

Indications of environmental literacy: using a new survey instrument to measure awareness, knowledge, and attitudes of university-aged students

by

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“ If today is a typical day on planet earth, humans will add fifteen million tons of carbon to the atmosphere, destroy 115 square miles of tropical rainforest, create seventy-two square miles of desert, eliminate between forty to one hundred species, erode seventy-one million tons of top soil, add twenty-seven tons of CFCs to the stratosphere, and increase their population by 263,000. Yesterday, today, and tomorrow. By year’s end the total numbers will be staggering: an area of tropical rainforest the size of the state of Kansas lost; seven to ten billion tons of carbon added to the atmosphere; a total population increase of ninety million... It is not too much to say that the decisions about how or whether life will be lived in the next century are being made now. We have a decade or two in which we must make unprecedented changes in the way we relate to each other and to nature.”

(David Orr, 1992)

I dedicate this thesis to my husband Jason O’Brien for his unconditional love, respect, and unselfish dedication to the fulfillment of my own dreams.

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CHAPTER 1. GENERAL INTRODUCTION

Introduction

A desired outcome of environmental education (EE) is to create a public that is environmentally literate. Many EE programs and materials have this as a stated purpose. However, measuring environmental literacy (EL) has remained elusive. Some national surveys have been conducted that attempt to measure it. A few states have attempted to periodically survey their citizenry to gather EL data. While these are important attempts, I believe that many of the questions asked still lack in accurately measuring EL. Further, I believe that these important instruments fail to account for cultural and educational system differences and don't always take into consideration accepted benchmarks for EE.

This project developed a survey instrument that aimed to accurately measure three components of environmental literacy: awareness and knowledge about, and attitudes toward environmental issues, especially as they relate to the midwestern United States. This included the development of careful questions, which were tested with Iowa State University students across all disciplines.

I anticipate that this instrument, when officially published, can potentially help REAP-CEP (Resource Enhancement And Protection-Conservation Education Program), which funded this research, and other institutions and organizations to track the results of environmental education efforts across the midwestern United States. If administered bi-annually in a random sample, I believe it will help guide EE curricular efforts and adult EE as well. Furthermore, it is my hope in future studies to develop the first environmental report card for the State of Iowa.

Thesis Organization

The present chapter of this thesis (Chapter 1) includes a general introduction to my research problem, its background and significance. Chapter 2 represents a manuscript to be submitted to the Environmental Education Research Journal; therefore it is written following the format required by the journal to facilitate subsequent publication.

Chapter 3 summarizes the results and general conclusions of this research. It includes a general discussion on environmental literacy at the university level and recommendations to improve environmental education efforts at Iowa State University campus, where this research was conducted. Authorship of chapters 2 and 3 is anticipated as follows: Susan Roberta M. O'Brien and James L. Pease, Ph.D. References cited are listed at the end of each chapter, following the format required by the Environmental Education Research Journal.

Literature Review

I. Defining environmental education (EE):

“Environmental education is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments, and skills to work individually and collectively toward solutions of current problems and the prevention of new ones.” (UNESCO, 1977)

a. “n. 1. The aggregate of all conditions affecting the existence, growth, and welfare of an organism or group of organisms”

b. “n. 1. The development and training of one’s mind, character, skills, etc... as by instruction, study, or example”

This is how the Webster’s dictionary (2006) defines the words “environmental” (a) and “education” (b). The way they are defined may seem simplistic, easily practicable, but in

reality, combining these two words to promote the well-known field of environmental education (EE) is a complex task.

Dinsinger (2005), in his essay entitled “Tensions in Environmental Education: Yesterday, Today, and Tomorrow”, expresses the semantic concern about the dramatically different perspectives from which environmental education can be approached, where people in the field can use the exact same words to express their understanding about what environmental education is, but their words normally mean different things. This play on words has been happening since the field was named, which reflects a clear disagreement in viewpoints, and also about what environmental education really means and what it should encompass.

The term “environmental education” and its first appearance in the academic literature are subject to discussion as credit is given to different people by different authors. There seems to be a disagreement about who did use or attempted to define the term for the first time (Dinsinger, 1983). Through personal communication with John Kirk, Dinsinger (1983) was able to mention an early use of the term by Thomas Pritchard, during a 1948 presentation at a Paris meeting of the International Union for the Conservation of Nature and Natural Resources (IUCN). At that time, Pritchard was a Deputy Director of the Nature Conservancy in Wales, and he mentioned the need for “environmental education” which he defined as “an educational approach to the synthesis of the natural and social sciences.”

The term was taken by Brennan (1979) as a synonym of “conservation education”, a term which he claims to have defined along with Bradwein in 1967. Considering this interesting remark, it is important to acknowledge the primary antecedents of environmental education, which were summarized by Nash (1976) as *nature study*, *outdoor education*, and

conservation education. According to the author, as of 1891 Wilbur Jackman published “Nature study for the common schools” which launched the nature study movement using an academic approach to take students outdoors to explore the environment. Outdoor education came later with a similar purpose to force appreciation of complex factors that the normal classroom tended to isolate. The “Dust Bowl” of the 1930s gave rise to the “conservation education” movement, which aimed to awaken Americans to the importance of conservation in the face of the emerging environmental problems.

The term “environmental education” is more loosely defined in several more recent events. According to Volk & McBeth (1998), the field of EE has had great contributions since the 1960s. Innumerable individuals, researchers, agencies, and organizations have written with respect to it. Many had an influential role in the early process of defining the goals of EE and consequently contributed to our understanding of how EE is currently defined globally. In April 1970, EE received one of its greatest contributions and endorsement through the celebration of the first Earth Day, which remains today a well-known and utilized movement in the field (Coyle, 2004).

There are four fundamental documents that serve as landmarks in the evolution of EE that should be highlighted in this review:

- The Belgrade Charter, 1975
- The Intergovernmental Conference on Environmental Education (Tbilisi Declaration), 1977
- The International Strategy for Action of Environmental Education and Training for the 1990s, which occurred in 1987
- The Agenda 21, 1992

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), the first to compose the historic puzzle of EE at the international level was the United Nations' Conference on the Human Environment at Stockholm in 1972, which made recommendations for an international framework for EE development. As a result of these recommendations, a series of meetings on EE were organized worldwide, culminating in the international Workshop on EE in Belgrade in 1975.

The main goal for EE resulting from this workshop was to *“develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones.”* In addition, one of the major recommendations from the workshop was the development of an International Conference on EE to specifically convey issues on policy and decision-making processes in education (UNESCO, 1975). As a result, this was the major goal of the Intergovernmental Conference on EE, organized by the UNESCO, which took place in Tbilisi (USSR) in 1977.

The collective aims, goals, and objectives of EE that resulted from this Conference are globally known as the Tbilisi Declaration (UNESCO, 1977), and it states five categories from which goals and objectives in EE should be aimed:

- Awareness: to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.
- Knowledge: to help social groups and individuals gain a variety of experiences in and acquire a basic understanding of the environment and its associated problems.

- Attitudes: to help social groups and individuals acquire a set of values and feelings of concern for the environment and motivation for actively participating in environmental improvement and protection.
- Skills: to help social groups and individuals acquire the skills for identifying and solving environmental problems.
- Action: to help provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems.

Collectively, these five categories compose what was named the “AKASA model”.

The Tbilisi Conference also provided 12 statements known as the Guiding Principles of EE (Appendix A). According to the Tbilisi Declaration, these principles call for the development of a more far-reaching process than the formal system of K-12 education, and it aimed to reach a broader audience, including citizens, adults, and environmental professionals (UNESCO, 1977).

In 1987, Ten years after the Tbilisi Declaration, UNESCO and the United Nations Environmental Programme (UNEP) organized an International Congress in Moscow (USSR) that proposed the creation of an International Strategy for Action on EE and Training for the 1990s. The main points discussed in the Conference were: environmental problems and the aim of an international strategy for action in the field of EE and training; principles and essential characteristics of EE and training; and guidelines, objectives and actions for an international strategy for the 1990s (UNESCO, 1988).

Five years later, in 1992, the Rio Earth Summit, also recognized as the United Nations Conference on Environment and Development (UNCED), created the Agenda 21,

which was an attempt to assess the previous 20 years of work in the field of EE. Chapter 36 of this agenda was entitled “Promoting Education, Public Awareness and Training” and became the basis of EE practices for sustainable development during succeeding years (UNESCO, 1992).

Ramsey & Hungerford (2002) agreed that, from the 1977 Tbilisi Declaration through today, discussion continues to be done with the concept of EE, and some writers express the need for an ecology-based definition instead of the problem-solving approach that is implicit in the technologic and economic dimensions of society. While the field has continued to mature, the Tbilisi Declaration’s original intent remains a central focus for EE, despite the fact that instrumental definitions of what environmental education really means still remain controversial. Regardless, according to Dinsinger & Monroe (1994), there is agreement among perspectives that the essential elements of EE are:

- Basic knowledge of ecological processes and social systems;
- Consideration of social, economic, political, technological, cultural, historic, moral, and aesthetic aspects that are interrelated with environmental issues;
- Consideration of humans feelings, values, attitudes, and perceptions as essential to analyze and resolve environmental issues;
- Emphasis on critical thinking and problem-solving skills as important for action.

Dinsinger & Roth (1992) and Volk & McBeth (1998) agreed that the central goal of EE is to make citizens aware of and active toward environmental issues, and ultimately environmentally literate. But, defining environmental literacy (EL), the outcome of environmental education, is an even more complex process.

II. Defining environmental literacy (EL):

As the term “literacy” first appeared, it was solely associated with the idea of being able to read and write. Michaels & O’Connor (1990) as cited in Dinsinger & Roth (1992), provided a better understanding of its concept, proposing that “... *we each have, and indeed fail to have, many different literacies. Each of these literacies is an integration of ways of thinking, talking, interacting, and valuing, in addition to reading and writing ... [literacy] is rather about ways of being in the world and ways of making meaning...*”

Dinsinger & Roth (1992), in their Environmental Literacy Digest, gave credit to Charles E. Roth as the one who coined the term “environmental literacy” in 1968. They reviewed various definitions of EL, and suggested that it should be based on an ecological paradigm, which includes interrelationships between natural and social systems. A person who is environmentally literate relates his/her values with knowledge to generate action. Here is a brief list of EL definitions given by various authors and organizations:

- “[EL] *is the capacity of an individual to act successfully in daily life on a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainably. This requires sufficient awareness, knowledge, skills and attitudes to incorporate appropriate environmental considerations into daily decisions about consumption, lifestyle, career, and civics, and to engage in individual and collective action.*” (Elder, 2003)
- “*Ecological Literacy presumes a breadth of experience with healthy natural systems... a broad understanding of how people and societies relate to each other and to natural systems and how they might do so sustainably... the knowledge necessary to comprehend interrelatedness... an attitude of care or stewardship... in a phrase, it is that quality of mind that seeks out connections... Ecological Literacy is driven by the sense of wonder, the sheer delight in being alive in a beautiful, mysterious, bountiful world... to become ecologically literate, one must certainly be able to read... to know what is countable and what is not... to think broadly, to know something of what is hitched to what... to see things in their wholeness... to know the vital signs of the planet... to know that our health, well-being, and ultimately our survival depend on working with, not against, natural forces...*” (Orr, 1992)

- *“EL is a set of understandings, skills, attitudes, and habits of mind that empowers individuals to relate to their environment in a positive fashion, and to take day-to-day and long term actions to maintain or restore sustainable relationships with other people and the biosphere ... The essence of EL is the way we respond to the questions we learn to ask about our world and our relationship with it; the ways we seek and find answers to those questions; and the ways we use the answers we have found.” (Roth, 2002)*
- *“Ecological Literacy is the ability to ask: And now what?” (Garret, 1999)*
- *“EL should aim to develop:*
 - *Knowledge of ecological and social systems, drawing upon disciplines of natural sciences, social sciences, and humanities;*
 - *Go beyond biological and physical phenomena to consider social, economic, political, technological, cultural, historic, moral, and aesthetic aspects of environmental issues;*
 - *Recognize that the understanding of feelings, values, attitudes, and perception at the center of environmental issues are essential to analyze and resolve these issues;*
 - *Critical thinking and problem-solving skills for personal decisions and public action.” (Dinsinger & Monroe, 1994)*
- *“EL should aim for:*
 - *Developing inquiry, investigative, and analytical skills;*
 - *Acquiring knowledge of environmental processes and human systems;*
 - *Developing skills for understanding and addressing environmental issues;*
 - *Practicing personal and civic responsibility for environmental decisions.” (NAAEE, 1999; Archie, 2003)*
- *“Standards for EL:*
 - *Ecological Knowledge: including major ecological concepts, how natural systems work, and its relationship with social systems;*
 - *Socio-political knowledge: understanding relationships between beliefs, political systems, and environmental values of various cultures;*
 - *Knowledge of environmental issues: understanding environmental issues and relating it to human interactions;*
 - *Cognitive skills: abilities to identify, analyze, synthesize, and evaluate information;*
 - *Affect: factors within individuals that allow them to reflect;*

- *Additional determinants of environmentally responsible behavior: personal responsibility and locus of control;*
- *Environmentally responsible behavior: individual and collective (civically and politically).”(National Project for Excellence in Environmental Education (NPEEE) in Volk & McBeth, 1998)*

In the face of the definitions listed above, even though all of them have some common attributes, based wholly or in part on the AKASA components listed in the Tbilisi declaration, some different aspects and considerations are arrived at through different perspectives:

Orr and Elder’s definitions are very similar (Orr uses the term “ecological literacy” instead of “environmental literacy”). However, Orr clearly emphasizes the importance of intrinsic values and abstract feelings, as do Dinsinger and Monroe. Dinsinger and Monroe, as well as NPEEE, mention “interdisciplinary” in their definitions; The NPEEE standards and others do not include the latest thoughts and advances in EE, such as notions of sustainability, or even locally-based educational issues. Roth takes these notions into consideration when implying the necessity to understand changes. The NAAEE definition refers not only to personal action but also goes further to mention “civic” obligation.

The question about what Environmental Literacy is and what it should approach at its core are still far from being answered in a common agreement between scientists and practitioners in the field. Morrone *et al* (2001) reaffirm that the study of environmental literacy is relatively new, and no definition has been given to it that is universally accepted, and consequently the attributes of an environmentally literate citizen are still subject to discussion and investigation. However, what has been discussed so far in the literature, and

in the thousands of meetings of the “real world of practicing EE”, are very important to compose our understanding of what environmental literacy should be aiming for.

III. Understanding environmental literacy components

A new ethic, embracing plants and animals as well as people, is required for human societies to live in harmony with the natural world on which they depend for survival and well-being.”(IUCN-UNEP-WWF, 1980)

The words - understand, relate, sustainably, see, and act – highlighted in the Elder (2003) definition of environmental literacy discussed in the previous section, illustrate the five essential components that should be attributed to someone who is considered to be environmentally literate, invoking the *AKASA* model proposed in the Tbilisi Declaration.

The components in *AKASA* are placed in a loose hierarchy, as they are considered to be from the simplest to the more complex. It is assumed that these components are interdependent, and must be reached one step at a time. In his field guide to environmental literacy, Elder (2003) uses the model for EE as a way to illustrate its process towards achieving EL:

- Awareness: idea of holding a general impression or consciousness about something without having to know much about it. Once an awareness level is reached, a desire to improve knowledge increases.
- Knowledge: reflects a more intellectual framework. It is more than to retain acquired information about an issue, but being able to orderly comprehend, apply, analyze, synthesize and evaluate situations. Being knowledgeable provides input for building and changing attitudes.

- Attitude: idea of expressing feelings of appreciation and concern about environmental issues, and furthermore becoming susceptible to develop personal skills to address these issues.
- Skills: idea of developing personal abilities such as problem solving and critical thinking to address environmental issues and plans of action.
- Action: the last component of environmental literacy. It represents the idea of being capable of acting in the favor of the environment.

IV. Applied research in environmental literacy

“Americans love trees, but appear to know more about tropical rainforests than they do about the forests in the nearby landscape” (The Biodiversity Project, 1998)

In order to appreciate the need for local EL first, it is important to mention some of the few applied studies in environmental literacy done at the international level. Hsu & Roth (1996) assessed environmental knowledge and attitudes of community leaders in the Hualien area of Taiwan, and their results indicated that educational level is the best predictor of environmental knowledge and attitudes. A similar idea is shared by Korhonen & Lappalainen (2004) who examined levels of environmental awareness of children and adolescents in the Ranomafana region in Madagascar, and affirmed a significant effect of education on students' environmental concern. Tikka *et al* (2000) studied a variety of educational establishments in Central Finland to measure effects of educational background on students' levels of environmental attitude, activity, and knowledge, and their results showed major variations among students in relation to their gender and educational backgrounds as well. Sharing similar conclusions, Sudarmadi *et al* (2001) conducted a survey to measure

environmental perception, knowledge, awareness, and attitude of educated and community groups in Jakarta, Indonesia, and they observed that educated groups demonstrated higher levels of perception, knowledge, awareness, and attitudes regarding global and local environmental issues than the community groups did.

Paraskeopoulos *et al* (1998) developed a study to measure environmental knowledge of elementary school students in Greece, and observed that children's environmental knowledge is influenced by their immediate experiences and by the content of books they use. Tuncer *et al* (2005) studied environmental attitudes of young people in Turkey and observed that such attitudes varied according to the respondents' school type and gender, although there was widespread support for environmental conservation overall.

Knowledge about the current status of environmental literacy in the US is based upon a small number of limited studies as well. These studies often apply different instruments and most of the times were developed to measure a single variable (Elder, 2003). Volk & McBeth (1998) did a review of these studies and concluded that the overall degrees of environmental literacy ranked from low to moderate according to the scale designed for the study. Most of these studies were directed mainly to the development and implementation of survey instruments to measure environmental knowledge, attitudes, and behavior. Much of the environmental literacy research done so far focused on the knowledge component and many of those focused on youth as their subjects (Morrone *et al*, 2001).

Leeming *et al* (1995) developed a scale designed to measure environmental attitude and knowledge of children in elementary, middle, and junior high schools in Memphis, and such scale appeared to satisfy the need for a scale to measure children's global environmental literacy. Bogan & Kromrey (1996) developed an environmental literacy survey of Florida's

high school students, which attempted to measure knowledge, attitude, behavior and political actions. The students scored 37% in the knowledge component, demonstrated a positive attitude towards the environment, knew environmentally responsible behaviors, but demonstrated limited knowledge of political action.

Gambro & Switzky (1996) conducted a national survey of high school students applying a multiple choice test of seven items from the *Longitudinal Study of American Youth*, and the results showed that the students presented a low level of environmental knowledge, and most importantly, the students presented very little knowledge growth from 10th to 12th grade. Brody (1996) assessed the environmental science knowledge of Oregon's marine resources in 4th, 8th, and 11th grade students, which revealed a number of misconceptions about such resources held by at least half of the students. Culen & Mony (2003) worked with Florida 4-H youth participating in non-formal environmental education programs to measure their levels of environmental literacy, and their study showed the effectiveness of such programs to the development of responsible environmental behaviors.

Few past studies involved adults as participants. Arcury & Christianson (1993) developed a telephone survey for Kentucky residents mainly to evaluate whether environmental knowledge and attitude can be affected by rural-urban differences. The study revealed that "urban-metro respondents were more knowledgeable about global issues than urban-nonmetro and rural-nonmetro respondents". These findings are supported by Zimmerman (1996), who summarized environmental education research during 15 years (from 1979 to 1993), and observed that demographic differences (ethnicity and gender) influenced environmental knowledge. According to Zimmerman, blacks and women are generally less knowledgeable in terms of environmental issues than whites and men.

While environmental education, with elementary and secondary schools curricula, and assessments of adults' environmental literacy at state, national, and international levels have received considerable attention, few researchers have focused on university-level assessments of environmental knowledge (Orr, 1995; Wilke, 1995; Kaplowitz and Levine, 2005).

Benton (1994) conducted research to examine environmental knowledge and attitudes among faculty members in the college of Arts and Sciences and the schools of Business, Social Work, and Education. Business faculty members were less knowledgeable and demonstrated less ecologically oriented attitudes than the non-business faculty. In more recent studies, Robinson & Crowther (2001) developed an environmental knowledge survey to compare responses of three groups of students in science education, biology and chemistry majors from a mid-sized western university, and observed significant difference in knowledge levels among the three groups. Wolf (2001) developed a survey to evaluate to what extent environmental education is provided to non-environmental major students at four-year institutions in the USA, and reported that only 12% of these institutions established some sort of requirement component on environmental and ecological knowledge.

Hodgkinson & Innes (2001) studied environmental attitudes and beliefs of freshman students in different disciplines at an Australian University and concluded that students involved in economically relevant disciplines such as business are consistently less pro-environmental than students in other disciplines. McMillan *et al* (2004) evaluated the impact of an introductory environmental studies class on environmental values of students at Dalhousie University in Canada, and observed that students appeared to be more environmentally concerned after taking the course. Kaplowitz & Levine (2005) conducted

research to measure levels of environmental knowledge of Michigan State University students. The authors argue that while the students showed a higher level of environmental knowledge than the general public, their overall score was still deficient.

The only national longitudinal data available is *The National Report Card on Environmental Attitudes, Knowledge, and Behavior* (NEETF 1997, 1998, 1999, 2001), which surveys American attitudes and knowledge toward the environment, and which was recorded by Roper Starch Worldwide commissioned by the National Environmental Education and Training Foundation (NEETF) during the last nine years. The results show that two out of three adult Americans still fail to correctly answer simple environmental questions. Even though 70% of Americans believe and say they know enough about environmental issues, only a third of these respondents received a passing grade, and among this third, only one in ten adults received a grade “A”.

According to the *Report Card*, in a period of three years, Americans seem to have learned little, but it is encouraging to mention that 90% of the adults believe that the economic process is deeply related to environmental protection, even though fewer understand their own role in stewardship of the environment.

Environmental Education at a Glance (NACD, 1998), developed by the Association for Conservation Districts in cooperation with the Environmental Education and Training Partnership, highlights a positive perspective about the field of environmental education by concluding that EE has made great progress, resulting in individuals, businesses, and governments working alongside one another, resulting in many areas with cleaner skies and less polluted rivers, and the expansion of environmental technology that will aid the U.S. and the world in the protection of natural resources.

In a certain way, we must recognize the progress already made in the field of EE since its inception. However, as concluded by Elder (2003), the gap in environmental literacy is apparently growing. According to Elder “despite the high level of public support for environmental literacy, the federal government has yet to grasp the potential of environmental literacy to help meet many of its environmental and education goals, and has failed to provide adequate resources to support the field’s development.” Therefore, it is a challenge to environmental educators to figure out how to reach large public audiences.

We can clearly observe this presumption illustrated in the results of the only two statewide environmental literacy surveys completed to date. These were developed in Pennsylvania and Minnesota.

The First Pennsylvania Environmental Readiness for the 21st Century Survey Report (PCEE, 2000), the first of its kind in the nation, reported the results of adult Pennsylvanians’ knowledge about, attitudes toward, and behaviors related to the environment. The report found that Pennsylvanians had positive attitudes toward the environment and accepted primary responsibility for solving environmental problems, although they had a poor grasp of both environmental knowledge and issues.

The first and second *Minnesota Report Cards on Environmental Literacy* were the results of surveys conducted in 2001 and 2003. The first survey created a baseline of environmental literacy for residents of the state. The second one followed a similar process, but it also examined changes in the results as compared to the first one. Results in both surveys indicate that there is a connection between Minnesotans’ environmental knowledge and their self-reported attitudes and behaviors. However, the question about how to elevate the level of environmental behavior still remains unanswered (Murphy, 2002, 2004).

In terms of statewide surveys more specifically applied to particular subject matters, Suveddi et al (2000) developed a study to assess groundwater knowledge and perceptions of Michigan residents, which were determined to be moderate. Georgia State developed a survey in order to assess residents' attitudes and opinions toward water resources issues in the state. One of the major findings of this study was that residents were concerned about water quality and water quantity in Georgia because of the potential effects on human well-being, more so than the potential effects on the well-being of the environment (Responsive Management, 2003). Most recently, Barney *et al* (2005) developed a cross-age study in North Carolina to measure people's knowledge, attitudes, and behaviors toward bottlenose dolphins, and their study suggests the species is *"generally poorly understood and that the negative utilitarian attitudes and potentially harmful behaviors are widespread, excepted among well-educated college students who have benefited by direct instruction."*

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though the population is aware of the importance of EE, Floridians have a low environmental knowledge, even at the most basic level.

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Considering all of the discussed goals, ideas, and results related to the status of environmental literacy in the U.S., the EL survey instrument developed and tested in this thesis was not merely designed to be a measurement tool, but also a source of information to debate and influence decisions, initiatives, and changes in the practice of environmental education specifically in the Midwest, and furthermore to contribute to the overall progress of the field.

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CHAPTER 2. ENVIRONMENTAL LITERACY: KNOWLEDGE AND ATTITUDES OF IOWA STATE UNIVERSITY' STUDENTS

A paper to be submitted for publication in the
Environmental Education Research Journal

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Abstract

The role of environmental education has received enough attention with applied environmental literacy research completed at the level of elementary and secondary schools curricula, as well as assessments on adults' environmental literacy at state, national, and even international levels. However, few studies have focused on university-level assessments as means for increasing people's environmental knowledge. The reported research examines the levels of environmental knowledge and attitudes of Iowa State University (ISU) undergraduate and graduate students registered for the 2007 spring semester. A new survey instrument was developed specifically for this study, accounting for local (Midwestern) and global environmental issues. Students were found to have a "moderate" level of environmental literacy. The results suggested correlations between environmental knowledge and attitudes and students' demographic characteristics such as age, gender, college, student status, childhood environment, and outdoor activities practiced as a child.

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Introduction

Dinsinger & Roth (1992) and Volk & McBeth (1998) agreed that the central goal of environmental education (EE) is to make citizens aware of and active toward environmental issues, and ultimately environmentally literate. But, defining environmental literacy (EL), the outcome of environmental education, is a complex process.

The question about what environmental literacy is and what it should approach at its core are still far from being answered in a common agreement between scientists and practitioners in the field. Morrone *et al* (2001) reaffirm that the study of environmental literacy is relatively new, and no definition has been given to it that is universally accepted, and consequently the attributes of an environmentally literate citizen are still subject to discussion and investigation.

For the purpose of this paper, we provide Elder's (2003) definition, which describes EL as *"the capacity of an individual to act successfully in daily life on a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainably. This requires sufficient awareness, knowledge, skills and attitudes to incorporate appropriate environmental considerations into daily decisions about consumption, lifestyle, career, and civics, and to engage in individual and collective action."*

The knowledge about the current status of environmental literacy in the US is based upon a small number of studies. These studies often apply different instruments and, most of the time, were developed to measure a single variable (Elder, 2003). Volk & McBeth (1998) did a review of these studies and concluded that the overall degrees of environmental literacy ranked from "low" to "moderate" according to the scale designed for the study. Most of these studies were directed mainly to the development and implementation of survey instruments

to measure environmental knowledge, attitudes, and behavior. Much of the environmental literacy research done so far focused on the knowledge component and many of those had youth as their objects of study (Morrone *et al*, 2001).

Leeming *et al* (1995) developed a scale designed to measure environmental attitude and knowledge of children in elementary, middle, and junior high schools in Memphis, and such scale appeared to satisfy the need to measure children's global environmental literacy. Bogan & Kromrey (1996) developed an environmental literacy survey of Florida's high school students, which attempted to measure knowledge, attitude, behavior and political actions. The students scored 37% in the knowledge component, demonstrated a positive attitude towards the environment, knew environmentally responsible behaviors, but demonstrated limited knowledge of political action.

Gambro & Switzky (1996) conducted a national survey of high school students applying a multiple choice test of seven items from the *Longitudinal Study of American Youth*, and the results showed that the students presented a low level of environmental knowledge, and most importantly, gained very little in knowledge from 10th to 12th grade. Brody (1996) assessed the environmental science knowledge of Oregon's marine resources in 4th, 8th, and 11th grade students, which revealed a number of misconceptions about such resources held by at least half of the students. Culen & Mony (2003) worked with Florida 4-H youth participating in non-formal environmental education programs to measure their levels of environmental literacy, and their study showed the effectiveness of such programs on the development of responsible environmental behaviors.

Few past studies involved adults as participants. Arcury & Christianson (1993) developed a telephone survey for Kentucky residents mainly to evaluate whether environmental knowledge and attitude can be affected by rural-urban differences. The study revealed that “urban-metro respondents were more knowledgeable about global issues than urban-nonmetro and rural-nonmetro respondents”. These findings are supported by Zimmerman (1996), who summarized environmental education research during 15 years, from 1979 to 1993, and observed that race and gender differences influenced environmental knowledge. According to Zimmerman, blacks and women are generally less knowledgeable in terms of environmental issues than whites and men.

The only national longitudinal data available is *The National Report Card on Environmental Attitudes, Knowledge, and Behavior* (NEETF 1997, 1998, 1999, 2001), which displays American attitudes and knowledge toward the environment, and which was recorded by the Roper Starch Worldwide commissioned by the National Environmental Education and Training Foundation (NEETF) in the last nine years. The results show that two out of three adult Americans still fail to correctly answer simple environmental questions. Even though 70% of Americans believe and say they know enough about environmental issues, only a third of these respondents received a passing grade, and among this third, only one in ten adults received a grade “A”.

The First Pennsylvania Environmental Readiness for the 21st Century Survey Report (PCEE, 2000), the first of its kind in the nation, reported the results of adult Pennsylvanians’ knowledge about, attitudes toward, and behaviors related to the environment. The first and second *Minnesota Report Cards on Environmental Literacy* were the results of surveys conducted in 2001 and 2003. The first survey created a baseline of environmental literacy for

residents of the state. The second one followed a similar process, but also examined changes in the results when compared to the first one. Results in both surveys indicate that there is a connection between Minnesotans' environmental knowledge and their self-reported attitudes and behaviors. However, the question about how to elevate the level of environmental behavior still remains unanswered (Murphy, 2002, 2004).

In terms of statewide surveys more specifically applied to particular subject matters, Suveddi et al (2000) developed a study to assess groundwater knowledge of Michigan residents, which was determined to be moderate. Georgia developed a survey in order to assess state residents' attitudes and opinions toward water resources issues in the state. Residents were concerned about water quality in Georgia mostly because of the potential effects on human well-being rather than the effects on the well-being of the environment (Responsive Management, 2003). Most recently, Barney *et al* (2005) developed a cross-age study in North Carolina to measure people's knowledge, attitudes, and behaviors toward bottlenose dolphins, and their study suggests the species is *"generally poorly understood and that the negative utilitarian attitudes and potentially harmful behaviors are widespread, except among well-educated college students who have benefited by direct instruction."*

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guide state-supported EE opportunities (Responsive Management, 1998). The survey's results showed that the most important issues for EE in Florida were related to water resources, land use/growth management, habitats and ecosystems, coastal protection, and personal actions. This survey, as with most of the others of its type, also illustrates that even though the population is aware of the importance of EE, Floridians have a low environmental knowledge, even at the most basic level.

The need for improvement of environmental literacy is also recognized by Iowans. The Iowa Conservation Education Council (ICEC) along with the Governor's office, state agency personnel, and Iowa citizens created a set of goals to fulfill EE needs, such as strengthening youth education, preparing educators and future leaders, strengthening community stewardship, and creating an efficient education system. For the purpose of strengthening stewardship, one of their recommendations was to conduct a statewide survey to determine the current level of environmental literacy of Iowa citizens and educators, and include that as part of a Report Card (ICEC, 2000).

While environmental education, with elementary and secondary schools curricula, and assessments of adults' environmental literacy at state, national, and international level have received considerable attention, few researchers have focused on university-level assessments of environmental knowledge (Orr, 1995; Wilke, 1995; Kaplowitz and Levine, 2005).

Benton (1994) conducted research to examine environmental knowledge and attitudes among faculty members in the college of Arts and Sciences and the schools of Business, Social Work, and Education. Business faculty members were less knowledgeable and demonstrated less ecologically oriented attitudes than the non-business faculty. In more

recent studies, Robinson & Crowther (2001) developed an environmental knowledge survey to compare responses of three groups of students in science education, biology and chemistry majors from a mid-sized western university, and observed significant difference in knowledge levels among the three groups. Wolf (2001) developed a survey to evaluate to what extent environmental education is provided to non-environmental major students at four-year institutions in the USA, and reported that only 12% of these institutions established some sort of requirement component on environmental and ecological knowledge.

Hodgkinson & Innes (2001) studied environmental attitudes and beliefs of freshman students in different disciplines at an Australian University and concluded that students involved in economically relevant disciplines such as business are consistently less pro-environmental than students in other disciplines. McMillan *et al* (2004) evaluated the impact of an introductory environmental studies class on environmental values of students at Dalhousie University in Canada, and observed that students appeared to be more environmentally concerned after taking the course. Kaplowitz & Levine (2005) conducted research to measure levels of environmental knowledge of Michigan State University students, and their findings affirm that while the students showed a higher level of environmental knowledge than the general public, their overall score was still deficient.

We agree with Kaplowitz & Levine (2005) in the argument that much of the previous research done at university levels have focused on comparisons of environmental knowledge of students in different majors, and that there is still a gap in understanding the relationship between university students' literacy and that of the general public. This paper reports the examination of levels of environmental knowledge and attitudes of undergraduate and

graduate students in all colleges at Iowa State University (ISU), and how the levels of such knowledge and attitudes change according to their demographic characteristics.

We took into consideration the fact that the desired outcome of environmental education (EE) is to create a public that is environmentally literate, but measuring environmental literacy (EL) has remained illusive. As we already discussed, some national surveys have been conducted that attempt to measure it. A few states have attempted to periodically survey their citizenry to gather EL data. While these are important attempts, we believe that many of the questions asked may not accurately measure EL. Further, we believe that these important instruments fail to account for cultural and educational system differences and don't always take into consideration accepted benchmarks for EE.

To conduct our ISU survey, we developed a new survey instrument that better accounted for local, educational, and cultural factors. Moreover, the instrument built was not merely designed to be a measurement tool, but also a source of information to debate and influence decisions, initiatives, and changes in the practice of environmental education specifically in the Midwest, and eventually contribute to the overall progress of the field.

Iowa State University (ISU)

Iowa State University, located in Ames (IA), is one of the nation's leading land-grant institutions. ISU was first chartered in 1858 as the Iowa Agricultural College and Model Farm. Organized as a land-grant institution in 1864, it opened the college in 1868-69, and its first class graduated in 1872. The college was renamed Iowa State College of Agriculture and Mechanic Arts in 1898 and became Iowa State University of Science and Technology in 1959.

Last year, ISU accommodated 25,462 students. According to the ISU Fact Book (2006/2007), the majority of the students were white Americans (83.2%); with small percentages of Asian/Pacific islanders (3.2%), African Americans (2.7%), Hispanics (2.3%), and Indian/Native Americans (0.3%). Some 8.3% of these students were international coming from a total of 104 countries. China, India, and South Korea were the most represented countries with 773, 301 and 267 students, respectively. Most of the U.S. undergraduates enrolled were from the Midwest, with 15, 735 students originally from Iowa.

Engineering, agriculture, family and consumer sciences, and veterinary medicine are fields of study in which Iowa State has led the development. Major initiatives in the bioeconomy, food safety and food security, human/computer interaction, combinatorial chemistry, keep Iowa State at the forefront of research in areas of vital importance to Iowa, the nation and the world (ISU Fact Book, 2006/07).

Methods

The reported research is based on a campus-wide survey of ISU undergraduate and graduate students registered in all colleges and departments during the 2007 spring semester. We developed a survey instrument to measure students' levels of awareness of, knowledge about, and attitudes towards environmental issues, globally and in the midwestern United States. This project was funded by Iowa's Resource Enhancement And Protection-Conservation Education Program (REAP –CEP).

Using published literature and ISU students' help, we compiled a list of the top five global and local environmental issues which environmentally literate students should be able to answer. Global issues included global climate change, population growth, pollution,

biodiversity and habitat loss, and energy efficiency. Local issues included agriculture, water quality, habitats and ecosystems, urban expansion, and private versus public land use.

Using some questions from previously published surveys (NEETF, 2001) and building original questions as well, we adapted them to better account for local knowledge (i.e. about agriculture) and awareness of local issues (i.e. public versus private land). The resulting questions were further reviewed by knowledgeable collaborators and adjustments were made.

To evaluate the instrument, account for the general flow of the survey and address confusion that could occur because of misunderstood or unclearly stated questions, we pre-tested the revised version of the instrument with undergraduate students in three ISU classes. Student participation was voluntary and anonymous. After analyzing the results from 50 respondents, we made further adjustments and improvements to the instrument for the final version. The final survey instrument (Appendix B) consisted of a questionnaire with a total of 52 questions divided into 4 categories: awareness, knowledge, attitudes, and demographics.

Awareness questions

The survey instrument has a total of four questions in the awareness category. Two are multiple choice questions and two are open ended questions (short answers) to provide information about the respondents' general consciousness about global and local environmental issues.

Awareness questions, in various survey instruments in the literature, are established as multiple choice questions to allow for ease of computation and analysis. We believe

however that this method may pre-determine choices. Justifying this, this survey allowed totally open-ended questions. While more difficult to analyze, we felt it more accurately reflected the awareness component.

Knowledge questions

A total of 16 questions were written for the knowledge category of the survey instrument. They are all multiple-choice type questions with only one correct answer and they incorporate (in part) the issue areas compiled in the global and local environmental issues' list previously discussed. The knowledge questions were developed to examine the respondents' more in-depth intellectual framework, and their ability to understand, apply, analyze and evaluate the environmental issues emphasized in the survey. They represent the breadth of knowledge necessary for environmentally literate citizens of the Midwest to know.

Attitude questions

The attitude portion of the survey contains 20 questions. All questions use a Likert-type scale (Likert, 1957), 16 of which have choices that range from "strongly disagree" to "strongly agree". The remaining four questions include choices that range from "improved a lot" to "declined a lot", as well as an option to choose "don't know". These last four questions were designed to provide a measure of optimism about the past and future state of our environment. The remaining questions in this category were designed to observe respondents' feelings of appreciation and concern about each global and local environmental issue included in the instrument.

Demographic questions

There are a total of 12 questions in this category. Some of them are multiple choice questions, presenting one or more than one possible answer, and some are open-ended (short answers). Questions in this portion of the survey are designed for the purpose of comparing the respondents' demographic characteristics such as age, gender, student status, etc., to their level of awareness and knowledge about, and attitudes toward the global and local environmental issues emphasized in the survey.

Applying the survey instrument

The instrument was developed as a web-based survey of ISU undergraduate and graduate students in all colleges. To accomplish this, we used the ISU Web Course Tools (WebCT), which is available for the development and online delivery of many ISU courses. WebCT is a free tool available to all ISU faculty, staff, and students with Iowa State user identification (Net-ID). The software includes communication tools, assessments, and course materials. Assessments include self-tests, surveys, and quizzes. In our study, we used the WebCT assessment materials to implement the survey.

Notice of the survey's availability, together with a "hotlink" was sent via email to all ISU undergraduate and graduate students registered for the 2007 spring semester (23,710) and stayed available for response for four weeks. We employed the method known as the "Tailored Design Method" developed by Dillman (2000). The method suggests making the survey respondent-friendly, including a stamped return envelop, using five varied contacts with the survey recipients, providing an incentive, and personalized correspondence. We

adapted the method to be used in the submission of our web survey, using the following steps:

- Step 1: An advance-notice letter was emailed to all students enrolled in the 2007 spring semester. The letter informed the students that they were being asked to participate in a survey of environmental knowledge and attitudes and that it would be available shortly via the WebCT system. They were encouraged to complete the survey and told that they would be placed into a drawing for an iPod if they completed the survey.
- Step2: A week after the advance-notice letter was sent out, we emailed the students a cover letter (Appendix C) with instructions of how to answer the questionnaire through the WebCT and a web link directly to the survey page. Checking this web link took students to the site to begin completing the survey.
- Step3: A week after the cover letter was sent and the questionnaire was made available for response, we sent a follow-up email to all students to remind them to participate. The follow-up email thanked those who had already answered the survey and requested response from those who had not yet responded. It also included the cover letter used in step 2.
- Step 4: Another follow-up email was sent as a reminder, and included all information described in step 3.
- Step 5: A final follow-up email was sent as a last reminder and included all the information described in step 3 and 4.

In all cases, the replies to the survey were anonymous and participation was voluntary. By answering the survey and submitting their responses, participants automatically gave us permission to use the information that they had provided.

After the survey process was completed, a raw data table was generated through the WebCT system and exported as a Microsoft Excel file to be inputted into the Statistical Analysis System software for statistical analysis (SAS Institute Inc., 2007).

Results

We received 3605 completed surveys. However, we eliminated 812 respondents who did not answer at least five of our demographic questions and most of the questions in the other categories, resulting in 2793 eligible respondents (11.8% of the total ISU student population for the respective semester).

Demographic items

The demographic characteristics of the respondents can be positively compared to those of the overall ISU student population. Respondents in this survey were not assumed to be a representative sample of the general public in the State of Iowa, but they were indeed representative of the ISU student population for the specific 2007 spring semester. Table 1 illustrates students' participation in the survey according to age, gender, student status and college of enrollment.

The majority of the respondents ranged between 17 to 25 years of age. The gender of the respondents approximates that of the ISU student population, which includes 56.1%

males and 43.9% females, although we had slightly more female (49.6%) than male respondents (48.7%) for our survey.

The distribution of students, according to their status and college of enrollment, is roughly similar in proportion to the enrollment data for the 2007 spring semester provided by the ISU Office of the Registrar. Most of the ISU student population is composed by undergraduate students, and among them, there is a bigger percentage of seniors (28.3%) and junior students (18.7%) then freshmen (14.4%) and sophomores (16.4%). The survey respondents were also mainly undergraduate students, and we observed a bigger percentage of seniors (24.3%) and juniors (18.4%) respondents as well (Table 1).

ISU's biggest college is the College of Liberal Arts and Sciences (LAS), which includes 26.5 % of the student population, followed by the College of Engineering (COE) with 22.2% of the student population. Our sampled respondents were similar, 22.5% in LAS and 19% in COE. The College of Veterinary Medicine (Vet Med) is the smallest college at ISU with 2.2% of the student population, and it was represented proportionally in our survey at 2.1% of respondents.

It should be noted that, in the survey's demographic question about student status, we did not offer the "special student" category as one of the alternatives. "Special student" is a category that some ISU students can be included in. Consequently, the respondents that might have belonged to this category could have either not answered the question and be automatically included in the "unknown" category, or they could have included themselves in other offered categories such as one of the undergraduate levels.

Table 1. Demographic characteristics of Iowa State University (ISU) environmental literacy survey's respondents and the ISU student population for the 2007 spring semester.

Characteristics	Level	Number of respondents (#)	Percent of respondents (%)	Spring 2007 ISU # (%) ¹
Age range	17-20 yrs	1083	38.8	3
	21-25 yrs	1219	43.6	3
	26-30 yrs	247	8.8	3
	31-40 yrs	145	5.2	3
	Over 40 yrs	76	2.7	3
	Unknown ²	23	0.8	3
Gender	Male	1360	48.7	13305 (56.1)
	Female	1384	49.6	10405 (43.9)
	Unknown ²	49	1.7	4
Student Status	Freshman	419	15.0	3422 (14.4)
	Sophomore	422	15.1	3882 (16.4)
	Junior	516	18.4	4433 (18.7)
	Senior	680	24.3	6705 (28.3)
	Graduate	490	17.5	4426 (18.7)
	Unknown ²	266	9.5	4
College	Agriculture	429	15.4	3040 (12.8)
	Business	287	10.3	3374 (14.2)
	Design	130	4.6	1783 (7.5)
	Engineering	531	19.0	4796 (20.2)
	Human Sciences	425	15.2	3239 (13.7)
	Liberal Arts and Sciences	630	22.5	6274 (26.5)
	Veterinary	60	2.1	521 (2.2)
	Medicine			
	Unknown ²	301	10.8	4

¹Numbers provided by the ISU Office of the Registrar, enrollment statistics for Spring 2007.

²Category includes respondents who did not provide information for the associated demographic characteristic.

³Numbers not available at the ISU Office of the Registrar.

⁴Not available or provided. May include "special students", "undeclared", and intercollegiate and interdepartmental majors.

We also did not include “Interdepartmental Units and Graduate Undeclared” as one of the alternatives for the demographic question about college of enrollment. Again, the students that might have belonged in this category might have not answered the question and have been automatically included in the “unknown” category or they could have chosen one of the other alternatives for college of enrollment.

Besides age, gender, student status and college of enrollment, there were other demographic characteristics explored in this study (Appendix B). We asked the students to provide information about “how long they have lived in the Midwest”, “what type of environment they spent the majority of their childhood in”, and “what kind of outdoor activities they experienced while growing up”.

Results demonstrated that 31.7% of the respondents reported to have been living in the Midwest U.S. their entire life, 8.4% confirmed to be in the Midwest from about 11 to 20 years, and 7.9% said they have lived in the Midwest for less than 5 years. About 5.3% of the respondents confirmed they lived in the Midwest from 21 to 30 years, 2.7% chose 5 to 10 years, 0.43% was placed in the range between 31 to 40 years, and only 0.12% of the respondents reported to have been living in the Midwest for more than 40 years. A total of 43.4% of the respondents did not provide information for this question. We should note though, that this question was a little confusing, since students who chose one of the age ranges such as 21 to 30 years could also possibly be classified as living in the Midwest “for their entire life”. The answer “all my life” as an option to respond the question should not have been provided.

In relation to the question about their childhood environment, 23.8% of the respondents reported to have grown up in a small city (2,500 to 50,000 people), 18.83% grew

up in rural farm environment, 17.83% confirmed to have grown up in a large city, 10.67% chose rural non-farm environment, 10.17% grew up in a small town ($\leq 2,500$ people), 10.13% came from suburban areas, and 0.39% chose “other” as an alternative. Some 8.2% of the respondents did not provide information about their childhood environment.

Regarding outdoor activities experienced during childhood, from the total of 15 alternatives (14 possible activities and an “others” category), the top outdoor activity, chosen by 93.98% of the respondents, was “just being outdoors”, followed by “visiting Zoos” with 89.4%, and fishing and camping which were both chosen by 82.78% of the respondents. The least chosen activity was “hunting” with 33.48% of the respondents, followed by “backpacking”, chosen by 35.02% of the respondents. The majority of the respondents reported a total of 8 to 14 outdoor activities practiced during childhood.

All demographic information reported in this section is analyzed in more detail later in relation to the *knowledge* and *attitudes* items.

Awareness items

From the total of four questions asked in the awareness section of this survey, the last two were open ended questions (Appendix B), where the respondents had to provide short answers divided in five items per question (total of ten items per respondent). The answers were directed to include global and local (Midwestern) environmental issues of which the respondents were aware. Considering that we had a total of 2793 valid respondents, there is a vast list of items answered in each of the two questions that are still being carefully observed and codified for further analysis. The results related to these two specific questions and how

they correlate to the knowledge, attitude, and demographic sections of this survey, will be published in a future paper.

Students were asked for a self-evaluation of their environmental knowledge, how much they thought they knew about environmental issues. Most of the students indicated that they had either “a reasonable amount” of environmental knowledge (43.3%) or that they knew “a little” (32.3%), and a considerably smaller number of students claimed to know “a lot” (7.4%) about environmental issues (Table 2).

Table 2. Awareness question 1: self-evaluation of sampled Iowa State University students about their general level of environmental knowledge.

<i>A1. Compared to other students in your college and/or department, how much do you feel you know about environmental issues and problems in general?</i>		
Alternatives	# Respondents	% Respondents
A lot	207	7.4
A reasonable amount	1208	43.3
A little	901	32.3
Almost nothing	168	6.0
Nothing	25	0.95
Don't know	27	0.97
Unknown *	257	9.2

*Category includes respondents who did not provide an answer.

We also asked what primary sources of environmental information were used by respondents. Results demonstrated that TV is the source of environmental information most utilized (72.9% of the students). Internet and newspaper are next (69.4% and 59.9%, respectively). Some 0.3% of the respondents indicated that they use “none” of the sources in the list (Table 3).

Table 3. Awareness question 2: total number and percentage of sampled Iowa State University's students by chosen source of environmental information.

A2. What are your primary sources for environmental information? Check as many as applicable:

Alternatives	# Respondents	% Respondents
TV	2037	72.9
Radio	816	29.2
Internet	1938	69.4
Magazines	1027	36.8
Newspapers	1675	59.9
Classes/courses	1274	45.6
Books	571	20.4
Library	140	5.0
Friends/relatives	1449	51.9
Other	226	8.1
None	9	0.3

Knowledge items

A total of 16 questions were included in the knowledge section of the survey. Table 4 displays the number of respondents, means and standard deviations of the number of questions answered right (Nright), as well as correlations among the 16 questions. Questions were numbered from “K5” to “K20”. Knowledge questions in Table 4 are named according to the environmental issue they represent in the survey to facilitate understanding (for the list of all 16 original questions, please refer to Appendix B).

Students who answered fewer than 6 questions correctly were classified as having a “low” knowledge level regarding the environmental issues explored in the survey; students who answered from 6 to 10 questions correctly were considered to have a “moderate” level of such knowledge; students who answered from 11 to 13 were placed in a “moderately high” level; and students who answered 14 or more questions correctly were classified as having a “high” level of such knowledge.

Table 4. Knowledge questions (total of 16), number of respondents, means and standard deviations for each questions, and Pearson coefficients of correlation (r) among these knowledge questions.

knowledge Questions	n	Means ₁	SD	Correlations (r)															
				K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15	K16	K17	K18	K19	K20
K5. Biodiversity	2679	0.55	0.50	-															
K6. Global pollution	2686	0.55	0.50	.10**	-														
K7. Population growth	2715	0.69	0.46	.10**	.07*	-													
K8. Climate change	2716	0.70	0.46	.01	.05*	-.02	-												
K9. Species extinction	2746	0.87	0.33	.07*	.12**	.08**	.04*	-											
K10. Global energy use	2743	0.92	0.27	.11**	.13**	.14**	.07*	.13**	-										
K11. Renewable	2737	0.84	0.36	.09**	.07*	.15**	.00	.12**	.25**	-									
K12. Sustainability	2738	0.59	0.49	.09**	.11**	.09**	.02	.11**	.12**	.11**	-								
K13. Carrying capacity	2733	0.77	0.42	.10**	.13**	.15**	.06*	.10**	.18**	.16**	.15**	-							
K14. Hunger	2739	0.70	0.46	.10**	.10**	.09**	-.07*	.07*	.11**	.10**	.08**	.11**	-						
K15. Local pollution	2748	0.76	0.42	.10**	.48**	.11**	.07*	.15**	.21**	.13**	.15**	.14**	.10**	-					
K16. Wetlands	2734	0.30	0.46	.07*	.11**	.06*	.00	.04*	.06*	.04*	.05*	.04*	.06*	.10**	-				
K17. Landscape change	2753	0.60	0.49	.11**	.13**	.13**	.14**	.11**	.14**	.15**	.12**	.15**	.02	.17**	.06*	-			
K18. Urban sprawl	2738	0.68	0.47	.10**	.11**	.10**	.10**	.09**	.12**	.10**	.12**	.13**	.04*	.18**	.09**	.22**	-		
K19. Local energy use	2751	0.76	0.43	.12**	.17**	.15**	.02	.08**	.38**	.20**	.15**	.21**	.17**	.23**	.08**	.19**	.15**	-	
K20. Management	2748	0.58	0.49	.02	.06*	-.01	.02	.04*	.08**	.05*	.05*	.09**	.04*	.05*	.09**	.04	.08**	0.7*	-
NRIGHT ²	2793	10.63	2.92																

*p<.05 **p<.0001

¹1.00 = 100% of respondents answering correctly.

² Average number of questions answered correctly (10.63).

From the total of 2793 respondents, 1479 of them (52.95%) were placed between the “moderately high” and “high” knowledge level categories, 925 (33.12%) showed a “moderate” knowledge level, and only 110 respondents (3.94%) demonstrated a “low” level of such environmental knowledge.

As Table 4 illustrates, an overall mean of 10.63 questions were answered correctly, which suggests that the respondents average an overall “moderate” environmental knowledge level. One knowledge item (K16), concerned the function of wetlands in the Midwest and only 30% of respondents answered correctly. Students failed to recognize that Midwestern wetlands don’t really recharge underground aquifers, even though this is one of the important functions of wetlands in some parts of the U.S. Most respondents (92%) correctly answered the question about global energy use (K10). They seem to know the sources of most of the energy that people use worldwide comes. A question on the local energy use (K19) however, revealed that only 76% of the respondents chose the correct answer.

Overall, respondents expressed high levels of knowledge regarding issues such as energy use, renewable resources and species extinction. Levels decrease when the questions involved issues such as sustainability, population growth and resource management. As also observed in Table 4, the correlation matrix showed that most questions were positively correlated, with “*p*” values either smaller than .0001 or .05.

Table 5 displays the distribution of knowledge questions by total number of respondents who answered a respective number of questions right, respondents who answered a respective number of questions wrong, and the number of respondents who did not answer a respective number of questions. Note that, from the total of 2793 respondents, 32 of them got 16 questions right and only 1 of the respondents got 16 questions wrong. The

majority of the respondents got from 8 to 14 questions right, and 2 to 7 questions wrong. A total of 2283 answered all the questions.

Table 5. Distribution of the total number of environmental knowledge questions answered either right or wrong.

Number of questions	Respondents by Nright¹	Respondents by Nwrong²	Respondents by Nmissing³
0	19	59	2283
1	3	161	368
2	15	302	78
3	25	379	21
4	36	425	11
5	52	405	8
6	93	311	4
7	153	242	0
8	201	180	2
9	266	135	0
10	323	78	2
11	396	51	0
12	417	34	0
13	355	19	0
14	273	7	1
15	134	4	1
16	32	1	14
Total	2793		

¹Number of respondents who answered the respective number of questions right.

²Number of respondents who answered the respective number of questions wrong.

³Number of respondents who did not answer the respective number of questions.

In relation to the students' self-evaluation of environmental knowledge (Table 2), the results shown in Table 6 suggest that there is not a significant difference between the way the students evaluated themselves in terms of environmental knowledge and the way they actually performed in the knowledge portion of the survey. Students who said they knew "a lot" were the ones who obtained the highest mean number of correct answers (mean of

Nright), which was 12.16 from a total of 16 knowledge questions. Students who said they knew “a reasonable amount” of environmental issues followed with a mean of 11.30 correct answers. Conversely, students who said they knew “nothing” about such issues were indeed the ones who obtained the lowest mean for Nright (7.20), followed by the ones who said they knew “almost nothing” (8.83).

Table 6. Mean number of questions answered right by students’ self-evaluation of knowledge.

Self-evaluation	N	Nright ¹		df	F value	P>F
		Means	SD			
Know “A lot”	207	12.16	2.37	5	61.73	<.0001
Know “A reasonable amount”	1208	11.30	2.53	2530		
Know “A little”	901	10.13	2.73			
Know “Almost nothing”	168	8.83	3.20			
Know “Nothing”	25	7.20	3.42			
“Don’t know”	27	8.70	3.30			
Missing ²	257	9.71	3.75			

¹Number of correct answers out of 16.

²Values reflect students who did not provide their self-evaluation of knowledge.

The Scheffe method was used to adjust for multiple comparisons of means. The results suggested a significant difference in some of the relationships between students’ actual knowledge and the way they self-evaluated their knowledge. The P values between students who answered they knew “a lot” and each of the other categories were very significant (.002, <.0001, <.0001, <.0001, <.0001), and in all the cases the students who said they knew “a lot” scored significantly higher than all the other students. The differences between students who answered they knew “a little” and the ones who answered “don’t know” were not shown to be significant. In the same way, the test showed that there was not

a significant difference between students who answered they knew “almost nothing” and the ones who answered they knew either “nothing” or “don’t know”.

In the second awareness question of the survey we asked the students what were the main sources of information they use to obtain environmental knowledge (Table 7).

Table 7. Average number of questions answered right by students’ total number of sources of environmental information.

Total number of sources	N	Nright ¹		df	F value	P>F
		Means	SD			
0 ²	243	9.42	3.83	10	10.63	<.0001
1	133	9.28	3.15	2782		
2	190	10.36	2.87			
3	469	10.44	2.78			
4	637	10.93	2.63			
5	474	10.88	2.72			
6	347	10.98	2.90			
7	195	11.21	2.71			
8	76	11.41	2.62			
9	21	10.95	2.82			
10	8	11.50	1.77			

¹Number of correct answers out of 16.

²Values reflect students who chose “none” or did not provide their sources of environmental information.

As the results show, the average number of questions answered correctly mostly increases as the total number of sources of environmental information increases. Students who chose 10 sources from the list provided obtained the highest mean for Nright, 11.50 from the total of 16 knowledge questions, closely followed by students who chose 8 or 7 sources. Students who chose only one of the sources had the lowest mean of Nright (9.28).

The applied Scheffe test obtained significant P values, generally indicating that students who utilize from 5 to 9 of the provided sources of environmental information scored significantly higher than the ones who chose fewer than 4 sources.

Knowledge Vs Demographic items

1. Age

The data suggested that there is a significant difference between students' level of environmental knowledge and their age range ($F=11.46$, $P<.0001$). Based on the mean number of questions that were correctly answered from the total of 16, students who are over 40 years of age scored the highest (11.20), and the youngest students, ranging in between 17 to 20 years of age, obtained the lowest score (10.20). A total of 23 respondents did not provide information about their age range and obtained a mean of 7.65 questions answered correctly (Table 8).

Table 8. Average number of questions answered right by students' age range.

Age range	N	Nright ¹		df	F value	P>F
		Means	SD			
17-20 yrs	1083	10.20	2.89	4	11.46	<.0001
21-25 yrs	1219	10.98	2.79	2765		
26-30 yrs	247	10.83	3.06			
31-40 yrs	145	10.76	3.17			
Over 40yrs	76	11.20	2.65			
Missing ²	23	7.65	4.74			

¹Number of correct answers out of 16.

²Values reflect students who did not provide their age range.

The results of the Scheffe test showed that there was a significant difference between the 17-20 and 21-25 age ranges ($P<.0001$), where the second scored significantly higher than

the first. The same occurred between the 17-20 and 26-30 age ranges, where the second scored significantly higher than the first as well ($P=.046$).

2. Gender

There was a significant difference between males and females students in relation to their mean number of correct answers. Males scored significantly higher than females ($T=7.81$, $P<.0001$), with a mean of 11.06 questions answered correctly from the total of 16 knowledge items, while females answered an average of 10.20 questions correctly (Table 9). From the total number of survey respondents, 49 of them did not provide their gender, and their mean number of right questions was 10.94.

Table 9. Average number of questions answered right by students' gender.

Gender	N	Nright ¹		df	T value	P>T
		Means	SD			
Male	1360	11.06	2.77	2732.58	7.81	<.0001
Female	1384	10.20	2.99			
Missing ²	49	10.94	3.64			

¹Number of correct answers out of 16.

²Values reflect students who did not provide their gender.

3. Student status

We found a significant difference between students' level of environmental knowledge and their academic status ($F=15.78$, $P<.0001$) (Table 10). Senior students obtained the highest mean of Nright (10.89), followed by the graduate students (10.82). The lowest mean of correct answers belonged to the freshman students (9.59).

The Scheffe method applied showed that there was a significant difference between freshman students and all the other academic levels. Freshmen scored significantly lower than all the other students (all four P values expressing the relationship between freshman and the other four academic status were significant). The test also showed that seniors scored significantly higher than sophomores ($P = .02$).

Table 10. Average number of questions answered right by students' academic status.

Student status	N	Nright ¹		df	F value	P>F
		Means	SD			
Freshman	419	9.59	2.94	4	15.78	<.0001
Sophomore	422	10.28	2.87	2522		
Junior	516	10.48	2.78			
Senior	680	10.89	2.74			
Graduate	490	10.82	3.03			
Missing ²	266	12.11	2.78			

¹Number of correct answers out of 16.

²Values reflect students who did not provide their academic status.

4. College of enrollment

Results showed a significant difference between students' environmental knowledge and their respective college of enrollment ($F = 30.89$, $P < .0001$) (Table 11). Students enrolled in the College of Veterinary Medicine obtained the highest mean for number of questions answered correctly (12.08), followed by students enrolled in the College of Agriculture (11.34). The lowest mean for Nright was obtained by students in the College of Business (9.29), followed by students in the College of Human Sciences (9.41). Notice that 301 students (10.77% of total respondents), did not provide information about their college of enrollment, and their mean for Nright was 12.18.

Table 11. Average number of questions answered right by students' college of enrollment.

College	N	Nright ¹		df	F value	P>F
		Means	SD			
Agriculture	429	11.34	2.82	6	30.89	<.0001
Business	287	9.29	2.68	2485		
Design	130	10.12	2.92			
Engineering	531	10.91	2.82			
Human Sciences	425	9.41	2.89			
Liberal Arts and Sciences	630	10.58	2.89			
Veterinary Medicine	60	12.08	2.13			
Missing ²	301	12.18	2.42			

¹Number of correct answers out of 16.

²Values reflect students who did not provide their college of enrollment.

The Scheffe test for comparison of means suggested that students in the College of Agriculture scored significantly higher than students in the Colleges of Business ($P<.0001$), Design ($P=.005$), Human Sciences ($P<.0001$), and Liberal Arts and Sciences ($P=.005$). The same observation applies to students enrolled in the College of Veterinary Medicine, who scored significantly higher than students in Business ($P<.0001$), Design ($P=.003$), Human Sciences ($P<.0001$), and Liberal Arts and Sciences ($P=0.016$). The test also showed that there was no significant difference between the means of students in the College of Business and students in the Colleges of Design and Human Sciences.

5. Years spent in the Midwest U.S.

Table 12 displays the relationship between students' environmental knowledge and the number of years they have been living in the midwestern U.S. Results showed a significant difference in students' knowledge scores according to their time spent in the Midwest ($F= 11.25$, $Pr<.0001$). Students who reported they have been living in the Midwest

for more than 40 years obtained the highest mean of knowledge questions answered correctly (12.00), followed by students who reported 31 to 40 years in the Midwest (11.33). The lowest mean for Nright was obtained by students who reported to have been living in the Midwest for less than 5 years (8.67).

In general, the mean number for Nright increases as the number of years spent in the Midwest increases, except in the case of the students that reported to have been living in the Midwest their entire life. These students obtained a mean of 10.24 questions answered correctly, which is smaller than all the other students placed in the ranges between 21 to 30, 31 to 40, and more than 40 years spent in the Midwest. A total of 1213 students (43.4% of the total respondents) did not provide information about their time spent in the Midwest, and they obtained a mean of 11.60 questions answered correctly.

The Scheffe test results suggested that students who reported less than 5 years in the Midwest scored significantly lower than students who reported about 21 to 30 years ($P < .0001$), and students who have been living in the Midwest their entire life ($P < .0001$). Following the same line, students who reported 5 to 10 years in the Midwest scored significantly lower than students who reported to have been living in the Midwest their entire life, even though the level of significance ($P = .04$) was not as high as in the previous case.

Again, we should note the issues with this question, since students who chose one of the other age ranges such as 21 to 30 years could also possibly be classified as living in the Midwest for their entire life.

Table 12. Average number of questions answered right by students' years spent in the Midwest U.S.

Years in the Midwest	N	Nright ¹		df	F value	P>F
		Means	SD			
Less than 5 yrs	222	8.67	3.29	6	11.25	<.0001
About 5-10 yrs	75	8.96	2.94	1573		
About 11-20 yrs	236	9.61	2.84			
About 21-30 yrs	147	10.37	3.17			
About 31-40 yrs	12	11.33	3.11			
More than 40 yrs	3	12.00	2.00			
All my life	885	10.24	2.90			
Missing ²	1213	11.60	2.46			

¹ Number of correct answers out of 16.

² Values reflect students who did not provide their time spent in the Midwest U.S.

6. Childhood environment

Results showed a significant difference between students' knowledge scores and the type of environment in which they spent the majority of their childhood ($F = 8.58$, $P < .0001$) (Table 13). A total of 229 students (8.2% of total respondents) did not provide information about their childhood environment. Their mean of Nright was 12.27.

Table 13. Average number of questions answered right by students' childhood environment.

Childhood environment	N	Nright ¹		df	F value	P>F
		Means	SD			
Rural Farm	526	10.93	2.83	6	8.68	<.0001
Rural non-farm	298	11.03	2.69	2557		
Suburban	283	10.49	2.97			
Small town ($\leq 2,500$ people)	284	10.70	2.90			
Small city (2,500 to 50,000 people)	664	10.24	2.92			
Large city	498	9.93	2.94			
Other	11	8.64	2.73			
Missing ²	229	12.27	2.57			

¹ Number of correct answers out of 16.

² Values reflect students who did not provide their childhood environment.

In relation to the respondents who provided information, students who grew up in a rural non-farm environment obtained the highest mean of Nright (11.03), followed by students who lived in a rural farm environment (10.93). The lowest mean of Nright was obtained by students who chose the “other” category (8.64), followed by students who reported to have grown up in a large city (9.93).

Results obtained through the Scheffe test suggest a significant difference in the means of students who grew up in a rural farm environment and students who either reported to have grown up in a small city ($P=.011$) or a large city ($P<.0001$). In both cases, students from the rural farm environment scored significantly higher. The same situation applies to students who grew up in a rural non-farm environment, who scored significantly higher than students from a small city ($P=.02$) or students from a large city ($P=.0002$). Results also suggested a significant difference between students who grew up in a small town and students who grew up in a large city ($P=.04$), where the first scored significantly higher than the latter.

7. Childhood outdoor activities

Results showed a significant difference between students' number of correct answers and the total number of outdoor activities they reported to have experienced during childhood ($F= 17.41$, $P<.0001$). We observed that students who reported a total number of 0 activities (from a total of 15 possible activities) obtained a larger mean of Nright than students who reported a total from 1 to 4 activities (Table 14). The remaining respondents who chose from a total of 5 to 15 outdoor activities, the mean number of correct answers generally increases as the total number of outdoor activities practiced during childhood increases.

Table 14. Number and percentage of students who chose each of the outdoor activities & Average number of questions answered right by students' total number of activities chosen.

Outdoor activities ²	# students	% students	Nright ¹						
			Total # activities	N	Means	SD	df	F value	P>F
Just being outdoors	2625	93.98	0	35	9.00	3.93	15	17.41	<.0001
Visiting Zoos	2497	89.40	1	23	7.96	3.07	2777		
Camping	2312	82.78	2	26	8.65	3.42			
Fishing	2312	82.78	3	39	8.13	3.21			
Planting a tree	2241	80.24	4	60	7.70	3.88			
Gardening	2187	78.30	5	88	9.25	2.83			
Hiking	2156	77.52	6	128	9.85	3.07			
Reading a nature book	2022	72.40	7	164	10.17	2.89			
Having or visiting a wild place	2020	72.32	8	206	10.53	2.99			
Canoeing	1837	65.77	9	239	10.12	2.81			
Watching "Animal Planet"	1604	57.43	10	304	10.74	2.71			
"Others"	1547	55.39	11	349	10.84	2.81			
Bird-watching	1171	41.93	12	343	11.08	2.46			
Backpacking	978	35.02	13	342	11.37	2.54			
Hunting	935	33.48	14	280	11.37	2.79			
			15	167	11.61	2.61			

¹Number of correct answers out of 16.

²Activities appear in order from the most chosen to the least.

Applying the Scheffe test showed that students who reported 0 activities scored significantly lower than students who reported 15 activities ($P=.049$). P values were also significant for the relationships between students who reported only one activity and students who reported from 12 to 15 activities. Scheffe results also showed that students who reported a total of 3 outdoor activities practiced during childhood scored significantly lower than

students who reported a total from 10 to 15 activities (P values between these relationships were all significant). A similar situation was observed for students who reported 4 outdoor activities in relation to the students who reported a total from 7 to 15 activities, P values between these relationships were also significant and demonstrated that students who reported 4 activities scored significantly lower than the students who reported from 7 to 15 activities.

Attitude items

A total of 20 questions were included in this section of the survey (going from “A21” to “A40”). The attitude questions were divided in two parts: the first part included answers on a Likert scale from “strongly disagree” to “strongly agree”. The second part included questions which were designed to observe respondents’ opinions about the past and future quality of the environment, both locally and globally.

Some 47.76% of the students believe that the overall quality of the planet’s environment has somewhat declined in the past 10 years, while 29.97% believes it has declined a lot (Table 15). Only 0.64% of the respondents believe that such environment has improved a lot in the last 10 years, and 10.02% of the respondents believe it has stayed the same.

When questioned about the future quality of the planet’s environment, 42.18% of the respondents believe that it will somewhat decline in the next 10 years, while 27.32% believe it will decline a lot. Only 1.11% of the students believe that the quality of the planet’s environment will improve a lot in the next 10 years, while 12.35% believe it will stay the same.

Table 15. Beliefs regarding past and future state of the global environment by students answering a web-based environmental literacy survey.

<i>A37. During the past 10 years, do you think that the overall quality of the planet's environment has...</i>				
Alternatives	# Respondents	% Respondents	Mean¹	SD
1. Improved a lot	18	0.64	4.10	0.94
2. Somewhat improved	206	7.37		
3. Stayed the same	280	10.02		
4. Somewhat declined	1334	47.76		
5. Declined a lot	837	29.97		
6. Don't know	92	3.29		
7. Missing ²	26	0.93		
<i>A38. In the next 10 years, do you think the overall quality of the planet's environment will...</i>				
1. Improve a lot	31	1.11	3.93	1.07
2. Somewhat improve	354	12.67		
3. Stay the same	345	12.35		
4. Somewhat decline	1178	42.18		
5. Decline a lot	763	27.32		
6. Don't know	99	3.54		
7. Missing ²	23	0.82		

¹ Mean numbers obtained from 1 to 6 based on the possible alternatives.

² Respondents who did not answer the questions.

Table 16 displays belief questions regarding the past and future quality of the air, soil, and water in the respondents' local environment. It also describes the number and percentage of respondents who chose each of the alternatives, and means and standard deviations for each of the two questions. Results showed that 39.74% of the respondents believe that the quality of the environment they live in has somewhat declined in the past 10 years, while 33.37% believe it has stayed the same. Only 7.88% of the respondents believe that such quality has somewhat improved.

Table 16. Beliefs regarding past and future state of the local environment by students answering a web-based environmental literacy survey.

<i>A39. During the past 10 years, do you think the quality of the air, soil, and water in the area you live has...</i>				
Alternatives	# Respondents	% Respondents	Mean¹	SD
1. Improved a lot	20	0.72	3.71	0.98
2. Somewhat improved	220	7.88		
3. Stayed the same	932	33.37		
4. Somewhat declined	1110	39.74		
5. Declined a lot	348	12.46		
6. Don't know	135	4.83		
7. Missing ²	28	1.00		
<i>A40. In the next 10 years, do you think that the quality of the air, soil, and water in the area you live in will...</i>				
1. Improve a lot	25	0.89	3.67	1.05
2. Somewhat improve	363	12.99		
3. Stay the same	759	27.17		
4. Somewhat decline	1113	39.85		
5. Decline a lot	363	12.99		
6. Don't know	142	5.08		
7. Missing ²	28	1.00		

¹ Mean numbers obtained from 1 to 6 based on the possible alternatives.

² Respondents who did not answer the questions.

When questioned about the future quality of their local environment, 39.85% of the respondents believe that it will somewhat decline in the next 10 years, while 27.17% believe it will stay the same. Only 12.99% of the students believe that the quality of their local environment will somewhat improve in the next 10 years, while 0.72 believe it will improve a lot.

Scores for these four questions (Tables 15 and 16) could range from 1 to 6 according to the alternatives offered in each questions. Respondent's mean for the belief scores in

question number 37 was 4.10, which reflects the belief that the overall quality of the planet's environment has somewhat declined in the past 10 years. The mean for question 38 was 3.93, which reflects that most students' opinions are placed between beliefs that such quality will either stay the same or somewhat decline in next 10 years.

Question number 39 received a mean of 3.71, which shows that students are more inclined to be middling beliefs that the quality of the environment they live in has stayed the same or it has somewhat declined in the last 10 years. The mean for question number 40 was 3.67, which reflects the same idea where students' beliefs are between the ideas that the quality of the environment they live in will either stay the same or somewhat decline in the next 10 years.

All of the 4 questions observed in Tables 15 and 16 were proven to be positively and highly correlated. In general, many students were shown to be somewhat pessimistic about the past and future of the quality of the global environment as well as the local environment in which they live. However, they showed a tendency to be a little more pessimistic in relation to the overall quality of the planet's environment than they were about the quality of their local environment.

Table 17 displays the number of respondents, means and standard deviations of respondents' attitude scores, and correlations among the attitude questions. Attitude questions are named here according to the environmental issue they represent in the survey to facilitate understanding (for the list of all 20 original attitude questions, refer to appendix B). Attitude scores for these questions can go from 1 to 7, which represent a scale from "strongly disagree" to "strongly agree".

Students who obtained scores ≤ 3 were classified as having more of a *negative* attitude towards the explored issues, students with scores >3 but <5 were placed in an *intermediate* position in relation to such issues, and students who scored ≥ 5 were considered to have more of a *positive* attitude (the scores were transformed so that attitudes were measured in the same direction). We define *negative* attitudes here as expressing disagreement with statements that represent a pro-environmental tendency, while *positive* attitudes express a tendency to agree with such statements. The *intermediate* classification expresses a tendency to go either way, having degrees of agreement or disagreement, or not having an opinion.

As Table 17 illustrates, the correlation matrix showed that mostly all questions are correlated, with “*p*” values either smaller than .0001 or .05. For most of the questions, students demonstrated more of an overall positive than negative view of the environmental issues expressed in the questions. As in question 21, where we stated that “all life on earth has the right to exist for no required reasons, regardless of their value to humans”, the mean for the students’ attitude score was 5.14, which places them between “somewhat agree” and “agree” options in the scale showing that students had more of a positive view on this issue. The same situation applies to question 27, where we asked respondents’ opinions about whether environmental education should be part of every school grade’s curriculum (K-12). The mean for this question was 5.88, placing the students between “somewhat agree” and “agree” options in the scale, which again shows a positive view of this issue.

Table 17. Attitude questions, number of respondents, means and standard deviations of attitude scores, and Pearson coefficients of correlation (r) among the questions.

Attitude Questions	N	Mean	SD	Correlations (r)															
				A21	A22	A23	A24	A25	A26	A27	A28	A29	A30	A31	A32	A33	A34	A35	A36
A21. Intrinsic value	2752	5.14	1.77	-															
A22. Protect by incentive	2753	3.21	1.75	-.04	-														
A23. Activists exaggerate	2766	4.04	1.71	-.16**	.22**	-													
A24. Distant habitats	2758	6.05	1.13	.29**	-.16**	-.22**	-												
A25. Change lifestyle	2759	3.58	1.57	-.08**	.31**	.23**	-.19**	-											
A26. Willing to pay less	2758	4.94	1.58	.18**	-.23**	-.25**	.37**	-.26**	-										
A27. EE from K-12	2758	5.88	1.25	.27**	-.19**	-.31**	.44**	-.25**	.40**	-									
A28. Vote	2770	4.31	1.56	.18**	-.16**	-.36**	.33**	-.27**	.42**	.48**	-								
A29. Technology	2767	2.02	1.27	-.21**	.26**	.33**	-.37**	.28**	-.29**	-.38**	-.28**	-							
A30. Private land use	2762	2.88	1.42	-.15**	.20**	.32**	-.31**	.29**	-.30**	-.36**	-.35**	.42**	-						
A31. Preserve for family	2764	4.66	1.43	.03	.13**	.05*	.04	.05*	-.02	.05*	.00	-.01	.02	-					
A32. Exaggerate run-off	2759	2.96	1.33	-.10**	.25**	.39**	-.27**	.29**	-.31**	-.29**	-.28**	.33**	.35**	.08**	-				
A33. Climate change	2768	2.70	1.71	-.21**	.21**	.51**	-.31**	.26**	-.32**	-.40**	-.37**	.39**	.38**	.03	.41**	-			
A34. Land owners right	2768	4.79	1.45	.23**	-.23**	-.40**	.32**	-.23**	.35**	.37**	.40**	-.30**	-.38**	-.01	-.30**	-.38**	-		
A35. Willing to pay more	2770	4.22	1.67	.16**	-.26**	-.29**	.33**	-.31**	.76**	.36**	.45**	-.28**	-.30**	-.02	-.31**	-.34**	.40**	-	
A36. Conservation	2767	4.41	1.35	.04	.14**	-.01	.04*	.11**	-.03	.04	.01	.02	.02	.09**	.07*	-.01	.02	-.04*	-

*p<.05 **p<.0001 ¹Highest possible mean equals 7.

It is interesting to compare questions 26 and 35, where we asked students about their willingness to pay to promote the sustainable use of our natural resources. In question 26, we asked if they were willing to pay up to \$50 more per year, and in question 35, we asked if they were willing to pay up to \$100 more per year. The mean for the first was 4.94 and 4.22 for the second. These means place the respondents in between the “don’t have an opinion” and “somewhat disagree” options in the scale, representing an intermediate position regarding this issue. However, the mean for question 26 was higher than the mean for question 35. In the first question, their mean approximates more to the “somewhat agree” option, while in the second question the mean approximates more to the “don’t have an opinion” option in the scale, which suggests that students are more likely to pay \$50 than they are to pay \$100 more per year to encourage sustainable use of natural resources. This basically says that the threshold is somewhere between \$50 and \$100.

Even though most of the students were classified as having an overall positive attitude, we did not observe an extreme “strong” level of positive views among the questions, except for question number 24. That question asked about whether we should care about the health of the coral reefs or the deforestation of the rainforests, even though they are not within our geographical region. The associated mean for this question (6.05) takes the respondents out of the “somewhat agree” and places them between “agree” and “strongly agree” options in the scale, which gives them a more strong positive view about this issue.

Questions 23 and 31 showed a little bit of a different scenario though. In question 23, we asked students opinions about whether environmental activists over-exaggerate in justifying their causes and actions, and the mean attitude score for this question was 4.04 placing the students in the intermediate classification, and the mean approximates the “don’t

have an opinion” option in the scale. We asked the students if they “would preserve natural resources on their land just to fulfill the needs of future generations of their family” (question 31), and they scored a mean of 4.66 which still places them in the intermediate classification, slightly towards the “somewhat agree” option in the scale. These were the only two questions that, even having mean scores that placed respondents in the intermediate position, still showed signs of a possible slightly negative view of the issues discussed. Overall, none of the individual means for each questions expressed a “strong” negative view about the environmental issues explored in the survey.

From the total of 2793 respondents, 1367 students (48.9%) were classified as having an intermediate position in relation to environmental issues explored in the survey, while 1097 (39.3%) were classified as having overall positive attitudes. Only 50 students (1.8%) were classified as having a negative attitude towards the environmental issues explored in the survey.

Attitude vs. Demographics

All relationships between attitude scores vs. demographics, as well as attitude scores vs. knowledge scores discussed from now on are based on the mean number of attitude scores obtained from the first 16 attitude questions (questions 21 to 36), as shown in table 17 (the scores were transformed so that attitudes were measured in the same direction).

1. Age

The data suggests that there is a significant difference between students’ attitude scores and their age range ($F=21.79$, $P<.0001$). Based on the mean number of attitude scores

(Table 18), students who are generally over 26 years of age obtained higher means of attitude scores (attscore). All means in this group were higher than 5, which classify these students as having overall positive attitudes towards the environmental issues discussed in the survey. Students between the ages of 17 to 25 years obtained means that were bigger than 4 but smaller than 5, which places them in the intermediate classification.

Table 18. Attitude scores by students' age range.

Age range	N	Attscore ¹		df	F value	P>F
		Means	SD			
17-20 yrs	1002	4.67	0.76	4	21.79	<.0001
21-25 yrs	1093	4.81	0.81	2502		
26-30 yrs	214	5.10	0.81			
31-40 yrs	129	5.07	0.73			
Over 40yrs	69	5.12	0.84			
Missing ²	7	5.21	0.71			

¹Attscore ranges from 1 – 7, representing a scale from strongly disagree to strongly agree.

²Values reflect students who did not provide their age range.

The results of the Scheffe test showed that there was a significant difference between students who are 17-20 and students in all the other age ranges. The P values for each of these relationships were all significant (.001, <.0001, <.0001, .0003, respectively). From these results, we can generally interpret that, even though students who are from 17 to 20 or 21 to 25 years old are placed in the intermediate classification according to their attitudes, the group of students in the first age range obtained a significantly lower attitude score than the group in the second range, showing that they are more strongly positioned in the intermediate category, while the second range approximates more of a positive classification. Regarding all the other age ranges, students that are older than 26 years scored significantly higher than

students who are 17 to 20 years old, and they were all classified as having positive attitudes towards environmental issues.

In this particular situation, the results agree with the idea that environmental attitudes are correlated to environmental knowledge. We observed in previous results that older students obtained higher means for the number of knowledge questions answered right than younger students did, except in the case of the students included in the 26-30 years age range who had a higher mean than students in the 31-40 age range. The same was observed in terms of attitude scores, where older students obtained higher scores (more of a positive) than younger students, with the same exception given to the students included in the 26-30 years age range who had a higher mean of attitude scores (5.10) than students in the 31-40 age range (5.07).

2. Gender

Regarding the respondents' gender, the results showed that there was a significant difference between males and females students in relation to their mean of attitude scores. As shown in Table 19, females obtained a significantly higher attitude score than males ($T=65.22$, $P<.0001$). Female's attscore mean was 4.92, while males' was 4.67. According to these means, both males and females are placed in the intermediate attitude classification.

These results demonstrated that students' environmental attitudes and knowledge are not necessarily correlated in all cases. We observed in earlier results that males scored significantly higher than females in the knowledge section of the survey, but they have lower attitude scores than females.

Table 19. Attitude scores by students' gender.

Gender	N	Attscore¹		df	T value	P>T
		Means	SD			
Male	1238	4.67	0.83	1	65.22	<.0001
Female	1239	4.92	0.75	2475		
Missing ²	37	5.17	0.76			

¹Attscore ranges from 1 – 7, representing a scale from strongly disagree to strongly agree.

²Values reflect students who did not provide their gender.

3. Student status

As shown in Table 20, the data suggests that there is a significant difference between students' environmental attitudes and their academic status ($F=17.77$, $P<.0001$). Graduate students obtained the highest attscore mean (5.01), and the lowest mean of attitude scores belonged to the freshman students (4.59). As with age, attscore means increase as the student status levels increase. According to these results, graduate students were the only ones that were classified as having more positive environmental attitudes; all the other students are situated at the intermediate attitude level.

Table 20. Attitude scores by students' academic status.

Student status	N	Attscore¹		df	F value	P>F
		Means	SD			
Freshman	387	4.59	0.70	4	17.77	<.0001
Sophomore	393	4.66	0.76	2271		
Junior	454	4.73	0.80			
Senior	613	4.78	0.83			
Graduate	429	5.01	0.78			
Missing ²	238	5.19	0.74			

¹Attscore ranges from 1 – 7, representing a scale from strongly disagree to strongly agree.

²Values reflect students who did not provide their academic status.

The Scheffe method applied showed that there was a significant difference between graduate students and all the other academic status. Graduate students scored significantly higher than all the other students. All four P values expressing the relationship between graduate students and the other four academic status were significant ($<.0001$, $<.0001$, $<.0001$, $.0002$, respectively). The test also showed a significant difference between freshmen and seniors ($P = .006$), where the second scored significantly higher than the first, which shows that senior students are closer to achieving a positive attitude classification than freshmen are.

These particular results seem to dispute the notion that environmental attitudes are correlated to environmental knowledge, since we observed in previous results that seniors scored significantly higher than graduate students in the knowledge section of the survey, therefore they should have presented a higher attscore mean, which was not the case. As for the other levels of student status, the assumption of a trend between knowledge and attitudes apply, since we observe that knowledge scores increased as student status increased up to the junior classification, and the same occurred with the attitude scores.

4. College of enrollment

Results showed a significant difference between students' environmental attitudes and their respective college of enrollment ($F = 9.77$, $P < .0001$). As observed in Table 21, students enrolled in the College of Veterinary Medicine obtained the highest mean of attitude scores (5.01), and were the only ones to be classified as having positive environmental attitudes. All the other colleges were included in the intermediate attitude classification with

attscore means >4 and <5 . From those, the College of Design obtained the highest mean (4.99). The College of Business had the lowest mean (4.56)

The Scheffe test for comparison of means suggested that students in the College of Agriculture scored significantly higher than students in the Colleges of Business ($P=.017$) and College of Engineering ($P=.046$). The same observation applies to students enrolled in the College of Veterinary Medicine, which scored significantly higher than students in Business ($P=.0004$) and Engineering ($P=.0006$). The test also showed that there was a significant difference between the means of students in the College of Business and students in the Colleges of Design ($P=.0003$), where the latter obtained a higher attscore mean.

Table 21. Attitude scores by students' college of enrollment.

College	N	Attscore ¹		df	F value	P>F
		Means	SD			
Agriculture	384	4.80	0.85	6	9.77	<.0001
Business	261	4.56	0.76	2237		
Design	121	4.99	0.74			
Engineering	487	4.61	0.78			
Human Sciences	365	4.76	0.71			
Liberal Arts and Sciences	572	4.85	0.79			
Veterinary Medicine	54	5.01	0.84			
Missing ²	270	5.21	0.75			

¹Attscore ranges from 1 – 7, representing a scale from strongly disagree to strongly agree.

²Values reflect students who did not provide their college of enrollment.

Students in the College of Veterinary Medicine obtained the highest knowledge scores, and students in the College of Business obtained the lowest. In this case, the results shown in Table 21 agree with the idea of correlation between environmental knowledge and attitudes, since students in Veterinary obtained the highest mean of attitude scores, while

students in Business obtained the lowest. Attitudinal scores of other colleges did not range in the same order presented according to their knowledge scores.

5. Years spent in the Midwest U.S.

Table 22 displays the relationship between students' environmental attitudes and the number of years they have been living in the Midwest U.S. Results showed a significant difference in students' attitude scores according to their time spent in the Midwest ($F= 4.38$, $P<.0002$). Students who reported they have been living in the Midwest for more than 40 years obtained the highest mean for attitude scores (5.34), and were the only ones to be classified as having positive environmental attitudes. All the other students were included in the intermediate attitude classification with attscore means >4 and <5 . From those, students who reported 31 to 40 years in the Midwest obtained the highest attscore mean (4.94), and the lowest mean was obtained by students who reported to have been living in the Midwest their entire life (4.55)

Table 22. Attitude scores by students' years spent in the Midwest U.S.

Years in the Midwest	N	Attscore¹		df	F value	P>F
		Means	SD			
Less than 5 yrs	194	4.82	0.67	6	4.38	0.0002
About 5-10 yrs	68	4.62	0.75	1400		
About 11-20 yrs	213	4.66	0.73			
About 21-30 yrs	128	4.57	0.88			
About 31-40 yrs	11	4.94	0.78			
More than 40 yrs	2	5.34	0.49			
All my life	791	4.55	0.74			
Missing ²	1107	5.04	0.79			

¹Attscore ranges from 1 – 7, representing a scale from strongly disagree to strongly agree.

²Values reflect students who did not provide their time spent in the Midwest U.S.

The only significant difference demonstrated by the Scheffe test was between students who reported less than 5 years in the Midwest and students who have been living in Midwest their entire life ($P < .002$), where the latter scored significantly lower than the first.

In relation to the idea of correlation between environmental knowledge and attitudes, students who reported to have been living in the Midwest for more than 40 years obtained the highest knowledge score and also the highest attitude score, showing a trend between these factors. Similarly, students who reported to have been living in the Midwest from 31 to 40 years obtained the lowest knowledge scores as well as the lowest attitude score, also showing a trend between knowledge and attitudes. For the remaining groups of students, this situation doesn't apply.

6. Childhood environment

As shown in table 23, results suggest a significant difference between students' attitude scores and the type of environment they spent the majority of their childhood ($F = 7.8$, $P < .0001$). A total of 204 students did not provide information about their childhood environment. Their attscore mean was 5.20. Considering the respondents who provided this information, all of them were placed in the intermediate attitude category (attscore > 3 but < 5).

Students who grew up in a small city obtained the highest attscore mean (4.87), while students who grew up in a large city obtained the lowest (4.46). Results obtained through the Scheffe test suggest a significant difference in the means of students who grew up in a rural farm environment and all the other 5 groups (Table 24) up to large city (P values were .02, .001, .006, .009, and $< .0001$, respectively). Students from a rural environment scored

significantly lower than all the groups, except when compared to large city, where it scored higher.

Table 23. Attitude scores by students' childhood environment.

Childhood environment	N	AttScore ¹		df	F value	P>F
		Means	SD			
Rural Farm	472	4.56	0.78	6	7.8	<.0001
Rural non-farm	278	4.79	0.79	2303		
Suburban	249	4.85	0.85			
Small town (<=2,500 people)	256	4.79	0.78			
Small city (2,500 to 50,000 people)	447	4.87	0.77			
Large city	11	4.46	0.82			
Other	472	4.56	0.78			
Missing ²	204	5.20	0.73			

¹AttScore ranges from 1 – 7, representing a scale from strongly disagree to strongly agree.

²Values reflect students who did not provide their childhood environment.

Attitude vs. Knowledge

In relation to the students' self-evaluation of environmental knowledge discussed in Table 2, the results suggest no significant differences between the way the students evaluated themselves in terms of environmental knowledge and their attitudes towards environmental issues explored in the survey.

As observed in Table 24, students who said they knew “a lot” were the ones who obtained the highest mean of attitude scores (5.33), placing these students as having an overall positive attitude towards environmental issues. Students who said they knew “a reasonable amount” of environmental issues followed with a mean of 4.94 in attitude scores. Conversely, students who said they knew “nothing” about such issues were indeed the ones

who obtained the lowest mean (4.13), followed by the ones who said they knew “almost nothing” (4.40).

Table 24. Attitude scores by students’ self-evaluation of knowledge.

Self-evaluation	N	Attscore ¹		df	F value	P>F
		Means	SD			
Know “A lot”	194	5.33	0.89	5	56.68	<.0001
Know “A reasonable amount”	1098	4.94	0.77	2298		
Know “A little”	810	4.56	0.71			
Know “Almost nothing”	155	4.40	0.62			
Know “Nothing”	23	4.13	1.10			
“Don’t know”	24	4.42	0.59			
Missing ²	210	4.90	0.81			

¹Attscore ranges from 1 – 7, representing a scale from strongly disagree to strongly agree.

²Values reflect students who did not provide their self-evaluation of knowledge.

The Scheffe test results showed that students who said they knew “a lot” about environmental issues obtained a significantly higher mean of attitude scores than students on all the other categories (P values for these relationships were all <.0001). Students who said they knew “a reasonable amount” obtained significantly different means than all the other students as well. In this case, these students had a significantly lower mean than the students who said they knew “a lot” (P<.0001) and a significantly higher mean than the students on all the other categories (P values for these relationships were all significant).

In this particular case, the idea that knowledge is positively correlated to attitudes applies. We observed in previous results that students who reported to know “a lot” about environmental issues obtained the highest mean of knowledge scores, followed by students who said they know “a reasonable amount”. Students in these two categories also obtained

the highest mean of attitudes scores in the same order. Students who reported to know “nothing” had the lowest means for knowledge and attitude scores as well.

Thinking in more general terms, the results showed in table 25 suggest that there is a significant difference between students’ knowledge scores and their overall classification according to their attitude scores ($F = 74.29$, $P < .0001$). Students classified as having positive attitudes towards environmental issues obtained the highest mean of knowledge questions answered correctly (11.5) and were classified as having a “moderately high” knowledge level of the environmental issues explored in the survey, while students placed in the intermediate category for attitudes obtained a smaller mean (10.19), which is barely placing these students out of the “moderate” level of knowledge to place them as having a “moderately high” level of environmental knowledge.

Lastly, students classified as having more negative attitudes obtained the smallest mean of knowledge questions answered correctly (9.84), which classifies them as having a “moderate” environmental knowledge.

Table 25. Students’ knowledge scores by attitude classification.

Attitude score	N	Means	SD	df	F value	P>F
Positive	1097	11.5	2.45	2	74.29	<.0001
Intermediate	1367	10.19	2.88			
Negative	50	9.84	3.21	2511		
Missing ²	279	9.48	3.75			

¹Number of correct answers

²Values reflect students who did not answered the attitude questions.

Discussion

As illustrated in Table 4, ISU students obtained a 10.63 mean number of correct answers from a total of 16 knowledge questions, which seems to demonstrate that they have a “moderate” knowledge level of the environmental issues emphasized in the survey. Most of the environmental literacy surveys applied in different fractions of the U.S. population, regarding either more general or specific environmental issues, seems to come to the conclusion that their respondents fail to correctly answer simple environmental knowledge questions. As an example, The Roper *National Report Card on Environmental Attitudes, Knowledge, and Behavior* (NEETF 1997, 1998, 1999, 2001) demonstrates that two out of three adult Americans still fail to correctly answer simple environmental questions (66.7% out of 1,500 respondents).

While we cannot compare our results with the results of the national Roper survey, since the survey instrument applied in our study was different in nature and application, and our scoring structure was also different, we can still discuss possible reasons why our respondents were successful taking a similar survey. Some 52% of our respondents got higher scores than the passing grade in the Roper survey. If we were to assign a letter grade to our survey, analogous to the Roper, a proportion of respondents classified as having a “moderate” level of knowledge would have had a passing grade in addition to the 52% who scored between “moderately high” and “high” on environmental knowledge, which is a greater proportion than the 32% who received a passing grade in the Roper survey. We think that our respondents, as being college students imbedded in the daily life of academia, are probably more exposed to the debate and discussion of current environmental issues than the general population, and therefore more likely to score higher.

Kaplowitz & Levine (2005) discussed this issue in their research, which was developed to measure environmental knowledge of Michigan State University (MSU) students and compare it to the knowledge scores of the general population obtained through the Roper National Report Card. They affirmed that the MSU students showed a higher level of environmental knowledge when compared to the general public. In that case, they were able to make direct comparisons between the two studies since they use the same survey instrument and scoring scheme as in the Roper survey. Their results confirmed that academic audiences are more likely to score higher because of their direct and current contact with educational tools that can provide them with such environmental information.

When it comes to self-evaluation of environmental knowledge, Coyle (2004) affirms that *“most Americans believe they know more about the environment than they actually do”*. According to Coyle, while 70% (from the total of 1500) of Americans believe and say they know enough about environmental issues, only a third of these respondents received a passing grade, and among this third, only one in ten adults received an excellent score A. We observed a different situation in our study. As observed in Table 2, only 207 respondents (7.4% of 2793) believed they knew a lot about environmental issues, and their belief was actually accurate since they were the ones that obtained the highest scores that would be comparable to a grade A. Results from Kaplowitz & Levine (2005) are similar when they showed that most of the MSU students (41.5%) indicated that they had “only a little knowledge” followed by students who answered they knew “a fair amount” (39.7%). Their results are similar to ours, since 43.3% of our respondents reported they knew “a reasonable amount” of environmental issues, which is compared to their “fair amount” category. Also, in our ISU study, 32.3% of the students said they knew “a little” which is also comparable to

MSU 41.5% respondents who reported they only had a little knowledge. In short, in both surveys, students showed to be fairly realistic about their level of environmental knowledge, supporting the idea that students may have a better ability to judge such knowledge than the general public.

Considering the actual knowledge scores of students in our ISU survey, 52.95% of them were classified as having between a “moderately high” and “high” knowledge level, 33.12% showed a “moderate” level, and 3.94% were classified as having a “low” level of environmental knowledge. While we created these categories, they are not meant to attribute the students any passing or failing grade, but rather to facilitate analysis. The point of our study was not to observe if students would pass or fail but rather to have general ideas about their environmental knowledge for the specific issues explored in the survey and observe how the survey instrument, which is largely new, functioned as questions were answered.

In speculating which sources of information are utilized by the students to acquire such environmental knowledge, the results in Table 3, show that low percentages of the respondents reported they use books and the library as source of environmental information. One would think that college students would utilize these sources more often for the purpose of seeking environmental knowledge since they are in close and constant contact with them; instead the major sources reported by them were TV, internet, and newspaper, which are probably the easiest and fastest ways to learn about environmental issues in the daily routine of college students, especially if they are not in any major somehow related to natural resources and the environment.

Mancl *et al* (2003) developed a profile of Ohio adults with low environmental literacy, which were defined as being less educated, below the median household income,

older, female, and minority. Their results showed that these low literacy adults are most likely to gain environmental information from television. In our ISU survey, we observed that TV was the most used source of environmental information as well, which can indicate that more educated people are as likely to use TV as the less educated do. This can indicate that levels of education may not be such an influential factor and TV is a very influential media on people's life in general. However, students also use internet and newspaper a lot, which maybe a plus. Therefore, we can draw the idea that, to take environmental education to different audiences, we must understand who they are and how they best receive information.

ISU students were placed just over the "moderate" level of environmental knowledge category. At least 50% of the respondents were able to answer each of the questions correctly, except for question number 16 (Table 4), where the majority of the students fail to recognize that wetlands in the Midwest U.S. don't really recharge underground aquifers, even though this is one of the important functions of wetlands elsewhere. This probably confused the students in terms of its "local" application. We believe this question may be too specific and will change it in future editions of this survey.

Talking about "local" versus "global" issues, as Table 4 also shows, most respondents were highly successful in answering question number 10 about global energy use correctly, but not so much in answering question number 19 about local energy use. Conversely, they were more successful in answering question number 15 regarding local pollution than they were in answering question 6 about global pollution. It is possible that the respondents were more exposed to the information about local pollution than they were about local energy use, maybe because the first issue is more visible than the second and more likely to be explored through various media sources.

Morrone et al. (2001) also investigated this issue, and after testing Ohioans' environmental knowledge, observed that the respondents appeared to be more knowledgeable about global environmental issues than they were about issues of local relevance. These contradictions among surveys results show the gap between local versus global environmental knowledge, and raises the issue about whether environmental education should start at local levels and gradually progress to explore global environmental issues. It supports the idea that such surveys must account for different knowledge bases and issues in different parts of the country.

Overall, our results showed that demographic characteristics including age, gender, student' status, college of enrollment, years spent in the Midwest U.S., childhood environment, and outdoor activities practiced during childhood are significantly related to the students' environmental knowledge and attitudes. Kaplowitz & Levine (2005), in their Michigan State students' survey, also suggested a positive correlation between students' environmental knowledge and their academic level and field of study. In their study, the five highest scoring colleges were (respectively) Osteopathic Medicine, Human Medicine, Agriculture and Natural Resources, and Veterinary Medicine, while the Colleges of Business and Education scored the lowest. Their results are similar to ours, where the Colleges of Veterinary Medicine and Agriculture also scored the highest, while the colleges of Human Sciences (which includes Education) and Business scored the lowest (Table 11).

Research done by Benton (1994) examined environmental knowledge and attitudes among faculty members in the college of Arts and Sciences and the schools of Business, Social Work, and Education at a private midwestern university. According to their results, business faculty were less knowledgeable and demonstrated less ecologically oriented

attitudes than the non-business faculty. The author also mentioned that business schools have done little to implement environmental issues on their campuses. As estimated in 1992 by the American Assembly of Collegiate Schools of Business, only 25 out of 700 of these schools are currently addressing such issues. Based on assumptions like this, is not surprising that students enrolled in business studies generally show a low level of environmental knowledge. These results raise the point that perhaps, to make positive environmental impacts on students, universities should also assess faculty knowledge and attitudes towards environmental issues. Environmental initiatives should not only be implemented in terms of university general curricula but also in terms of faculty environmental development and training, specially the ones who are involved in non-environmental sciences.

In terms of university students' status, Kaplowitz & Levine (2005) confirmed that Michigan State students with the highest scores were upper-level graduate students, and that the lowest scores were obtained by undergraduate freshmen and sophomores. In our ISU study, as shown in Table 10, the highest scores were obtained by senior undergraduate students, followed by graduate students. Maybe this difference is due to the fact that the Colleges of Medicine at Michigan State University are heavily dominated by students seeking both a professional or doctoral degree, and they were the ones to score the highest. However, the authors observed that seniors scored higher than masters students (lower-level graduate students), which agrees with our results. Similarly, undergraduate freshman and sophomore students at ISU scored the lowest, as well. Arcury & Christianson (1993), Hsu & Roth (1996), and Tikka *et al.* (2000) also tended to support this notion that environmental knowledge levels increase as educational attainment increases.

Regarding attitudinal results, Hodgkinson & Innes (2001) developed a survey to examine the differences between environmental attitudes and ecological beliefs among 1st-year students at an Australian University. They predicted that students studying disciplines traditionally associated with economic rationalism, such as commerce and business studies, and disciplines associated with social and political conservatism, such as law, are less pro-environmental than students in disciplines that are considered more liberal. In our ISU study, we also observed that students in the college of business not only scored the lowest in environmental knowledge but also obtained the lowest attitude scores, indicating they demonstrate less positive environmental attitudes than students in the other colleges. Our results agree with the cited authors, when they affirm that although most university students hold positive environmental attitudes, different disciplines attract students from a particular attitudinal orientation.

Robinson & Crowther (2001) developed an environmental knowledge survey to compare responses of three groups of students in science education, biology and chemistry majors from a mid-sized western university. They compared the environmental knowledge of these three groups of students by gender and education. They observed no statistically valid difference between males and females, but they did show significant difference between students under the age of 25 and students who were age 25 or older. The mean number of environmental knowledge questions answered correctly was higher for students who were 25 or older. Our results similarly showed that students who were 21 or older scored higher than students under the age of 21. While the above cited research does not show significant differences between males and females, our study observed the opposite. As shown in Table 9, males scored significantly higher than females.

Other studies observed similar results regarding such demographic information. Arcury & Christianson (1993) developed a telephone literacy survey for Kentucky residents, and showed that there were significant differences regarding the respondent's environmental knowledge in terms of their level of education, age, and gender as well. These findings are supported by Zimmerman (1996), who summarized environmental education research during 15 years, from 1979 to 1993, and observed demographic differences influencing environmental knowledge as it relates to ethnicity and gender. According to the author, females and blacks were shown to be less knowledgeable about ecological concepts than males and whites, which agreed with our results where females showed less knowledge than males as well. We did not explore differences based on race or ethnicity in our research.

Mancl *et al* (2003), in their survey of Ohio adults, also confirm differences between environmental knowledge regarding respondents' gender and ethnicity, and they confirmed that females and minority respondents had a low level of environmental knowledge. Tikka *et al.* (2000) surveyed students in a variety of educational establishments in Finland, and observed that female students tended to show more responsibility toward the environment than males did, but males showed a higher level of environmental knowledge. The results of our ISU survey agree with these results.

WE found it notable that ISU students' environmental knowledge tended to increase as the number of years they have spent in the Midwest increased. We can infer that students with less time in the Midwest could not have answered the local knowledge questions as well as students who have lived in the area for a longer time. Furthermore, we can also consider the fact that ISU comprises a very diverse community with students from many countries around the world, exhibiting different backgrounds, cultures and beliefs, and who were

exposed to different educational systems. All of these factors could very well have influenced the results in some degree. Taken together, however, it supports our assertion that the socio-cultural content of one's education must be taken into account in the development of questions for such surveys.

We also sought to investigate how childhood experiences could be related to the students today's levels of knowledge and attitudes toward environmental issues. To do so, we asked them about their childhood environment and what kind of outdoor activities they experienced while growing up. The results suggest that, in general, their levels of environmental knowledge decrease as they move further away from the natural daily experiences in rural areas and into the more urban centers. Possible reasons for this tendency include the fact the people who grow up in relatively less urban such as rural farm, rural non-farm, and suburban, are most likely to be exposed to the natural outdoors on a daily basis than people who grow up in small towns or cities and larger cities.

Supporting this idea, our results also showed that students who grew up on rural-farm and rural non-farm environments were the ones reporting to have experienced a larger number of outdoor activities as children, which suggests that these students most likely had more exposure to the outdoors and nature concepts. Consequently, these individuals have better chance to understand and appreciate nature at the personal level, develop attitudes and grow up with nature helping to form important values and beliefs. As Tikka et al. (2000) remarks, there is no doubt that childhood experiences and milieu affect people's subsequent choices of education.

Similar ideas are discussed by Arcury & Christianson (1993). They developed a telephone survey for Kentucky residents mainly to evaluate whether environmental

knowledge and attitude can be affected by rural-urban differences. The study revealed that “urban-metro respondents were more knowledgeable about global issues than urban-nonmetro and rural-nonmetro respondents”. In this case, the authors are not referring to childhood experiences and are very specific as emphasizing “global” environmental issues. We cannot infer about what may have or have not influenced these results in terms of childhood experiences, but we can reflect on the idea that perhaps urban-metro respondents were more knowledgeable for other reasons such as availability of wider media sources to obtain such knowledge or simply a more frequent exposure to global issues.

Another study developed by Suvedi *et al.* (2000) tested Michigan residents’ knowledge and perceptions of risk about groundwater issues, specifically residents in urban, rural, and farm households. They found significant differences among the three groups, where rural respondents perceived a slightly higher amount of risk associated with land use and groundwater in their county than those who lived on farms. They also found that farmers and non-farmers differed significantly in their views of the effects of land use practices on groundwater, and conclude with the argument that people perceived a lower level of risk from land use practices to groundwater in their homes and properties, and that this perception should change. People should understand that if there is a problem at the national, state, and county levels, the same problem can surely be in their properties as well.

In relation to “global” environmental issues, the majority of the respondents to our survey tended to agree that the overall quality of the environment has either somewhat declined or declined a lot in the past ten years, and will somewhat decline or decline a lot more in the next ten years as well. However, when asked about “local” environmental issues, the majority of the respondents believe that the quality of the environment they live in has

somewhat declined or stayed the same in the past years, and will somewhat decline or stay the same in the future. Considering these results, we can reflect on the idea that the difference between their global and local points of view may be due to what has been called “proximity effect” when people tend to believe that things that are close to them are in better shape than things in more distant situations.

The results above also show a pessimistic tendency, which is a little surprising considering that the respondents of our survey were all students, and as such we would expect them to have a more optimistic view about the world. They are the ones that inherit the present environment and we often look to the “idealism of youth” to find new societal solutions to problems. It may reflect a greater degree of “realism” or it may simply reflect fatigue from over-exposure to problems. If they maintain such pessimism, they may be less likely to do anything to improve the situation. From these results we emphasize the need for environmental literacy initiatives at the university level, which could generate a better appreciation, involvement, and the optimistic ideas necessary to contribute to the quality of our environment.

Morrone *et al* (2001), call attention to the idea that, whether theoretical or applied, research in environmental literacy often makes connections between knowledge and behavior, and that theorists hypothesize that this relationship can result in both positive and negative impacts on the environment. Furthermore, the authors discuss the idea that knowledge sometimes does not lead to responsible behavior, maybe because behavior begins at home, but locally relevant environmental issues do not receive the attention the global issues do.

In our ISU study, we observed that, in general, students' environmental attitudes were positively correlated with their knowledge, although this was not true in some very specific cases such as in the relationship between gender, knowledge and attitudes, where males demonstrated a higher knowledge levels than the females, but females reported more positive attitudes. The truth is that the magnitude and direction of this connection between knowledge and attitude/behavior has still a lot of room for discussion and investigation.

Conclusions

The findings of this research indicate that Iowa State students are classified as having a “moderate” level of environmental knowledge regarding the issues explored in our survey. Although their mean number of questions answered correctly placed them just above a “moderate” knowledge level, they did demonstrate reasonable levels of knowledge, and were predictably different based on their areas of study. Students' demographic characteristics including age, gender, student' status, college of enrollment, years spent in the Midwest U.S., childhood environment, and outdoor activities practiced during childhood were shown to be significantly correlated to the their environmental knowledge and attitudes, and their knowledge levels in most cases were shown to be positively correlated to their attitudes as well.

It is fair to say that while general university education does seem to reflect improvement in some students' environmental knowledge, the overall level of knowledge is not uniformly widespread throughout Iowa State University. Considering that the majority of our survey respondents were born between the years of 1982 and 1990 (after the rise of the environmental education movement in the 1970s), our results do not present any evidence

about the effectiveness of environmental education practices in the last two decades. It is fair to say that educators are possibly in need of increasing environmental education initiatives at the high school level, and possibly K-12 as well.

This brings us to highlight an interesting result of our survey. Students in the College of Human Sciences, which is heavily composed by students in Education, demonstrated a fairly low level of environmental knowledge. These results suggest the need for initiatives to increase the environmental knowledge of not only current school teachers but tomorrow's teachers as well.

The days when environmental impacts could be ignored or dismissed are long past. Institutions of higher education have much room to improve their efforts in promoting environmental education and disseminating it to all students regardless of their majors of study.

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CHAPTER 3. GENERAL CONCLUSIONS

Iowa State students were classified as having a “moderate” level of environmental knowledge regarding the issues explored in this survey. However the overall mean number of questions answered correctly did indicate a tendency for them to move in direction of a “moderately high” knowledge level. Students’ demographic characteristics including age, gender, student’ status, college of enrollment, years spent in the Midwest U.S., childhood environment, and outdoor activities practiced during childhood were significantly correlated with their environmental knowledge and attitudes. Also, their knowledge levels in most cases were shown to be positively correlated with their attitudes. While general university education does seem to reflect improvement in some students’ environmental knowledge, the overall level of such knowledge is not uniform throughout Iowa State University.

While these are important and valid results, such results do not represent environmental literacy (EL) as a whole. As discussed in the previous chapters, the question of what environmental literacy really is and what it should encompass is still far from being answered. EL surveys are still very limited, only giving us ideas and perspectives about certain literacy components such as knowledge and attitudes. In fact, one may infer that measuring environmental literacy as a whole is not even possible, considering the complexity of issues involved in its components and issues which are not totally agreed upon within the scientific community.

Most of the existing environmental literacy research is based, in a general sense, on the AKASA components (awareness, knowledge, attitudes, skills, and action) generated in the Tbilisi Declaration. EL can then be understood as the culmination of these components,

which are part of a hierarchical process, which determines how human actions and choices affect the health of the environment, and, if this process succeeds, how we act sustainably to maintain such health for future generations.

There is no doubt that the AKASA components are a place to start, but further considerations are necessary, such as what these components should consist of and be aimed for. The field of environmental education (EE) is still relatively new, approximately 35 years in its modern form. EE practitioners are too busy doing EE, leaving little time for consuming debate about whether changes are necessary to aspects of the model. The roots of EE have become strongly planted, documented, and largely accepted over the years, but a missing dynamic aspect seems to be emerging. Scientists and educators, caught in the struggle to choose between acting and advocating, forget to debate EE's modern limits for fear of undermining their own profession.

For the purpose of our ISU study and the creation of a new environmental literacy survey instrument for the midwestern U.S., in which we are trying to account for such gaps in the modern approaches to EE, we composed our own definition of what should be an environmentally literate person. We agreed that such a person is *“someone who knows enough to care, cares enough to learn more, and learns more to act”*.

General Discussion on EL at the university level

As Orr (1994) suggested, the blame for the environmental crises should not be primarily given to the *“ignorant and uneducated”*, but to degree-holding individuals who pursue the notion that humans should dominate nature. The author recognized the need for reconsideration of the *“substance, process, and purposes of education at all levels”*.

Wolf (2001) refers to the 1998 edition of the Peterson's Guide to Four-Year Colleges, and affirms that there are 983 programs among Institutions offering majors in environmental science or studies, as well as related subjects, but the degree to which universities and colleges educate students in other majors about environmental issues is unknown. According to Brough (1994), most college students will graduate with a shallow environmental knowledge if no continuous changes are made within the higher education process. Coppola (1999) points out the fact that students in non-environmental majors are lacking the opportunity to learn about the relationships between humans and nature, and therefore they don't develop environmentally responsible behaviors.

How can environmental literacy be incorporated in university and college's curricula? Coppola (1999) believes that the only way to achieve this goal is through the creation of a general education requirement. Collett & Karakashian (1996) and Wilke (1995) share the same opinion. According to Moody *et al* (2005), the University of Georgia (UGA) is one of the first universities in the U.S. that require that every undergraduate student complete an environmental literacy requirement (ELR), established in 1993. ELR was examined through various studies and surveys, which showed that students welcomed increased environmental knowledge and were enthusiastic about the requirement. The faculty members, although recognizing the value of the requirement, were not satisfied with the lack of coordination and leadership which resulted in misconceptions about the ELR in the institution. According to the author, to avoid these mixed feelings, it is important that environmental literacy be implemented as a link to conventional scholarship and not presented as an ideology or an alternative to different culture and patterns of society.

Wolf (2001), conducted a survey of Chief Academic Officers in Four-Year Institutions to know to what extent environmental education reaches non-environmental major students. The study affirmed that respondents from two institutions where general education requirements include an EL course indicated that this method has been successful in positively impacting students life styles, while two other respondents demonstrated a different opinion about such approach, where they believe that students are drawn to courses oriented towards environmental issues because of its interest and reputation, not because such courses are required.

The author also mentioned one respondent from university in the south central USA who raised the issue that resource availability heavily influences such curricular decisions, and that the implementation of a course to be required for all students would also require a larger number of faculty to teach such a course to all new students who start in college every year. Another possibility mentioned by Wolf is the creation of an “introductory” course or courses designed to provide a foundation for students in non-environmental majors. However, the author affirms that it may not be the ideal vehicle to improve EL of such students, depending on the way such course can be handled and controlled within the colleges.

But would one single course, whether generally required of all students or just introductory to non-environmental major students, be effective enough? Smith-Sebasto (1995) gives an affirmative answer to this question. The author conducted research to evaluate how environmentally responsible behavior is influenced by students taking an environmental studies course, and reported statistically significant differences in behaviors among students who completed such a course in comparison to students who didn't. Benton

(1993) investigated whether an environmental course would make a difference in the business schools, and affirmed that MBA students who completed a ten-week-long environment management course expressed a higher knowledge and concern about the environment than they did before completing the course.

Robinson and Crowther (2001), in their environmental knowledge survey of students in science education, biology and chemistry majors from a mid-sized western university, also affirmed that having one or more environmental science courses does improve students' environmental literacy. According to their results, students in all three areas of study who had taken at least one class in environmental science scored higher in their knowledge test than students who had not taken such a class. McMillan *et al* (2004) also developed a study to evaluate impacts of an introductory-level environmental studies class on the values of students at Dalhousie University in Canada, and observed that such values were deepened after taking the class, and students became more "ecocentric" and less "homocentric". Various studies in the literature showed results that are consistent in attributing positive value changes in students due to university-level environmental classes (Carpenter, 1981; Leeming *et al.*, 1993; Mangas *et al.*, 1997).

While the discussion about how to implement an EL course in university curricula is still debated, there are other ways to help achieve the goal of improving environmental knowledge of college students. Wolf (2001) mentioned ideas about sponsoring campus events to raise levels of environmental understanding, and integrating environmental issues into courses across the curriculum, promoting faculty development programs to incorporate such issues in their classes. Another way to attempt to improve environmental literacy at university levels mentioned by the author is to consider EL as an educational outcome, in

which case higher education institutions would focus on learning outcomes instead of increasing curricula requirements. The author reported that this trend is reflected in Iowa State University's responses to her survey, where in personal communication with ISU academic chief Shapiro in 1999, he said:

"Through our curriculum process, we are looking at re-defining our core set of expected outcomes for students. Among those being considered is environmental literacy...We have seven undergraduate colleges, and few general education requirements for all students at Iowa State. Our focus on core student outcomes is the way in which we achieve common curricular goals without requiring all curricula to accomplish those outcomes in the same way (namely, with the same course requirements). We believe that this approach is consistent with the current trends in higher education focusing on student learning outcomes rather than curricular inputs".

From the time that Shapiro, who was the vice-provost for undergraduate programs, made this comment to today's date, Iowa State University doesn't have an EL course requirement, but it is true that such courses are available. However, environmental information through ISU classes only reaches a relatively small portion of students.

Recommendations to improve EL at Iowa State University

We agree with Gray *et al* (2001) when they reaffirm the challenge of developing environmental knowledge and appreciation in the widest possible range among university students. However, there are many ways, as previously discussed, to incorporate EL practices not only at ISU but in any other college or university. The basic ideas and concepts about the natural environment and how human beings connect to such ideas and concepts are extremely broad and can be incorporated in almost any subject.

The best approaches will differ though according to the nature and culture of different institutions. Since ISU does have core requirements in their general education curricula, these

requirements could include an environmental course. Otherwise, if it is still the point of view of Iowa State to focus on learning outcomes rather the curriculum inputs, as affirmed by Shapiro, environmental literacy should be included among such expected outcomes.

Environmental literacy programs can reach out to a wide spectrum of the campus community in a variety of different ways such as creating courses designed particularly for non-environmental majors. Other approaches, adopted alone or in combination, include initiatives such as: newspaper articles featuring environmental information and issues; an environmental section inside the “Vision” or any other ISU magazine; a monthly environmental newsletter sent to ISU students’ emails to promote such literacy; environmental literacy focused radio programs such as a monthly section in the “The Talk of Iowa” (WOI); environmental events and activities conducted on campus involving clubs, organizations, etc.; special environmental lectures and seminars appropriate to reach general ISU audiences; promoting faculty development to incorporate environmental themes in their classes; developing online environmental elective courses and providing internships as credit hours for students to work with the community regarding local environmental issues.

Furthermore, students’ environmental knowledge improvement is not the only goal in need. In fact, to reach this goal, universities should set themselves as an example by adopting initiatives to turn into a more “green” environment in daily functions. Here are some examples of what can be done:

- Annual audits to check resources such as water and energy used campus-wide, as well as management of materials used and waste disposal;
- Being careful with purchases, making sure to account for environmental impacts and leverage support for local and regional economies;

- Invest in sustainable development;
- Maintain campus architecture following an ecological design, construction, maintenance and operation;
- Create a student environmental center.

These and many other approaches to turn university's campuses green is extensively discussed in the "Blueprint for a Green Campus: The Campus Earth Summit Initiatives for Higher Education", developed by the Heinz Family Foundation (HF Foundation, 1995) to help higher education institutions across the globe to work toward an environmentally sustainable future.

Keniry's (1995) "Ecodemia: Campus environmental stewardship at the turn of the 21st Century", is another resource, which was developed by the National Wildlife Federation to report how campuses around the country, staff, administrators, faculty, and students are redesigning the basic principles to transform the global environment, local communities, campus morale, and the institutions' fiscal bottom-line.

We hope that ISU leaders embrace these suggestions and be bold and visionary to step up in the process of implementing environmental literacy initiatives on campus to help create more knowledgeable citizens and future decision makers on behalf of our natural environment because, as Orr (1995) remarked about the challenges of higher education:

"If the environment and the human prospect that depends on it are to be rescued, those now being educated will have to do what the present generation has been unable or unwilling to do: stabilize world population, reduce emissions of greenhouse gases that threaten to change the climate, protect biological diversity, reverse the destruction of forests everywhere, and conserve soils. They must learn how to use energy and materials with great efficiency. They must learn how to run civilization on sunlight. They must rebuild economies in order to eliminate waste and pollution. They must learn how to manage renewable

resources for the long term. They must begin the great work of repairing, as much as possible, the damage done to the Earth in the past 150 years of industrialization. And they must do all of this while they reduce worsening social, ethnic, and racial inequities. No generation has ever faced a more daunting agenda”.

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APPENDIX A. TBILISI GUIDING PRINCIPLES OF ENVIRONMENTAL EDUCATION

Environmental Education should...

1. Consider the environment in its totality - natural and built, technological and social (economic, political, cultural, historical, moral, aesthetic);
2. Be a continuous lifelong process, beginning at the preschool level and continuing through all formal and non-formal stages;
3. Be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective;
4. Examine major environmental issues from local, national, regional, and international points of view so that students receive insights into environmental conditions in other geographical areas;
5. Focus on current and potential environmental situations, while taking into account the historical perspective;
6. Promote the value and necessity of local, national and international cooperation in the prevention and solution of environmental problems;
7. Explicitly consider environmental aspects in plans for development and growth;
8. Enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences;
9. Relate environmental sensitivity, knowledge, problem-solving skills, and values clarification to every age, but with special emphasis on environmental sensitivity to the learner's own community in early years;
10. Help learners discover the symptoms and real causes of environmental problems;
11. Emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem-solving skills;
12. Utilize diverse learning environments and a broad array of educational approaches to teaching / learning about and from the environment, with due stress on practical activities and first-hand experience.

APPENDIX B. FINAL SURVEY INSTRUMENT

This is a quick survey that could help us understand the levels of Environmental Literacy (EL) on University's campuses. We are measuring awareness and knowledge about and attitude towards Midwest environmental issues and problems. It won't take more than 20 minutes to take the survey. Please, take your time to answer each question as best as you can.

Part I: Information about the environment

(Question 1) Compared to other students in your college and/or department, how much do you feel you know about environmental issues and problems in general?

1. A lot
2. A reasonable amount
3. A little
4. Almost nothing
5. Nothing
6. Don't know

(Question 2) What are your primary sources for environmental information? Check as many as applicable:

1. TV
2. Radio
3. Internet
4. Magazines
5. Newspaper
6. Classes/courses
7. Books
8. Library
9. Friends/ relatives
10. Other
11. None

(Question 3) Quickly write down as many current GLOBAL environmental issues as you can think of. Use 1-3 words for each.

1. _____
2. _____
3. _____
4. _____
5. _____

(Question 4) Quickly write down as many environmental issues as you are aware of that are distinctly LOCAL or "MIDWESTERN" in nature. Use 1-3 words for each.

1. _____
2. _____
3. _____
4. _____
5. _____

Part II: Your reactions to expressions about the environment. Please choose one alternative for each question.

(Question 5) The expression “Different varieties of life (animals and plants) living in a variety of different environments” is a simple definition for the term...

1. Evolution
2. Ecosystem
3. Biodiversity
4. Biological community
5. Don't know

(Question 6) What do you think is the most important source of pollution that affects the quality of water in the earth's streams, rivers, and oceans?

1. Waste disposal from the cities
2. Trash washed into the water from polluted shorelines
3. Waste disposal from factories and industries
4. Runoff water from cities, yards, paved lots, and farm fields
5. Don't know

(Question 7) Human population of the Earth is now approximately...

1. 3.0 billion
2. 6.5 billion
3. 10 billion
4. 25 billion
5. Don't know

(Question 8) Global climate change is the warming of our planet Earth, a process also known as global warming. Which of the following better represents its cause(s)?

1. Ozone layer depletion
2. Fossil fuel consumption
3. Carbon dioxide (CO₂) emission
4. All of the above
5. Don't know

(Question 9) What is the most common cause for plant and animal species to become extinct?

1. Predation by other species
2. Habitat loss and fragmentation
3. Temperature change

4. Competition between species
5. Don't know

(Question 10) Where does most of the energy that people use worldwide come from?

1. Fossil fuels
2. Wind power
3. Hydro power
4. Nuclear power
5. Don't know

(Question 11) Which of the following is a non-renewable resource?

1. White-tailed deer
2. Fresh water
3. Oil
4. Trees
5. Don't know

(Question 12) Sustainable agriculture aims to...

1. Produce enough food to sustain human society
2. Meet the demand for food at any costs
3. Produce enough food while maintaining stable economic costs
4. Produce enough food while maintaining a stable environment
5. Meet the requirement for food while maintaining a healthy social, economic, and ecological environment
6. Don't know

(Question 13) If one is to say a species exceeded the carrying capacity of its habitat, it means that:

1. It no longer has enough food, water, and cover available to sustain the species in its current condition for an indefinite future
2. It no longer has enough food, water, and cover available to sustain the species at all anymore
3. It no longer has enough food, water, and cover available to share with other species
4. None of the above
5. Don't know

(Question 14) Many people around the world suffer from hunger. This is because...

1. There is not enough food production to fulfill the global demand
2. Food is not equally distributed among, between, and within nations
3. Food trade is in hand of multinational exportation companies
4. All of the above
5. Don't know

(Question 15) What are the main sources of pollution to streams, rivers, and lakes in the Midwest?

1. Waste disposal from the cities
2. Trash washed into the waters from polluted areas
3. Waste disposal from factories and industries
4. Runoff water from cities, yards, paved lots, and farm fields
5. Don't know

(Question 16) Which one of the following is NOT a function of wetlands in the Midwest?

1. To serve as a sponge, soaking up excessive run-off water
2. To filter out run-off water to remove soil and nutrients
3. To recharge underground aquifers
4. To provide habitat for wildlife
5. Don't know

(Question 17) What happened between the years of 1830 and 1900 to change the landscape of the Midwest?

1. The prairies were steadily transformed into farm lands
2. Native American tribes were displaced by Euro-Americans
3. The loss and fragmentation of habitat caused many species to be extirpated
4. All of the above
5. Don't know

(Question 18) Urban sprawl in the Midwest results in:

1. Increases in the cost of developing municipal sewer and water systems
2. Increases in the cost of developing roads and freeways
3. The loss of farmland
4. All of the above
5. Don't know

(Question 19) From what source does the vast majority of the Iowa energy come?

1. Fossil fuels
2. Wind power
3. Hydro power
4. Nuclear power
5. Don't know

(Question 20) To maintain healthy woodlands and forests, we must:

1. Leave them alone
2. Check them every 40-50 years
3. Carefully manage them, including some thinning and cutting
4. Maintain abundant wildlife populations
5. None of the above

Part III: Your feelings about the environment in and around you. Please, choose only one answer.

(Question 21) All life on Earth has the right to exist for no required reasons, regardless of their value to humans.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 22) I am willing to protect endangered animals on my land only if the Federal Government provides me with some financial incentive.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 23) Environmental activists over-exaggerate in justifying their causes and actions.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 24) We all should care about the health of the coral reefs or the deforestation of the rainforest even though they are not within our geographical region.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 25) I'll do my best to protect our environment as long as I don't have to change my lifestyle.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 26) I would be willing to pay up to \$50 more per year to promote the sustainable use of our natural resources.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 27) Environmental Education should be part of every school grade's curriculum, K- 12.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 28) My decision on who to vote for in an election is strongly influenced by a candidate's record or stance on environmental protection.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 29) We should not worry about the future of our environment because, even though we won't be here to see it, advancing technology will take care of our potential environmental problems.

1. Strongly disagree
2. Disagree

3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 30) How other people use their private land is of no concern to me.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 31) If I were to preserve natural resources on my land, the main reason I would do it is to fulfill the needs of future generations of my family

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 32) People tend to exaggerate the effects of run-off on water quality.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 33) Global warming is largely a scare tactic by environmentalists.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 34) If I had to choose between landowner's rights and preserving species, I would choose to preserve species.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 35) I would be willing to pay up to \$100 more per year to promote the sustainable use of our natural resources.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 36) The government should pay for conservation practices on private land, not the landowner.

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Don't have an opinion
5. Somewhat agree
6. Agree
7. Strongly agree

(Question 37) During the past 10 years, do you think that the overall quality of the planet's environment has...

1. Improved a lot
2. Somewhat improved
3. Stayed the same
4. Somewhat declined
5. Declined a lot
6. Don't know

(Question 38) In the next 10 years, do you think the overall quality of the planet's environment will...

1. Improve a lot
2. Somewhat improve
3. Stay the same
4. Somewhat decline
5. Decline a lot
6. Don't know

(Question 39) During the past 10 years, do you think the quality of the air, soil, and water in the area you live has...

1. Improved a lot
2. Somewhat improved
3. Stayed the same
4. Somewhat declined
5. Declined a lot
6. Don't know

(Question 40) In the next 10 years, the quality of the air, soil, and water in the area you live will...

1. Improve a lot
2. Somewhat improve
3. Stay the same
4. Somewhat decline
5. Decline a lot
6. Don't know

Part IV: Demographic information for analytical purposes

(Question 41) Your age:

1. 17 - 20 years
2. 21 - 25 years
3. 26 - 30 years
4. 31 - 40 years
5. Over 40 years

(Question 42) Your gender:

1. Male
2. Female

(Question 43) Country of birth:

Answer: _____

(Question 44) In what kind of environment did you spend the majority of your childhood?

1. Rural farm
2. Rural non-farm
3. Suburban
4. Small town ($\leq 2,500$ people)
5. Small city (2,500 to 50,000 people)
6. Large city
7. Other

(Question 45) Your student status:

1. Freshman
2. Sophomore
3. Junior
4. Senior
5. Graduate

(Question 46) What College are you in?

1. College of Agriculture
2. College of Business
3. College of Design
4. College of Engineering
5. College of Human Sciences (Combines Colleges of Education and Family & Consumer Sciences)
6. College of Liberal Arts and Sciences
7. College of Veterinary Medicine

(Question 47) Please write down your Department (i.e. NREM)

Answer: _____

(Question 48) What is your current major?

Answer: _____

(Question 49) Did you have another major before? If yes, please write it down; otherwise fill NA (not applicable).

Answer: _____

(Question 50) Please, write down the semester and year you expect to graduate (i.e. Fall 2008)

Answer: _____

(Question 51) How long have you lived in the Midwest?

1. Less than 5 years
2. About 5-10 years
3. About 11-20 years
4. About 21-30 years
5. About 31-40 years
6. More than 40 years
7. All my life

(Question 52) Mark as many as the activities below that you experienced on your childhood:

1. Fishing
2. Hunting
3. Hiking

4. Gardening
5. Camping
6. Planting a tree
7. Reading a nature-related book
8. Having a wild place or visiting one
9. Just being outdoors
10. Canoeing
11. Bird-watching
12. Visiting Zoos
13. Backpacking
14. Watching "Animal Planet"
15. Others

Thanks a lot for filling out our Environmental Literacy (EL) survey. You have helped us understand the status of EL on the campus you are in, and also address suggestions to promote initiatives in development of Environmental Education programs and curricula. Great job! We will contact you if your name is one drawn to win one of the two iPod prizes. Thanks again and have a great semester!

APPENDIX C. SURVEY COVER LETTER SENT TO STUDENTS

Dear fellow student:

Many of us are concerned about our environment and how it can best be maintained and improved. As a graduate student in Animal Ecology at Iowa State University, I am concerned about the quality of information that is available to make responsible decisions about our environment. As part of a research project to obtain reliable and valid measures of key concepts, I am developing a new survey instrument to measure three components of environmental literacy: awareness and knowledge about, and attitudes towards, environmental issues as they relate to environmental problems in the midwestern United States. The results of this research will be used to write a thesis for my Masters of Science degree in Animal Ecology.

To help achieve this goal, we selected students in all colleges to participate in a survey that will help us better measure and ultimately understand environmental issues. The results of the survey will be important in our efforts to improve environmental education practices and curricula not only on this campus but also across the entire Midwest.

You were selected to participate in this important survey, and we strongly encourage you to do so. Your participation in this survey is entirely voluntary and you may opt out at any time. It shouldn't take more than 20 minutes and your name will be added to a April 2007 drawing for two iPods. By completing the survey you are giving us the consent to publish the results. However, your information will remain confidential. Please fill out the survey and help us understand the status of the environmental literacy on campus.

To start the survey you need to log on the WebCT using your Net-ID and password (which are the same as your ISU webmail login ID and password). Please click on the link below to start.

If you have any questions about the rights of research subjects, please contact the IRB Administrator, (515) 294-4566, jcs1959@iastate.edu, or Diane Ament, Director, Office of Research Assurances (515) 294-3115, dament@iastate.edu.

Be engaged! And thanks for taking the time!

Sincerely,

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