Jane York

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Resource Development

Major professor

Date September 2, 1998

EFFICACY OF THE WORLD WIDE WEB IN K-12 ENVIRONMENTAL EDUCATION

By

Kimberly Jane York

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Resource Development

1998

ABSTRACT

EFFICACY OF THE WORLD WIDE WEB IN

K-12 ENVIRONMENTAL EDUCATION

By

Kimberly Jane York

Despite support by teachers, students, and the American public in general, environmental education is not a priority in U.S. schools. Teachers face many barriers to integrating environmental education into K-12 curricula. The focus of this research is teachers' lack of access to environmental education resources.

New educational reforms combined with emerging mass communication technologies such as the Internet and World Wide Web present new opportunities for the infusion of environmental content into the curriculum. New technologies can connect teachers and students to a wealth of resources previously unavailable to them. However, significant barriers to using technologies exist that must be overcome to make this promise a reality.

Web-based environmental education is a new field and research is urgently needed. If teachers are to use the Web meaningfully in their classrooms, it is essential that their attitudes and perceptions about using this new technology be brought to light. Therefore, this exploratory research investigates teachers' attitudes toward using the Web to share environmental education resources.

Both qualitative and quantitative methods were used to investigate this problem. Two surveys were conducted—a self-administered mail survey and a Web-based online

survey—to elicit teachers perceptions and comments about environmental education and the Web. Preliminary statistical procedures including frequencies, percentages and correlational measures were performed to interpret the data. In-depth interviews and participant-observation methods were used during an extended environmental education curriculum development project with two practicing teachers to gain insights into the process of creating curricula and placing it online.

Findings from the both the mail survey and the Web-based survey suggest that teachers are interested in environmental education—97% of respondents for each survey agreed that environmental education should be taught in K-12 schools. In addition, a small percentage of respondents for each survey reported they are already using the Web to find curricular resources. Most importantly, more than 86% of those responding to the Web-based survey indicated that they would visit and use an environmental education Web site designed specifically for teachers. Findings also indicate that time is a major constraint faced by teachers; Web sites must offer high-quality information and be easy to navigate. Finally, teachers reported having greater access to the Web and Web-based environmental information than they do to any kind of environmental education-related curriculum guides. Such findings indicate that further research and an investment of resources in Web-based environmental education are warranted.

To the newest member of our family who inspired me to finish—or else.

And to Ocek, my family and friends who were always

great sources of encouragement and support.

ACKNOWLEDGMENTS

I would like to thank my research committee for their unwavering support during my years at Michigan State: Dr. Eckhart Dersch, Dr. Tom Edens, Dr. Cynthia Fridgen, and Dr. Carrie Heeter. All of them, in one way or another, have provided me with invaluable opportunities and experiences for which I am very grateful. In addition, I would like to extend a special thanks to Dr. John Schweitzer who was not on my committee but spent enough time with me to become an honorary member.

Finally, I would like to thank the many teachers who contributed their time and effort to make this research possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

This research investigates K-12 teachers' attitudes toward environmental education and the World Wide Web (Web). The literature indicates that teachers are interested in environmental education but often lack access to curricular resources. Emerging mass communication technologies such as the Internet and Web present new opportunities to connect teachers instantly to a multitude of rich and diverse environmental education resources. However, there are also significant challenges. Research in this field is essential. This research examines K-12 teachers' attitudes toward the Web and environmental education to investigate the feasibility of using the Web as a means for sharing resources to overcome a significant barrier to environmental education. The findings should provide insights about the value of using the Web to connect teachers to the environmental resources that they seek.

BACKGROUND

There is a compelling need for improved environmental education in the United States. The National Environmental Education Act of 1990 called for national leadership to increase environmental literacy in this country (U.S. Environmental Protection Agency [USEPA], 1998). Six years later, very little was known about the status of environmental literacy in the U.S. (Volk & McBeth, 1998). Surveys of the American public's environmental knowledge have indicated "disappointingly low" levels of understanding of basic environmental concepts (Arcury, 1990). A recent national survey of high school

seniors found that while most understood basic concepts related to the environment, few could comprehend the consequences or potential solutions related to environmental problems (Gambro & Switzky, 1996). Other research has shown that teachers and students hold serious misconceptions about fundamental environmental concepts (Beiswenger, 1991; Hooper, 1988; Munson, 1994).

Environmental education is not a priority in this country (National Environmental Education Advisory Council [NEEAC], 1996). If it exists at all, it is loosely organized and has little sense of direction. It is neither systematic nor comprehensive; attempts at environmental education are often sporadic and vary widely by school and teacher (Hungerford & Volk, 1990; Ramsey, Hungerford & Volk, 1992). Because environmental education is essentially omitted from the K-12 curriculum, students learn that environmental education is not important. Thus, our nation is not preparing its young people to be environmentally literate and concerned individuals.

The rationale for environmental education is simple: educated citizens make better decisions about complex environmental problems than those less informed. Carol Browner, the Administrator of the EPA, invites all citizens to become involved:

> An informed and involved local community always does a better job of environmental protection than some distant bureaucracy. If we are to move beyond environmental regulation to true environmental protection, Americans in businesses and communities throughout this country must be full and active participants in solving environmental problems (Browner, 1998).

In order to maintain and improve environmental quality, individuals must understand the complex interrelationships between the natural environment and human activity (Disinger, 1993). Environmental problems often involve the sciences, engineering, sociology, psychology, politics, communication, history, and many other

subject areas. Solutions are not necessarily "common-sense" and instead require educated individuals with the knowledge, problem solving skills and abilities to understand the multiple dimensions of a problem in a holistic manner.

Since its inception, environmental education has a definitional problem (Disinger, 1998a); it means different things to different people. The roots of environmental education can be found in nature study, outdoor education and conservation education, and many people use the terms interchangeably. It is therefore necessary to define "environmental education" for the purposes of this research. The definition coined by William Stapp is sufficient,

> *Environmental education* is aimed at producing 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, 1969)

Environmental education can and should begin in the public schools—at the earliest grade levels and continue throughout a student's educational experience. Today's students are tomorrow's future leaders. They will make decisions, design policies and take actions that will impact the environment. These students must be able to assess and devise alternative solutions to the complex environmental problems they will encounter as adults. If one of the aims of public education is to prepare young people to become knowledgeable adults able to contribute to society, environmental education is needed now more than ever.

There are several important barriers to integrating environmental education into the curriculum that have been identified in the literature. This research focuses on one barrier: teachers' lack of access to environmental education resources. (Ham & Sewing, 1988).

Educators simply do not know where to turn for assistance in teaching about the environment (Childress & Wert, 1976). A recent study (Wilson & Smith, 1996) found that there is a scarcity of environmental education information in the education literature compared to that available 20 years ago. Although many environmental education resources have been developed and exist, they are often scattered and finding them requires additional time and funding that many teachers do not have (Samuel, 1993; Simmons, 1989). Other studies indicate that more curricular materials need to be developed (Culen, 1998; Simmons, 1989). Teachers cannot be expected to integrate environmental education into their curricula if they lack resources and assistance in doing so.

Clearly, some teachers are able to overcome formidable barriers to include environmental education in their curricula, but they are the exception rather than the norm. Disinger writes, "environmental education is currently in schools to the extent that teachers want to include it strongly enough to find ways to do so" (Disinger, 1998b, p.6). If our nation is to move beyond piecemeal environmental education to a more comprehensive and systematic approach, teachers must have quick and easy access to environmental education resources.

Current Trends in K-12 Education

There are two important trends in education today relevant to this research: systemic reform and technology integration. New concepts of educational reform hold promise for environmental education in the 1990s and beyond. Systemic reform embodies three components: (1) the promotion of ambitious student outcomes for all students; (2) the alignment of policy approaches and institutions to promote these

outcomes; and (3) a restructuring of the governance system to support improved achievement (U.S. Department of Education, 1996).

Although it is beyond the scope of this research to address all of the aspects of systemic reform, there is one concept that relates directly to environmental education. Systemic reform focuses on restructuring the curriculum in schools such that students continually build upon their prior knowledge throughout their schooling and connections are made between disciplines. Such a restructured curriculum can facilitate environmental education. The current practice of discipline-based education does not support inquiry and exploration of multidisciplinary subjects like environmental education. As educators move away from teaching discrete subjects toward a more thematic and integrative approach to teaching, environmental education becomes possible.

Another important change occurring in education is technology integration—specifically, the introduction of the Internet and Web in K-12 schools. President Clinton's State of the Union Address (1997) issued seven priorities for all students in the United States. One of the seven was, "Every classroom will be connected to the Internet by the year 2000 and all students will be technologically literate" (U.S. Department of Education, 1997). There is strong public support and political will to bring these new technologies to all schools.

Emerging mass communications technologies such as the Internet and Web present new opportunities for teaching and learning such as increasing student motivation and connecting teachers and students to a world of resources beyond the classroom walls (U.S. Congress, 1995). However, there are important challenges as well. Barriers to

integrating technology into K-12 classrooms include teachers' lack of access to technologies, technical support and curricular support.

Research is urgently needed to demonstrate that these new technologies can support and enhance K-12 environmental education classroom instruction and teacher professional development by connecting teachers and students to environmental resources that were previously unavailable to them. In the environmental education literature, this is an emerging field called "computer-aided environmental education." According to Rohwedder, it offers "a vast expanse of uncharted territory filled with both problems and promises" (Rohwedder, 1990, p. 1) worthy of study.

Several studies have examined the use of computer-aided environmental education to enhance students' learning experiences. Some researchers have focused on virtual reality (Clark, 1995; Taylor & Disinger, 1997) and hypermedia systems (Huning, Palmer & DiSilvestro, 1990; Lynch, 1990; Tway, 1995) as a way for students to investigate and explore environments. Similarly, in the past few years, there has been an unprecedented growth in telecommunications projects like GLOBE (Global Learning and Observations to Benefit the Environment) (Pyke, 1995), the JASON Project (JASON Foundation, 1998), and "electronic field trips" (Copen, 1995; Dyrli & Kinnaman, 1996; Holzberg, 1996). These projects connect classrooms of students to authentic data and resources such as databases of environmental information or audio, video and text information about explorations in different parts of the world.

However, there is a dearth of research related to the use of the Web as a means for sharing environmental education resources among K-12 teachers. Although Web sites exist that serve as clearinghouses for environmental education such as EE-Link (http://ee-

link.net) and Envirolink (http://www.envirolink.org), they are not focused on the special needs of K-12 teachers. Therefore, it is necessary to investigate whether or not K-12 teachers perceive the Web as a useful means for sharing environmental education resources.

STATEMENT OF THE PROBLEM

American students' level of environmental knowledge is unacceptably low. Few K-12 students are prepared to assess and devise alternative solutions to complex environmental problems. Currently, environmental education occurs sporadically and the quality tends to vary by teacher and school. One important barrier to environmental education infusion is teachers' lack of access to environmental education resources.

The current wave of educational reform efforts combined with the introduction of mass communication technologies in schools present new opportunities to infuse environmental content into the curriculum. New approaches to teaching allow for the study of interdisciplinary subjects like environmental education. Similarly, new technologies have the potential to connect teachers to environmental resources that were previously unavailable to them. However, there are significant barriers to integrating technologies into the curriculum that must be overcome.

If teachers are to use the Web, it is important to bring to light their attitudes about using this new technology in their classrooms. Research is needed to guide our actions in this field. Given the multitude of educational Web sites that vie for teachers' attention and time, research focusing on teachers' attitudes toward the Web is essential.

Therefore, this exploratory research examines K-12 teachers' attitudes toward using the Web to share environmental education resources. Assuming that teachers are

interested in environmental education but lack access to resources, this study also seeks to develop recommendations for needed online environmental education resources and for future research directions for Web-based environmental education.

OVERVIEW AND SCOPE OF THE STUDY

The overall objective of this research is to investigate K-12 teachers' attitudes toward using the Web to share environmental education resources. However, before this objective can be met, it is important to address several underlying issues. First, it is necessary to determine whether or not teachers are interested in environmental education, and whether or not schools have the hardware, software and Internet access necessary. Second, although there are many environmental education sites on the Web, few of them publish teachers' lesson plans and curricula. Therefore, it is necessary to design and publish a Web site that highlights teachers' curriculum and comments, and provides examples of students' work. Finally, in order to elicit teachers' attitudes toward the Web and environmental education, an online survey is added to the Web site. Thus, the research study is composed of three phases; each of the research questions below is specific to a particular phase.

RESEARCH QUESTIONS

The study seeks to answer the following research questions.

Phase 1: Investigating a Need for the Research

1. Is there sufficient evidence to suggest that Michigan teachers are interested in environmental education?

2. Is there sufficient evidence to suggest that the proposed research is technically possible (i.e., do Michigan schools have the necessary hardware, software and Internet access)?

Phase 2: Developing K-12 Environmental Education Curriculum

1. How does each teacher approach (i.e., begin) the environmental education curriculum development process?
   a) Do teachers begin with curriculum standards, selected activities or students' suggestions?
2. Which environmental topics does each teacher select as central to the curriculum development process?
   a) What can be learned about teachers' conceptions of environmental education based on the topics they choose to teach?
3. Into which subject areas are environmental concepts infused?
   a) Do teachers select science only, or other subject areas?
4. What types of resources do teachers use to help them develop environmental education curricula?
   a) Do teachers use textbooks, colleagues, the Web, et cetera?

Phase 3: K-12 Teachers' Attitudes Towards Environmental Education and Web

1. Do K-12 teachers who complete the online survey exhibit positive attitudes toward environmental education?
2. Do K-12 teachers who complete the online survey exhibit positive attitudes toward using the Web in education?

3. Is there a relationship between teachers' access to environmental education resources and their attitudes toward environmental education?
4. Is there a relationship between teachers' attitudes toward environmental education and their attitudes toward using the Web in education?
5. Using only electronic methods to advertise the online survey, how many K-12 teachers will complete and submit the online survey in a 45-day period?

RESEARCH HYPOTHESES

In association with these research questions, the following hypotheses were tested.

H_1: Teachers who have greater access to environmental education resources will exhibit a more positive attitude toward environmental education than teachers who have access to fewer resources.

H_2: Teachers who exhibit a more positive attitude toward environmental education will also exhibit a more positive attitude toward using the Web in education.

GUIDING ASSUMPTIONS

In educational research, it is important to make assumptions about pedagogy explicit. This research is grounded in constructivist educational theory. The following assumptions have been made throughout the study.

1. Teachers are learners. Rather than tell teachers what to think about environmental education, it is appropriate to begin the curriculum development process with teachers' conceptions of environmental education.
2. Environmental education curriculum development is not for environmental education specialists only. Teachers have special knowledge about their students, school and community. They are likely to know the kinds of activities their students will enjoy, and are able to take advantage of local opportunities.
3. Teachers tend to use environmental education activities and curricula that have been developed or used by other teachers and have been tested in the classroom.
4. Placing environmental education curricula on the Web requires hardware, software and technical skills that many teachers do not have. It is appropriate to team educators with technology specialists (i.e., Web designers, programmers, artists, etc.) to place content online.
5. Because environmental education is not required in most U.S. states, any efforts made by teachers to integrate environmental education into curricula are commendable. Unless and until environmental education is made a priority in this country and curricular integration is required by state education agencies, it is likely that environmental education will continue to vary widely by teacher, school and geographic region.

SUMMARY

Environmental education is aimed at producing a citizenry that is knowledgeable about the multiple dimensions of environmental issues and has the skills and motivation to resolve environmental problems. Unless and until environmental education is made a priority in this country, comprehensive, systematic environmental education is not likely to occur. In the United States today, it is clear that environmental education in K-12 schools can be much improved.

An important barrier to integrating environmental education in K-12 curricula is teachers' lack of access to environmental education resources. The literature indicates that teachers are often disconnected to the environmental education curricula that exists.

The current wave education reform and the advent of mass communication technologies in schools create new opportunities for the infusion of environmental education in K-12 schools. As educators begin thinking and teaching in more integrative, thematic and multi-disciplinary ways, doors open for the study of environmental issues. Similarly, as more schools become connected to the Internet and Web, there are more opportunities to connect to a multitude of rich resources such as experts, databases, primary source materials, and other educators. Teachers may be able to use this medium to share ideas about environmental education curricula, activities, news and local or regional opportunities.

Because computer-aided environmental education is a new field, more research is necessary to bring the opportunities and limitations to light. There are many environmental Web sites available today, and it is likely that more will continue to be developed. However, very few focus on the special needs of K-12 teachers. If the Web

is to be used to connect K-12 teachers to the resources they seek, it is imperative that research brings to light the expectations, needs and perceptions of K-12 teachers for using this medium. This exploratory research will examine K-12 teachers' perceptions about environmental education and the Web to determine the feasibility of using this medium to share environmental education resources.

PREVIEW

The rationale for the research questions and hypotheses are further developed in Chapter 2—the literature review. Chapter 3 describes the methods used to answer the research questions and hypotheses. The results and analyses are presented in Chapter 4 and findings and recommendations are discussed in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

This literature review consists of three sections. The first section reviews the environmental education and curriculum development literature. The second section examines the education technology literature and highlights the promises and challenges to technology integration in K-12 schools. The third section provides an overview of the Internet and Web in K-12 education and reviews the status of computer-aided and online environmental education.

ENVIRONMENTAL EDUCATION LITERATURE

The Unique Role of Teachers

Classroom teachers are the gatekeepers of formal environmental education. Teachers are ultimately responsible for what is taught in the classroom (Childress, 1978; Eisner, 1985) and research indicates they influence their students' environmental attitudes (Buethe & Smallwood, 1987). Because most states do not mandate environmental education, it exists in curricula today to the extent that teachers want to include it (Disinger, 1998b). According to Stone, "If change is to come about, teachers can be the primary instigators of these changes. It is teachers who hold the key to the presently locked environmental education classroom door." (Stone, 1989, p. 159)

Barriers to Environmental Education

However, teachers face many significant barriers to integrating environmental education into the existing curricula. Ham and Sewing (1988) identified four general categories of barriers: conceptual, logistical, educational, and attitudinal. Conceptual barriers result from the lack of consensus about the scope and content of environmental education (Knapp, 1972; Samuel, 1993). For example, teachers may not be sure what environmental education is or how to create instructional objectives. Logistical barriers stem from teachers' perceived lack of time, funding, curricular resources and support (Childress, 1978; Groves, Cauley & Smith, 1978; NAEEAC, 1996; Samuel, 1993; Simmons, 1989; Volk, Hungerford & Tomera, 1986). For example, teachers must take additional time out of the school day to find environmental education resources and plan how they will be used in the classroom. Educational barriers arise from teachers' own misgivings about their competence to teach environmental education (Samuel, 1993). Many teachers have had little or no background in environmental education and are reluctant to teach it in their classrooms. Finally, attitudinal barriers stem from teachers' attitudes about environmental education and science instruction (Clark, 1975; Disinger, 1993; Hungerford, 1975; Ritz, 1977). For example, many teachers believe that science is the most appropriate subject for environmental education integration. This conception precludes them from integrating environmental education into language arts, social studies and other non-science subjects.

One of the logistical barriers most often cited in the literature is teachers' lack of access to environmental education resources. There is a need to develop more classroom curricula and there is a concomitant need to connect teachers to the materials that already

exist (Childress, 1976; Culen, 1998; Simmons, 1989). A recent report published by the National Environmental Education Advisory Council (1996) found that one of the greatest challenges for environmental education is limited access to materials and information on programs. Additional studies similarly conclude that teachers lack access to environmental education resources.

- Champeau, Gross and Wilke (1980) surveyed Wisconsin teachers about their perceptions of the 'Goals for Curriculum Development in Environmental Education' as put forth in a document by Hungerford et al. in 1980. They found that the majority of teachers in central Wisconsin believed the goals to be an important component of educational programs but lacked the training or instructional resources to accomplish them.
- Volk and Tomera (1986) surveyed environmental educators and concluded there is an immediate and critical need for the development of new curricula which address the goals for environmental education.
- Wilson and Smith (1996) examined the education literature from the 1970s to the 1990s. They concluded that teachers need access to information, guidance and resources to infuse environmental education into all areas of the curriculum and they are unable to use the formal education literature as a resource.
- Beiswanger, Sturges and Jones (1991) surveyed Wyoming educators on their knowledge of water topics and incentives to include water topics in the curricula more often. They found that pre-developed materials, hands-on

activities and software specific to grade level would serve as important incentives to teachers.

- Lane, Wilke, Champeau and Sivek (1994) surveyed Wisconsin teachers about their perceived competencies in and attitudes toward teaching environmental education. Teachers indicated that inservice training and better access to resources would most influence them to teach environmental education more often.
- Groves et al. (1978) surveyed teacher education students enrolled in natural resource courses to determine their knowledge of forestry topics. They found there is a need to increase teachers' awareness of the availability of different educational materials.
- Samuel (1993) examined the process and problems of integrating environmental education into a secondary school. She found that materials for environmental education have been developed but they are scattered and take an investment of time and funds to accumulate.

Quality of Environmental Education Curricular Materials

Also at issue is the need for high quality materials. Much curricula has been developed by government, educational institutions, non-profit organizations and public and private commercial entities. Not only is there duplication of curricula but the quality of curricula varies greatly (NEEAC, 1996). This creates additional burdens for teachers by requiring them to sift through and weed out inappropriate or poorly designed materials. To address such problems, the North American Association for Environmental Education (1996) published a document *Environmental Education Materials: Guidelines*

for Excellence. The purpose of the document is to help curriculum developers and evaluators make informed decisions about designing and selecting curricular materials. However, the guidelines are strictly voluntary and only available for purchase from the North American Association for Environmental Education. It is not known how widely distributed this document is at this time.

A relatively new phenomenon related to the quality of environmental education curricula is the recent "backlash" against environmental education by conservatives. In their 1996 book *Facts Not Fear* written for parents who are "worried about what our children are learning" (p. 1), Sanera and Shaw write,

> Environmental activism is the latest in a series of social reforms championed in our schools. Schools are fighting the war on drugs, encouraging physical fitness, fostering self-esteem, teaching about sex—you name it. And now our children are supposed to save the Earth (p. 13)

The debate about what to teach in environmental education is not new. Two decades ago Kauchak, Krall and Heimsath (1978) wrote about the need for education not "indoctrination." Indoctrination implies telling learners what to think; education is presenting the learner with a balanced view of the issue in question. According to Kauchak et al. (1978), "Most controversies in the environmental education curriculum can be viewed as clashes between competing value orientations" (p. 21). This is clearly evident today.

Both anti- and pro-environmental education advocates bemoan the fact that any organization can develop "environmental" curricula to provide to K-12 schools. However, unlike textbooks and other educational materials, there is no official review process for such materials (Lapp, 1994). Thus, a corporate curriculum that expounds upon the benefits of nuclear power can find its way into schools just as easily as curricula

created by anti-nuclear groups. Today, school curricula is being developed by many corporations including Shell, the American Plastics Council and the American Nuclear Society (Manilov & Schwartz, 1997). Similarly, pro-environmental groups like the National Wildlife Federation, the Sierra Club and the National Audubon Society make curricula available to schools. The problem, according to Adler (1993) is that,

> ...few educators take the time to investigate these matters for themselves. Many classroom materials are developed by, or under the advisement of, leading environmental lobbying organizations. The Sierra Club has been publishing environmental materials for children since 1977 and the World Resources Institute's teacher's guide is used in schools around the world. This results in materials that present the environmental view most conducive to these organizations' political agendas (p. 13).

The current controversy raises the question, Whom should develop environmental education curricula?

Curriculum Development in Environmental Education

Traditionally, environmental education content "specialists"—often non-teachers—have developed formal environmental education curriculum to be used in classrooms. It is only recently that more discussion in the environmental education literature has focused on the role of the teacher in the curriculum development process (Cantrell, 1993; Hart, 1993; Robottom, 1993). There are many factors that may discourage teachers from becoming involved in the process. For example educational paradigms and perspectives regarding teachers' roles, the lack of academic environmental education standards, and teachers' lack of environmental education professional development opportunities may all be contributing factors.

For decades the environmental education literature has indicated that teachers desired curricula (Beiswenger et al., 1991; Childress, 1978; Groves et al., 1978;

Simmons, 1989). In response, environmental education curriculum developers created pre-packaged products for teachers to use in their classrooms. Developers assumed that pre-packaged curricula could be easily integrated into teachers' existing curricula. However, follow-up studies and surveys indicated that teachers were not using the curricula to any great extent (Childress, 1978; Ham, Rellergert-Taylor & Krumpe, 1988). Ham et al clearly state the problem with this approach.

> It was hoped that if teachers understood that environmental education was both multidisciplinary and interdisciplinary, they would feel that the time spent planning and conducting environmental education was time also spent on their usual subjects. Still, teachers are continually pressed to emphasize the basics, and each subject is usually taught separately, from a pre-planned curriculum. Interdisciplinary environmental education activities presented in ready-to-use-packages to a teacher who already has a set plan for teaching the basic subjects could indeed be seen as taking extra preparation time and additional classroom time. (p. 31)

In addition to problems associated with pre-packaged curricula, teachers are confused about how environmental education fits into the overall curriculum. This is a result, in part, to the lack of academic standards for environmental education (Simmons, 1998). Teachers are often required to teach specific content for math, science, and language arts that is based on academic standards. These standards are then translated into instructional and behavioral objectives that further clarify teaching and learning expectations. Although voluntary standards for environmental education are in development, at the present time, no specific academic standards exist for environmental education. According to Simmons (1998),

> A set of standards not only provides educators in general, and the field of environmental education specifically, with an understanding of the knowledge and skills that lead to environmental literacy, but a vision of environmental education's place within the school curriculum (p. 73)

If teachers are to integrate environmental education into their existing curricula, it is imperative that they understand how different environmental education concepts and activities correspond to standards in other subjects. The development of environmental education standards may help teachers more easily identify points of integration within their curricula and help them to make transdisciplinary connections with students.

Another factor affecting teachers' involvement in the curriculum development process is the teachers' level of environmental knowledge and education. Environmental education teacher "training" traditionally has involved persuading teachers to adopt ideas and behaviors determined by external "authorities" and encouraging them to implement particular environmental education activities in their classrooms (Stevenson, 1993). In other words, teachers have been treated as "curricular consumers rather than professional educators" (Wade, 1996, p. 14). According to Hart,

> It is apparent that environmental educators have focused their attention on the development of environment-related goals and have neglected to probe deeply enough into pedagogy, particularly at the level of the teacher. The process problem remains in environmental education because environmental educators have not focused on the real-life working conditions of teachers, their perceptions about change, and the support system needed to facilitate change in teaching method demanded by these new curriculum materials. (Hart, 1993, p. 118)

Again, the role of the teacher is critical to the success of environmental education programs. Stevenson (1993) argues that the failure of environmental education curriculum efforts is a result of neglecting teachers' knowledge of what can be implemented in their own settings. Other researchers have concluded similarly:

- A survey of environmental educators found that one area for improvement is to better understand "where teachers are coming from" including the demands

on teachers and the kinds of activities that can be practically implemented in the classroom (Wade, 1996, p. 13).

- Samuel (1993) describes the implementation of a new environmental education program in a secondary school. She concludes that teacher participation in decision making is imperative. Teachers need time to "explore the assumptions and philosophy behind environmental education and to assess it in terms of their own values, expectations, and teaching patterns" (p. 28).
- Suggesting new directions for environmental education research, Hart (1993) concludes that the central problem in environmental education change is the lack of teacher involvement and participation; "Authentic teacher participation in curriculum research and development must be supported" (p. 119).

According to Wade, there has been a goal to infuse environmental education into schools, but there has not been a corresponding goal to infuse environmental education with education (Wade, 1996).

There has been much written in the education literature about curriculum development, educational paradigms and planned change in schools. Although an extensive review is beyond the scope of this research, it is important to highlight fundamental concepts related to each to better understand why new approaches to environmental education curriculum development and teacher professional development are needed.

Curriculum Development and the Education Literature

According to Gay (1980), curriculum development is

> ...far from being a purely objective or scientific enterprise that follows a universal, predetermined planning process; curriculum development is more of an "artistic" endeavor that is often chaotic, political, and emergent. It embodies a combination of intuition, individual initiative and creativity, trial-and-error experimentation, social politics, and educated guesses (p. 120).

The pedagogical perspective one subscribes to has profound implications for curriculum development. Educational theorists have described a variety of perspectives in the literature. For the purpose of this discussion, three broad perspectives will be outlined and their implications for curriculum development noted.

The Technical Perspective

The technical perspective assumes that knowledge exists outside of the learner. All can discover the "truth" through objective, scientific study. The ends (i.e., knowledge, facts) are known, therefore curriculum development is a careful process of planning the sequential steps needed to attain the desired ends. Curriculum is developed by "specialists" who are able to determine the most effective ways to organize learning on a particular topic because they have studied the topic in-depth. Traditionally, this perspective has dominated the thinking and research approach in environmental education (Hart, 1993; Robottom & Hart, 1995; Stevenson, 1993).

The Interpretive Perspective

The interpretive perspective assumes that knowledge is a social construction and that all learners are engaged in a continual process of meaning-making. The learner generates knowledge through interactions with others. As such, there are multiple realities that exist and understanding the learning context is essential. From this perspective, the purpose of curricula is to help learners investigate their world and come to terms with their discoveries; curricula is problem-centered (Eisner, 1985). Curricula

may be developed by someone external to the teacher, but the teacher will always interpret the curricula and re-present it to students based on his or her own knowledge.

The Critical Perspective

The critical perspective critiques the sociopolitical structures that serve to oppress individuals. In order to free themselves, students must look critically at who is in control, and determine what power structures perpetuate social inequity and injustice. Power relationships are recognized only through praxis; reflection and action (Friere, 1970). Individuals must be self-critical and self-aware to reflect on power structures; action is reflexively generated. The focus from this perspective is on emancipation from repression. The emphasis in curriculum development is on questions of power rather than subject matter or content. Curricula is emergent and is developed ad hoc by the students and teachers together (Hart, 1993).

Each of the three orientations described—Technical, Interpretive, and Critical—advances particular assumptions about the nature of knowledge, learning, teaching and curriculum development. These assumptions greatly affect what is included or excluded from the curriculum. Not surprisingly, curriculum developers (both teachers and non-teachers) have certain agendas in mind when designing curricula and their perspective influences all aspects of the educational process. In practice, however, it is likely that the curriculum developer or teacher chooses from several perspectives to suit the purposes at hand.

In environmental education today, there is a trend toward research that reflects more and diverse perspectives including the interpretive and critical views. Although one's theoretical orientation toward education influences curriculum development, there

are other powerful forces that affect the acceptance or rejection of curriculum innovations in schools.

Change Processes in Schools

There are many forces shaping curriculum change both within and outside of the school. New educational programs and curricula are continually being developed and schools are regularly engaged in the task of implementing multiple innovations simultaneously (Fullan, 1993). Essentially, schools are in a perpetual process of social change.

According to Rogers and Shoemaker (1970), social change involves three sequential steps: innovation, diffusion, and consequences. Diffusion is the process by which new ideas are communicated to others. For the purposes of this research, curriculum adoption includes the process of diffusion. Change occurs on two levels—at the individual level, and within the social system. Rogers and Shoemaker (1971) suggest that the transfer of ideas occurs most frequently between a "source" and "receiver" who are homophilous—the degree to which pairs of individuals who interact are similar in certain attributes such as beliefs, values, education and social status (Rogers & Shoemaker, 1971, p.14). Thus, an effective strategy for the diffusion of curricular programs might be to encourage teachers to share (i.e., "transfer") new curriculum ideas to other teachers.

Hall and Hord's research (1987) supports this. They studied the adoption of curriculum innovations by teachers and developed a "concerns-based" theory of change. The theory proposes that teachers perceive innovations differently based on the considerations and concerns they experience in the classroom. For example, beginning

teachers tend to be concerned with class control, their own content adequacy and evaluations by supervisors. More experienced educators are likely to have concerns about the impact of their teaching on students and therefore may be more receptive to innovations.

The theory defines four developmental stages of concern through which teachers proceed, as they become more experienced.

> Concerns theory and research reveal that concerns change over time in a fairly predictable, developmental manner. If we can predict how concerns will change throughout the phases of the change process, we can design in-service and other intervention activities in advance. Those interventions could be designed to address the different concerns as they emerge (Hall & Hord, 1987, p. 70).

In conclusion, the researchers recommend that change facilitators consider the different needs of teachers when delivering teacher interventions. Essentially, the "source" (i.e., change facilitator) must understand the concerns of the "receiver" (i.e., teacher) if communication and transfer of ideas is to be successful.

Change also occurs at the societal level. There are other forces beyond the individual which affect the adoption of an innovation (Gay, 1980). These forces include local, state, and national educational organizations and agencies, political interest groups, school boards, parent groups and community organizations. The literature indicates that too often change is implemented or initiated in schools based on flawed assumptions. Some of the assumptions that lead to failure include the following ideas:

- That you can mandate what matters (Eisner, 1985; Fullan, 1993). Implementing change requires skills, creative thinking and committed action.
- That there is a "best way" to implement change (Czajkowski & Patterson, 1980; Fullan, 1993). Rather than following a "blueprint," change is a process

that is dependent upon the organizational culture of the school. The "best way" to implement change will likely vary dramatically by school.

- That schools are objects to be manipulated (Czajkowski & Patterson, 1980). The cultural and political dimensions of school communities are often overlooked.
- That people are resistant to change (Czajkowski & Patterson, 1980). People tend to adopt curricular changes when they see value added to the educational process.

According to Fullan (1993), important lessons have been learned about the school change process. First, rapid change does not work. It tends to create confusion, ambiguity and conflict. Similarly, Gay (1980) found most innovations took three to five years to be accepted and implemented. Second, every person is a change agent: "Only when individuals take action to alter their own environments is there any chance for deep change" (Fullan, 1993, p. 130). Third, connection to wider environments is critical to success. If schools are to be learning organizations and respond to the issues of the day, they must engage with and learn from the ideas of others in the broader educational community.

How, then, does school change occur? Czajkowski and Patterson (1980) describe three ways of initiating change. First, change can occur when school staffs note a discrepancy between what the curriculum is and what it could be. Second, an innovation may happen to be an attractive alternative to something currently done in school, and momentum for it grows. Third, the change is mandated.

Similarly, the authors propose three strategies for change: power, influence, and reason strategies. A power strategy usually emanates from the "top-down;" the school or teachers have little control over the decision to participate. Influence strategies are designed to persuade participants that the change proposed is a desirable one. Reason strategies appeal to the participants' commitment to the change itself. Teachers see the need for the change and take the steps necessary to achieve their goal (p.168).

In summary, the path to curriculum change, acceptance, integration and adoption is complex. Given the findings from research on curriculum development, educational pedagogy, and school change, it is not surprising that environmental education integration to date has been less than successful. Teachers are expected to teach required curricula as well as integrate new curricula regularly. Where environmental education is not mandatory, curriculum change efforts should focus on the teacher as the individual change agent. Research shows that teachers are interested in teaching environmental education and believe their students would benefit from it (Champeau et al., 1980; Johnson, 1980; Lane et al., 1994) but face very serious time and resource constraints. Research also indicates that teachers are the gatekeepers for environmental education and as such, ultimately decide whether or not to integrate environmental education into the curricula. By using reason and influence strategies with teachers, it may be possible to affect positive change toward the increased integration of environmental education in K-12 schools.

K-12 EDUCATIONAL TECHNOLOGY LITERATURE

In February 1996, President Clinton announced "America's Technology Literacy Challenge," the goal of which is to make every young person technologically literate

(Clinton, 1996). He challenges Americans to meet this goal by addressing: (1) the need for teacher training and technical support, (2) the need for developing engaging software and online learning experiences that can be integrated into the school curriculum, (3) the need for access to modern computers for all teachers and students, and (4) the need to connect every school and classroom in the U.S. to the Internet. The President dedicated more than $2 billion in funding over the course of five years to achieve these goals. Clearly, the integration of new telecommunications technologies and other educational technologies is a priority for America's schools.

The Promise of Educational Technologies

There are many potential benefits to using technologies in education. Negroponte, Resnick and Cassell (1997) suggest that digital technologies will radically change how children learn, what they learn and whom they learn with. The authors propose digital technologies will encourage children to become more active, independent learners. Students will be able to tackle more complex tasks than previous generations of students in the "pre-digital" era. Finally, due to the "global connectedness" of digital technologies, students will become part of global knowledge communities collaborating with others around the world (Negroponte et al., 1997).

Jonassen (1996) believes that the computer can enhance students' thinking and learning. He suggests that computers should be used as "unintelligent" tools in the classroom with students providing the intelligence. Although computers can take massive amounts of data and display patterns or can make thousands of calculations per second, ultimately, learners must be able to describe and interpret the resulting output. In this way, computers can enhance students' critical thinking and analytical abilities by

freeing them from lower-order thinking skills like calculations or graphing, to focus on higher-order thinking skills like interpretation and synthesis.

Other benefits from using technology in schools include improving student motivation and learning, addressing students' different learning style needs, and exposing students to a wider world of information and experts (U.S. Congress, 1995). However, very little mention is made of teachers in the discussion of the benefits of technology. Potential benefits to teachers include encouraging them to use new teaching methods, increasing their sense of professionalism, and stimulating them to present more complex tasks to students (Means & Olson, 1994; U.S. Congress, 1995).

Although there are many compelling reasons to consider using technology in K-12 classrooms, there are significant barriers that must be overcome if technology is to become an effective educational resource for teachers and learners.

Barriers to Integrating Educational Technologies

There are many significant barriers to classroom integration of technologies identified in the literature. Among those cited most frequently and as most important are barriers relating to teachers. Specifically, teachers lack time to experiment with technologies, to attend inservice workshops and to develop curricula integrating technologies (Means & Olson, 1994; U.S. Congress, 1995; U.S. Department of Education, 1998).

Teachers must feel comfortable using technologies before they will use them as resources in the classroom. However, the investment in time to learn hardware and software is significant and training opportunities for teachers have been scant (Coley, Cradler & Engel, 1997). Research indicates that teachers dislike the current approach to

inservice education which is often short, "menu-driven" workshops or "injections of training" (Duffield, 1997; U.S. Congress, 1995). Often, teachers must learn to teach themselves to use technology if it is to be used at all.

Additionally, teachers need time to develop strategies to integrate technologies meaningfully into the curricula. They need time to determine how to use new technologies to help them meet instructional and educational goals. Curricular integration of technologies is essential if they are to be used effectively as classroom learning resources (Coley et al., 1997; Software Publishers Association [SPA], 1994). However, the U.S. Congress Office of Technology Assessment (OTA) found that curricular integration is a resource-intensive and time-consuming task (U.S. Congress, 1995). Other researchers suggest that, instead, short inservice workshops, teacher professional development opportunities should include authentic tasks like curriculum development (Barron & Goldman, 1994; David, 1994). This would give teachers the time needed to design ways to use and integrate technology meaningfully.

Other barriers include the lack of access to technologies, the high cost of technologies, the lack of on-site technical support, inconvenient scheduling of equipment, attitudinal barriers, and issues related to technology like copyright and access to objectionable materials (U.S. Congress, 1995).

It is evident that many of the barriers to integrating technologies into the classroom are similar to those for environmental education integration. As was the case for environmental education, the teacher has a critical role as the gatekeeper of technology (Cuban, 1986).

The Unique Role of the Teacher

The literature indicates that teachers are "essential" in realizing the full potential of technology (Clements, 1995; Solomon, 1986). Their attitudes influence students' attitudes toward technology (U.S. Congress, 1995). Furthermore, the ways that they choose to use technology determines overall instructional effectiveness (SPA, 1994). For example, a creative teacher can use even the most pre-programmed "drill and skill" software with students in effective ways. As the OTA reports, the challenge of integrating technology into classrooms is much more human than it is technological:

> ...it is about helping people, primarily teachers, integrate these technologies into their teaching as tools of a profession that is being redefined through the process (U.S. Congress, 1995).

History of Technology in Schools

Cuban's book *Teachers and Machines: The Classroom Use of Technology Since 1920* clearly illustrates that the classroom has hosted a succession of technologies including the textbook, chalkboard, radio, film, television and computers (Cuban, 1986). Often new technologies were conceived, planned and adopted for use in schools by non-teachers. In other words, the impetus for change came from the "top-down." Teachers were often singled out as inflexible and resistant to change and thus, blamed as the cause technologies were not used as widely—or as successfully—as they could have been. That is still the case today. Coley et al. recently reported, "Teachers are seen as part of the problem and are burdened with solving it" (Coley et al., 1997, p. 7)

Cuban's historical review illustrates that, in some areas, little has changed in the educational technology field. Ironically, the obstacles to integrating film in schools in the 1950s were much the same as those for integrating computers and telecommunications

technologies are in the 1990s. For example, barriers to film included teachers' lack of skills in using films and equipment, the cost of materials and equipment, the inaccessibility and difficulty scheduling equipment, and finally, difficulty finding the right film to fit the class or curricula (Cuban, 1986, p. 18). Similar cases can be made for obstacles to integrating instructional television, videos, and interactive video disks.

Cuban identifies the problem as non-teaching reformers and policy makers pushing technological innovations based on two flawed assumptions. The first assumption is that schools are like military organizations where orders are given from the top and executed faithfully in the ranks. The second assumption relates to adopting technologies to improve classroom "efficiency." This implies that teaching is a mechanical process of applying knowledge and skills to students. Both neglect the importance of the political and cultural forces present within the school.

Hodas' critical essay "Technology Refusal the Organizational Culture of Schools" (1993) suggests that schools are institutions designed to transmit information and authority and to inculcate certain values and practices while minimizing others. Only technologies that reinforce the existing power structures within schools will be adopted—and these may or may not be implemented at the classroom level. He argues that no technology is neutral:

> ...its values and practices must always either support or subvert those of the organization into which it is placed; and that the failures of technology to alter the look-and-feel of schools frequently result from a mismatch between the values of school organization and those values that are embedded within the contested technology itself. (Hodas, 1993)

While society may be rapidly adopting and using new technologies, schools are not necessarily "failing." Rather, they are doing the job they were created to do and have refined over generations—transmitting knowledge and values to America's youth.

However, some teaching practices have changed as a result of the introduction of new technologies. According to Cuban, only those technologies that solved problems defined by teachers as important have been adopted. Teachers ask very different questions of technology than policy makers, non-teaching reformers and scholars.

A recent study by Lowther and Sullivan (1996) supports this. They examined the perceptions of two groups—K-12 teachers and education technology faculty and graduates—and discovered a large number of significant differences between the teachers and technology groups. They found,

> Educational technologists clearly believe that they can produce more effective instructional programs than teachers, probably because of their training and their use of a systematic design and development approach. Teachers, in contrast, believe that they can produce better instructional programs than instructional designers, most likely because of their greater familiarity with the students and the schools (p. 17).

Their study underscores the need to involve teachers in educational technology planning and decision making.

The literature indicates that teachers' attitudes about technology must be taken into account if innovations are to be successful (Coley et al., 1997). Technological innovations are more effective when teachers feel ownership (Means & Olson, 1994), and school programs are likely to have greater credibility among teachers if it is clear that one or more teachers played a role in their development (Lowther & Sullivan, 1996). The success of technology integration depends on the active involvement of teachers (U.S. Congress, 1995).

In summary, the literature review for educational technology indicates that teachers are ultimately responsible for using technologies in the classroom. Teachers' attitudes strongly affect how students' perceive technology. Similarly, teachers' technology use determines what and how students learn with technology. Teachers are the most important change agents in implementing technology but also face significant time constraints and barriers to integrating technology effectively. Teachers' perceptions and attitudes about using technologies in the classroom should be examined when devising curricular technology innovations.

THE WEB AND ONLINE ENVIRONMENTAL EDUCATION

In the past few years, the Internet and Web have grown phenomenally. The Internet is often referred to as the global network of computers. Although the precursor of the Internet, Advanced Research Projects Agency Network (ARPANet), had been in development by the U.S. Department of Defense since the 1960s, it is relatively recently that Internet use has become widespread. The Internet allows users to connect to a vast array of global information resources. Some computers act as hosts that "serve" information to others, while other computers act as terminals that can only access, not serve, information on the Internet. In 1995, the estimated number of Internet hosts was 5.85 million. As of January 1998, that figure jumped to 26.1 million (Network Wizards, 1998).

Similarly, the Web has grown exponentially in the 1990s. According to Gray (1996), in 1993 the Web had a doubling period of less than 3 months; by 1996 the doubling period had slowed somewhat but was still less than 6 months. The Web, first conceived in 1989 by Tim Berners-Lee and made popular by the advent of the Mosaic

browser in 1993, can be thought of as a way of organizing the information available on the Internet (Cailliau, 1995; Hahn & Stout, 1994) or as,

> A system of Internet servers that support specially formatted documents. The documents are formatted in a language called HTML (HyperText Markup Language) that supports links to other documents, as well as graphics, audio, and video files. This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the Web (AdSmart Corporation, 1997).

Special software called Web browsers allow users to graphically view and interact with information. The Web enables publishers to hyper-link information across other Web sites. In addition, the Web programming language (hypertext markup language—HTML) is relatively easy to learn and allows virtually anyone to become a Web publisher. These are a few of the advantages to using the Web that have contributed to its explosive growth and popularity.

The Web: A New Digital Medium

The Web is a new digital medium and as such it is worth noting the its affordances and limitations as identified in the literature. Norman (1993) defines "affordances" as the possible functions of a technology; what people perceive it can do. Some of the affordances of the Web include providing users with (1) a volume of diverse information, (2) current information, (3) data sets, and (4) a wealth of visual information (Windschitl, 1998). Its simple programming language (HTML) allows virtually anyone to become an information provider. As such, the Web allows users to retrieve, publish and interact with information provided on the Internet. Lightner, Bose and Salvendy (1996) predict,

> As more users join the Web one realizes that its future diffusion is beyond our imagination—undoubtedly the World Wide Web promises to become a part of our everyday existence (p. 996).

However, using the Web can be challenging as well. Searching for information online is difficult and time consuming (Lightner et al., 1996). Bandwidth issues are also of concern. Bandwidth refers to the amount of information that can be transferred from one computer to another. Users are connecting to the Web at a variety of speeds and information providers are sending information that require increasing bandwidth capabilities (Levi & Conrad, 1996). The end result is that some users will have to wait longer than others to download information or to view a Web page. A 1997 study of Internet delays found that users prefer multimedia sites over text-only sites, but they are unwilling to tolerate the substantial network delays associated with delivering multimedia (Sears, Jacko & Borella, 1997). Pitkow and Kehoe have been conducting online surveys about the Web since 1994. Their findings from a 1996 survey indicate that the most important problem with the Web identified by respondents was the time it took to download pages and information (Pitkow & Kehoe, 1996). This was followed by users' inability (1) to find pages they knew were available, (2) to organize information gathered and (3) to return to a page once found.

Another problem with the Web is the lack of representative users or a definable Web population. Pitkow and Kehoe (1996) studied emerging trends of the Web and found that "substantial shifts in the characteristics of Web users have occurred" (p. 3). Specifically, more users responded to their survey representing diverse segments of the population (i.e., more women and more older and younger respondents than in previous surveys). Levi and Conrad (1996) studied Web usability and concluded that it is difficult

to predict or measure the highly diverse Web user population. This has important implications for the design of Web sites. It means that users visiting Web sites have many and varied expectations for design, content and interactivity, and are connecting to the site with a wide range of computers, monitors and connection speeds.

Web site usability and marketing research indicates that Web site design is critical to the success of any site. According to Sano (1997), Web site publishing is a design process and the technical constraints and limitations of the Web must be taken into consideration. Eighmey (1997) studied users browsing different commercial web sites. He concluded that users are assisted by information placed in an enjoyable context, by clearly identified strategic purposes of the site, and by efficiently executed designs. Other findings from research indicate that

- people make a direct connection between the perceived finish of Web pages and the perceived reliability of the information provided (Levine, 1995).
- most people do not read on the Web; they scan words and links (Nielsen, 1997b).
- people tend to value content over clever format and design (Levine, 1995)
- Web writing should be short, succinct and easily scanned (Levine, 1995; Nielsen, 1997a).

Given the need for careful design and an understanding of Web limitations, it is unrealistic to expect K-12 teachers to design and maintain educational Web sites as a means of integrating technology into the curriculum. Instead, teams of developers including educators, designers, programmers and the like should plan and design sites appropriate for education (Norman, 1993; Sugrue & Kobus, 1997).

Using the Web in K-12 Schools

The number of schools accessing the Web and publishing Web sites is growing exponentially. Beginning with a few sites in 1994, by March 1998 there were approximately 7,685 school Web sites (Carlson, 1998). It is estimated that nearly 82 percent of all K-12 public schools in the United States are online (Editor & Publisher Interactive, 1998; Hamilton, 1998); and 98% of all schools own computers (Coley et al., 1997). Internet access does not necessarily mean classroom access. Making the Internet accessible to all students in all instructional rooms will require much effort (U.S. Department of Education, 1998) and is the next national goal for increasing accessibility. Those schools furthest behind in both Internet access and computer access tend to be schools with the highest proportion of economically disadvantaged and minority students (Coley et al., 1997; Editor & Publisher Interactive, 1998).

Since the Web is relatively new, educational uses and applications are continually in development. As with all innovations, there are challenges and opportunities. With the Web, teachers have the potential to engage students in unprecedented learning opportunities. For example, the Web can be used to simulate hands-on activities that would otherwise be too costly, dangerous or unpleasant (Ellsworth, 1997) such as online frog dissections or viewing "virtual fly-throughs" of the human body. Students can participate in virtual field trips to explore underwater shipwrecks, past civilizations, wildlife and ecosystems, and the like (DeWall, 1989; Holzberg, 1996). Finally, students and teachers can connect with others around the globe to explore particular topics of interest collaboratively. The International Education and Resource Network (I*EARN)

uses the Internet to widen students' awareness of global social problems and encourages them to contribute efforts in solving these problems (Copen, 1995).

In more general terms, the Web can bring the world to the school by connecting students and teachers to a wealth of online resources. At the same time, though online publishing, the Web can bring the school to the world. The Web can be used to support multi-site collaborative learning. It can also be used to prepare learners for tasks and activities they will complete in class, and can provide follow-up to those activities as well (Ellsworth, 1997).

The Web and Internet can be integrated into classrooms in more specific, practical ways as well. Teachers can integrate the Internet or Web by creating a Web page for the class guiding students to relevant sites, by "bookmarking" relevant sites on the browser, or by downloading and printing out Web-based information for students (Braun, 1997). Students can email questions to other students or experts, teachers can subscribe to multiple listservs to learn more about Web-based curricular opportunities, or teachers can post questions to online newsgroups. All of these actions assume a certain level of skill on the part of both students and teachers—skills that many may not yet possess.

There are also limitations to using the Web in schools. First, there is a lack of high-quality educational material on the Web and finding appropriate curricular materials is time-consuming (Mendels, 1997). Second, there is such a vast amount of information available–and so many information publishers online–that determining the accuracy and value of information can be challenging for teachers and students (Braun, 1997). Finally, as with other educational technologies, many teachers lack the technical skills to use the Web effectively in their classrooms (Carlson, 1998; Hamilton, 1998; Mendels, 1997).

The remainder of this chapter will review the status of computer-aided environmental education and online environmental education Web sites.

Computer-Aided Environmental Education

Computer-aided environmental education is the "utilization of computer technology to promote the goals and objectives of environmental education" (Rohwedder, 1990). It is an emerging field in environmental education and research is needed to fully understand the promises and challenges associated with it.

Four potential problems include inequality of access to technology, environmental substitution, unfounded euphoria, and environmental impact (Rohwedder, 1990). To be effective, computer-aided environmental education must be affordable and accessible to all. Computer-based experiences should not substitute for "real world" environmental experiences. Instead, they should be used as catalysts for field instruction and outdoor exploration. "Unfounded euphoria" refers to the need to critically examine and evaluate computer-based environmental education software and projects. Although the "promises" of technology may be enticing, the realistic effects of any technology application in environmental education should be carefully analyzed. Finally, computer-aided environmental education should be held to the same environmental impact assessment that would be conducted on any other technology. As more people use computers, it is important to examine the costs to the environment that result.

Rohwedder's book (1990) *Computer-aided Environmental Education* highlights several examples of the varied ways computers have been used in environmental education. Computers have been used in environmental simulation and modeling projects as well as in telecommunications and collaborative learning projects. Interactive

software programs (i.e., hypermedia) were also described as a valuable way educators were using computers in environmental education. These projects and programs represented state-of-the-art technology and applications at the time. However, in the eight years since the book was published, much has changed in terms of technology and applications—including the advent of the Web and reduced costs for other new technological applications such as Virtual Reality.

Taylor and Disinger (1997) studied the application of Virtual Reality (VR) software programs to environmental education. They surveyed 400 environmental educators by mail and 40 VR developers by electronic mail to determine the acceptability and potential role of VR in the field of environmental education. Both groups selected the same VR applications as "most beneficial" to environmental education. They were: (1) explore existing places and things to which students would not otherwise have access, and (2) explore real objects that without alterations of scale in size and/or time could not otherwise be effectively examined (p. 40). The two groups disagreed on applications thought to be least useful, however. The authors conclude that if VR is to become an effective educational tool, educators must become actively involved in its development while it is still in its infancy.

Other than this recent VR study and Rohwedder's book, there have been very few computer-aided environmental education research studies published in the literature. Clearly, more published studies in this field are needed to advance the knowledge base on this important and emerging topic.

Online Environmental Education

At the time this dissertation was written, virtually no published research studies on Web-based environmental education projects were found in reviewing the environmental education literature. There are scattered online projects highlighted in educational technology journals such as the GLOBE Project and the JASON Project that apply to environmental education but do not necessarily focus on developing the knowledge, skills and attitudes of learners that are the goals of environmental education.

The GLOBE Project (Global Learning and Observations to Benefit the Environment) was launched Earth Day 1995 by Vice President Al Gore. The purpose is to encourage students to make scientifically sound measurements and observations about their environment and to share that data with others via state-of-the-art communication systems (Pyke, 1995).

Similarly, the JASON Project began in 1989 and also uses state-of-the art technology including satellites, robotics, fiber optics and computers to broadcast live explorations of various unique environments (DeWall, 1989). The first event in 1989 featured an exploration of the *Titanic*. Currently, on its tenth exploration, the 1998 JASON Project features an exploration of the rainforests of the Peruvian Amazon (JASON Foundation, 1998). Both projects provide curricula for teachers to use with students in the classroom however, it is not clear whether or not educators were involved in the development and design of curricula.

A cursory keyword search of the Web for "environmental education" will elicit literally tens of thousands of documents related to the topic. Although there are certain to be many sites that focus on formal environmental education in schools, finding them is

difficult and time consuming. There are very few comprehensive environmental education sites—and of those that exist, almost none focus on providing information for K-12 teachers specifically. Many environmental education sites focus on a particular topic such as sea turtle migrations or weather patterns, for example. Teachers can find curricula at sites of national environmental organizations such as The National Wildlife Federation (http://www.nwf.org/), The Rainforest Action Network (http://www.ran.org/) and The National Audubon Society (http://www.audubon.org/) as well as at the Environmental Protection Agency (http://www.epa.gov/epahome/students.htm). But, again, finding the resources and determining how to integrate them into existing curricula is time-intensive.

EE-Link (http://eelink.net/) was one of the earliest environmental education sites and continues to be one of the most comprehensive on the Web. The new, reorganized site is tailored to the needs of three groups—teachers, students and environmental education professionals. Teachers can find general information about environmental education goals as well as searchable databases for curricula. Another early and comprehensive site is Envirolink (http://www.envirolink.org). It maintains a library of environmental education resources categorized from A to Z, but is not focused on the needs of K-12 teachers.

While this review of Web sites is by no means comprehensive or even representative, it highlights the difficulty of finding environmental education resources on the Web at present. As indicated previously in this chapter, most schools are connected to the Internet and Web and access is expected to increase within the next few years. However, most teachers simply do not have the time to invest looking for

resources even if they believe environmental education is important and would benefit their students. It is clear that a gap exists between the environmental education resources available on the Web and the needs of teachers to find and access those resources in a timely and organized manner. Research is needed to explore teachers' attitudes toward using the Web to access environmental education resources, to learn how teachers envision future environmental education sites and to identify their expectations for sites offering environmental education curricular resources.

SUMMARY

The literature in both environmental education and educational technology highlights the essential role of teachers. Teachers are ultimately responsible for what is taught in the classroom and as such, teachers are the key to curriculum change.

The challenges to integrating environmental education are significant—even for teachers with a strong desire to teach about the environment. The literature reveals that involving teachers in the environmental education curriculum development process and improving access to environmental education resources is critical. If teachers can connect with like-minded teachers, find sample activities and lesson plans, and learn about environmental education goals and objectives, they may be more likely to integrate environmental education into their curricula.

The Web promises to be an essential educational resource for teachers now and in the future. It is possible that this medium could enable some teachers to connect to environmental education resources they desire. However, at present, very few comprehensive environmental education sites exist that are tailored specifically to the

needs of K-12 teachers. Further research is necessary to determine if teachers desire Web-based environmental education resources.

Published research in Web-based environmental education is virtually non-existent at present and is urgently needed. This literature review provides a rationale for the further exploration of the use of the Web as a means to connect teachers to environmental education resources.

CHAPTER 3

RESEARCH METHODOLOGY

OVERVIEW

This study was conducted in three phases. The first phase consisted of a self-administered mail survey of teachers to confirm that further research of educators' use of the Web in environmental education was warranted and to verify that teachers had access to Internet and Web technologies in their schools. The second phase of research consisted of designing and developing a pilot Web site that highlighted two teachers' environmental education lesson plans and curricula. This was followed by the third phase of research—an online, Web-based survey—which asked respondents to indicate their level of access to various environmental education resources, their attitudes toward environmental education and their attitudes toward using the Web in education.

PHASE 1: THE SELF-ADMINISTERED MAIL SURVEY

Purpose

The purpose of the mail survey was twofold. First, the survey would determine whether or not teachers had the technological capacity (i.e., hardware, software and Internet access) to engage in this research. Second, the survey would establish whether or not teachers' level of interest in environmental education warranted further research on this topic.

Research Questions Addressed

The research questions addressed by this methodology are:

1. Is there sufficient evidence to suggest that Michigan teachers are interested in environmental education?
2. Is there sufficient evidence to suggest that the proposed research is technically possible (i.e., do Michigan schools have the necessary hardware, software and Internet access)?

The results will be discussed in detail in Chapter 4, however, the data indicated that teachers were interested in environmental education and had the hardware, software and Internet/Web access necessary for the proposed research study.

Rationale

There are several advantages to the self-administered mail survey method. Surveys are excellent data gathering techniques (Singleton, Straits & Straits, 1993). They are useful in describing the characteristics of large populations and can make sampling large populations feasible (Babbie, 1995). They are flexible in that many questions can be asked about a particular topic to elicit a range of attitudes and beliefs. Mail surveys in particular tend to be less expensive than other types of survey methods and are relatively quick and easy to administer.

Some disadvantages to this method include lower response rates than with other survey methods and susceptibility to "reactivity" (i.e., respondents may give socially desirable answers). In addition, surveys can not measure behavior; "they can only collect self-reports of recalled past action or hypothetical action" (Babbie, 1995, p. 274). In

exploratory studies such as this one, surveys can indicate associations between variables but cannot easily establish cause-and-effect relationships (Singleton et al., 1993).

Because the purpose the first phase was to quickly and easily establish whether or not the proposed research was technically possible and of interest to teachers, the self-administered mail survey was selected as the most appropriate method.

Sampling Procedure

Sample Selection Criteria

Fourth grade teachers in Michigan were selected as the target population for the first two phases of this research because all share a common state-mandated curriculum that includes academic standards relevant to environmental education. For example, the Michigan social studies content standards include "strands" such as Human/Environment Interaction, Global Issues and Events, and Individual and Household Choices (U.S. Department of Education, 1998) that are directly related to environmental education. Because all fourth grade teachers prepare their students for required exams that test content standards, it was assumed that these teachers might have a particular knowledge of and interest in environmental education that teachers of other grade levels might not share.

Sample Selection Process

All fourth grade teachers in ten local school districts in Ingham County, Michigan, were surveyed between February and May 1997. Based on the 1997 Directory of Ingham County Schools, each school was contacted, the survey was described to a secretary or administrator, and the names of fourth grade teachers were requested for direct mailing purposes.

Data Collection Methods

The mail survey requested respondents' views on such matters as:

- Teaching environmental education;
- Developing curricula for environmental education;
- environmental education inservice education experiences;
- Access to computers and Internet in schools and classrooms;
- Types of software programs available to teachers and students; and
- Computer inservice education experiences.

Direct questioning was used in the survey. It was organized as follows:

1. Section 1: Environmental Education – consisted of seven questions about teaching environmental education, finding resources, receiving inservice education and developing curricula.
2. Section 2: Computers in Education – consisted of six questions about access to computers, the Internet and the World Wide Web, availability of different types of software programs, respondents' method of learning software, and ways computers are used in instruction.
3. Section 3: General Information – consisted of eight questions about respondents' teaching experience, educational background, ethnicity, gender, age and school community.

Pre-test/Evaluation

The Ingham County School District's technology coordinator, a statistics professor and the doctoral research committee reviewed the survey. Revisions were made based on comments received and subsequently mailed to teachers.

Permission

After receiving approval for the survey from the University Committee on Research Involving Human Subjects in February 1997, schools were contacted to request permission to mail surveys to fourth grade teachers. In some cases, school administrators required a faxed version of the survey be sent to them for approval prior to mailing surveys directly to teachers. Each of the following ten school districts granted permission: Dannsville, East Lansing, Haslett, Holt, Leslie, Okemos, Stockbridge, Waverly, Webberville and Williamston.

Each fourth grade teacher was mailed a cover letter, consent form, survey and postage-paid return envelope (See Appendix A).

Recording of Data

Data from the mail surveys were entered into SPSS for Windows Version 7.5. The frequencies, percentages, means, and standard deviations were computed to determine whether or not the majority of respondents had (1) an interest in environmental education, and (2) access to the hardware and software necessary for the proposed Web-based research project.

PHASE 2: TWO DESCRIPTIVE CASES

Purpose

The purpose of this phase of the research was to (1) examine the environmental education curriculum process of two practicing fourth grade teachers and (2) to generate teacher-developed environmental education content to place on the Web for others to review and comment on in Phase 3.

Research Questions Addressed

The research questions addressed by this methodology are:

1. How does each teacher approach (i.e., begin) the environmental education curriculum development process?
    a) Do teachers begin with curriculum standards, selected activities or students' suggestions?
2. Which environmental topics does each teacher select as central to the curriculum development process?
    a) What can be learned about teachers' conceptions of environmental education based on the topics they choose to teach?
3. Into which subject areas are environmental concepts infused?
    a) Do teachers select science only, or other subject areas?
4. What types of resources do teachers use to help them develop environmental education curricula?
    a) Do teachers use textbooks, colleagues, the World Wide Web, et cetera?

Rationale for Qualitative Methods

Participant observation and in-depth interviewing were used during this phase of the research. Qualitative methods were chosen as most appropriate because the goal of the research for Phase 2 was to understand the complex process of environmental education curriculum development by teachers. Samuel (1993) found that "very little research has been done to explore how environmental education has actually been implemented" (p. 26). This may be due, in part, to a dearth of environmental education research that has employed qualitative methods.

Researchers have indicated that qualitative methods are most appropriate when trying to understand naturally occurring phenomena in naturally occurring settings (Marshall & Rossman, 1989; Patton, 1990). In particular, if the focus of research is on a process such that *how* something occurs is more important than the end result, direct participation in and observation of that process may be the best methods for understanding it (Patton, 1990). With qualitative methods, the context and meaning created by researchers and participants is paramount to understanding the phenomena.

There is also an advantage to striking a balance between the use of qualitative and quantitative methods in a study. Triangulation of methods allows the researcher to corroborate information and further refine conclusions and recommendations (Cantrell, 1993; Stake, 1995; Yin, 1994). Thus, qualitative methodologies employed in this phase should complement survey methodologies used in phases 1 and 3.

Selection of Teachers

Researchers recommend selecting a sample that represents the widest range of variation in the phenomena, settings or people to maximize what can be learned (Marshall & Rossman, 1989; Stake, 1995). Two Michigan fourth grade teachers were invited to participate in this research project. Both were members of a statewide consortium of school districts participating in an innovative five-year Technology Challenge Grant sponsored by the U.S. government. The researcher worked for the project for several months and developed a relationship with the teachers there.

One teacher was from a large, urban center and had a class of approximately 16 students. The school served approximately 1,600 students—many of them economically disadvantaged. She taught language arts and computers. The other teacher taught in a

relatively affluent suburban school. The school was only five years old and served approximately 350 students total. Teachers team-taught 54 students; classrooms were multi-age consisting of students from three consecutive grade levels. The school was founded upon Dr. William Glasser's ideas for "Total Quality Schools."

Because teachers represented vastly different school cultures and settings, they were selected for participation in the study.

Data Collection Methods

Interviews

Prior to the beginning of the environmental education curriculum development project, the researcher met with each teacher for an "Entry" interview. Interviews generally lasted a few hours. The goal was to clearly explain the purpose of the project, generate possible projects and establish a mutually agreeable timeline for completing environmental education curriculum development and infusion.

At the close of the project, "Exit" interviews were scheduled with teachers to gain their insights and reflections about the curriculum development process and the role the Web might play in elementary and/or formal environmental education.

Participant-Observation

During the Entry interviews, plans were made for the researcher to teach one or more classes to students. In one case, the teacher was most interested in having class sessions on Web page development for students; the other teacher wanted students to participate in a hands-on paper recycling activity. The researcher role was clearly defined at the outset and both teachers wanted active participation by the researcher rather than observation alone.

Developing the Prototype Web Site

The final task to be completed for this phase of the research was the production of a prototype Web site to highlight the curriculum and lesson plans developed by teachers, to provide examples of students' work, and to provide teachers' comments about activities. Once teachers had developed environmental education curriculum, it was placed on the Web by the researcher. The pilot site was to serve as a unique demonstration site for other teachers to review and comment on in Phase 3.

PHASE 3: THE WEB-BASED SURVEY

Purpose

The purpose of the Web-based survey was to recruit a diverse sample of educators who regularly used the Web or, at least, had some minimal knowledge and experience using the medium. Because survey questions asked respondents to indicate attitudes about using the Web in K-12 classrooms and to indicate interest in and ideas for future online environmental education sites, it was necessary to recruit Web-savvy respondents. It was assumed that teachers with no Web experience would be least able to present ideas and insights about ways to integrate the Web in their classrooms.

Research Questions Addressed

The research questions addressed by this methodology are:

1. Do K-12 teachers who complete the online survey exhibit positive attitudes toward environmental education?
2. Do K-12 teachers who complete the online survey exhibit positive attitudes toward using the World Wide Web in education?

3. What is the relationship between teachers' access to environmental education resources and their attitudes toward environmental education?
4. What is the relationship between teachers' attitudes toward environmental education and their attitudes toward using the World Wide Web in education?
5. Using only electronic methods to advertise the online survey, how many K-12 teachers will complete and submit the online survey in a one-month period?

In association with these research questions, the following hypotheses were tested:

H_1: Teachers who have greater access to environmental education resources will exhibit a more positive attitude toward environmental education than teachers who have access to fewer resources.

H_2: Teachers who exhibit a more positive attitude toward environmental education will also exhibit a more positive attitude toward using the Web in education.

Rationale

There was almost no discussion of Web-based surveys in the formal research methodology literature. Recker and Greenwood (1998) conclude, "Electronic, 'asynchronous' surveying is uncharted territory and research is needed to identify potential biases that may arise."

Researchers at Georgia Tech's Graphics, Visualization and Usability Center have been using this methodology regularly since 1994 to survey Web users. They found that this survey method suffers from two problems: self-selection and sampling (Graphics

Visualization and Usability Center, 1997; Pitkow & Kehoe, 1996). People who choose to participate in the survey self-select themselves. This is true of all surveys, however.

The second issue is sampling:

> The surveys use a form of non-probabilistic sampling which relies on users' awareness of the surveys for participation. As a result, all portions of the user population may not be represented in the sample. This reduces the ability of the gathered data to generalize to the entire Web user population (Pitkow & Kehoe, 1996).

Similarly, responses generated by teachers completing the Web-based survey for this research must be interpreted cautiously and, most likely, do not accurately represent the population of Web-using teachers.

However, there are advantages to using this methodology. First, online collection of data improves efficiency and reduces the possibility of data-entry error (Recker & Greenwood, 1998) since respondents' answers are automatically stored in a database. Second, because this exploratory research focuses on the use of a new technology, it is essential that teachers who participate are experienced users of the technology. Therefore, the bias exhibited by respondents is desired. Finally, the ease of communication combined with the vast number of individuals that can be quickly and inexpensively contacted via e-mail and the Web makes this survey method most appropriate for the task.

Sampling Procedure

Sample Selection Criteria

K-12 teachers were selected as the target population for this survey. All K-12 teachers were selected for two reasons. First, expected response rates are difficult to determine in advance of the survey and by limiting the kinds of teachers eligible to

respond, it would necessarily reduce the response rate. Second, because the goal of the survey was to enlist a diversity of respondents with experience teaching and using the Web there was no reason to exclude any teachers from the survey as it was expected that all would have insights and opinions that would be valuable.

Sample Selection Process

The survey was announced to educators and other interested individuals via the Internet using e-mail, listservs (i.e., e-mail based discussion lists focused on particular topics), and Internet news groups (i.e., Internet-based bulletin boards). In addition, the research pilot Web site URL (Uniform Resource Locator; Internet address) was registered with a number of Web "search engines." Table 1 lists the Internet contacts and where possible, identifies the number of individuals contacted.

Table 1: Internet and Web-Based Contacts for Survey Recruitment

Internet/Web-Based Contact	Number of Individuals Contacted
Listservs	
ENVST-L (Environmental Studies)	572
WWW-EDU (WWW in Education)	1,657
ED-TECH (Education Technology)	3,884
K-12 OPPS (Opportunities in K-12 Education)	2,662
TOTAL	**8,775**
Newsgroups	
Environment	
sci.environment	Unknown
talk.environment	
Education	
alt.education.research	
alt.education.alternative	
misc.education	
misc.education.science	
UK.education.teachers	
alt.teachers.lesson-planning	
K12.chat.elementary	
K12.chat.teacher	
K12.ed.comp.literacy	
K12.ed.science	
K12.ed.soc-studies	
K12.ed.tech	
Web Search Engines	
AOL Netfind (http://www.aol.com/netfind/)	Unknown
Excite (http://www.excite.com)	
Hot Bot (http://www.hotbot.com)	
Infoseek (http://www.infoseek.com)	
Lycos (http://www.lycos.com)	
WebCrawler (http://www.webcrawler.com)	
Yahoo (http://www.yahoo.com)	

Data Collection Methods

The Web-based survey was to be completed within 45 days and requested respondents' views on such matters as:

- Teaching environmental education;
- The need for environmental education in K-12 schools;
- Access to environmental education resources;
- Using the Web to find classroom resources;
- The future of the Web in education;
- The effect of the Web on teaching methods.

Two versions of the survey were developed—one for teachers and one for non-teachers. It was anticipated that individuals other than teachers might visit the Web site and want to fill out a survey. For this reason, a much shorter survey was developed as a means to prevent non-teachers from completing the teaching survey and possibly skewing results. For the purposes of this research, however, only teacher surveys will be discussed here.

The entire teacher survey comprised a single Web page (see Appendix B). Each of the four sections of the survey was clearly marked. The layout of the survey was as follows:

1. Section 1: Environmental Education – consisted of eight questions about teaching environmental education, integrating environmental education into the curricula and the need for environmental education in K-12 schools.

2. Section 2: Using the Web in Environmental Education – consisted of eleven questions about predicting future Web use, using the Web to find classroom resources and the impact of the Web on teaching practices.
3. Section 3: Access to Environmental Education Resources – consisted of 16 questions about respondents' access to a variety of national, state and local environmental education resources.
4. Section 4: Tell Us About Yourself – consisted of eight closed-ended questions about teaching experience, gender, geographic location, Internet access and e-mail/Web browsing habits, and included four open-ended questions about concerns for using the Web in school and teaching environmental education..

Scoring

Sections 1 and 2 consisted of eight and 13 statements respectively that were measured on a Likert scale. Statements were worded in a positive direction and were scored as follows: Strongly Agree (5), Agree (4), Not Sure (3), Disagree (2), and Strongly Disagree (1). The scoring for statements written in a negative manner were reversed in order to provide a total score that reflects a positive attitude toward the item in question. In this way a person favoring environmental education or the Web will agree with positive items and disagree with negative ones and vice versa. Scores in Section 1 could range from 40 to 8. The higher the score, the more favorable the respondent's attitude toward environmental education. Scores in Section 2 could range from 55 to 11. The higher the score, the more favorable the respondent's attitude toward using the Web in education.

Section 3 asked respondents to indicate whether or not they had access to particular environmental education resources. Answers were scored as follows: Yes (2), Not Sure and No (0). Access scores could range from 32 to 0. The higher the score, the greater the respondent's access to resources.

Pre-test/Evaluation

Two environmental education professors, a statistics professor, an education professor and graduate student (who specialize in educational technology), two elementary school teachers and the doctoral research committee reviewed the survey. Revisions were made based on comments received by all parties. The newly-revised version of the survey was placed on the Web; all reviewers were notified and invited to review and submit final comments for changes. Based on final comments, minor changes were made and the survey was considered complete.

Permission

After receiving approval for the survey from the University Committee on Research Involving Human Subjects in March 1998, the survey was linked to the prototype Web site created in Phase 2. Before respondents could take the survey, they had to view a "consent form," press a button to indicate their consent and this would link them to the survey. It was virtually impossible for any respondent to get to the survey without first reading the consent form page.

Recording of Data

Data generated by the Web-based surveys were stored directly on the server in Microsoft Access '97; results were captured and imported into SPSS for Windows Version 7.5. The frequencies, percentages, means, standard deviations and correlational

measures were computed to evaluate relationships between access to environmental education resources, attitudes toward environmental education and attitudes toward the Web.

CHAPTER 4

ANALYSIS AND RESULTS

OVERVIEW

This chapter consists of three sections. The first section is an analysis and describes the results of the mail survey sent to a sample of fourth grade teachers in Ingham County, Michigan. The data presented includes the response rate and sampling distribution, frequencies, and a description of the research questions addressed. The second section describes the results of the environmental education curriculum development process by two Michigan fourth grade teachers. Their descriptive cases are compared and contrasted to gain insight into the process, obstacles and opportunities of environmental education curriculum development. Sample content from the Web site is provided. The third section presents an analysis and the results of the Web-based survey. The data presented include the sampling distribution, frequencies, hypotheses tested, research questions addressed, and results from additional statistical analyses.

THE MAIL SURVEY

Response Rate

Ninety-three surveys were mailed to fourth grade teachers in Ingham County, Michigan, between February and May 1997. The total number of surveys returned was 45 resulting in a response rate of 48 percent. Of the surveys returned, eight respondents indicated their wish to not participate. These surveys constitute "missing data" and were

removed from the analysis. Therefore, the results that follow are derived from the 37 completed, returned surveys. Although the sample size is somewhat small, according to Kachigan (1986),

> ...based on various empirical sampling studies, it has been found somewhat surprisingly that a sample size as small as n=30 will often result in a sampling distribution that is very nearly normal in form, even when the original population deviates quite markedly from a normal distribution (p. 111).

Given the formula for the sample standard error

$$\sigma = \sqrt{pq / n}$$

where n represents the sample size (e.g. 37), p represents the probability of one of the outcomes of a binary variable (e.g. 0.5) and q=1-p (e.g. 0.5). Thus, the margin of error for a sample of size 37 is ±18.5%.

Sampling Distribution

Table 2 compares the population distribution to the sample distribution of respondents. The data indicate that the distribution of surveys received was fairly representative of the school districts in Ingham County, Michigan.

According to Kachigan (1986), a normal distribution can be estimated using the sample size n and the proportion p:

> As a rule, the sampling distribution for a proportion can be considered to be very nearly normal in form as long as the product of np exceeds a value of 5 (p. 126).

For the mail survey the product of np (37 x 0.5) is 18.5 and the sampling distribution does appear to be normal in form.

Table 2: Mail Survey Distribution By School District

School District	Number of Teachers	Percent of All Teachers	Number of Surveys Returned	Percent of Surveys Returned
Dannsville	3	3%	2	4%
East Lansing	17	18%	5	11%
Haslett	9	10%	5	11%
Holt	18	19%	10	22%
Leslie	5	5%	2	4%
Okemos	14	15%	5	11%
Stockbridge	7	8%	3	7%
Waverly	10	11%	6	13%
Webberville	3	3%	1	2%
Williamston	7	8%	6	13%
TOTALS	93	100%	45	48%

Presentation of Frequencies

General Characteristics of Respondents

Of the 37 teachers who completed and returned their questionnaires, 31 were female (83.8%) and 6 were male (16.2%). Most of the respondents (83.8%, n=31) were 41 to 60 years old while only 16.2% (n=6) were 40 years or younger. All respondents were Caucasian. The majority of respondents (83.8%, n=31) had a Master's degree; 13.5% (n=5) had credits beyond a BA/BS and 2.7% (n=1) had completed post-doctoral study. Approximately 70% of all respondents (70.3%, n=28) reported 10 years or more of teaching experience. No respondents represented urban schools: 78.4% (n=29) represented suburban schools and 21.6% (n=8) represented rural schools. When asked about the type of community their schools server, 64.9% (n=24) of teachers reported "middle class", 13.5% (n=5) reported "economically disadvantaged" and "affluent" and

the remaining 8.1% (n=3) reported serving all categories. Table 3 presents the data gathered on respondents

Table 3: Summary of General Characteristics of Respondents

Variable	Category	Frequency	Percent
Gender	Male	6	16.2%
	Female	31	83.8%
Age Range	21-30 yrs	4	10.8%
	31-40 yrs	2	5.4%
	41-50 yrs	20	54.1%
	51-60 yrs	11	29.7%
Ethnicity	Caucasian	37	100%
Highest Level of Education Completed	Credits beyond BA/BS	5	13.5%
	MA/MS	31	83.8%
	Post-doctoral study	1	2.7%
Years Teaching K-6	1-5 yrs	6	16.2%
	6-10 yrs	3	8.1%
	11-15 yrs	4	10.8%
	16-20 yrs	8	21.6%
	21 yrs or more	16	43.2%
Number of Students in Class	25 or less	33	89.2%
	26-50	4	10.8%
Type of Community: Economics	Econ. Disadvantaged	5	13.5%
	Middle-Class	24	64.9%
	Affluent	5	13.5%
	All Above	3	8.1%
Type of Community: Geographic Region	Rural	8	21.6%
	Suburban	29	78.4%
	Urban	0	0

Environmental Education Responses

Teaching Environmental Education (EE). Respondents were asked if they teach environmental concepts in the classroom. Most respondents indicated that they did (78.4%, n=29), while 21.6% (n=8) did not (See Table 4). When the eight respondents

who do not teach environmental concepts were asked to identify barriers to teaching environmental education, the most common responses included "Do not have class time to teach environmental education" (n=5), "Do not have time to prepare" (n=4), "Other reasons" (n=3) and "Concepts unrelated to subjects taught" (n=2).

Curriculum Guides and Inservice Education. With regard to environmental education curricula and inservice education opportunities, 37.8% (n=14) of respondents reported that they own or have access to environmental education curriculum guides, and 45.9% (n=17) have received some environmental education inservice education. Conversely, the majority of respondents (62.2%, n=23) reported they do *not* own or have access to environmental education curriculum guides, and 54.1% (n=20) have *not* received any environmental education inservice education.

Table 4: Respondents' Experience Teaching EE

Variable	Category	Frequency	Percent
Teach environmental concepts			
	Yes	29	78.4%
	No	8	21.6%
Access to EE Curriculum Guides			
	Yes	14	37.8%
	No	23	62.2%
Past EE inservice education			
	Yes	17	45.9%
	No	20	54.1%

To determine whether or not the relationship between access to guides and in-service education was independent, a cross-tabulation analysis with Pearson Chi-Square was performed. The results were significant at the .001 level and indicate that the two variables are dependent: those who have had inservice education experiences are more likely to have access to environmental education curriculum guides and vice versa.

Developing EE Curricula. Teachers were presented with eight possible curriculum development resource options and asked to select all that they use when developing environmental education curricula. They reported the following (see Table 5): "I develop my own unique curriculum and activities" (62.2%, n=23); "I get my ideas for environmental curricula from my colleagues" (40.5%, n=15); "I use special environmental education curriculum guides" (29.7%, n=11); "Other" (19.4%, n=7); "I do not teach about environmental concepts" (13.5%, n=5); "I use the World-Wide Web and the Internet to develop environmental curricula" (10.8%, n=4); and, "I use the state/county required curriculum guides." (8.1%, n=3).

Table 5: Resources Used to Develop EE Curricula

Variable	Category	Frequency	Percent
Resources used to develop EE curricula	I develop my own unique curricula	23	62.2%
	I get ideas from colleagues	15	40.5%
	EE curriculum guides	11	29.7%
	Other	7	19.4%
	Do not teach EE	5	13.5%
	Internet/WWW	4	10.8%
	State/County curriculum guides	3	8.1%

Environmental Education in K-12 Schools. When asked if environmental education should be taught in school one respondent (2.7%) was "Not sure." A majority of teachers (67.6%, n=25) responded "Definitely, Yes" and an additional 29.7% (n=11) responded "Yes." No respondents disagreed with the statement. (See Table 6.)

Comfort Level Teaching EE. When asked how comfortable they would feel teaching their students about environmental concepts, 43.2% (n=16) responded "Very

comfortable", 40.5% (n=15) reported that they were "Comfortable" and 16.2% (n=6) indicated "Neutral" feelings.

Teaching EE More Often. Finally, respondents were asked to identify as many situations as apply that would be most likely to influence them to infuse environmental education into their curricula in the future. The responses, in descending order, were as follows: more preparation time (73%, n=27), better access to curricula (56.8%, n=21), more environmental education in-service classes (56.8%, n=21), more funding (40.5%, n=15), more administrative support (24.3%, n=9), and "Other" (18.9%, n=7).

Table 6: Respondents' Beliefs About Teaching EE

Variable	Category	Frequency	Percent
EE should be taught in schools	Definitely Yes	25	67.6%
	Yes	11	29.7%
	Not Sure	1	2.7%
Comfort level teaching EE	Very Comfortable	16	43.2%
	Comfortable	15	40.5%
	Neutral	6	16.2%
Factors influencing you to teach EE more often	More prep time	27	73.0%
	Better access to EE resources, curricula	21	56.8%
	More EE inservice	21	56.8%
	More funding	15	40.5%
	More school support	9	24.3%
	Other	7	18.9%

Teaching with Computers

Computer Access. Teachers were asked about computer access in their classrooms and schools (see Table 7). Most of the respondents (86.5%, n=32) indicated that they have at least one computer in the classroom. However, of that total number (n=32), almost half had a single computer in the classroom (46.9%, n=15), 9.4% (n=3) had two computers, and 43.7% (n=14) had three or more computers. Most respondents

(68.8%, n=22) indicated that the computer(s) they have are at least two years old or more; only 10 respondents (31.2%) reported having computers less than two years old. Teachers reported using Macintosh (53.1%, n=17), IBM (34.4%, n=11) and both platforms (12.5%, n=4) in their classrooms. Additionally, of those who have one or more computers in the classroom, 71.9% (n=23) also have Internet access from their classrooms. When asked if their school has a computer lab, more than half of all teachers (67.6%, n=25) reported that they did. Of those schools with computer labs (n=25), only 28% (n=7) have Internet access from the school computer lab.

Table 7: Respondents' Access to Computers and Internet

Variable	Category	Frequency	Percent
Have 1 or more computers in classroom (n=37)	Yes	32	86.5%
	No	5	13.5%
Number of computers in classroom (n=32)	1	15	46.9%
	2	3	9.4%
	3	9	28.1%
	4	3	9.4%
	more than 4	2	6.2%
Age of newest computer(s) (n=32)	Less than 1 year	1	3.1%
	1-2 years	9	28.1%
	2-4 years	20	62.5%
	More than 4 years	2	6.3%
Computer platform (n=32)	IBM	11	34.4%
	Mac	17	53.1%
	Multiple platforms	4	12.5%
Internet access from classroom (n=32)	Yes	23	71.9%
	No/Not sure	9	28.1%
School has a computer lab (n=37)	Yes	25	67.6%
	No	12	32.4%
Lab has Internet access (n=25)	Yes	7	28.0%
	No/Not sure	18	72.0%

Software Available in Classrooms or Computer Labs. Next, teachers were asked to select all of the kinds of software available in their classrooms and school computer labs. Table 8 illustrates the results.

Table 8: Software Available to Respondents

Software	Frequency	Percent
Word-processing	34	91.9%
Drawing	33	89.2%
Games	31	83.8%
Spreadsheet	26	70.3%
Educational Software	25	67.6%
Database	25	67.6%
E-mail	28	62.2%
WWW-browser	20	54.1%
Hypermedia	11	29.7%
Presentation	11	29.7%
Other/Not sure	3	8.1%

Almost all teachers (91.9%, n=34) had access to word processing software, drawing programs (89.2%, n=33) and computer games (83.8%, n=31). The least common software programs available were those for presentation (i.e., MS Powerpoint) and Hypermedia (i.e., Hyperstudio, Macromedia Director); only 29.7% of respondents (n=11) indicated access to each of these programs. More than half of all teachers reported the availability of email (62.2%, n=28) and Web browsing (54.1%, n=20) software.

Computer Inservice Education. When asked whether or not they have received inservice education to learn software programs, 55.6% (n=25) responded that they had received inservice education, while 26.7% (n=12) had not (see Table 9).

Ways of Learning Computers/Software. Next, teachers were asked to indicate the ways they learned to use computers and software programs; they selected as many options as applied. The majority of teachers reported that they were self-taught (81.1%,

n=30), 67.6% (n=25) indicated that they learned from their colleagues and 51.4% (n=19) cited inservice education programs as an educational resource. (See Table 9)

Using Computers in Instruction. When asked whether or not they use computers in instruction, 78.4% of respondents (n=29) reported that they did use computers while 21.6% (n=8) reported that they did not. Those who reported that they did *not* use computers (n=9) were asked to indicate situation(s) that would be most likely to influence them to use computers in instruction in the future. The frequencies of responses, in descending order, are as follows: more computers in the classroom (n=7), more computer inservice education (n=6), access to better hardware/software (n=6), more preparation time (n=4), other (n=1).

The respondents who indicated that they did use computers in instruction (78.4%, n=29) were asked to answer four additional questions. First, they were asked to indicate the primary way(s) they use computers in instruction. The most frequently cited response was "Educational Software" reported by 62.1% of teachers (n=18). Nearly 35% of respondents indicated "Other" ways of using computers in instruction (34.5%, n=10) and these included writing and word processing, hypermedia, publishing documents and testing students. Internet research (24.1%, n=7), email (13.8%, n=4) and Internet publishing (6.9%, n=2) were among the uses least frequently reported by respondents.

Table 9: Respondents' Experience with Computers

Variable	Category	Frequency	Percent
Computer inservice education (n=37)	Yes	25	55.6%
	No	12	26.7%
Ways of learning computers/software (n=37)	Self-taught	30	81.1%
	Colleagues	25	67.6%
	In-service ed. programs	19	51.4%
	Students	15	40.5%
	My children; family members	12	32.4%
	Courses outside of my school	5	13.5%
	Other	3	8.1%
Teach with computers (n=37)	Yes	29	78.4%
	No	8	21.6%
Factors that would influence you to use computers more in the future (n=8)	More computers in classroom	7	87.5%
	More inservice education	6	75.0%
	Better hardware/software	6	75.0%
	More prep time	4	50.0%
	Other	1	2.2%
Ways computers are used for instruction (n=29)	Educational software	18	62.1%
	Other	10	34.5%
	Computer-aided instruction	9	31.0%
	Presenting information	8	27.6%
	Internet research	7	24.1%
	E-mail	4	13.8%
	Internet publishing	2	6.9%
	Data analysis	1	3.4%

Web and Computer-based EE. Next, the teachers who reported using computers in instruction (n=29) were asked to indicate whether or not they had ever found lesson plans or activities on the World-Wide Web and incorporated them into classroom teaching. More than one-quarter of respondents (27.6%, n=8) reported that they had found lessons on the Web while 72.4% (n=21) had not. Only two respondents (6.9%) had contributed their own lesson plans to a Web site. Six respondents (20.7%) indicated that they had used computers to teach their students about the environment and the remaining 23 teachers (79.3%) had not. (See Table 10)

Table 10: Computer-Using Teachers' Responses

Variable	Category	Frequency	Percent
Found lesson plans on Web and used in classroom (n=29)	Yes	8	27.6%
	No	21	72.4%
Put own activities on Web for others to use (n=29)	Yes	2	6.9%
	No	27	93.1%
Used computers to teach about environment (n=29)	Yes	6	20.7%
	No	23	79.3%

Research Questions Answered

1. Is there sufficient evidence to suggest that Michigan respondents are interested in environmental education?

The data provide evidence that the majority of respondents are interested in environmental education despite the barriers that exist. Nearly 80% of teachers surveyed reported teaching environmental education to their students. Over 97% agreed that environmental education should be taught in K-12 schools and nearly 84% reported feeling comfortable teaching environmental education. According to one respondent,

> I feel that environmental education is being totally neglected and feel we must get it into the curriculum. Kids love it and are sponges about absorbing it because no one teaches it to them. My class has adopted a manatee for the third year in a row and we are actively recycling and trying to get other kids and parents (teachers, too) more involved in recycling. It is a constant battle as the kids are finding out. — *A teacher of 32 years*

Another teacher writes,

> What is needed most is time for planning, and just as important, collaboration. I see environmental education as an excellent way to link all subject areas. As a theme it fits very well with my science and geography focus. The possibility of using novels I have or could use and potential art projects seem logical as well. — *A teacher of 12 years*

2. Is there sufficient evidence to suggest that the proposed research is technically possible (i.e., do Michigan schools have the necessary hardware, software and Internet access)?

The data provide evidence that supports the technical feasibility of engaging in the next phase of research. Survey results indicate that nearly 87% of teachers surveyed reported having computers in their classrooms. Of those teachers, approximately 72% reported having Internet access as well. Nearly 68% of all teachers have access to a computer lab in their school and of those teachers, 28% reported having Internet access from the labs. The majority of teachers have the hardware necessary to access the Internet from their schools and/or classrooms.

In addition, more than half of the teachers surveyed indicated that they have email (62.2%) and Web (54.1%) software available to them. Almost 80% of teachers reported using computers in instruction, and of those using computers, some are using them for email (13.8%), Internet research (24.1%) and Internet publishing (6.9%). Finally, more than one-quarter of those using computers in instruction (27.6%) reported finding lesson plans and using them in their classrooms and 20.7% of them indicated that they had used computers to teach their students about the environment. Thus, more than half of teachers have the software necessary for the research and approximately 20% have used the Internet in instruction or have used computers to teach environmental education. As access to computers and the Internet increases in schools and classrooms, these numbers are likely to rise. One teacher writes,

> My student intern has involved my students to some extent in an email activity designed for fourth graders in our county but she has to rely on her computer at home. I am hoping to get involved and become more knowledgeable next year when email will be available in my classroom.
> — *A teacher of 31 years*

Another submitted these comments,

> I would like to do more with environmental education and the Internet but we are so overwhelmed with all of the curriculum we're supposed to cover, it's almost impossible to do much more. I am starting to use one period a week to teach some new computer software or use of the Internet.
> — *A teacher of 31 years*

In summary, the mail survey provides evidence that the majority of respondents (1) are interested in environmental education, and (2) have access to computers, the Internet and Web-browsing software in their classrooms or schools. The data show that teachers tend to "develop their own unique environmental education curricula" or rely on colleagues for activities and ideas rather than using printed curriculum guides. In addition, more than half of the respondents indicated that they would "teach environmental education more often" if they had better access to environmental education resources and curricula. Therefore, the mail survey results provide evidence for the feasibility of the next phase of the research: designing a Web site to share practicing teachers' environmental education curricula with other teachers.

RESULTS FROM TWO DESCRIPTIVE CASES

This next phase of the research involved collaborating with two practicing fourth grade teachers to develop environmental education curriculum and place the content on the World-Wide Web. Because very few (if any) environmental education Web sites exist that are designed specifically for the purpose of sharing lesson plans and activities with other teachers, it was necessary to develop a pilot Web site. During the period of

August 1997 through January 1998, curricula was developed and implemented in two different fourth grade classrooms in Michigan. Between the months of February 1998 and April 1998, the pilot Web site was developed.

The purpose of this phase of research was to gain insights into the process of curriculum development as experienced by teachers and to identify the challenges and opportunities for creating a curriculum Web site for teachers. Qualitative methods including in-depth interviewing and participant observation were used to gather data on these processes. The results are provided in the brief description of teachers that follow.

Brief Description of the Teachers

Following is a brief description of each teacher. All names have been changed to protect confidentiality. (See Appendix C for a summary of the information.)

Karen: Urban School

Karen teaches at Williams Elementary located in an urban center in Michigan. The school serves approximately 1,160 students, primarily African-American, and the theme for the school is "Technology." She is in her early thirties and has been teaching for eight years—seven of them at Williams. This is her first year teaching fourth grade and she is responsible for teaching Language Arts and Computers to her 16 students.

Educational background. Karen has a Bachelor's degree in Film and Communications and a Master's degree in Education with an emphasis in Social Science and Reading. At present, she is exploring opportunities to pursue her Ph.D. in Educational Administration.

Computer experience. She has had a variety of jobs and experiences that have required her to learn and use computer including working at General Motors, the

Electrical and Computer Engineering Department at a university, and for a local business backing up their computer server.

She has been the computer lab teacher at Williams Elementary for the past three years and is currently continuing her professional education to become a Computer Network Administrator.

Teaching experience. Her first teaching experience began in December 1989—at another elementary school. After completing her term, she was offered a job at Williams Elementary and has been teaching there since 1990. At Williams she taught third grade for two years and then became the computer lab teacher. In 1997, she was offered and accepted a position as a fourth grade "homeroom" (i.e., language arts) teacher in addition to teaching computers.

Computers in the school. She has two older 486 IBM-compatible computers in her classroom that students use for keyboarding assignments. The computers are not networked and not connected to the Internet. Her classroom is across from the school computer lab. The lab houses 25 networked Pentium computers all connected to the district server as well as the Internet. Students and teachers have access to a scanner, color printer and digital camera. In addition, all faculty and students are assigned email accounts. However, at the time of the project, these accounts were not working reliably due to network problems.

Experience teaching EE. During Karen's first year of teaching, she decided to begin a large-scale, year-long recycling unit. She sought out a variety of resources to develop the curricula and planned that each day, in class, students would collect and

separate waste paper, newspaper and aluminum cans. They would discuss issues related to recycling in class and or would write about recycling in Language Arts.

Although the project was a success, she soon discovered there were no recyclers interested in coming to the school to pick up the materials. She was willing to bring recyclables to a drop off center but the only one in her area closed. After only three months, she cancelled the project.

Since that experience, she has not taught any other environmental education units.

Developing EE curricula. At our first meeting, Karen emphasized the need to build curriculum around "hands-on" projects. We decided to create three small projects or activities as part of the environmental unit.

Her first suggestion was to begin with the topic of recycling, "Recycling is very important and there's a lot of information out there about it. That's a good one to do right now." We brainstormed ideas for projects and determined that a paper-making activity would teach students important concepts related to paper recycling, would be hands-on and would also be enjoyable. We selected that as our first project.

Next, she mentioned a vacant lot across from the school and a park a few blocks away that was in need of cleaning and maintenance. She suggested,

> The second project could be the children writing letters to the Mayor about that vacant lot and asking that it be cleaned. It could be a writing assignment involving environmental issues. Or, there's a park about six blocks from the school that is not well-kept and could be a project for the students in the Fall and in the Spring they spend a day cleaning the park and getting it back into shape.

We brainstormed possible assignments and activities. She suggested putting students in small teams; each team would interview "stakeholders" about the vacant lot across from the school. Stakeholders might include the homeowner next to the lot, a

community service activist, a teacher at the school, a student at the school, and a representative from the City Parks and Recreation Department. After interviewing stakeholders, each team would prepare a report that would be put on the Web. Students could use the scanner or digital camera to include pictures in their Web pages. After all the reports were online, students would present their findings to the whole class. She decided this should be a culminating project at the end of the unit and would be subject to change.

We talked more about ways to use the computer lab and Web to study environmental issues. Karen liked the idea of having students do research via the Web,

> Oh, that's good! See they can travel the Web and they're learning about the environment. In the computer class I could set it up after I introduce them to the Internet. They would have to demonstrate that they are able to locate particular sites. And then I can see if they actually get into them and perform tasks. Ok, that's another project.

She decided that was something students could do during each scheduled computer class to help them refine their computer skills. However, this would not be a "project."

Finally, we brainstormed possible creative writing activities. She liked the idea of an email writing assignment where one student writes a paragraph, sends it to another student who adds on to it and so forth until the story is complete. Karen would provide the topic sentence to start the story; it would connect paper recycling to litter on the vacant lot and serve to bridge those two projects. Students would gain keyboarding and email experience as well as work on creative writing and environmental issues.

We decided to start with these three projects. It was important to both of us to maintain openness to new ideas and projects should the need arise. When asked if she felt comfortable with the proposed projects Karen responded, "Oh, these are excellent!

And once we get started we may decide to scratch one and go with another new one. So this is good."

The operational EE curriculum. Karen began introducing students to environmental issues, concepts and vocabulary through non-fiction literature. She gathered several books from the school library including *The Great Kapok Tree* and *Just a Dream*. She read aloud to students and students read aloud to each other. As part of their writing curriculum, she assigned them the task of rewriting one of the stories they had read together and creating a new ending of their choice. She integrated art into the assignment by giving students time and supplies to draw illustrations to support their written text. This was the first project.

For the second project, she had students work in pairs to research and print out recycling information from the Web. It was successful. Later in the term students wrote short reports about recycling and used the Web-based references they had found.

The final project for the environmental unit was the hands-on paper recycling activity. I was responsible for teaching this class; Karen documented the process taking pictures and maintained order in the classroom.

It was a great success and the students were eager to talk about the process of recycling as well as the other environmental projects they had worked on during the semester. Karen said that once the papers dried, students drew pictures about the environment on them and took them home. She also integrated another writing assignment and had students describe the process of paper recycling. She said she would definitely do the activity again.

Resources used. Karen used three resources to develop and teach the environmental unit. The core resource was her "reader"—a required textbook from her school district. She gathered library books for use in class, and also used the Web. She said,

> I compared what we wanted to do to the reader that we have. And, I didn't have to do a lot of research because a lot of information was on the Internet in science. The Internet played a big part.

Time spent on EE. She began the unit in late September 1997 and completed it by late October 1997. She estimates spending approximately two to three classes per week on the environment at the start of the unit to help students learn vocabulary and work on reading skills. She estimates that each class she spent teaching about the environment was 45 to 60 minutes long.

Obstacles. There were several obstacles to the project that resulted in altering the initial curriculum plans. First, a potential teachers' strike early in the school year required much of her and delayed the start of the unit. Second, email worked sporadically and rarely in the building and there was no technical support to resolve the problem. This made the email project we had planned impossible, and also significantly reduced our ability to communicate with each other. Third, Karen discovered that her students lacked fundamental reading skills and she decided to end further plans to integrate environmental issues into their classes and instead, focus on "the basics."

Karen's reflections on using the Web. When asked what would influence other teachers in her school to use the Web more in their teaching or in the curriculum development process, Karen responded, "If it was mandatory (laughs). And only, if it was

mandatory because they have so many other things to do. When they think about the Web, they think 'I'm not going to bother with that.'"

Karen's reflections on EE. Karen is very passionate about the need for environmental education despite the obstacles she has faced trying to teach it. In her entry interview she said,

> I think it is so important to have some type of guidelines or something you can reference. At the time I was doing that [first recycling] project, I didn't have access to the Internet or computers like I do now. Now it's much easier. But I still feel that even on the Web, if there was a page that presented a curriculum that you could use in the classroom... Now, naturally, anything that you use or borrow, you're going to structure it into something that is your own to suit your purposes. But I think there is a great need for it to be there.
>
> I think environmental education should be an early part of children's education because so many children are brought up in poverty and all they see is poverty. And they don't get an opportunity to see the beauty of a lot of things and so, therefore, they're very neglectful. They don't take care of things the way they should because they don't feel it'll last or it's important. So I think from pre-K all the way through, environmental education needs to be an integral part of the curriculum.

Karen considers the unit a partial success and wishes she could have spent more time focusing on environmental issues. She was surprised to learn that the one of the most important outcomes of the unit had very little to do with environmental knowledge at all and instead, was the development of interpersonal skills in her students. After reading, writing about and discussing environmental issues in class, students found they shared common ideas and concerns and were able to collaborate and work together in ways that they had been unable to previously:

> [Students] had just gotten to a point where they could work cooperatively and so working on an environmental issue helped me with that. It was something that brought them together and didn't pull them apart. They all had strong opinions about the environment and they knew it was important

to keep it clean. They were more apt to help each other on that particular topic.

For Karen, this was a major accomplishment. She is hopeful that later in the semester she and her students will explore more environmental issues.

Anne: Suburban School

Anne teaches at Greenview Elementary located in a suburban area in Michigan. The school was built five years ago and serves approximately 370 students. She has been teaching for nine years—five of them at Greenview. She co-teaches a mixed-age classroom of 54 third, fourth and fifth grade students with her partner, Bill. She and Bill have worked together for two years.

The School and classroom. The school is unique in the country. It was founded upon Dr. William Glasser's Choice and Reality Theories. Both teachers and students are committed to quality education. Some of the school values include a warm, friendly environment, free of coercion; useful, meaningful learning; and self-evaluation.

The class routine is structured to give students choice in what and how they learn. Students are presented with a variety of tasks and projects to complete for the week and they are responsible ensuring projects are completed on time. Students are also included in the curriculum development process and their suggestions on how they would like to be assessed for particular assignments are integrated into formal assessments.

Educational background. Anne has a Bachelor's degree in Elementary Education, with a minor in English and Science and a Master's degree in Curriculum Development and Classroom Instruction. Upon receiving a position at Greenview, she was certified as a "Quality School Teacher" in May of 1995 along with the rest of the staff. Each year

she attends multiple conferences and workshops to continue her education and certification as a quality school teacher.

Computer experience. Anne has her own personal computer and she uses email regularly. She admits to finding lesson plans on the Web once or twice but considers herself an "advanced beginner" when it comes to computers.

Computers in the school. Greenview has a Media Center/Computer Lab that houses 30 IBM-compatible 486 multimedia computers. At the time of our collaboration, the computers were running Windows 3.1 and were networked together and to the district's Web server but not to the Internet. In the school, there was only one computer (a Macintosh) that could connect to the Internet. It was stored on a portable cart and moved to classrooms as needed. There was one Media Specialist who had previously been a Special Education teacher. She appeared overwhelmed by the position and was often unable to resolve the technical problems that arose. However, the district also provided technical support to schools—"Computer Services"—but it was often not available when needed. Consequently, repairs were made later rather than sooner.

In Anne's room, there were five older 486 IBM-compatible computers that were used for keyboarding written assignments. In addition, the school had recently purchased 30 laptop computers to use for special classroom projects. Teachers would request them from the principal. Students could take the computers home to complete classroom assignments. Anne was given the laptops for use on this project.

Experience teaching EE. At first Anne could not recall designing and teaching an environmental unit. However, she later remembered,

> When I taught in the lower elementary, we (all of the teachers) did a unit on recycling and made mini-landfills in class. What a smell! The students

were also responsible for a campaign that led to the recycling program at school which we are still using today.

Developing EE curricula. Anne began by looking at the three-year report card standards and objectives they are required to teach. Since they have students for three years, there are many objectives they must meet over that period of time. Some are especially relevant to environmental education (See Table 11).

Table 11: District Standards Selected for Greenview EE Unit

Standard 3.5: Earth and Space	The learner will analyze the domestic and public uses of selected water resources by humans and design a written plan for personal water preservation and conservation.
Standard 3.10: Science in Society	The learner will examine technological and other human activities affecting the environment and develop a plan showing how natural resources can be used responsibly.
Standard 5.4: Earth and Space	The learner will investigate how human activity affects the environment and how waste products create pollution.

They decided to begin building their unit around water. In recounting what they did, Anne said,

> I looked at the district standards—because we have three grade levels we look at the 3rd, 4th, and 5th grade standards to see which ones will go along with whatever unit we're doing. Since this one's environment we went through the 3rd, 4th and 5th grade standards.
>
> Then we started with a science theme. We looked at, what they call "analysis sheets." Those are just the different steps [the district] would like us to go through, the vocabulary, and it'll even give a sample lesson plan. We can or we don't have to follow it. It will give us a sample assessment but a lot of times we like our kids to come up with their own projects and we put the rubrics with it. And so sometimes the kids develop their own projects which I think is more meaningful for them.
>
> Once that's done, then we go through the language arts standards and see which ones go for 3rd, 4th and 5th. In this particular [unit], they each had to write a report. They had a choice of topic—and we did pull the topic list

> from this analysis sheet where we combined the 3rd, 4th and 5th. We told them that they were samples of questions they could take. If they could come up with other environmental issues they just had to check it out with us first before they could continue. And a lot of kids chose endangered animals, which was fine, because they talked about pollution—that was part of it.

After our initial meeting together, Anne created the unit and wrote detailed lesson plans that she shared with Bill and faxed to me for the Web site. She had collected approximately, 20-25 hands-on activities, compiled a list of resources for use in the classroom and scheduled two field trips for students. In her mind, these would structure the unit, but she also wanted the students to be involved with the development of the unit. As she was brainstorming plans for the unit, Anne said,

> I guess for part of our lesson plans for the next few weeks we can just plan to ask the kids to help us design this unit on water. Maybe we can have them brainstorm in a group what kinds of activities they would like to do.

The operational EE curriculum. At the close of the project, the operational curriculum was nearly identical to the curriculum she and Bill had planned before the semester began. This may be due, in part, because Anne is a curriculum designer and because in their classroom, they regularly teach "themes" for an extended period of time. Rather than try to integrate a few environmental education activities into other subjects, they developed an entire science theme around environmental topics.

Resources used. Anne used a variety of resources to create the unit. She used the district curriculum guide that provided suggested activities and resources available within the school. Resources included "science boxes" which are located in the Media Centers of schools in the district. They contain many kinds of hands-on resources such as microscopes, curriculum guides and lesson plans, puzzles, water and soil testing kits, videos and the like. She found some environmental posters and hung them around the

room. She researched children's literature and requested books from the school librarian and also gathered resources from the public library to share with students. She planned two field trips—one to the local water treatment plant and one to a local park that the school had adopted a few years prior. She used activities from two curriculum guides in addition to the district's guide: *Water, Precious Water* published AIMS Education Foundation™ and another guide published by Teacher Created Materials™.

Time spent on EE. Anne estimates spending approximately six weeks on the unit. She said they usually worked on the activities for three to four days per week and each session lasted from 45 minutes to an hour.

Obstacles. The main obstacles faced were technical ones. Initially, we had planned to install Netscape Gold (a free Web editing and browsing software program) on to the 486 computers in the school computer lab. Even though the district computer network support person was there for assistance, we were unsuccessful.

Next, we tried to install Netscape Gold on the single, portable Internet computer. However, because Internet access was unreliable and unpredictable during the early weeks of the project, we were unable to download the program.

Fortunately, one teacher at a school approximately 15 minutes away, came to Greenview to help us diagnose the problem. He offered to give us Claris Works Homepage to use with students. The following is an excerpt from my journal on that day,

> ... it is important to note that this man is a full-time teacher. Because he has a Macintosh computer and likes them, he is now, unofficially, the district contact person for any Mac problems. He does not get paid for doing this. He's just helpful. The Media Center Coordinator said that since the district decided to go with IBM-compatibles, they essentially have told schools with Macs to find someone else to help maintain them. There is no one at Computer Services that knows anything about Macs. It's more than a little frustrating since Greenview has a Mac with an internet connection,

> a scanner connected to it, and several educational software and CD roms—and they have no one to help support them when they run into problems.

Once Claris Homepage was installed, the only remaining difficulty was getting all 54 kids online in a timely manner.

Anne's reflections on using the Web. When asked if she ever considered using the Web while pulling together resources for this unit, Anne quickly responded, "No." When asked if there was anything she could think of that would influence her to do that, she said,

> Yes, you know when the Mars Rover was going on—I started messing around with some of that because we were doing stuff with the solar system. And I did one unit last year that I pulled something off when we were doing solutions and mixtures and I don't remember how I got there now but I did find lesson plans and downloaded them and used them. That was my first. I'm pretty new at the Web.

She concluded that for current events information, she would "probably" use the Web.

Anne's Reflections on EE. Anne really enjoyed the unit and she said the kids liked all of the activities. She said the only thing she would do differently next time is to separate "endangered species" from the group of issues they covered in class. Even though the students suggested endangered species and were very excited about the topic, she would probably include it in a unit on animals rather than one on environmental problems. She had a positive experience teaching environmental education and would do it again.

Research Questions Answered

1. How does each teacher approach (i.e. begin) the environmental education curriculum development process?

Karen began with a topic that interested her and subsequently developed activities around that topic which could be integrated into her required curriculum. Anne began with standards and objectives as required by the district. She then selected a variety of activities to develop a six-week unit.

2. Which environmental topics does each teacher select as central to the curriculum development process?

   a) What can be learned about teachers' conceptions of environmental education based on the topics they choose to teach?

Karen selected littering and recycling. She had a strong personal interest in recycling and believed that all of her students would benefit by learning more about the topic. It seemed as if, to her, environmental education was synonymous with recycling. She was unable to identify other topics or concepts that she would teach in an environmental unit. Her personal definition of environmental education seemed to be somewhat limited and narrow. However, she was extremely committed and interested in the topics she selected.

Anne chose "water and other environmental problems" as a result of the topics and concepts identified in the standards she was trying to meet. Her conception of environmental education appeared to be much broader than Karen's conception. While she did bring up recycling almost immediately as a possible topic, she also discussed concepts of erosion, industrialization, endangered species, water and soil testing and geology. However, it is not clear if these were her personal ideas about environmental education or if they were suggestions made based on the objectives identified by the district.

3. Into which subject areas are environmental concepts infused?

    a) Do teachers select science only, or other subject areas?

Karen infused environmental education activities and concepts into her Writing, Language Arts and Computer classes. These are the classes that she is responsible for teaching; her students have other teachers who work with them on art, math, music, science, and social studies. Anne infused environmental education into science, primarily, but also integrated environmental concepts into Language Arts, Listening, and Public Speaking.

4. What types of resources do teachers use to help them develop environmental education curricula?

    a) Do teachers use textbooks, colleagues, the World Wide Web, et cetera?

Neither teacher used colleagues as a resource for developing her unit. Karen used the students' required textbook, library books and the Internet/Web as primary resources. Anne used multiple curriculum guides, field trips, posters, library books, videos, posters and students' suggestions to develop her curriculum.

Brief Description of Materials Developed for the Web

After teachers concluded their environmental education units, a Web site was created to publish teachers' work and to provide samples of students' work that resulted from the curriculum. In total, the site consisted of more than 200 Web pages and approximately 100 images. An interactive survey was added to elicit teachers' views about environmental education, about using computers in education, and to identify their degree of access to various environmental education resources. (The results of that survey are presented in the following section.)

In summary, during this phase of research, two teachers developed curricula and activities to teach environmental education. One teacher focused on recycling and another developed a theme around water and other environmental issues. A pilot Web site was developed by the researcher to publish teachers' curricula, show examples of students' work, and provide teachers' comments and suggestions for the different activities. Prior to the development of this pilot Web site, very few environmental education Web sites were found that were designed specifically for teachers; even fewer contained curricula and lesson plans created *by* practicing teachers. Therefore, there was a need to create the pilot Web site to demonstrate new possibilities for using the Web in environmental education.

The development of the Web site was also necessary for the final phase of the research: asking other K-12 teachers to visit the Web site and complete a brief online survey about environmental education and the Web.

WEB-BASED SURVEY

For the final phase of research, K-12 teachers from around the world were invited via electronic means (i.e., listservs, email and newsgroups) to participate in an online survey about environmental education, using the Web in education, and using the Web in environmental education. The survey was featured on the pilot Web site developed in the second phase of research. The results from the survey are provided below.

Sampling Distribution

Eighty-one K-12 teachers completed and submitted the Web-based survey between April 5, 1998 and May 15, 1998. Because the online survey was available to an

unknown population of teachers, calculating a response rate is not possible. Instead, a calculation of the standard error of the sample was made. The standard error of the sample was calculated based on the formula:

$$\sigma = \sqrt{pq / n}$$

where *n* represents the sample size (e.g. 81), *p* represents the probability of one of the outcomes of a binary variable (e.g. 0.5) and q=1-p (e.g. 0.5). Thus, for the Web-based survey with a sample of size 81, the standard error is ±11.2 percent. As cited earlier in the chapter,

> As a rule, the sampling distribution for a proportion can be considered to be very nearly normal in form as long as the product of *np* exceeds a value of 5 (Kachigan, 1986, p. 126).

For the web based survey the product of *np* (81 x 0.5) is 40.5 and the sampling distribution does appear to be normal in form.

Presentation of Frequencies

General Characteristics of Respondents

Of the 81 teachers completing the survey, the majority of respondents were female (82.7%, n=67). The age range of respondents was relatively evenly distributed across categories (see Table 12) with the greatest number of respondents representing the age range between 26 and 30 years (21%, n=17). Most respondents were practicing teachers (86.4%, n=70) with only 11 (13.6%) preservice teachers completing the survey. All (96.3%, n=78) but three respondents were from the United States; two were from Australia and one was from Canada. The following 19 states were represented by respondents: AZ, CT, FL, HI, IA, IL, KS, KY, MA, MI, MS, NC, NY, OH, OR, PA, TX, and VA.

Respondents were asked about their email and web-browsing habits as well as their means for accessing the Internet. Table 12 presents the information gathered. Most respondents check email "almost every day" or "several times a day" (64.2%, n=51) but only 39.5% (n=32) browse the Web as often. Conversely, 16% (n=11) of respondents "never" check email and 9.9% "never" browse the Web. Most respondents indicated that they had access to the Internet at home and at school (64.2%, n=52) while 19.8% (n=16) had access at school only and 16% (n=13) had access at home only.

Finally, when asked how they learned about the online survey, the majority of respondents indicated that "a friend" had told them about it (49.4%, n=40). Other responses included "email" (25.9%, n=21), a "listserv" (18.5%, n=15) and "by chance" (6.2%, n=5).

Table 12: Summary of General Characteristics of Respondents

Variable	Category	Frequency	Percent
Gender			
	Male	14	17.3%
	Female	67	82.7%
Age Range (years)			
	21-25	7	8.6%
	26-30	17	21.0%
	31-35	11	13.6%
	36-40	12	14.8%
	41-45	9	11.1%
	46-50	11	13.6%
	51-55	9	11.1%
	56-60	3	3.7%
	61-65	2	2.5%
Type of Teacher			
	Pre-service	11	13.6%
	Practicing	70	86.4%
Frequency checking email (x=times)			
	Never	13	16.0%
	1x/mo.	2	2.5%
	1x/wk.	2	2.5%
	2-3x/wk.	12	14.8%
	Almost everyday	31	38.3%
	Several x/day	21	25.9%
Frequency browsing Web (x=times)			
	Never	8	9.9%
	1x/mo.	18	22.2%
	1x/wk.	6	7.4%
	2-3x/wk.	17	21.0%
	Almost everyday	28	34.6%
	Several x/day	4	4.9%
Internet Access			
	Home	13	16.0%
	School	16	19.8%
	Both	52	64.2%
Learn About Survey			
	By chance	5	6.2%
	By a friend	40	49.4%
	By email	21	25.9%
	By listserv	15	18.5%

Attitudes Toward Environmental Education

To measure respondents' attitudes toward environmental education, a scale was created based on eight questions in the Environmental Education section of the survey. The reliability score for all eight items was 0.78 indicating an acceptable level of internal validity. As explained in Chapter 3, the scoring of statements was conducted such that higher scores reflect a more positive attitude toward environmental education. Scores for each statement range from 1 to 5 and the mean indicates respondents' attitude toward it. The data for all statements are presented in Table 13 below.

Environmental education should be taught in K-12 schools. All but one respondent (1.2%) "Agreed" or "Strongly agreed" that environmental education should be taught in K-12 schools (97.5%, n=80). The mean for this statement (x=4.56, sd=0.65) was higher than all other means in this section indicating a strongly positive attitude toward this statement.

There are not enough hours in the school day to teach environmental education. The mean for this statement was lower than all other means (x=2.64, sd=1.26) indicating that time is an important constraint for many respondents, even for those who think environmental education should be taught in public schools. Sixty-three percent of teachers (n=51) "Strongly agreed," "Agreed" or were "Not sure" about this statement; 37% (n=30) "Strongly disagreed" or "Disagreed."

Environmental education is another curricular fad. The majority of teachers "Disagreed" or "Strongly disagreed" with this statement (88.9%, n=72); 11.1% (n=9) "Agreed" or were "Not sure." The mean was 4.15 with a standard deviation of 0.67.

Environmental education should be integrated into subject areas wherever possible. Approximately 93% of respondents "Strongly agreed" or "Agreed" with this statement (92.6%, n=75); five respondents were "Not sure" (6.2%) and one respondent (1.2%) "Disagreed." The mean for this item was 4.38 with a standard deviation of 0.66.

As a K-12 teacher it is my responsibility to teach my students to care for the Earth. This statement had a mean of 4.46 and standard deviation of 0.65. The majority of teachers "Strongly agreed" or "Agreed" (96.3%, n=78); two individuals "Disagreed" (2.5%) and one was "Not sure" (1.2%).

It is worth the extra time it takes me to teach environmental education. No respondents disagreed with this statement. Ten individuals were "Not sure" (12.3%); the remaining 71 respondents "Agreed" or "Strongly agreed" (96.3%) with the statement. The mean for this item was 4.23 with a standard deviation or 0.66.

It doesn't make sense to try to integrate environmental education into some subjects. Although responses to an earlier question regarding environmental education infusion "into subjects wherever possible" were relatively favorable, responses to this statement were less positive. The mean was 3.64 with a standard deviation of 1.10. Twenty-one percent of teachers (n=17) "Strongly agreed" or "Agreed" with this statement indicating a less positive attitude toward environmental education; 69.2% (n=56) "Disagreed" or "Strongly disagreed" and 9.9% (n=8) were "Not sure."

Environmental education should be mandatory in K-12 public schools. Almost half of the respondents "Agreed" with this statement (46.9%, n=38) and an additional 18.5% (n=15) "Strongly agreed." Twenty individuals (24.7%) were "Not sure," 8 individuals (9.8%) "Disagreed" or "Strongly disagreed" with the statement. The mean

for this item was 3.73 with a standard deviation of 0.91. Figure 1 presents a comparison of means for all statements.

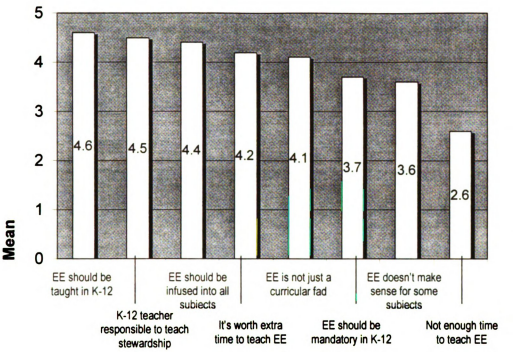

Figure 1: Comparison by means for statements measuring environmental attitude.

A score was calculated for each respondent based on his or her responses to each of the statements presented on the survey. The scores could range from a high of 40 indicating a very positive attitude toward environmental education and a low of 8 indicating a less positive attitude. The actual scores for respondents ranged from a low of 21 to a high of 40 with a mean of 31.79 and a standard deviation of 3.89. These scores will be used to test hypotheses discussed in a later section of this chapter.

Table 13: Summary Statistics for Environmental Education

Variable	Category	Frequency	Percent	Mean	Std. Dev.
EE should be taught in K12 schools	Str. Agree	49	60.5%	4.56	0.65
	Agree	30	37.0%		
	Not sure	1	1.2%		
	Disagree	0	0		
	Str. disagree	1	1.2%		
Not enough hours in school day to teach EE	Str. Agree	16	19.8%	2.64	1.26
	Agree	31	38.3%		
	Not sure	4	4.9%		
	Disagree	26	32.1%		
	Str. disagree	4	4.9%		
EE is another curricular fad				4.15	0.67
	Str. Agree	0	0%		
	Agree	2	2.5%		
	Not sure	7	8.6%		
	Disagree	49	60.5%		
	Str. disagree	23	28.4%		
EE should be integrated into subject areas wherever possible	Str. Agree	38	46.9%	4.38	0.66
	Agree	37	45.7%		
	Not sure	5	6.2%		
	Disagree	1	1.2%		
	Str. disagree	0	0		
As a K-12 teacher, it is my responsibility to teach my students to care for the Earth	Str. Agree	42	51.9%	4.46	0.65
	Agree	36	44.4%		
	Not sure	1	1.2%		
	Disagree	2	2.5%		
	Str. disagree	0	0		
It is worth the extra time it takes me to teach EE	Str. Agree	29	35.8%	4.23	0.66
	Agree	42	51.9%		
	Not sure	10	12.3%		
	Disagree	0	0		
	Str. disagree	0	0		
It doesn't make sense to try to integrate EE into some subjects	Str. Agree	3	3.7%	3.64	1.10
	Agree	14	17.3%		
	Not sure	8	9.9%		
	Disagree	40	49.4%		
	Str. disagree	16	19.8%		
EE should be mandatory in K-12 public schools	Str. Agree	15	18.5%	3.73	0.91
	Agree	38	46.9%		
	Not sure	20	24.7%		
	Disagree	7	8.6%		
	Str. disagree	1	1.2%		

Attitudes Toward Using the Web

To measure respondents' attitudes toward the Web, a scale was created based on 11 questions in the section of the survey titled, "Using the Web for Environmental Education." The reliability score for all 11 items was 0.77 indicating an acceptable level of internal validity. As described in the previous section, the scoring of statements was conducted such that higher scores reflect a more positive attitude toward using the Web. Scores for each statement range from 1 to 5 and the mean indicates respondents' attitude toward it. The data for all statements are presented in Table 14.

Respondents were asked to imagine a Web site where hundreds of K-12 teachers had submitted their environmental education lesson plans and activities. The site could be searched by topic, keyword and grade level. They were then asked to respond to the following statements.

I would definitely visit the Web site. The mean for this statement was 4.35 with a standard deviation of 0.74. Only one respondent (1.2%) "Disagreed", 10 individuals (12.3%) were "Not sure" and the remaining 70 (86.4%) "Agreed" or "Strongly agreed" that they would visit an environmental education web site similar to the one described if it existed.

If I found something interesting, I would print out lessons. No respondents disagreed with this statement. Only one respondent (1.2%) was "Not sure" and the remaining 80 respondents (98.8%) "Agreed" or "Strongly agreed" with the statement. The mean for this item was 4.56 with a standard deviation of 0.52.

If it seemed appropriate, I would use in my classroom. As above, only one respondent was "Not sure" while the remaining 80 (98.8%) "Agreed" or "Strongly agreed." The mean for this statement was 4.52 with a standard deviation of 0.53.

I would tell another teacher about the site. The mean was highest for this statement (x=4.58, sd=0.50) although only slightly higher than the previous two statements. All respondents either "Agreed" (42%, n=34) or "Strongly agreed" (58%, n=47).

I would submit my own lesson plans and contribute to the Web site. This statement elicited the lowest scores from respondents and had a mean of 3.64 with a standard deviation of 0.88. Although 49.4% (n=40) of respondents "Strongly agreed" or "Agreed" that they would submit their lesson plans, 44.4% (n=36) were "Not sure" and an additional 6.2% (n=5) "Disagreed." (See Figure 2)

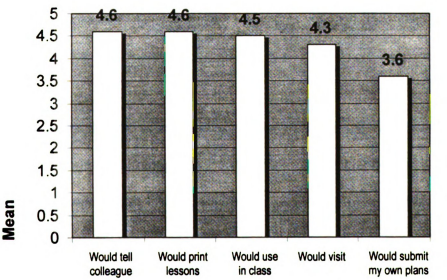

Figure 2: Comparison by means for hypothetical EE Web site.

Table 14: Summary Statistics for Hypothetical EE Web Site

Variable	Category	Frequency	Percent	Mean	Std. Dev.
Hypothetical EE Web Site: I would visit the site	Str. Agree	40	49.4%	4.35	0.74
	Agree	30	37.0%		
	Not sure	10	12.3%		
	Disagree	1	1.2%		
	Str. disagree	0	0		
Hypothetical EE Web Site: I would print lessons	Str. Agree	46	56.8%	4.56	0.52
	Agree	34	42.0%		
	Not sure	1	1.2%		
	Disagree	0	0		
	Str. disagree	0	0		
Hypothetical EE Web Site: I would use in my classroom	Str. Agree	43	53.1%	4.52	0.53
	Agree	37	45.7%		
	Not sure	1	1.2%		
	Disagree	0	0		
	Str. disagree	0	0		
Hypothetical EE Web Site: I would tell another teacher about the site	Str. Agree	47	58.0%	4.58	0.50
	Agree	34	42.0%		
	Not sure	0	0		
	Disagree	0	0		
	Str. disagree	0	0		
Hypothetical EE Web Site: I would submit my own lesson plans	Str. Agree	17	21.0%	3.64	0.88
	Agree	23	28.4%		
	Not sure	36	44.4%		
	Disagree	5	6.2%		
	Str. disagree	0	0		

Teachers scored the hypothetical environmental education Web site questions relatively highly. It is not surprising that they would be less likely to submit their own lesson plans to the contribute to the site because this requires computer skills and/or time that many teachers may not possess. However, it is encouraging that teachers would visit such a site, print out lessons, use in class and tell others about it.

The remaining questions in this section asked teachers to respond to statements about using the Web in education in general and are not specific to environmental education.

The existence of the World-Wide Web has not changed my teaching methods significantly. The mean score for this statement was 3.36 with a standard deviation of 1.14. Nearly a third of teachers (33.3%, n=27) "Agreed" or "Strongly agreed" with this statement, 13.6% were "Not sure" (n=11) and the remaining 53.1% (n=43) "Strongly disagreed" or "Disagreed."

I would take advantage of them if there were more teacher-developed lessons and activities on the World-Wide Web. Three respondents (3.7%) "Strongly disagreed" with this statement, 14 (17.3%) were "Not sure" and the remaining 64 teachers (79%) "Agreed" or "Strongly agreed." The mean for this item was 4.02 with a standard deviation of 0.91.

The quality or usefulness of classroom resources I find on the World-Wide Web is not worth the time I invest looking for them. This statement elicited the lowest scores from teachers and had a mean of 3.21 with a standard deviation of 0.90. Twenty-one percent of respondents (n=17) "Agreed" or "Strongly agreed," 37% (n=30) were "Not sure" and the remaining 42% (n=34) "Disagreed" or "Strongly disagreed" with the statement.

I regularly look for information or activities on the World-Wide Web to use in my classroom. There was a wide range of responses for this statement (x=3.26, sd=1.20). Fifty-three percent (n=43) of respondents "Agreed" or "Strongly agreed," 6.2% (n=5) were "Not sure" and 40.8% (n=33) "Disagreed" or "Strongly disagreed" with the statement.

Five years from now the World-Wide Web will be extremely important in K-12 education as a means for sharing and finding curricular resources. This statement elicited

the highest scores from respondents; the mean was 4.25 with a standard deviation of 0.72. Only 1 respondent (1.2%) "Disagreed." Ten respondents (12.3%) were "Not sure" while the remaining 70 teachers (86.4%) "Agreed" or "Strongly agreed."

Five years from now teachers in K-12 public schools will teach very much in the same way as they are teaching today. Given the previous statement, the results for this statement were somewhat surprising. Slightly more than half of the respondents (50.6%, n=41) reported that they "Strongly agreed," "Agreed" or were "Not sure" indicating that they anticipate only minimal impact of the Web on teaching practices even though many reported agreeing that the Web would be extremely important in K-12 for sharing resources. Conversely, 49.3% (n=40) "Strongly disagreed" or "Disagreed" with the statement. The mean was 3.33 with a standard deviation of 1.06.

However, given that approximately half of respondents reported that the Web had changed their teaching methods or that they use the Web regularly to find classroom resources, the results for this statement are not as surprising as they first appeared.

Figure 3 presents a graphical comparison by mean; Table 15 presents all of the data for each statement.

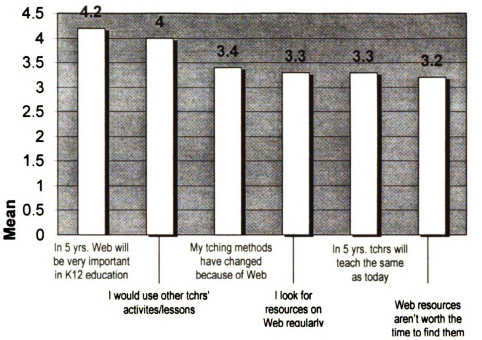

Figure 3: Comparison by means for statements measuring attitude toward Web.

Table 15: Summary Statistics for Using the Web in Education

Variable	Category	Frequency	Percent	Mean	Std. Dev.
The existence of the World-Wide Web has not changed my teaching methods significantly	Str. Agree	1	1.2%	3.36	1.14
	Agree	26	32.1%		
	Not sure	11	13.6%		
	Disagree	29	35.8%		
	Str. disagree	14	17.3%		
I would take advantage of them if there were more teacher-developed lessons and activities on the World-Wide Web	Str. Agree	25	30.9%	4.02	0.91
	Agree	39	48.1%		
	Not sure	14	17.3%		
	Disagree	0	0		
	Str. disagree	3	3.7%		
The quality or usefulness of classroom resources I find on the World-Wide Web is not worth the time I invest looking for them	Str. Agree	3	3.7%	3.21	0.90
	Agree	14	17.3%		
	Not sure	30	37.0%		
	Disagree	31	38.3%		
	Str. disagree	3	3.7%		
I regularly look for information or activities on the World-Wide Web to use in my classroom	Str. Agree	13	16.0%	3.26	1.20
	Agree	30	37.0%		
	Not sure	5	6.2%		
	Disagree	31	38.3%		
	Str. disagree	2	2.5%		
Five years from now the World-Wide Web will be extremely important in K-12 education as a means for sharing and finding curricular resources	Str. Agree	32	39.5%	4.25	0.72
	Agree	38	46.9%		
	Not sure	10	12.3%		
	Disagree	1	1.2%		
	Str. disagree	0	0		
Five years from now teachers in K-12 public schools will teach very much in the same way as they are teaching today.	Str. Agree	3	3.7%	3.33	1.06
	Agree	17	21.0%		
	Not sure	21	25.9%		
	Disagree	30	37.0%		
	Str. disagree	10	12.3%		

A score was calculated for each respondent based on his or her responses to each of the statements presented on the survey. The scores could range from a high of 65 indicating a very positive attitude toward using the Web and a low of 13 indicating a less positive attitude. The actual scores for respondents ranged from a low of 31 to a high of

52 with a mean of 42.99 and a standard deviation of 5.23. These scores will be used to test hypotheses discussed in a later section of this chapter.

Access to Environmental Education Resources

To measure respondents' access to environmental education resources, a scale was created based on 16 items. The reliability score for the 16 items was 0.77 indicating an acceptable level of internal validity. Scores for each item ranged from 0 (i.e., "No" or "Not sure") to 1 (i.e., "Yes"). The data for all items are presented in descending order by mean in Table 16.

Almost all respondents (95.1%, n=77) have access to books about the environment. More than half of the respondents has access to:

- environmental magazines (84%, n=68);
- local parks and nature centers (82.7%, n=67);
- environmental videos and movies (79%, n=64);
- environmental posters (75.3%, n=61);
- local environmental professionals or specialists (63%, n=51);
- background information about environmental topics on the Web (59.3%, n=48); and
- environmental education curricula on the Web (55.6%, n=45).

However, less than half of the respondents have access to:

- other teachers in their schools or districts who teach environmental education (49.4%, n=40);
- local environmental educators or environmental education organizations (45.7%, n=37);

- locally-produced environmental education curriculum guides; text books that contain environmental education material (40.7%, n=33);
- text books that contain environmental education material (39.5%, n=32);
- national environmental education curriculum guides (37%, n=30);
- computer-based environmental education software programs (34.6%; n=28);

And less than one-quarter of respondents have access to:

- State Department of Education curriculum guides that contain environmental education material (23.5%, n=19); and
- local school district curriculum guides that contain environmental education material (23.5%, n=19).

A score was calculated for each respondent based on his or her responses to each of the items presented on the survey. The scores could range from a high of 16 indicating access to all of the listed environmental education resources and a low of 0 indicating a no access. The actual scores for respondents ranged from a low of 0 to a high of 15 with a mean of 8.88 and a standard deviation of 3.39. These scores will be used to test hypotheses discussed in the next section of this chapter.

Table 16: Summary Statistics for Access to EE Resources

Variable	Category	Frequency	Percent	Mean	Std. Dev.
Books about the environment	Yes	77	95.1%	0.95	0.22
	No/Not sure	4	4.9%		
Environmental magazines	Yes	68	84.0%	0.84	0.37
	No/Not sure	13	16.0%		
Local parks and nature centers	Yes	67	82.7%	0.83	0.38
	No/Not sure	14	17.3%		
Environmental videotapes, movies, filmstrips	Yes	64	79.0%	0.79	0.41
	No/Not sure	17	21.0%		
Environmental posters	Yes	61	75.3%	0.75	0.43
	No/Not sure	20	24.7%		
Local environmental specialists and professionals	Yes	51	63.0%	0.63	0.49
	No/Not sure	30	37.0%		
Background information about environmental topics on the Web	Yes	48	59.3%	0.59	0.49
	No/Not sure	33	40.7%		
EE curricula and activities on the World-Wide Web	Yes	45	55.6%	0.56	0.50
	No/Not sure	36	44.4%		
Other teachers in my school or district who teach about the environment	Yes	40	49.4%	0.49	0.50
	No/Not sure	41	50.6%		
Local environmental educators, EE organizations	Yes	37	45.7%	0.46	0.50
	No/Not sure	44	54.3%		
Locally produced EE curriculum guides	Yes	33	40.7%	0.41	0.49
	No/Not sure	48	59.3%		
Text books that contain EE material	Yes	32	39.5%	0.40	0.49
	No/Not sure	49	60.5%		
National EE curriculum guides	Yes	30	37.0%	0.37	0.49
	No/Not sure	51	63.0%		
Computer-based EE software programs	Yes	28	34.6%	0.35	0.48
	No/Not sure	53	65.4%		
State Dept. of Education curriculum guide that contains EE material	Yes	19	23.5%	0.23	0.43
	No/Not sure	62	76.5%		
Local school district curriculum guide that contains EE material	Yes	19	23.5%	0.23	0.43
	No/Not sure	62	76.5%		

Hypotheses Tested

In association with several research questions, the following hypotheses were tested after data had been collected and analyzed from the Web-based survey. It is important to note that these are hypotheses are exploratory in nature.

H_1: Teachers who have greater access to environmental education resources will exhibit a more positive attitude toward environmental education than teachers who have access to fewer resources.

H_2: Teachers who exhibit a more positive attitude toward environmental education will also exhibit a more positive attitude toward using the Web in education.

To test the first hypothesis, a correlation analysis was performed using two of the scales created—the sum of respondents' environmental education resources access scores and the sum of respondents' environmental education attitude scores—to determine whether or not a significant relationship exists between the two variables. The Pearson Correlation score was 0.148 with a 1-tailed significance value of 0.094. Because $p>0.05$, we can assume that there is no statistically significant relationship between the two sets of scores and must reject H_1. Based on this data, attitude toward environmental education does not appear to be related to one's level of access to different environmental education resources.

A similar procedure was followed to test the second hypothesis. In this case, it was hypothesized that respondents' who exhibited a positive attitude toward environmental education would also exhibit a positive attitude toward using the Web in

education. A correlation analysis was conducted using the sum of respondents' environmental education attitude scores and the sum of respondents' Web attitude scores. The Pearson Correlation score was 0.172 with a 1-tailed significance of 0.062. Although the value of p is only slightly greater than 0.05, we still assume that there is no statistically significant relationship between the two variables and reject H_2. Based on this data, attitude toward the Web does not appear to be related to attitude toward environmental education and vice versa.

Please note that the findings and conclusions drawn here are preliminary and should be interpreted with caution. In order to draw conclusions with confidence, larger survey sample sizes would be necessary. In addition, more rigorous development and testing of scales is advised.

Additional Analyses

Additional statistics were conducted to further interpret the data. First, correlation analyses were conducted on individual variables to determine whether or not significant relationships exist. Second, a Compare Means analysis with ANOVA was performed to determine whether or not individuals' level of Internet access was related to their responses in the sections measuring environmental attitude and attitude toward using the Web.

Correlation analysis. Each of the eight questions measuring environmental education attitudes were correlated with the 11 questions measuring attitudes toward the Web. Several significant relationships came to light.

The question that asked respondents about the hypothetical environmental education Web site was significantly correlated to five of the eight statements in the section measuring environmental education attitudes.

Thus, on these specific individual items, there appears to be a positive linear relationship: individuals' environmental education attitudes are significantly correlated to their attitudes toward visiting and using a hypothetical environmental education Web site. Teachers who exhibit positive attitudes toward environmental education also exhibit positive attitudes toward using an environmental education Web site as described in the survey. These findings lend some support to the research hypothesis, H_2.

Compare Means with ANOVA. A second analysis was conducted to determine whether or not individuals' level of Internet access (i.e., access at home only, school only, or both) was related to their responses on questions measuring environmental education attitudes and attitudes toward using the Web in education. Respondents were split into three groups by Internet access: home access only (n=13), school access only (n=16) and both (home and school; n=52). Next, the procedure Compare Means with ANOVA was used to compare responses to the 11 questions measuring attitude toward the Web. The results indicate a significant difference exists between groups. In each case below, the group with access at "both home and school" scored significantly higher than those with Internet access at "home only" or at "school only." In response to the statement:

- "I regularly look for information on the web to use in my classroom," the means for home, school, and both were 2.85, 2.25, and 3.67 respectively. These differences were significant at the level of 0.000 (2-tailed).

- "The Web hasn't changed my teaching methods significantly," the means for home, school, and both were 2.92, 2.56, and 3.71 respectively. These differences were significant at the level of 0.000 (2-tailed).

Therefore, teachers who have a higher level of Internet access (i.e., at home and school) are more likely to browse the Web regularly for information to use in their classrooms than those teachers with Internet access at only one location. Similarly, teachers with greater Internet access are more likely to perceive that the Web has influenced their teaching methods than those have with limited Internet access.

Next, a Compare Means analysis was performed for the questions measuring environmental education attitudes. Again, significant differences between groups were found. However, in this case, those with home access only scored higher than teachers with access at school only or those with access at both home and school. In response to the statement:

- "There are not enough hours in the school day to teach environmental education," the means for home, school, and both were 3.38, 2.31, and 2.56 respectively. These differences were significant at the level of 0.051 (2-tailed).
- "Environmental education should be mandatory in K-12 public schools," the means for home, school, and both were 4.38, 3.06, and 3.77 respectively. These differences were significant at the level of 0.000 (2-tailed).

Therefore, teachers who have Internet access at home only are more likely to agree that environmental education should be mandatory in K-12 schools than those teachers with Internet access at school only or at both home and school. Similarly,

teachers with home access only are more likely to perceive that there are enough hours in the day to teach environmental education than those with Internet access at school only or both home and school.

Research Questions Answered

1. Do K-12 teachers who complete the online survey exhibit positive attitudes toward environmental education?

Overall, the data indicate that teachers who completed the Web-based survey exhibit positive attitudes toward environmental education. The means for questions measuring environmental education attitudes ranged from a low of 2.64 to a high of 4.56. The overall mean of these scores is 4.0 out of a possible high score of 5.0.

2. Do K-12 teachers who complete the online survey exhibit positive attitudes toward using the World Wide Web in education?

The data indicate that teachers who completed the Web-based survey exhibit positive attitudes toward using the Web in education. The means for questions measuring Web attitudes ranged from a low of 3.21 to a high of 4.58. The overall mean of these scores is 3.9 out of a possible high score of 5.0.

3. What is the relationship between teachers' access to environmental education resources and their attitudes toward environmental education?

Based on the data collected by the survey instrument, there appears to be no significant relationship between teachers access to environmental education resources and their attitudes toward environmental education. Teachers' attitudes toward environmental education appear to be independent of their access to environmental education resources.

4. What is the relationship between teachers' attitudes toward environmental education and their attitudes toward using the World Wide Web in education?

In general, findings from the data indicate that there is no significant relationship between teachers' attitudes toward environmental education and their attitudes toward the Web. However, additional analyses found teachers' attitudes toward environmental education on specific items were significantly related to teachers' attitudes toward the Web on specific items. Several items measuring environmental education attitudes were found to be significantly, positively correlated to items measuring teachers' attitudes toward visiting and using a hypothetical environmental education Web site designed for teachers.

5. Using only electronic methods to advertise the online survey, how many K-12 teachers will complete and submit the online survey in a 45-day time period?

Within two weeks of placing the survey online, approximately 50 K-12 teachers had responded and completed the survey. After 45 days, 81 K-12 teachers had completed and submitted the online survey.

In summary, the Web-based survey results indicate that (1) respondents' environmental attitudes appear to be unrelated to the number of environmental education resources available to them; and (2) respondents' environmental attitudes appear to be unrelated to their attitudes toward using the Web in education. However, findings also suggest that respondents' environmental attitudes on certain statements (i.e., Environmental education should be taught in schools, Environmental education should be mandatory, Teaching environmental education is worth the extra time required, etc.) do appear to be related to respondents' attitudes toward visiting and using a hypothetical

environmental education Web site. Respondents who exhibit more positive environmental attitudes on particular statements identified above exhibit more positive attitudes toward visiting an environmental education Web site, finding and using lesson plans, telling colleagues about the site and submitting their own lesson plans.

In addition, those respondents with greater access to the Internet and Web tend to exhibit more positive attitudes toward using the Web in education than those with less access.

A discussion of the highlights from the research findings, implications and conclusions will be presented in the following chapter.

CHAPTER 5

FINDINGS AND RECOMMENDATIONS

The overarching goal of this research was to investigate the feasibility of using the World-Wide Web as a means for sharing environmental education curricular resources among K-12 teachers and thus, reduce a significant barrier to environmental education identified in the literature. This chapter reviews the steps taken to achieve this goal, identify key findings from the analysis of results, discuss the implications of results, and present recommendations for future directions for Web-based environmental education.

THE MAIL SURVEY

In order to investigate the feasibility of using the Web to share environmental education curricula, it was first necessary to determine whether or not a sample of teachers: (1) were interested in environmental education, and (2) had the hardware, software and Internet access necessary for Web-based research. If findings suggested that teachers were not interested in environmental education, or if the majority of teachers did not have the technical capability for participating in a Web-based study, the research questions would have been reevaluated.

Key Findings

Results from the mail survey indicated that respondents were interested in environmental education and had the technical capability for participating in Web-based projects. Key findings from the survey include the following.

- The overwhelming majority of teachers (97.3%) indicated that environmental education should be taught in K-12 public schools, most teachers (87.3%) reported feeling comfortable teaching environmental education and 78.1% of respondents indicated that they regularly teach environmental concepts in their in classrooms.
- Teachers reported using the following resources most often in developing environmental education curricula: develop own "unique" environmental education curricula (62.2%), get ideas from colleagues (40.5%), and use environmental education curriculum guides (29.7%).
- More than half of respondents (62.2%) reported having no access to environmental education curriculum guides and 54.1% never received environmental education inservice education.
- Respondents indicated they would teach environmental education more often in their classrooms if they had more preparation time (73.0%), better access to resources and curricula (56.8%) and more environmental education inservice education opportunities (56.8%).
- Most teachers (86.5%) indicated they have one or more computers in the classroom; of those, 71.9% have Internet access available.
- More than half of respondents (62.2%) reported having access to email and Web-browsing software (54.1%).
- A small percentage of teachers have found lesson plans on the Web (27.6%), contributed their own lessons to a Web site (6.9%), and/or have used computers to teach about the environment (20.7%).

In summary, the findings from the mail survey support earlier studies citing that teachers are interested in environmental education and believe it is a valuable subject in K-12 education (Champeau et al., 1980; Johnson, 1980; Lane et al., 1994). In addition, evidence from this survey indicates that the primary barriers to teaching environmental education include lack of time to prepare for classes, lack of access to resources and curricula and lack of inservice education opportunities. This also supports earlier findings in the environmental education literature (Childress, 1978; Ham & Sewing, 1988; Volk et al., 1986). Other findings from this research have implications for use of the Web in environmental education.

Implications for Using the Web in Environmental Education

The majority of respondents (62.2%) indicated that they develop their own environmental education curricula—and the same amount (62.2%) reported no access to, and thus, do not use environmental education curriculum guides. In addition, a large percentage of teachers reported relying on colleagues for environmental education activities and curricula. Findings suggest it is worth exploring environmental education resources that facilitate teacher-to-teacher communication and searchable "idea banks" or databases of curriculum information that can be used to help teachers develop their own "unique" curricula. The Web can facilitate these kinds of activities on demand.

In addition, a small percentage of teachers are already using the Web to find lesson plans and are using computers to teach about the environment. As Internet access improves in schools and classrooms, it is likely that more teachers will use this medium as a curricular resource.

In summary, the mail survey provided evidence for the feasibility of the next stage of research: studying the process of environmental education curriculum development with two practicing teachers and developing a prototype Web site to share curricula with others.

TWO DESCRIPTIVE CASES

The next step in investigating the feasibility of using the web to share environmental education resources involved engaging in the curriculum development process with two practicing teachers. While the "infusion" approach to environmental education is regularly discussed and recommended in the environmental education literature (Disinger, 1993; Ramsey et al., 1992; Volk, 1993), there is very little research documenting how environmental education has been implemented (Samuel, 1993).

The purpose of this phase of the research was to (1) gain insights about the curriculum development process, and (2) to generate curricula to place online to share with others. As a result of this phase of research, a prototype Web site was created to share the curricula developed with other teachers. Although some environmental education Web sites were already available online at the time of this research, very few were specifically focused on the needs of teachers or provided teacher-developed curricula.

Key Findings

Results from the collaborative curriculum development process with teachers suggest that the experience can vary widely from one teacher to the next. For example, key findings include the following:

- Beginning the curriculum development process. One teacher began with district-required standards and objectives to be met; the other began with a particular environmental topic, developed activities around the topic and then determined ways to meet district standards.
- Selecting topics. One teacher selected recycling as the environmental topic because she was passionate about the subject. The other teacher selected water and other environmental problems because specific district objectives outlined these topics for study.
- Subjects environmental education infused into. One teacher developed a science "theme" around water and other environmental problems and integrated language arts, public speaking and listening skills into the theme. The other teacher integrated recycling into the two primary subjects she taught: language arts and computers.
- Resources used to develop curricula. One teacher gathered a variety of resources from her school, home, public library and community organizations to develop curricula. The other teacher used books from the library and the Web as her primary resources.

In summary, each teacher approached the process from different perspectives, selected very different environmental topics for study, integrated environmental education into a variety of subjects and used vastly different resources to create the curricula. These findings have important implications for the use of the Web in environmental education.

Implications for Using the Web in Environmental Education

Teachers have very different curricular needs and those needs can change dramatically over time. It is virtually impossible to anticipate the varied and dynamic needs of teachers and develop environmental education curriculum guides or other printed resources that meet those needs effectively in a cost-efficient manner. Furthermore, evidence from the survey in Phase 1 of this research as well as the environmental education literature suggests that many teachers lack access to environmental education guides and are disconnected from the wealth of environmental education resources that already exist.

The Web could be used to minimize these problems. The Web is rapidly becoming available in schools across America and is, as yet, an under-utilized resource. One of the teachers developing curricula mentioned that she expected to find more information about environmental education on the Web such as ideas for environmental activities and guidelines for teaching environmental education. It is very likely that more teachers will turn to the Web for environmental education information.

One of the advantages of the medium is the ability to create "links" between information. This could be a very simple and powerful way of connecting teachers to the resources they seek. The Web can also be used to provide "information on demand." Large, searchable databases are currently available online; users can search through a sea of information using keywords and phrases. Hypothetically, if an environmental education Web site housed a database cataloging K-12 teachers' environmental education lesson plans or activities, at any point in time, teachers could search and find the curricula

they need in a timely manner. However, such a site should be centrally located, easy to find, and well-designed enabling teachers to use it efficiently.

Lessons from Web Design

For the prototype Web site, Web design and curriculum development was concurrent. Ideally, content is completed before site design begins. This enables the designer to focus on structuring the information available to facilitate navigation of the site. Because the prototype Web site was being developed as teachers created curricula, navigation was less than optimal. Furthermore, teachers' curricula emerged in very different forms and creating a standard look was challenging.

Several lessons were learned about environmental education design during this phase of the research:

- Creating templates for presenting curricula would help maintain consistency of the site. However, such design constraints could unnecessarily constrain content.
- Prototype Web site visitors reacted positively to viewing samples of students' work online that resulted from the curricula taught.
- Prototype Web site visitors reacted positively to reading teachers' comments about specific activities.
- Providing links to additional environmental education resources on the Web dramatically increases the cost of maintaining the site. Even during the short period the prototype Web site was available online (approximately 4 months), several external links to other environmental education Web sites became outdated and several new, relevant sites came online.

In summary, the findings from teachers' environmental education curriculum development experiences suggest that teachers' needs for environmental education resources vary widely and are dynamic in nature. It would be extremely difficult to develop printed environmental education curriculum guides flexible enough to meet those needs. Because the Web can facilitate "linking" between resources and can provide "information on demand," it is an educational resource that should be investigated further.

For the next phase of the research, a Web-based survey was placed on the prototype Web site to elicit teachers' perceptions about environmental education and using the Web in education, and to identify teachers' access to various environmental education resources.

THE WEB-BASED SURVEY

The first phase of research provided evidence that teachers were interested in environmental education and had the hardware and software necessary to participate in Web-based research. The second phase of research resulted in the generation of environmental education curricula designed by practicing teachers and the creation of pilot demonstration Web site. The last phase of the research necessary to investigate the feasibility of using the Web to share environmental education resources was the implementation of a Web-based survey. The purpose of the survey was to elicit teachers' perceptions about environmental education and using the Web in education, and to identify the kinds of environmental education resources available to teachers. If the Web is to be a means for reducing barriers to environmental education for teachers, it is

essential that teachers' perceptions, attitudes and beliefs about environmental education and the Web be explored.

Key Findings

Results from the Web-based survey indicated that teachers exhibited positive attitudes toward environmental education. This supports survey results from Phase 1 as well as earlier studies cited in the environmental education literature (Champeau et al., 1980; Johnson, 1980; Lane et al., 1994). Teachers also exhibited positive attitudes toward using the Web in education. Although many teachers reported having access to a wide variety of environmental education resources, more than half of the respondents lacked access to any kind of environmental education-related curriculum guides.

Attitudes Toward Environmental Education

- Almost all respondents (97.5%) agreed that environmental education should be taught in K-12 schools although fewer (65.4%) agreed that it should be mandatory.
- Many teachers agreed that "it is worth the extra time it takes to teach environmental education" (87.7%), but a majority of teachers indicated there "are not enough hours in the day to teach everything that is required plus environmental education" (58.1%). This supports earlier research studies citing lack of time as an important barrier to environmental education (Ham & Sewing, 1988; Ham et al., 1988).

Attitudes Toward Using the Web in Education

- Respondents exhibited very positive attitudes toward visiting and using a hypothetical environmental education Web site designed for teachers to share environmental education curricula.
- Most teachers (86.4%) agreed that in "five years from now the Web will be extremely important in K-12 education as a means for finding and sharing curricular resources." Respondents exhibited the most positive attitude toward this statement.
- Respondents indicated that finding quality resources on the Web for classroom use is difficult; they exhibited the least positive attitude toward this statement.

Respondents' Access to Environmental Education Resources

- More than half of respondents reported access to environmental magazines, parks and nature centers, environmental videos and movies, posters, local environmental professionals, and Web-based "background" information and curricula.
- Fewer than half of the respondents indicated access to other teachers who teach environmental education, local environmental education organizations and educators, locally- or nationally produced environmental education curriculum guides, textbooks that contain environmental education material and computer-based environmental education software programs.
- Less than one-quarter of respondents reported access to state or local school district curriculum guides that contain environmental education material.

It was hypothesized that teachers who reported access to a greater number of environmental education resources would exhibit a more positive attitude toward environmental education than teachers reporting access to fewer resources. In addition, it was hypothesized that teachers exhibiting more positive attitudes toward environmental education would also exhibit more positive attitudes toward using the Web in education.

Hypotheses Tested

- An analysis of the Web-based survey data indicated that teachers' access to environmental education resources does not appear to be significantly related to teachers' environmental attitudes. Some teachers who reported access to very few resources exhibited very positive attitudes toward environmental education and vice versa. Findings suggest attitude toward environmental education appears to be independent of one's access to environmental education resources.
- An analysis of the Web-based survey data indicated that teachers' attitude toward environmental education does not appear to be significantly related to teachers' attitude toward using the Web in education. Although additional analyses (see below) suggested that attitude toward environmental education is related to attitude toward *using the Web in environmental education*, in general, environmental education attitude appears to be independent of one's attitude toward using the Web in education.

Additional Analyses

- Five (of eight) items measuring attitude toward environmental education were significantly related to statements about visiting and using a hypothetical

environmental education Web site designed for teachers. Specifically, statements about teaching environmental education in schools, making environmental education mandatory, teaching environmental education being worth the extra time, environmental education not being a fad, and K-12 teachers being responsible for teaching environmental education were positively correlated with the environmental education Web site questions. Teachers who scored highly on the above statements also scored highly on statements about visiting a hypothetical environmental education Web site, using lesson plans found there, submit their own lesson plans and tell a colleague about the site.

- Respondents with greater Internet access (i.e., at home and at school) scored higher on two items measuring attitude toward using the Web in education than those with access at home or at school only. Not surprisingly, those with greater access appear to be more likely to use the Web to look for classroom resources and to report that the Web has influenced their teaching methods.
- Respondents with less Internet access—at "home only"—scored higher on two items measuring environmental education attitude than those with access at "school only" and those with access at "both home and school". Those with Internet access at "home only" tended to score more highly on two statements: (1) "Environmental education should be mandatory in K-12 public schools," and (2) "There are enough hours in the day to teach environmental education." This finding is somewhat unexpected and difficult to explain. Perhaps those who had home access only felt strongly enough about

environmental education to find and complete the survey during their personal time at home. Results could also represent "outliers" and data are not representative of users with home access only. Additional research is necessary to explain these unexpected findings.

Limitations to the Study

Initially, one hypothesis of the Web-based survey was to explore whether or not teachers who exhibited positive attitudes toward environmental education would also exhibit positive attitudes toward using the Web *in environmental education*. However, because few environmental education Web sites designed specifically for teachers existed at the time of the survey, only one multi-part question about a hypothetical Web site was included. More questions targeted to measure attitudes toward using the Web in environmental education would be necessary to create a scale and test the hypothesis.

Similarly, general questions measuring attitudes toward using the Web in education should have been included in a separate scale. In the case of the Web-based survey, two different variables (i.e., attitude toward using the Web in environmental education and attitude using the Web in education) were measured using one scale and it is likely that this affected the results.

Finally, all of the statistics presented should be interpreted cautiously. The purpose of both surveys was to explore teachers' perceptions and attitudes. In order to draw conclusions and seek cause-effect relationships among variables it would be necessary to survey a larger sample of respondents and to modify and refine the scales used here.

Implications for Using the Web in Environmental Education

The most important result from this survey is that respondents who exhibited positive attitudes toward environmental education also exhibited positive attitudes toward using a hypothetical environmental education Web site that is designed for teachers. Additionally, more respondents reported access to Web-based environmental education information than to any kind of environmental education-related curriculum guides. Furthermore, those teachers with greater Internet access (i.e., access at home and at school) reported using the Web more often to find resources to use in the classroom. The following implications are based on these findings.

As access to the Internet and Web increases in U.S. schools, it is likely that teachers will rely on this medium more often for curricular resources and information. The results from the mail and Web-based surveys indicate that a small percentage of teachers are already using the Web for these purposes. If current trends continue, we can anticipate that this number will grow substantially over the next decade.

Evidence from the Web-based survey suggests that the target population for an environmental education Web site should be teachers who exhibit positive attitudes toward environmental education. These are the teachers most interested in finding additional resources and using the Web for these purposes. The literature review of change processes in schools indicated that when a curriculum change is not mandated—and environmental education is mandatory in only a few states—strategies that focus on the teacher as an individual change agent are often most effective and can be source of "profound change."

Because the Web is accessible to so many educators, and because the medium affords unique features such as facilitating communication, linking information sources and providing information on demand, it can be an invaluable resource for environmental education. Further research, discussion and debate within the environmental education community about the value and use of the Web is essential. Environmental educators should be active in all aspects of Web-based environmental education to guide the development of thoughtful, creative Web sites that provide the kind of environmental education resources that foster environmentally-literate, concerned and active individuals.

RECOMMENDATIONS

1. The Web is a vastly underutilized resource in environmental education. There is a need for further research to explore using the Web (1) to connect teachers to environmental education resources, (2) to facilitate teacher-to-teacher communication about environmental education topics and activities, and (3) to provide online inservice educational opportunities.
2. There is a need to create a central clearinghouse of environmental education information on the Web targeted to K-12 educators. Many environmental education Web sites exist and more are created every day. However, finding quality sites and determining how to integrate environmental education content into curricula is time-consuming for teachers. If the Web is to be used by teachers, it must be simple to find and quick to use. A single organization like the Environmental Protection Agency or environmental education-Link should take responsibility for the design and maintenance of a K-12 environmental education clearinghouse. In order to create an effective

environmental education clearinghouse Web site, additional research is recommended to:

- Identify current barriers to using the Web experienced by K-12 teachers;
- Explore K-12 teachers' expectations for environmental education Web sites and the types of curricular resources they desire;
- Discover the expectations and identify the concerns of both Web designers and environmental educators for an environmental education Web site.

3. The environmental education community must become more actively involved in Web-based environmental education opportunities. Creative discussion, debate and development of prototype Web-sites is urgently needed if the environmental education community is to *drive* the creation of Web-based environmental education rather than *react* to online environmental education information already in existence. While environmental educators are often loath to advocate the use of computers and other technologies for teaching about the natural world, there can be many valuable ways to use technologies in environmentally appropriate ways. It is the responsibility of environmental educators and activists to engage in this debate to determine the best possible uses of the Web in environmental education.

APPENDIX A

MAIL SURVEY

Survey of Ingham County 4th Grade Teachers

1997

Please indicate your answer to each question by placing an **X** in the box beside the appropriate answer, or by writing in your answer when requested to do so.

Section I. Environmental Education

In this section, we would like to know what you think about teaching environmental education.

1. Do you teach environmental concepts in your classroom?

❑ Yes ❑ No

If "No", why not?
(Please select all that apply.)

- ❑ Concepts unrelated to subjects taught
- ❑ Do not have environmental ed. background
- ❑ Do not have class time
- ❑ Not enough prep time
- ❑ Not appropriate for grade level
- ❑ Other (Please specify: _____)

If "Yes", are environmental concepts:

- ❑ Taught as a separate subject (i.e., environmental studies, env. science)
- ❑ Integrated into other subject areas
  - Please specify the subject area in which you *most often* teach environmental concepts: _____

2. Do you personally own or have access to Environmental Education curriculum guides?

❑ Yes ❑ No

If "Yes", please specify up to three guides:

1. _____
2. _____
3. _____

3. Have you ever received in-service education for environmental education?

❑ Yes ❑ No

If "Yes", please specify up to 2 organization(s) that provided it:

1. _____
2. _____

4. If you teach your students about environmental concepts, what source(s) you use to develop curriculum? (Please select all that apply.)

- ❑ I use special *environmental education* curriculum guides
- ❑ I develop my own unique curriculum and activities
- ❑ I get my ideas for environmental curricula from my colleagues
- ❑ I use the state/county required curriculum guides
- ❑ I use the World-Wide Web and the Internet to develop environmental curricula
- ❑ Other (Please specify: _____)
- ❑ I do not teach about environmental concepts

5. Do you believe environmental education should be taught in elementary schools?

❑ Definitely Yes ❑ Yes ❑ Not Sure ❑ No ❑ Definitely No

6. Please rate how comfortable you would feel teaching your students about environmental concepts:

❑ Very comfortable ❑ Comfortable ❑ Neutral ❑ Uncomfortable ❑ Very uncomfortable

7. Which of the following situations would be *most likely* to influence you to infuse environmental education into your regular curriculum in the future? (Please select all that apply.)

- ❑ More in-service classes on environmental education
- ❑ Better access to resources and curricula
- ❑ More preparation time
- ❑ More funding
- ❑ More support from the school administration
- ❑ Other (Please specify: _____)
- ❑ None

Section II. Computers in Education

In this section, we would like to know what you think about the use of computers in teaching.

1. Do you have one (or more) computers in your classroom?

❑Yes ❑No

a.) If "Yes", how many computers are in your classroom? _____

b.) How many years have you had the *newest* computer in your classroom?

- ❑ Less than one year
- ❑ 1-2 years
- ❑ 2-4 years
- ❑ More than 4 years

c.) Please tell us what kind(s) of computer(s) you have in your class room (i.e., Macintosh, Windows, System 7, Pentium, etc.). Please be as specific as possible.

_____

_____

_____

_____

_____

c.) Do you have internet access from your classroom?

❑ Yes ❑ No ❑ Not sure

2. Does your school have a computer lab?

❑Yes ❑No

If "Yes", can students access the Internet from lab computers?

❑ Yes ❑ No ❑ Not sure

3. **What kinds of software are available on the computers you have access to (i.e., in your classroom and/or computer labs)?** (Please select all that apply.)

- ❑ Word processing
- ❑ Spreadsheet
- ❑ Database
- ❑ Presentation
- ❑ Draw/paint
- ❑ E-mail
- ❑ WWW browser *(i.e., Netscape)*
- ❑ Hypermedia *(i.e., Hypercard)*
- ❑ Games
- ❑ Educational software (Please specify: _____)
- ❑ Other (Please specify: _____)
- ❑ Not sure

4. **Have you ever received in-service education on using software programs?**

❑Yes ❑No

a.) If "Yes", what organization(s) provided the in-service? Please specify up to two organizations.

1. _____
2. _____

b.) Do you receive in-service educational programs on a regular basis?

❑Yes ❑No

5. **Think about the ways in which you have learned how to use various software applications. Which of the following sources best represents the way(s) *you* learned how to use software?** (Please select all that apply.)

- ❑ In-service educational programs
- ❑ Self-taught; experimentation
- ❑ Courses outside of my school (i.e., Community college, Evening college, etc.)
- ❑ Colleagues
- ❑ Students
- ❑ My children; younger family members
- ❑ Other (Please specify: _____)

6. Do you use computers in instruction?

❑ Yes ❑ No

If "No", which one of the following situations would be *most likely* to influence you to use computers in instruction in the future?

- ❑ More computer training
- ❑ More computers in the classroom
- ❑ Access to better computer hardware/software
- ❑ More preparation time
- ❑ Other (Please specify: _____)

a.) If "Yes", please specify the *primary* way you use computers in instruction:

- ❑ Internet research
- ❑ Internet publishing (i.e., creating class/student web pages)
- ❑ Data analysis (i.e., using spreadsheet, graphs, database software)
- ❑ Presenting information (i.e., using presentation/drawing software)
- ❑ E-mail (i.e., gathering and sharing information with others)
- ❑ Educational software (i.e., digital encyclopedias, specialized ed. software)
- ❑ Computer-aided instruction programs
- ❑ Other (Please specify: _____)

b.) Have you ever found lesson plans/activities on the World-Wide Web and incorporated them in your classroom teaching?

❑ Yes ❑ No

c.) Have you ever placed your own activities and/or lesson plans on the World-Wide Web for others to use?

❑ Yes ❑ No

d.) Have you ever used computers to teach students about environmental concepts?

❑ Yes ❑ No

Section III. General Information

In this section, we would like to learn a little more about you and your school community.

1. **How many years have you been employed as an elementary school teacher (K-6)?** _____

2. **What is your elementary school *subject specialization*?** _____

3. **Educational background. (Please indicate the highest level of education completed.)**

- ❑ High school
- ❑ Teaching certificate
- ❑ College/university (B.A./B.S. degree)
- ❑ Credits beyond Bachelor's degree
- ❑ Master's degree
- ❑ Ph.D. degree
- ❑ Post-doctoral study
- ❑ Other (Please specify: _____)

4. **How many students are in your class?** _____

5. **Which of the following terms best describes the community your school serves? Please select one response from Column A *and* Column B.**

Social Class	*Geographic Area*
❑ Middle-class	❑ Suburban
❑ Affluent	❑ Rural
❑ Economically-disadvantaged	❑ Urban

6. **What is your ethnicity?**

- ❑ African/African-American
- ❑ Asian/Asian-American
- ❑ Caucasian
- ❑ Latin/Latin-American
- ❑ Native American
- ❑ Multi-racial
- ❑ Other

7. **What is your gender?**

- ❑ Male
- ❑ Female

8. **What is your age range?**

- ❑ under 21 years old
- ❑ 21 to 30 years old
- ❑ 31 to 40 years old
- ❑ 41-50 years old
- ❑ 51 to 60 years old
- ❑ 61 years and older

Thank you very much for your participation in this survey. If you would like to add any additional comments about environmental education, educational technology, or your school, please include them in the space provided below.

A summary of the results of this survey will be made publicly available to you, the respondents, via the World-Wide Web as soon as the data has been collected and analyzed. If you would like the web address, or, if you would like to receive the summary via e-mail, please send a message to **yorkkimb@pilot.msu.edu** indicating your preference. If you would like to receive a hard-copy of the survey results, please send a self-addressed stamped envelope to:

Kimberly York
323 Natural Resources Building
Resource Development Department
Michigan State University
East Lansing, MI 48824

E-mail: yorkkimb@pilot.msu.edu
Phone: 517/353-6811

Additional Comments:

APPENDIX B

WEB-BASED SURVEY

K-12 Environmental Education Survey

This survey is for K-12 teachers and pre-service teachers. You will be asked about your teaching experiences. Pre-service teachers, if you are not currently teaching in a classroom, please respond to questions based on how you anticipate you would teach in the future.

By completing the survey, you inicate your voluntary participation and consent. This survey is also available online: http://rdserv1.rd.msu.edu/enved/survey.html

The results of the survey will be published online by May 30, 1998:
http://rdserv1.rd.msu.edu/enved/results/

Thank you for your participation.

Section 1: Environmental Education

Please indicate how strongly you agree or disagree with the following statements.

	Str. agree	*Agree*	*Not Sure*	*Disagree*	*Str. Disagree*
1. Environmental education should be taught in K-12 schools.	☐	☐	☐	☐	☐
2. There are not enough hours in the school day to teach everything that is required plus environmental education.	☐	☐	☐	☐	☐
3. Environmental education is another curricular fad.	☐	☐	☐	☐	☐
4. Environmental education should be integrated into subject areas wherever possible.	☐	☐	☐	☐	☐
5. As a K-12 teacher, it is my responsibility to teach my students to care for the Earth.	☐	☐	☐	☐	☐
6. It is worth the extra time it takes me to teach environmental education.	☐	☐	☐	☐	☐
7. It doesn't make sense to try to integrate environmental education into some subjects.	☐	☐	☐	☐	☐
8. Environmental education should be mandatory in K-12 public schools.	☐	☐	☐	☐	☐

Section 2: Using the World-Wide Web in Environmental Education

Please indicate how strongly you agree or disagree with the following statements.

	Str. agree	*Agree*	*Not Sure*	*Disagree*	*Str. Disagree*
9. Imagine a web site where hundreds of K-12 teachers have put their environmental education activities and lessons online. A friend tells you that you can search the information by grade level, subject area, or keywords.					
• I would definitely visit the site.	☐	☐	☐	☐	☐
• If I found something interesting, I would print out lessons.	☐	☐	☐	☐	☐
• If it seemed appropriate, I would use in my classroom.	☐	☐	☐	☐	☐
• I would tell another teacher about the site.	☐	☐	☐	☐	☐
• I would submit my own lesson plans and contribute to the web site.	☐	☐	☐	☐	☐
10. The existence of the World-Wide Web has not changed my teaching methods.	☐	☐	☐	☐	☐
11. I would take advantage of them if there were more teacher-developed lessons and activities on the World-Wide Web.	☐	☐	☐	☐	☐
12. The quality or usefulness of classroom resources I find on the World-Wide Web is not worth the time I invest looking for them.	☐	☐	☐	☐	☐
13. I regularly look for information or activities on the World-Wide Web to use in my classroom.	☐	☐	☐	☐	☐
14. Five years from now, the World-Wide Web will be extremely important in K-12 education as a means for sharing and finding curricular resources.	☐	☐	☐	☐	☐
15. Five years from now, teachers in K-12 public schools will teach very much in the same way as they are teaching today.	☐	☐	☐	☐	☐

Section 3: Access to Environmental Education Resources

Please indicate whether or not you have access to each of the following environmental education resources below.

	Yes	*No*	*Not Sure*
16. National Resources & Curricula			
• Printed national env. education curriculum guides (i.e., Project Learning Tree, Project Wild)	☐	☐	☐
• Books about the environment	☐	☐	☐
• Text books that contain env. education material	☐	☐	☐
• Environmental magazines (i.e., Ranger Rick, World)			
• Environmental videotapes, movies, filmstrips	☐	☐	☐
• Computer-based env. education software programs	☐	☐	☐
• Envrironmental posters	☐	☐	☐
17. State & Local Resources			
• Locally produced, printed env. education curriculum guides (i.e., local environmental organization's curricula)	☐	☐	☐
• State Dept. of Education curriculum guide that contains environmental content	☐	☐	☐
• Local school district curriculum guide that contains environmental content	☐	☐	☐
• Local parks and nature centers	☐	☐	☐
• Local environmental specialists & professionals (i.e., scientists, advocates, resource managers)	☐	☐	☐
• Local environmental educators; env. ed. organizations	☐	☐	☐
• Other teachers in my school or district who teach environmental education	☐	☐	☐
18. Web-Based Information			
• Env. education curricula and activities on the World-Wide Web	☐	☐	☐
• Background information about environmental topics on the World-Wide Web	☐	☐	☐

Section 4: Tell Us About Yourself

19. If you are a:
    - **Teacher**: How many years have you been teaching? _____
    - **Pre-service teacher**: What is your current year of study? *Fr.* | *So.* | *Jr.* | *Sr.* | *Grad.*

20. Please select your age range:

☐ 17 - 20	☐ 46 - 50
☐ 21 - 25	☐ 51 - 55
☐ 26 - 30	☐ 56 - 60
☐ 31 - 35	☐ 61 - 65
☐ 36 - 40	☐ 66 - 70
☐ 41 - 45	☐ 71+

21. Please select your gender: ☐ Male ☐ Female

22. I have internet access: (Please select all that apply)
    - ☐ At home
    - ☐ At school/work
    - ☐ Other (Please specify:) _____
    - ☐ No internet access

23. How often do you: (Please circle)
    - Check e-mail? (x=times)
      Never | *1x/month* | *1x/week* | *2-3x/week* | *Almost every day* | *Several x/day*
    - Browse the web? (x=times)
      Never | *1x/month* | *1x/week* | *2-3x/week* | *Almost every day* | *Several x/day*

24. Geographic information: Which state do you live in? ____

25. Opportunity for comments: What would encourage you to use the World-Wide Web more in your teaching and/or integrate environmental education into your teaching more often? Other comments?

APPENDIX C

SUMMARY OF TEACHER CASES

Table 17: Summary of Teacher Cases

	Karen	Anne
School Community	Urban	Suburban
Students in School	1,160	370
Students in Class	16	54
Type of classes taught	4th grade Language Arts ("Homeroom"), Computers	Multi-age: 3rd, 4th, and 5th gr. All subjects taught
Years Teaching	8	9
Education	BA in Film & Communications MA in Education—emphasis in Social Science and Reading	BA in Elementary Education—emphasis in English and Science MA in Curriculum Development and Classroom Instruction Certified Quality School Instructor
Computer Experience	Significant experience in work before becoming a teacher Is school computer teacher	Very little other than personal, home use; word processing and email
Computers in School	School lab has 25 Pentium computers, Internet access, networked to district, scanner, printer and digital camera. Has two older 486 computers in classroom suitable for keyboarding	School computer lab has 30 IBM-compatible 486 multimedia computers networked to district server. No Internet access 1 internet computer (Macintosh) on a portable cart School shares 30 portable laptop computers
Experience Teaching EE	First year of teaching Karen started an ambitious recycling project only to discover 2 months later that no one would take all of the recyclables they had collected.	In early years of teaching Anne did a unit on recycling. As a result, the students led a campaign that began the recycling program at school still in use today

	Karen	Anne
Obstacles to Project	Email rarely worked	Unable to install Web page software in computer lab
	Threat of teacher strike	Internet access was sporadic
	Difficulties connecting with teacher because she moved and was without phone, email, etc.	Difficulty installing Web page software on portable computer
	Overestimated students' skills in reading and writing; had to abandon project plans	Had to get all 54 kids online using only 1 computer
My Role	Create web pages describing projects Karen was doing with students	Create Web pages highlighting Anne's curricula and lesson plans
	Teach class how to make recycled paper	Teach class how to make their own web pages; get all reports online.
Teacher's Approach to EE Curriculum Development	Began with topic of interest to teacher and then developed activities around it	Began with standards and objectives (report card)
		Asked students for input
Topics Selected for EE	Recycling/Litter	Water and Other Environmental Problems
Subject Areas EE Curriculum Infused Into	Language Arts, Computers/Technology	Science, Language Arts, Listening, Public Speaking
Types of Resources Used	Required textbook, library books (fictional environmental stories),	District curriculum guide, library books, posters, videos, field trips, local park, "science boxes," other curriculum books with hands-on activities
	Internet/Web	
Time spent per class on EE	45-60 minutes; 2-3 times per week for 4 weeks	45-60 minutes; 3-4 times per week for 6 weeks
Students' favorite part of unit	Making recycled paper	All of the hands-on activities and field trips
What would encourage you to use the Web more often?	"If using the Web was mandatory."	"Nothing."
		Possibly for current events

REFERENCES

Adler, J. H. (1993). Child's garden of misinformation. Consumer's Research, 11-16.

ADSmart Corporation. (1997). ADSmart.net glossary [On-line]. Available: http://www.adsmart.net/l4_sc_glossary.html#w

Arcury, T. A. (1990). Environmental attitude and environmental knowledge. Human Organization, 49(4), 300-304.

Babbie, E. (1995). Practice of social research. Detroit, MI: Wadsworth Publishing Company.

Barron, L. C. & Goldman, E. S. (1994). Integrating technology with teacher preparation. In B. Means (Ed.), Technology and Education Reform: The reality behind the promise (pp. 81-110). San Francisco, CA: Jossey-Bass Publishers.

Beiswenger, R., Sturges, E. L. & Jones, R. (1991). Water education in Wyoming: Assessing educators' knowledge of water topics and their use in the elementary curriculum. Journal of Environmental Education, 23(1), 24-29.

Braun, J., Jr. (1997). Past, possibilities, and potholes on the information superhighway. Social Education, 61(3), 149-153.

Browner, C. (1998) Why environmental education? It is critical to maintaining our quality of life [On-line]. Available: http://www.epa.gov/region5/enved/html/03_txt.htm

Buethe, C. & Smallwood, J. (1987). Teachers' environmental literacy: Check and recheck, 1975 and 1985. Journal of Environmental Education, 18(3), 39-42.

Cailliau, R. (1995). A little history of the World Wide Web [On-line]. Available: http://www.w3.org/History.html

Cantrell, D. C. (1993). Alternative paradigms in environmental education research: The interpretive perspective. In R. Mrazek (Ed.), Alternative Paradigms in Environmental Education Research (pp. 81-105). Troy, OH: National Association for Environmental Education.

Carlson, C. E. (1998). What's on the menu? School Web sites in the United States, 1998 [On-line]. Available: http://www.teacherzone.com/specialreports/onmenu/onmenuinto.html

Champeau, R., Gross, M, and Wilke, R. (1980). An assessment of teachers' understanding and use of 'Goals for curriculum development in environmental

education.' 9th Annual Conference of the National Association for Environmental Education, ERIC.

Childress, R. & Wert, J. (1976). Challenges for environmental education planners. Journal of Environmental Education, 7(4), 2-6.

Childress, R. B. (1978). Public school environmental education curricula: A national profile. Journal of Environmental Education, 9(3), 2-11.

Clark, E. (1975). Good education is environmental. Journal of Environmental Education, 6(4), 1-5.

Clark, N. (1995). Being consoled? Virtual nature and ecological consciousness. Futures, 27(7), 735-747.

Clements, D. H. (1995). Teaching creativity with computers. Educational Psychology Review, 7(2), 141-161.

Clinton, W. (1996). America's technology literacy challenge [On-line]. Available: http://www.whitehouse.gov/WH/New/edtech/2pager.html

Coley, R., Cradler, J., & Engel, P. (1997). Computers and classrooms: The status of technology in U.S. schools [On-line]. Available: http://www.ets.org/research/pic/compclass.html

Copen, P. (1995). Connecting classrooms through telecommunications. (How technology Is transforming teaching). Educational Leadership, 53(2), 44-48.

Cuban, L. (1986). Teachers and machines: The classroom use of technology since 1920. New York: Teachers College Press.

Culen, G. (1998). The status of environmental education with respect to the goal of responsible citizenship behavior. In H. Hungerford, W. Bluhn, T. Volk, & J. Ramsey (Eds.), Essential readings in EE (pp. 37-45). Champaign, IL: Stipes Publishing L.L.C.

Czajkowski, T. & Patterson, L. (1980). Curriculum change and the school. In ASCD 1980 Yearbook Committee (Eds.), 1980 ASCD yearbook: Considered action for curriculum improvement (pp. 158-175). Alexandria, VA: Association for Supervision and Curriculum Development.

David, J. L. (1994). Realizing the promise of technology: A policy perspective. In B. Means (Ed.), Technology and Education Reform: The reality behind the promise (pp. 169-189). San Francisco, CA: Jossey-Bass Publishers.

DeWall, M. (1989). The JASON project. The Science Teacher, 56(3), 48-52.

Disinger, J. F. (1998a). Environmental education's definitional problem. In H. Hungerford, W. Bluhn, T. Volk, & J. Ramsey (Eds.), Essential readings in EE (pp. 17-31). Champaign, IL: Stipes Publishing L.L.C.

Disinger, J. F. (1993). Environment in the K-12 curriculum: An overview. In R. Wilke (Ed.), Environmental education: Teacher resource handbook (pp. 23-43). Millwood, NJ: Kraus International Publications.

Disinger, J. F. (1998b). Tensions in environmental education: yesterday, today, and tomorrow. In H. Hungerford, W. Bluhn, T. Volk, & J. Ramsey (Eds.), Essential readings in EE (pp. 4-11). Champaign, IL: Stipes Publishing L.L.C.

Duffield, J. (1997). Trials, tribulations, and minor successes. Techtrends, 42(4), 22-26.

Dyrli, O. E. &. Kinnaman, D. E. (1996). Connecting with the world through successful telecommunications projects. Technology and Learning, 16(6), 57-63.

Eighmey, J. (1997). Profiling user responses to commercial web sites. Journal of Advertising Research, 37(3), 59-66.

Editor & Publisher Interactive (1998). Web trends watch: most schools connected to net. [On-line]. Available: http://www.mediainfo.com/ephome/news/newshtm/webnews/wt050198.htm

Eisner, E. W. (1985). The Educational imagination: On the design and evaluation of school programs. New York: Macmillian.

Ellsworth, J. (1997). Curricular integration of the World Wide Web. Techtrends, 42(2), 24-30.

Friere, P. (1970). Pedagogy of the oppressed. New York: Continuum.

Fullan, M. (1993). Innovation, reform, and restructuring strategies. In G. Caweth (Ed.), 1993 ASCD yearbook: Challenges and achievements of American education (pp. 116-133). Alexandria, VA: Association for Supervision and Curriculum Development.

Gambro, J. S. & Switzky, H. N. (1996). National survey of high school students' environmental knowledge. Journal of Environmental Education, 27(3), 28-33.

Gay, G. (1980). Conceptual models of the curriculum-planning process. In ASCD 1980 Yearbook Committee (Eds.), 1980 ASCD yearbook: Considered action for curriculum improvement (pp. 120-143). Alexandria, VA: Association for Supervision and Curriculum Development.

Graphics Visualization and Usability Center, Georgia Tech (1997). GVU's WWW user surveys [On-line]. Available: http://www.gvu.gatech.edu/user_surveys/survey-1997-10/

Gray, M. K. (1996). Web growth summary [On-line]. Available: http://www.mit.edu/people/mkgray/net/web-growth-summary.html

Groves, D., Cauley, V. Jr., & Smith, D. (1978). Some important variables related to teachers' natural resource knowledge and opinion and some of their strategies for teaching a forestry unit. Journal of Instructional Psychology, 4(4), 32-39.

Hahn, H. & Stout, R. (1994). Internet complete reference. New York: Osborne McGraw-Hill.

Hall, G. & Hord, S. (1987). Change in schools: Facilitating the process. Albany, NY: State University Press of New York.

Ham, S., Rellergert-Taylor, M. & Krumpe, E. (1988). Reducing barriers to environmental education. Journal of Environmental Education, 19(2), 25-33.

Ham, S. H. & Sewing, D. R. (1988). Barriers to environmental education. Journal of Environmental Education, 19(2), 17-24.

Hamilton, A. (1998). How the web was won [On-line]. Available: http://www.zdnet.com/anchordesk/story/story_2082.html

Hart, P. (1993). Alternative perspectives in environmental education research: Paradigm of critically reflective inquiry. In R. Mrazek (Ed.), Alternative paradigms in environmental education research (pp. 107-130). Troy,OH: The North American Association for Environmental Education.

Hodas, S. (1993). Technology refusal and the organizational culture of schools [On-line]. Available: http://homepage.seas.upenn.edu/~cpage/techref.html

Holzberg, C. S. (1996). Class trips in cyberspace: No passports required. Technology & Learning, 17(3), 58-63.

Hooper, J. (1988). Teacher cognitions of wildlife management concepts. Journal of Environmental Education, 19(3), 15-18.

Hungerford, H. R. (1975). Myths of environmental education. Journal of Environmental Education, 7(2), 21-26.

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

Huning, B., Palmer, C. & DiSilvestro, R. (1990). The mystery of the disappearing ducks: An interactive multimedia design example. In W. J. Rohwedder (Ed.), Computer-Aided Environmental Education (pp. 26-41). Troy, OH: National Association for Environmental Education.

Jason Foundation (1998). JASON Foundation for Education [On-line]. Available: http://www.jason.org/jason.html

Johnson, W. (1980). Teachers' perceptions and circumstances that influence willingness to teach environmental studies. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Jonassen, D. H. (1996). Computers in the classroom: Mindtools for critical thinking. Englewood Cliffs, NJ: Prentice Hall.

Kachigan, S. (1986). Statistical analysis: An interdisciplinary introduction to univariate and multivariate methods. New York: Radius Press.

Kauchak, D., Krall, F. & Heimsath, K. (1978). The need for education, not indoctrination. Journal of Environmental Education, 10(1), 19-22.

Knapp, C. E. (1972). Attitudes and values in environmental education. Journal of Environmental Education, 3(4), 26-29.

Lane, J., Wilke, R., Champeau, R. & Sivek, D. (1994). Environmental education in Wisconsin: A teacher survey. Journal of Environmental Education, 25(4), 9-17.

Lapp, D. (1994). Private gain, public loss. Environmental Action, 26(1), 14-17.

Levi, M. & Conrad, F. (1996). Usability tesing of World Wide Web sites [On-line]. Available: http://stats.bls.gov/ore/htm_papers/st960150.htm

Levine, R. (1995). Sun on the net: Guide to Web style [On-line]. Available: http://www.sun.com/styleguide/tables/Printing_Version.html

Lightner, K., Bose, I., & Salvendy, G. (1996). What is wrong with the World-Wide Web? A diagnosis of some problems and prescription of some remedies. Ergonomics, 39(8), 995-1004.

Lowther, D. L., & Sullivan, H. J. (1996). Perceptions of educational technology among K-12 teachers and educational technologists. In D. P. Ely, and B.B. Minor (Eds.), Educational media and technology yearbook: Vol. 21 (pp. 14-21). Englewood, CO: Libraries Unlimited, Inc.

Lynch, P. J. (1990). Hypermedia for environmental education and the life sciences. In W.J. Rohwedder (Ed.), Computer-Aided Environmental Education (pp. 11-25). Troy, OH: National Association for Environmental Education.

Manilov, M. & Schwartz, T. (1997). The assault on eco-education. Earth Island Journal, 12(1), 36-37.

Marshall, C. & Rossman, G. (1989). Designing qualitative research. Newbury Park, NJ: Sage Publications.

Means, B. & Olson, K. (1994). Tomorrow's schools: Technology and reform in partnership. In B. Means (Ed.), Technology and Education Reform: the reality behind the promise (pp. 191-22). San Francisco, CA: Jossey-Bass Publishers.

Mendels, P. (1997). Study faults net training for teachers [On-line]. Available: http://www.nytimes.com/library/cyber/week/071797benton.html

Michigan Department of Education (1998). Overview of social studies content strands [On-line]. Available: http://cdp.mde.state.mi.us/MCF/ContentStandards/SocialStudies/default.html

Munson, B. H. (1994). Ecological misconceptions. Journal of Environmental Education, 25(4), 30-34.

National Environmental Education Advisory Council. (1996). Report assessing environmental education in the United States and the implementation of the National Environmental Education Act of 1990. Washington, DC: US Environmental Protection Agency.

Negroponte, N., Resnick, M., & Cassell, J. (1997). Creating a learning revolution [On-line]. Available: http://www.education.unesco.org/unesco/educprog/lwf/doc/portfolio/opinion8.htm

Network Wizards (1998). Internet domain survey, January 1998 [On-line]. Available: http://www.nw.com/zone/WWW/report.html

Nielsen, J. (1997a). Be succinct! (Writing for the Web) [On-line]. Available: http://www.useit.com/alertbox/9703b.html

Nielsen, J. (1997b). How users read on the Web [On-line]. Available: http://www.useit.com/alertbox/9710a.html

Norman, D. A. (1993). Things that make us smart: defending human attributes in the age of the machine. New York: Addison-Wesley Publishing Company.

Patton, M. (1990). Qualitative evaluation and research methods. London: Sage Publications.

Pitkow, J. E. & Kehoe, C. M. (1996). Emerging trends in the WWW user population. Communications of the ACM, 39(6), 1-8.

Pyke, T. J. (1995). GLOBE partnership launched [On-line]. Available: http://www.epa.gov/reg5oopa/enved/html/07_txt.htm

Ramsey, J. M., Hungerford, H. R., & Volk, T. L. (1992). Environmental education in the K-12 curriculum: Finding a niche. Journal of Environmental Education, 23(2), 35-45.

Recker, M. & Greenwood, J. (1998). An interactive student evaluation system [On-line]. Available: http://www.vuw.ac.nz/~mimi/papers/wwww.html

Ritz, W. C. (1977). Involving teachers in environmental education. Journal of Environmental Education, 8(3), 40-47.

Robottom, I. (1993). Beyond behaviourism: Making EE research educational. In R. Mrazek (Ed.), Alternative Paradigms in Environmental Education Research (pp. 133-143). Troy, OH: The North American Association for Environmental Education.

Robottom, I. and Hart, P. (1995). Behaviorist EE research: Environmentalism as individualism. Journal of Environmental Education, 26(2), 5-9.

Rogers, E. M. & Shoemaker, F. F. (1971). Communication of innovations: A cross-cultural approach. New York: The Free Press.

Rohwedder, W. J. (Ed.). (1990). Computer-aided environmental education. Troy, OH: North American Association for Environmental Education.

Samuel, H. R. (1993). Impediments to implementing environmental education. Journal of Environmental Education, 25(1), 26-29.

Sanera, M. & Shaw, J. S. (1996). Facts not fear: A parent's guide to teaching children about the environment. Washington, D.C.: Regnery Publishing, Inc.

Sano, D. (1997). Web design technical limitations [On-line]. Available: http://developer.netscape.com/news/viewsource/sano_webdesign.html

Sears, A., Jacko, J. & Borella, M. (1997). Internet delay effects: How users perceive quality, organization, and ease of use of information [On-line]. Available: http://condor.depaul.edu/~asears/publications/FullPapers/UserPerceptions1.html

Simmons, D. A. (1998). Education reform, setting standards, and environmental education. In H. Hungerford, W. Bluhn, T. Volk, & J. Ramsey (Eds.), Essential readings in EE (pp. 67-74). Champaign, IL: Stipes Publishing L.L.C.

Simmons, D. A. (1989). More infusion confusion: A look at environmental education curriculum materials. Journal of Environmental Education, 20(1), 15-18.

Singleton, R., Straits, B. C., & Straits, M. M. (1993). Approaches to social research. New York: Oxford University Press.

Software Publishers Association. (1994). Report on the effectiveness of technology in schools 1990-1994. New York: Software Publishers Association.

Solomon, C. (1986). Computer environments for children: A reflection on theories of learning and education. Cambridge: MIT Press.

Stake, R. E. (1995). The art of case study research. Thousand Oaks, CA: Sage Publications.

Stapp, W. B. (1969). The concept of environmental education. Journal of Environmental Education, 1(1), 30-31.

Stevenson, R. B. (1993). Being compatible: Curriculum and environmental thought. Journal of Environmental Education, 24(2), 4-9.

Stone, J. (1989). Preparing teachers to become involved as environmental educators. Contemporary Education, LX(3), 159-162.

Sugrue, B. & Kobus, R. (1997). Beyond information: Increasing the range of instructional resources on the World Wide Web. Techtrends, 42(2), 38-42.

Taylor, G. & Disinger, J. (1997). The potential role of virtual reality in environmental education. Journal of Environmental Education, 28(3), 38-43.

Tway, L. (1995). Multimedia in action! San Diego, CA: AP Professional.

U. S. Congress, Office of Technology Assessment (1995). Teachers and technology: Making the connection [On-line]. Available: http://www.wws.princeton.edu/~ota/disk1/1995/9541.html

U.S. Department of Education (1998). Internet access in public schools. [On-line]. Available: http://nces.ed.gov/pubs98/98031.html

U.S. Department of Education (1997). President's and secretary's priorities [On-line]. Available: http://www.ed.gov/inits.html

U.S. Department of Education (1996). Systemic reform: Summary review of the literature [On-line]. Available: http://www.ed.gov/pubs/SER/SysReform/chap1.html

U.S. Environmental Protection Agency (1998). Environmental education: Region 5 [On-line]. Available: http://www.epa.gov/region5/enved/index.htm

Volk, T., Hungerford, H., & Tomera, A. (1986). A national survey of curriculum needs as perceived by professional environmental educators. Journal of Environmental Education, 17(1), 10-19.

Volk, T. and McBeth, W. (1998). Environmental literacy in the United States. In H. Hungerford, W. Bluhn, T. Volk, & J. Ramsey (Eds.), Essential Readings in EE (pp. 75-88). Champaign, IL: Stipes Publishing L.L.C.

Volk, T. L. (1993). Integration and curriculum design. In R. J. Wilke (Ed.), Environmental Education: Teacher Resource Handbook. (pp. 45-75). Millwood, NJ: Kraus International Publications.

Wade, K. S. (1996). EE teacher inservice education: The need for new perspectives. Journal of Environmental Education, 27(2), 11-17.

Wilson, R. A. & Smith, J. (1996). Environmental education and the education literature. Journal of Environmental Education, 27(2), 40-42.

Windschitl, M. (1998). The WWW and classroom research: What path should we take? Educational Researcher, 27(1), 28-33.

Yin, R. K. (1994). Case study research: Design and methods. Thousand Oaks: Sage Publications.