AN ANALYSIS OF THE CORRELATIONS BETWEEN THE ATTITUDE, BEHAVIOR, AND KNOWLEDGE COMPONENTS OF ENVIRONMENTAL LITERACY IN UNDERGRADUATE UNIVERSITY STUDENTS

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2000

ACKNOWLEDGMENTS

I would like to thank the members of my committee, Dr. Marshall Breeze, Dr. Mike Scicchitano and my chair, Dr. Les Thiele, for their guidance and support on this research project. I am indebted to Dr. Mike Moulton, Dr. Cassandra Moseley, Jennifer Languell, Julie Sinn, Josh Trotter and Lisa Hager for their invaluable assistance in making this study possible. Dr. Kenneth Portier gave important guidance in statistical analysis of the data. I am also indebted to Dorothy Beaupied for constantly keeping my spirits buoyed and for her thorough editorial assistance. Finally and most important, I am grateful to my parents for their vital support, love and encouragement throughout this process and over the years. I could not have been successful without them.

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August 2000

Chairman: Leslie Thiele
Major Department: Interdisciplinary Ecology

As far back as the 1972 United Nations Conference in Stockholm, lack of public awareness about the environment has been a topic of international concern. This commitment to raising public environmental awareness was renewed in 1992 at the Earth Summit in Rio de Janeiro and is manifested in Chapter 36 of Agenda 21. In 1977, a United Nations conference was convened in Tbilisi, Georgia that resulted in the Tbilisi Declaration which affirmed the international commitment to international environmental education. The Tbilisi Declaration was reaffirmed at the Thessaloniki Conference on environmental education in 1997. Environmental literacy is the embodiment of this international commitment to raise environmental awareness in citizens around the world. Environmental literacy goes a step further than basic literacy by including environmental knowledge as well as attitudes and behaviors that are related to environmental sustainability.

The purpose of this study is to analyze the relationships between the major components of environmental literacy—attitudes, behaviors and knowledge—in undergraduate university students; and to examine differences in scores on components of environmental literacy by gender, class standing and age subpopulations. The study involved administering the Environmental Literacy Survey (ELS), a version of the Modified Wisconsin Environmental Survey. There were 817 respondents to the ELS, representing a wide variety of academic majors. Of the respondents, 51.6 % were males and 48.4% were female; 68.2% were younger than 20 years of age, and 31.8% were 20 years of age or older; 49.7% of the respondents were freshmen, 24% sophomores, 14.7% juniors, and 11.6% seniors. Undergraduates at UF have a moderately high environmental attitude (70.5%), followed by moderate knowledge (65.5%) and very low environmental behaviors (39%).

The environmental literacy model used to analyze the correlations was developed by reviewing behavior change and persuasion theories, studies of the components of environmental literacy and their relationships, and environmental education research. Pearson's (r) and Spearman's (r_s) correlations were calculated for the data. Knowledge and attitude had a weak correlation ($r = .220$, $r_s = .202$). Attitude and behavior components demonstrated a moderate correlation ($r = .480$, $r_s = .494$). These correlations substantiated my hypothesis that knowledge and attitude would have a weak correlation, knowledge and behavior no relationship, and attitude and behavior a moderate relationship. As a result of principal component analysis, an additional component "perceived behavioral control" was added to the model. The correlations that were calculated for this model produced basically the same results as the initial correlations.

Knowledge had an insignificant relationship with behavior and with perceived behavioral control. Knowledge again had a weak correlation with attitude ($r = .232$, $r_s = .211$). The relationship between attitude and behavior was still moderate ($r = .439$, $r_s = .448$). Behavior and perceived behavioral control also demonstrated a moderate correlation ($r = .376$, $r_s = .373$). Finally, attitude and perceived behavioral control had a moderate relationship ($r = .399$, $r_s = .379$).

With respect to subpopulation differences analyzed with ANOVA, a portion of my research hypothesis was substantiated at the $\alpha = .01$ level, that is, males did have a significantly higher knowledge component score, while females had a significantly higher attitude score. At the $\alpha = .05$ level, females also had a significantly higher behavioral score than males did. There was no significant difference in the overall environmental literacy index score in the gender subpopulation analysis.

The remaining part of my hypothesis was not substantiated in that significant differences were found in each component of environmental literacy at the $\alpha = .05$ level (and for most of the components at the $\alpha = .01$ level); and in the environmental literacy index score as well, in the age and class standing subpopulation analysis of variance.

Further research is necessary to understand how the various components of environmental literacy interact in reality, particularly in different subpopulations, so that an effective course of action can be established for environmental literacy programs. Building on existing tendencies for environmental literacy to increase naturally, as was demonstrated by the class standing and age subpopulations, will allow students to engage deliberately in responsible environmental behavior.

CHAPTER 1
INTRODUCTION

The major environmental problems that the world currently faces such as deforestation, loss of biodiversity, ozone depletion, global climate change, pollution and over-consumption of natural resources directly impacts our ability to develop economically while at the same time sustaining the health of people as well as plants and animals. As early as the 1972 United Nations Conference of the Environment held in Stockholm, environmental awareness has been a priority of the international community who recognized that economic security and development is directly tied to the health of the environment. As a result of directives from the Stockholm Conference, from which the Declaration of the United Nations Conference of the Human Environment was created, the Intergovernmental Conference on Environmental Education was held in Tbilisi, Georgia in 1977 where the Tbilisi Declaration was adopted. The critical objectives of the Tbilisi Declaration included heightening people's environmental awareness, sensitivity, attitude and concern for the environment, skills and motivation to act for environmental improvement and protection, and participation in solving environmental problems (Knapp 2000).

In 1992, the United Nations Conference on Environment and Development was held in Rio de Janeiro. At this conference, the Stockholm Declaration was reaffirmed and built upon to insure the integrity of the global environment. Also at the Rio Conference, Agenda 21, a program for achieving sustainable development in the 21st Century, was adopted. In Chapter 36 "Promoting Education, Public Awareness and Training", a

framework is presented for how each country can undertake educating its citizenry for environmental literacy- knowledge of the environment, but also with attitudes, skills and behaviors that are consistent with environmental sustainability (UNESCO-UNEP 1995). The Tbilisi Declaration was reaffirmed by 81 countries at the 1997 International Conference on Environmental Education in Greece in the Thessaloniki Doctrine which also incorporates parts of the framework from Chapter 36 of Agenda 21 (Knapp 2000).

Universities and Environmental Literacy

In Chapter 36 of Agenda 21, universities are directly challenged to increase their role in developing an environmentally literate citizenry. Moreover, universities were specifically asked to play a prominent role in preparing citizens to analyze and resolve environmental issues. Additionally, in 1994, the Council of State Governments, in their book, Suggested State Legislatures, presented a model environmental education legislation for adoption by state legislatures that would require universities to develop an environmental studies requirement or an integrated general studies requirement designed to instill environmental literacy in university undergraduates (Wilke 1995).

Governments, as well as international organizations, are interested in developing environmental and ecological literacy with the hope that if students are taught about the environment in general, their personal impact on the planet and to think critically about their surroundings, that their attitudes will become sensitive to the Earth's ecology and be followed by sustainable behavior. Ultimately, it is believed that these students will use these values, attitudes, and behaviors throughout their lives, and particularly in their careers. Eventually these environmentally literate graduates would attain significant

status in their careers and become supporters for environmentally friendly innovations. Institutions will eventually be pervaded by a new mindset that makes decisions in harmony with the environment rather than simply to meet institutional goals. A new culture of environmental stewardship would become a basis for societal decision-making.

Since universities are charged with shaping students to become part of our society, it is vital that they be the forerunners in creating a culture of environmental stewardship in our society. Further, university graduates are currently causing many of the world's environmental problems, or in David Orr's (1992, p.149) words, "environmental mismanagement is too often the work of the highest educated people with B.A.'s, B.S.'s, LL.B.'s, M.B.A.'s, and Ph.D's." Responsible universities will provide students with the knowledge (both skills and factual) they need so that they can live sustainably if they choose to do so.

Defining Environmental Literacy

While both literacy and ecology are easily defined, environmental or ecological literacy is not easily defined. Literacy is the ability to read and write and ecology refers to the relationship between organisms and their environment. Indeed, there is no definition for environmental literacy universally agreed upon by scholars in the field. Maser (1997, p. 211) states that the foundation of environmental literacy is "understanding that change, or the principle of Creation, is a continual flow of cause-and-effect relationships that precisely fit into one another at differing scales of space and time and are constantly changing within and among those scales." As David Orr (1998/99, p.24) stated, "The problem of education in our time is how to make ecologically intelligent people in an

ecologically ignorant society." Orr (1990) believes that true ecological literacy is the ability to answer the question "What then?" originally posed by Hardin (1968) in his classic paper "Tragedy of the Commons".

In this paper, Hardin discusses how individuals choose to overuse resources because the system of common ownership encourages this behavior without consequence. In the oft-quoted example from this paper, a villager decides to add an extra cow to an already overextended common grazing area because he believes it will increase his personal economic security with no obvious repercussion to him. In the context of environmental literacy, rather than simply adding a cow in the hopes of some additional personal economic gain, the villager could have thought about and attempted to answer "What then?" by analyzing the impact of the addition of a cow on himself, the other villagers, and their livestock both economically and environmentally. The villager may find that if all of the villagers worked together to limit the number of livestock that the market price would increase because of decreased supply, increasing the economic value per unit of cattle. Also, the quality of the livestock would increase due to more food and water per unit than in the open common arrangement. Finally, presumably the environment may be improved or at least sustained, because the number of cattle is limited reducing the direct impact on the land. Simply having knowledge about grazing cattle would not be sufficient to solve the problem of the commons. The problem is that people are not able to answer "What then?" without being taught how to think through complex problems.

As environmental literacy is not just knowledge, simply transferring knowledge about ecological systems is not enough to achieve environmental literacy. In addition to

instruction about ecology, people must be taught the skills to think critically about the interplay of ecological, political and economic systems; to problem solve creatively; to think outside of the traditionally defined "box"; and perhaps, most importantly, to be members of a democratic society. In Leslie Thiele's (1999, p.197) Environmentalism for a New Millennium, one person identified only as a conservation biologist, founder and member of a number of conservation organizations states "every personal act--of production, consumption, travel, communication, recreation, disposal, voting--is an ecological act. And every ecological act should be a conscious one." If every act is to be an ecological act, knowledge of skills to perform sustainable behaviors is crucial. Wendell Berry (1999, p.14) takes this concept a step further, "We have to abandon the old standard of mere profitability, productivity, or efficiency and realize that--in the terms of the grant to us of the use of the world--we have other standards to meet. We have the right to use--but not use up--the things that we need and are dependent upon." Thus concern and attitudes related positively to environmental sustainability are also central to environmental literacy. Clearly environmental literacy is much more than simple factual knowledge about the environment, it also includes attitudes and behaviors that support environmental sustainability. Environmental literacy is the basis for action for protecting our resources for ourselves, our species' future and the future of the other species with whom we share Earth.

Roth's (1992) definition of environmental literacy is commonly cited. He believes that environmental literacy is an individual's knowledge about and attitudes toward the environment and environmental issues, skills and motivation to work toward the resolution of environmental problems, active involvement in working toward the

maintenance of dynamic equilibrium between the quality of life and quality of environment and the understanding that humans are in fact a part of nature. Thus, in summary, environmental literacy is comprised of several components: knowledge, attitudes (affect and efficacy), and behavior. Environmental education is the means to instilling environmental literacy in students.

Study Outline

This thesis is an analysis of the relationships between attitude, behavior and knowledge, the three major components of environmental literacy, in university undergraduates. To analyze this relationship, a study was designed that utilizes a version of the Wisconsin Environmental Literacy Survey that was modified for use semantically with adults by Dr. Peggy Green in 1997. The survey is divided into three components of environmental literacy: 1) Attitudinal, which includes statements related to self-efficacy, and behavioral intentions, as well as affective statements, 2) Behavioral and 3) Knowledge. A score is generated for each section, allowing correlation analysis of the components. By adding the scores of the three sections together, an index of environmental literacy is generated for the individual respondent, which can be used by a university to track the progress of the student population's environmental literacy when assessing institutional environmental literacy programs.

Scope

The University of Florida, the flagship university of the State of Florida's university system, with a reputation for excellence, was used as the basis for this study

because it has no formal environmental literacy program. In order to ensure that the correlations among the components of environmental literacy were not being affected by an existing educational program, it was necessary to select an institution without an environmental literacy program for this study. Furthermore, this study provides the University of Florida with a baseline measurement of environmental literacy for use in assessing future progress, should a formal environmental literacy requirement and program be implemented.

University of Florida and Environmental Literacy

The University of Florida (UF) is located in Gainesville, and is physically comprised of a 2,000-acre campus and 875 buildings. The campus population includes 42,336 students (74 percent are undergraduates, 19 percent are graduate students and 7 percent are in professional programs), 4,000 faculty members and 10,000 staff members for a total population of 56,336 in 1998. UF had an operating budget of $1,568,859,000 in 1998-99.

UF is not simply an educational institution but a small city unto itself. Like other towns, UF consumes water, energy, food and other materials while outputting waste. UF's ecological footprint, an area measure of resource consumption, far exceeds its actual area and, like other U.S. towns, draws resources from an area that is 8 times its actual land area (Wackernagel 1995). Thus, it is apparent that UF should take a serious look at sustainability issues on its campus and identify areas where campus ecology can be improved. More importantly, because UF is an educational institution with the power to impact students both while they are at school as well as after they graduate and are pursuing their endeavors, it is clear that if UF did formally engage in the creation of a

campus culture of environmental stewardship, starting with increasing environmental literacy on campus, the results may be much further reaching than just the campus.

Institutional Commitment to Environmental Literacy

The greening of the University of Florida actually began in 1990 when President Lombardi signed the Talloires Declaration promising to make environmental education and research a central goal in this institution. In addition to UF, 254 other universities from around the world have signed this agreement. Over 200 universities in Europe have signed a similar document, the Copernicus Charter. Unfortunately, Dr. Lombardi made a formal commitment, not a personal one. He made no significant effort to fulfill the promises of the declaration at any level in the university community. The person who was capable of making environmental literacy and greening a priority at UF did not act to implement the provisions of the Talloires Declaration. Institutional greening at UF had to wait until an individual, or a group of people, came along and believed it was important enough to try to force through the institutional system from a less privileged status position than president.

In 1995, a group of faculty members at UF organized and formed a new college, the College of Natural Resources and Environment, that offers an interdisciplinary ecology program for undergraduates. In 1999, a program for graduate students was initiated. This was a major step for UF. It now has an entire college, albeit a horizontal one, dedicated to the study of issues related to environmental literacy. However, the remaining 43,000 students on campus still have no official way to acquire environmental literacy. Individual students may inadvertently take a course that has an environmental literacy component or be involved with a campus environmental club, but there is no

formal plan to educate the student population. Although individual departments can choose to create classes that relate environmental literacy ideals to their discipline, this has not occurred in most areas of the university. Noticeable exceptions to this are the natural sciences, Political Science, School of Building Construction and Latin American Studies. This has happened because there were environmental literacy champions in these departments at the highest level- the department heads and the director of the school. All of this activity is driven by individuals, but a concerted group effort to critically examine campus ecology, and ecological literacy for the entire campus community was yet to come.

Seven years after signing the declaration, Greening UF, a grassroots organization, was formed in October 1997, to approach the ideals set forth in the Talloires Declaration. The organization is comprised of students, faculty and staff. There are two major foci: 1) Facilities and Operational Greening and 2) Environmental Literacy. Facilities and operational greening refers to improving campus ecology- better waste management, alternative transportation, using reclaimed water, reducing energy and water consumption.

Statement of the Problem

A number of universities have instituted environmental literacy programs (Tufts University, University of Wisconsin at Stevens Point, and Clark University to name a few) to attempt to provide students knowledge about the effects of human-nature interaction; to develop skills, attitudes and behaviors to solve complex environmental problems; and to motivate them to take action when necessary. These universities believe

that, “The environment is one subject about which there is a clear and overriding need for all students to be informed. There is no right that grants students and teachers the freedom to be ignorant of the central concern that affects human civilization in this, its greatest struggle for life. (Collett and Karakashian 1996)” However, it appears from the literature that there is a lack of empirical data regarding the impact of environmental cognitive levels on environmental affective and behavioral levels at the undergraduate level.

As the University of Florida and other institutions embark on the journey to “green their curricula” and create general education requirements, it is necessary to investigate how the components of environmental literacy (affective, behavioral and cognitive) interact. Further, this study has created a benchmark at the University of Florida that can be used to determine if environmental attitudes, behaviors and knowledge are improving, disintegrating or static as a result of either adopting an environmental literacy program or taking no action to improve environmental literacy, attitudes and behaviors in the student population.

Research Questions

The following research questions were addressed:

1. What will be the extent of the relationship of an individual’s score on the separate components of the environmental literacy survey (knowledge/cognitive, attitudes/affective and behavior)?

2. Will there be a measurable difference in the subpopulations (male/female, class standing/age) scores on the three sections and total score?

Hypotheses

These hypotheses are made based on correlations that have been ascertained from studies of a variety of different demographic groups that are presented in the literature review (Chapter 2).

1. An individual's score on the knowledge section will correlate weakly to the score on the attitude section but not to the behavior section of the environmental literacy survey. The behavioral models presented in Chapter 2 (Azjen 1988, Azjen and Fishbein 1980, Hines et al. 1986/87, Marcinowski and Rehring 1995) show no direct link between knowledge and behavior hence the lack of a hypothetical relationship between these components. Some models do not include knowledge as a component at all, instead maintaining that knowledge is a precondition of the other components. When knowledge is included it is connected to attitude, hence the hypothesis that there will be a weak correlation to attitude.

   The attitude section and the behavior section will have a moderate correlation. The behavioral models presented in Chapter 2 all show a link between attitude and behavior but that connection is often moderated by another component referred to as behavioral intention, which is why the correlation is hypothesized to be moderate rather than strong.
2. In the male/female subgroups, there will be no difference in the behavioral section. In the affective section, females will score higher whereas in the cognitive section males will score higher. This hypothesis was made because in prior studies that studied male and female differences in the components of environmental literacy, it was found that females generally demonstrated more

concern and positive attitudes than males towards the environment, whereas males typically performed higher on the knowledge component (Eagles and Demare 1999, Dietz 1998, Gifford et al. 1982/83, Hausbeck et al. 1992, Scott and Willits 1994). No studies showed a difference in environmental behaviors.

There will be no significant difference in any of the sections based on class standing or age. This hypothesis was made because there is no environmental literacy program in place at UF so no significant difference is expected across class or age groups. No research related to differences in closely related age groups or class groups was found in the literature.

Significance of the Study

As mentioned above, many institutions have begun implementing environmental literacy programs but few studies have been published indicating what methods of environmental education have been effective in creating changes in specific components of environmental literacy. This study establishes how the components of environmental literacy are related for undergraduates at a university without a formal environmental literacy program. This would allow the university to decide which components should be the focus of a formal environmental literacy program. Further, for institutions of higher learning already engaged in an environmental literacy program, this study will allow them to examine if the components of environmental literacy they are focusing on will likely have the desired outcome.

Limitations

The study has the following limitations:

1. The results can only be generalized to the population under discussion- undergraduate students at the University of Florida.
2. The research does not determine if significant life experiences of individual students affect the outcome of the study.

Summary

Environmental literacy is more than simple knowledge of environmental and ecological concepts. It also includes the skills necessary to perform sustainable behaviors, and the attitude and concern for the environment to provide motivation to perform environmental behaviors. Environmental education, of which an environmentally literate citizenry is the ultimate goal, has been a focus of the international community since the 1972 UN Conference of the Environment in Stockholm and has been regularly reaffirmed by conferences in Tbilisi, Rio and Thessaloniki over the last 28 years with increasing emphasis on affecting the non-traditional literacy components—attitudes and behaviors related to sustainability.

The purpose of this study is to establish if there are correlations between the components of environmental literacy while also establishing a benchmark measurement of undergraduate environmental literacy at the University of Florida. This study will

provide information for the University of Florida to use in planning an environmental literacy program particularly on which components of environmental literacy to focus.

For general application, this study provides a framework for other universities to measure their students' environmental literacy and to assess the various components of environmental literacy over time to determine the actual effects of their environmental literacy programs.

CHAPTER 2
LITERATURE REVIEW

The purpose of this study is to examine the relationship between the three components of environmental literacy—attitudes, knowledge and behavior. To explain how these components are theoretically related, this chapter will define terminology as well as review the literature about theories that address behavioral change, the interrelationships of the environmental literacy components, and relevant subpopulation case studies.

Definition of Terms

In behavior change literature, it is necessary to define the actual terms, what they refer to and which ones are synonymous. The term, self-efficacy, an individual's belief in their ability to control the outcome of events, is also referred to as locus of control (Hines et al. 1986/87) and perceived behavioral control (Azjen 1988). Self-efficacy is sometimes included within the attitude or affective section of surveys (Marcinowski and Rehring 1995) or represented as a separate component (Azjen 1988). The term affective refers to the attitude section of a survey or model. Attitudes are also sometimes referred to as consciousness.

The term knowledge can refer to anything from general principles knowledge to specific skill knowledge or all types of knowledge combined into one component. In

Azjen and Fishbein (1980) knowledge is referred to as beliefs. Knowledge is also referred to as a cognitive component.

The term behavior can refer to specific behaviors or general behaviors. Behavior is occasionally referred to as being connative when it is being used as a component of attitude, usually with cognitive and affective components.

Theoretical Behavioral Models

Various disciplines ranging from psychology and sociology to marketing and advertising, describe in a plethora of theories which components mediate behavior and further how these components are related to each other. Invariably, these theories are based on attitude, behavior and knowledge components. Thus, these models hypothesize how the components of environmental literacy—attitudes, behaviors and knowledge—interact. Because the purpose of this study is to examine the correlations between these components, it is necessary to be familiar with the theoretical basis of these relationships. The major theories in use today relevant to environmental literacy are presented below.

Theory of Planned Behavior

Perhaps the most frequently referenced model used to describe the correlative components of behavior is Azjen's (1988) Theory of Planned Behavior that resulted from Azjen and Fishbein's (1980) Theory of Reasoned Action which is presented in Figure 2-1. Attitudes and subjective norms contribute to behavioral intentions, which can be used to predict behavior. Subjective norms in this context refer to an individual's beliefs about whether their society's members—family, friends, and co-workers—believe that the

individual should or should not engage in a specific behavior. The social environment has been shown to mediate the affect of environmental attitude on environmental behaviors (Petrzelka 1996).

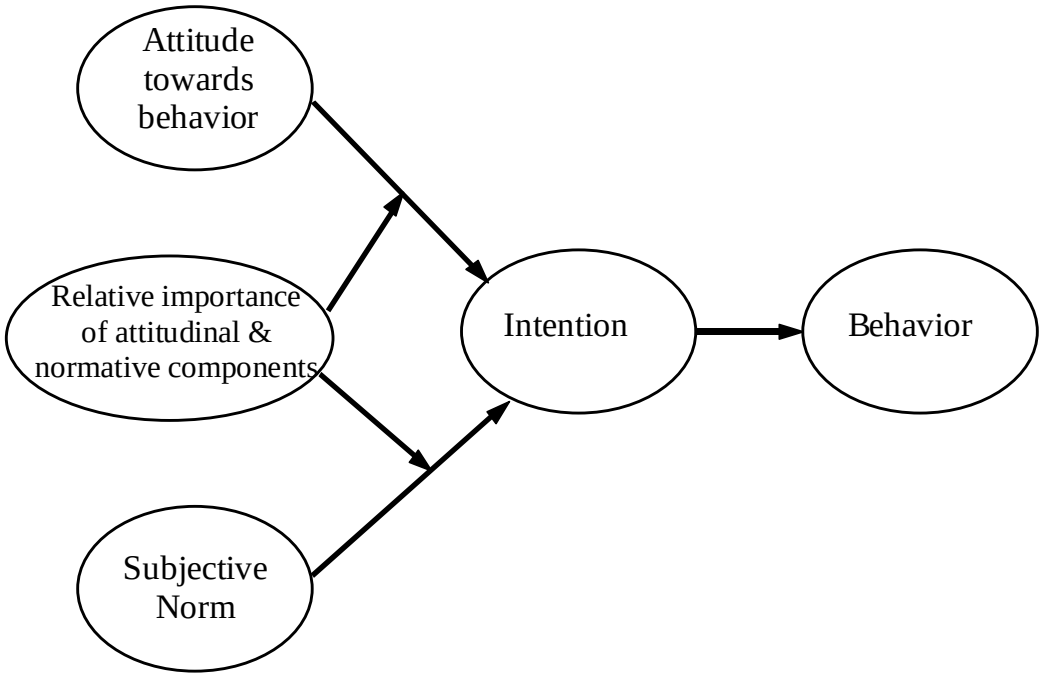

Figure 2-1. The Theory of Reasoned Action (Azjen and Fishbein 1980).

Knowledge is not a specific component in the model but Azjen and Fishbein (1980, p. 7) do state that, “attitudes are a function of beliefs.” In this context, beliefs refer to knowledge about a specific behavior. Dillon and Gayford (1997) further support the notion that Azjen’s model does allow for representation of cognitive elements through affective elements by their influence on beliefs. For example, when a person understands that they have control over a certain situation, their behavioral intentions reflect this understanding as much as their beliefs as to the outcome of a certain behavior.

Regarding the relationship of all of the components of the Theory of Reasoned Action, Azjen and Fishbein (1980, pg. 91) remark that:

> On the basis of different experiences, people may form different beliefs about the consequences of performing a behavior and different normative beliefs. These beliefs, in turn determine attitudes and subjective norms which then determine intention and the corresponding behavior. We can gain understanding of a behavior by tracing its determinants back to underlying beliefs, and we can influence the behavior by changing a sufficient number of these beliefs.

Thus knowledge, or beliefs, have a mediated connection through attitudes, subjective norms and intention prior to behavior. The relative importance of the attitude and subjective norm in determining the intention will be different for each individual and situation.

The basis of the Theory of Planned Behavior is that attitude, subjective norm, and perceived behavioral control all influence behavior through an intention component. The perceived behavioral control component has an independent link to the behavior that is not moderated by the behavioral intention component. This theory is presented in Figure 2-2.

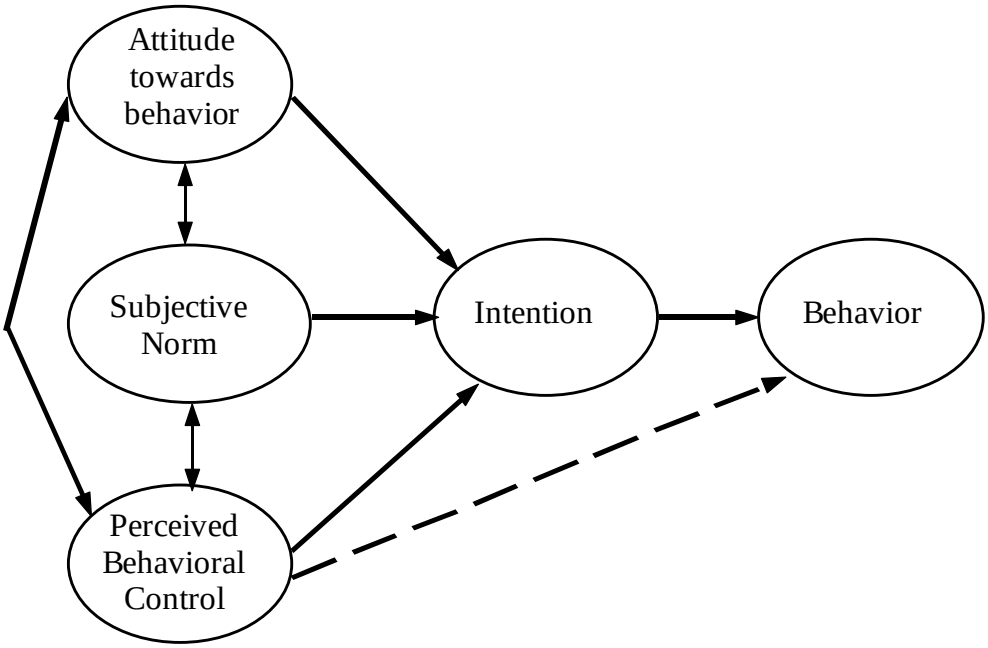

Figure 2-2. Theory of Planned Behavior (Azjen 1988)

The major modification in the Theory of Planned Behavior from the Theory of Reasoned Action is the addition of a perceived behavioral control component. Perceived behavioral control "refers to the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles (Azjen 1988, p. 132)." When an individual believes that they can influence the political process related to environmental policy, they are more likely to be involved in political action and lobbying. Another example is if an individual does not believe that when they put a can into a recycling bin that it is actually recycled, they are not very likely to recycle their cans. Thus perceived behavioral control is a mediating factor of whether or not an individual, regardless of their attitude, will engage in responsible environmental behaviors.

One could hypothesize that a person who has positive attitudes, subjective norms and perceived behavioral control regarding a specific behavior will have a positive intention and a high likelihood of actually performing the behavior. Azjen (1988) further points out that perceived behavioral control may have very practical constraints relating to situational conditions whereas intention only refers to an individual's willingness to perform a behavior, hence the direct connection to the behavior. For example, if someone is very willing to use a solar water heater, but there are no solar water heaters to purchase, or materials or knowledge to make one, then it is not possible to adopt the use of a solar water heater even if the individual is willing to do so. The notion of control is specifically relevant to environmental concerns. Dillon and Gayford (1997) point out that the issue of control is often left out of environmental behavioral studies. They recommend that environmental education programs very specifically ask questions that will encourage students to explore their personal values and develop related vocabularies. If this type of education does not take place, and only basic knowledge is transferred, there will not be a way to translate the cognitive and affective elements into environmentally responsible behaviors.

Based on this theory, Kaiser et al. (1999) recommend in their study that an abbreviated version of the Theory of Planned Behavior should be used as a theoretical framework to increase the ability to predict environmental behaviors based on observed environmental attitudes.

Model of Responsible Environmental Behavior

The term 'responsible environmental behavior' refers to "the variety of recognized approaches to environmental action available to individuals and groups for

use in preventing or resolving environmental problems or issues" (Hsu and Roth 1988, p. 232).

Hines et al. (1986/87) proposed the model of responsible environmental behavior which is shown in Figure 2-3. In order to construct this model, the researchers performed a meta-analysis of 128 previously conducted environmental behavior prediction studies. This model was proposed as result of the correlations that were found between the various components that predicted responsible environmental behavior.

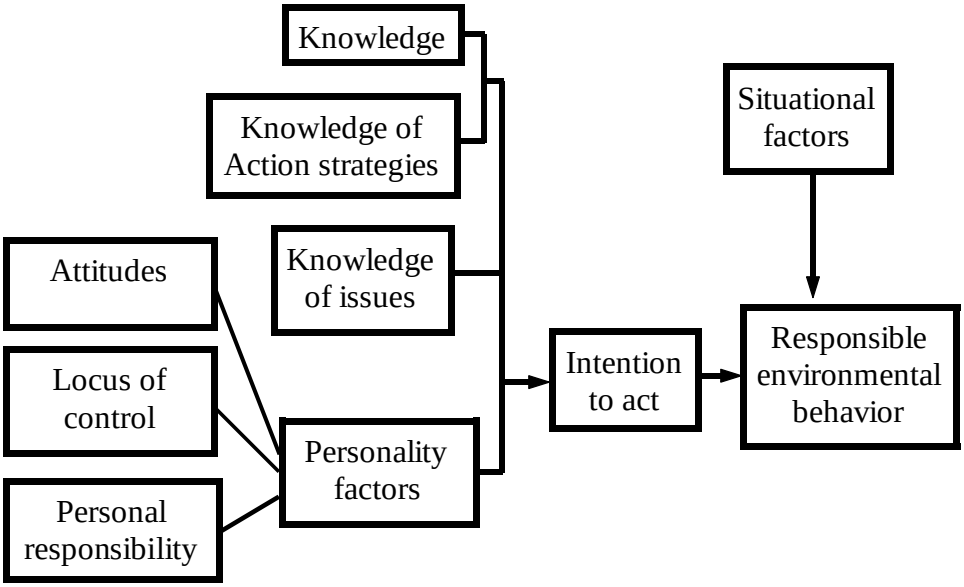

Figure 2-3. Proposed model of Hines et al. (1986/87) for responsible environmental behavior.

Hines et al.'s model describes how the different types of knowledge interact to determine the intention to act, which then leads to the desired responsible environmental behavior. This model indicates how important it is for ecological literacy to be much more than simple ecological knowledge. It must also include knowledge of action strategies, action skills, exercises to develop self-efficacy (locus of control) and environmentally sensitive attitudes.

Unlike the Theory of Planned Behavior, knowledge is one of the base components of the model proposed by Hines et al. but the researchers are careful to show that it is not simply factual knowledge that is the source of responsible environmental behavior. “An individual must also possess knowledge of those courses of action which are available and which will be most effective in a given solution” (Hines et al., 1986/87, p. 6). This is particularly important as situational factors create changeable conditions. An individual must be able to adapt accordingly. If their knowledge is limited to a specific situation, they may be unable to adapt when situational factors change.

On the basis of their model, Hines et al. propose that knowledge and skill components as well as attitude components can and should be addressed by environmental educators. “Approaches which address both affective and cognitive experiences and which provide individuals with opportunities to develop and to practice those skills necessary to lead to environmental action must be developed and implemented in our school’s systems” (Hines et al. 1986/87, p.8).

In Hsu and Roth’s (1998) study of environmentally responsible behavior in secondary school teachers in Taiwan, they found that knowledge and skill in using environmental action strategies were powerful predictors of responsible environmental behavior. Hsu and Roth suggest that these two predictors should receive major emphasis at the secondary and post-secondary levels. Further, based on the findings of their study, Hsu and Roth (1988, p.240) comment, “one may infer that an individual is more likely to express an intention to take environmental action if that individual has knowledge of environmental action strategies, accepts environmental responsibility (i.e. sense of obligation toward alleviating environmental problems) and has positive environmental

attitudes." Of these elements, cognitive skills are easily addressed in a formal educational setting. It is, of course, more challenging to address attitude or behavior components, but not impossible.

Hines et al. (1986/87) recognize that prediction of behaviors is very complex and that further research is necessary to understand how all of the variables in the model relate to each other. They recommend that research focus on many components rather than just the interaction of two components to start to achieve a more holistic picture of responsible environmental behavior.

Environmental Literacy Framework

Marcinowski and Rehring (1995) proposed the environmental literacy framework that was used in constructing the Environmental Literacy Survey (ELS), the instrument used as the basis for the study presented in this thesis. The original framework consisted of four parts. In order to adhere to the components of the ELS, the affective dimension section and the additional determinants of environmentally responsible behavior (self-efficacy and responsibility) have been combined into the affective section. Major elements of the ELS are: 1) Cognitive dimensions (knowledge and skills); 2) Affective dimensions and additional determinants of environmentally responsible behavior (attitude, efficacy, empathy); and, 3) Personal involvement in environmentally responsible behavior (eco-management, economic/consumer action, persuasion, political and legal action). The modified environmental literacy framework that will be used to interpret the relationships among components from the ELS is presented in Figure 2-4.

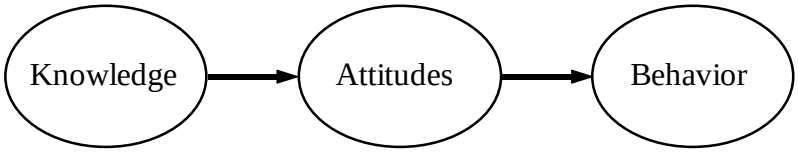

Figure 2-4. Modified Environmental Literacy Framework (After Marcinowski and Rehring 1995)

This model implies that behavioral intention, which is the central element of both the Theory of Reasoned Action (Azjen and Fishbein 1980) and the Theory of Planned Behavior (Azjen 1988), is included as part of the attitude section. This is primarily because behavioral intentions are measured from attitudes, subjective norms and, in some cases, from perceived behavioral control elements. “It appears that intention to act is merely an artifact of a number of other variables acting in combination (e.g. cognitive knowledge, cognitive skills, and personality factors)” (Hines et al. 1986/87, p.6).

This framework does not include social influences of subjective norms though both of these components no doubt have impact on environmental behavior. This is due to the limited impact that universities have on these areas. This framework is designed to allow universities to track progress on the components that universities can impact—knowledge and attitudes (self-efficacy, affective, locus of control, and perceived behavioral control)—in creating responsible, environmentally literate students.

Persuasion Theory

Persuasion theories are mainly used in marketing and advertising rather than by psychologists and sociologists. Yet they are still relevant to this literature review because these theories describe methods for changing individual behaviors and attitudes. In addressing behaviors and attitudes, these theories have underlying themes about how

attitude, behavior and knowledge are related. “Some persuasion theories deal with directive, channeling aspects of the person (how he or she processes the persuasive information). Others deal with dynamic, energizing aspects (why he or she processes it) (McGuire 1989, p.44).” Persuasion theories are usually based on an individual’s response to an outside source, but an alternative method is to make an individual’s existing information more prominent (McGuire 1989).

The Yale attitude change approach

In this approach, developed by Carl Hovland, attitudes are influenced or changed by altering the opinions or beliefs (the knowledge component) that people have. The structure for changing someone’s attitude is based on persuasive communication. The approach has four steps for achieving attitude change. First, you must get the individual’s attention. Second, the message about the attitude you are trying to change must be comprehended by the individual receiving the message. Third, the individual has to accept the message and fourth, they must retain the message long enough to change their behavior. These steps will be impacted positively or negatively based on the source of the message (i.e. the credibility, and status of the source), how you communicate with the individual, how the individual reacts to different messages, and how persuadable they are. This approach is used in advertising and marketing. (Zimbardo et al. 1977)

Rather than explaining how the variables are related, this approach explains what factors have an impact on attitude change and that attitudes are changed by altering beliefs. This is relevant to this study because the theories presented in this literature review all indicate some type of relationship between attitudes and behaviors. Thus, because knowledge changes attitudes and attitudes have an effect on behavior, this

approach provides a basis for understanding why knowledge must be a part of any attempt to ultimately alter behavior.

Attribution theory

Attribution theory explains individual action based on internal or external factors. External factors are situational factors such as social influences (Azjen's subjective norm 1988) or the physical environment. Internal factors are dispositional and refer to an individual's personal characteristics to explain behavior. Internal factors are most often used to explain an individual's behavior (Zimbardo et al. 1977).

This theory explains only how people tend to explain human behavior. It does not tell us how these factors can be impacted. Internal factors, when they include attitude, are part of the environmental literacy framework. Since, internal factors are most often used to explain behavior, these are naturally the focus of attempts to change an individual's behavior. The focus is on changing a person's attitudes rather than on changing their situation or their social influences. Attribution theory supports the behavioral models of Azjen 1988, Azjen and Fishbein 1980, Hines et al. 1986/87, Marcinowski and Rehring 1995 because these models are also based on internal factors.

Social learning theory

Social learning theory explains how behavior can be predicted based on the individual's belief that the outcome will affect them positively or negatively and that people gain their belief about specific behavior based on a learning process. An individual can learn that a behavior is good or bad by directly experiencing the behavior or by seeing someone else perform the behavior (vicarious experience). People can also

be persuaded verbally or emotionally to perform a particular behavior (Zimbardo et al. 1977).

A good example of the social learning theory in an environmental context is the decision to get your car certified to the state emissions standards. If an individual fails to do this, then they will not be able to renew their car registration, which can lead to hefty fines. An individual learns that failing to certify their car will lead to negative consequences for themselves and thus they perform the desired behavior.

Dissonance theory

Dissonance theory is a departure from the standard persuasion theory, such as the Yale attitude change approach presented above, in that changed attitude results from a change in behavior rather than attitude change always being the precursor to behavior change. This idea stems from cognitive dissonance theory in which people adjust their attitudes to match their behavior or that people, based on subjective norms, cannot stand to be different than their peers and thus adjust their attitudes and behaviors accordingly (Zimbardo 1977). When a situation comes up that causes dissonance, a gap between behaviors and either attitudes or knowledge, the individual is motivated, depending on the extent of the difference, to adjust their attitudes, or their beliefs to reduce dissonance. McGuire (1989) believes that this theory is not exclusive of, but rather a supplement to, persuasion based theories.

In an environmental situation, cognitive dissonance would be present if an individual believes that it is acceptable to throw away recyclable goods, and then they find that their peers believe the opposite, that it is not acceptable to throw away recyclable goods. The individual must either change their view and decide like their peers

that they should recycle rather than throw away recyclable goods, or they must change their peer group to one that believes like they do, that throwing away recyclable goods is acceptable.

Relationships Between Components of Environmental Literacy

In the review of relevant theories of behavior change, there has already been discussion of the relationship among many of the components of environmental literacy. In this section, these relationships will be specifically addressed.

Attitudes and Behavior

From the literature review presented above, attitudes and behaviors should be correlated at least moderately with a correlation coefficient above r = .30. Hines et al. (1986/87) found that attitude and behavior had an overall moderate correlation of r = .347. This finding is substantiated by Kaiser et al. (1999, p.4) who found that, “the usual findings reveal either a moderate relationship between environmental attitude and ecological behavior or a weak relationship.” In the Kuhlemeier et al. (1999) study of environmental literacy in Dutch ninth graders, they found a moderate correlation (r = .36) between attitude and behaviors. Counter-intuitively, Hines et al. (1986/87) found that when the behavior was actually observed rather than self-reported, the attitude-behavior correlation went up to r = .427. Other studies have assumed that self-reported behavior is usually over-reported. The results from the Hines et al. (1986/87) study may have been enhanced because the attitudes and behaviors that were correlated were specifically related. For example, a question about how someone feels about recycling is directly

correlated to how much they recycle, whereas other studies correlate general environmental attitudes with specific environmental behaviors.

Conversely, Scott and Willits (1994), in their study of Pennsylvanians' environmental attitudes and behaviors, found that attitudes were predictive of behaviors but the correlations were weak at r = .21.

Attitudes and Knowledge

The relationship between attitudes and knowledge has been studied in several different populations and manners. As Kaiser et al. (1999, p.4) remark, "factual knowledge about the environment is a precondition of one's environmental attitude." The relationship between knowledge and attitude is a complex one and is not fully understood (Zimmerman 1996). In Petrzelka and Korsching's (1996) study of environmental attitudes and behavior toward sustainable agriculture, they found that changing the knowledge and beliefs of farmers about sustainable agriculture also changed their attitudes. In the Kuhlemeier et al. (1999) study of environmental literacy in Dutch ninth grade students, they found a weak correlation between knowledge and attitude.

In Bradley et al.'s (1999) study of knowledge and environmental attitude in high school students, they found that after an environmental science course, students had higher environmental knowledge and attitudes between the pre- and post-tests. In both the pre- and post-tests, students with higher knowledge scores also had higher attitude scores when compared with students who had lower environmental knowledge scores. Similarly, Mangas and Martinez's (1997) study regarding university students enrolled in an elective environmental education course showed that students' environmental

knowledge increased at the end of the course and was accompanied by an increase in environmental attitudes.

Knowledge and Behavior

As indicated by the theoretical models of behavior change described above, knowledge and behavior are not expected to have a strong correlation. In the Kuhlemeier et al. (1999) study of environmental knowledge, attitudes, and behaviors in ninth graders in Holland, they found a weak correlation (r = .20) between knowledge and behavior. In the Hines et al. (1986/87) study they also examined the relationship of knowledge and behavior and found an overall correlation of r = .299 from the 17 studies that reported this data. Those studies that drew from a population of individuals in environmental organizations had a correlation of r = .691 as compared with members of the general public (r = .268) or children (r = .192). Kaiser et al. (1999, p. 4) explains the high correlation between knowledge and behavior reported by Hines et al. (1986/87): "When this relationship (knowledge and behavior) appears to be stronger, it is knowledge about an ecological behavior rather than factual knowledge about the environment that is related to ecological behavior."

These studies support Azjen's (1988, p.134) notion that knowledge is a pre-condition for behavior although it is not included as a separate component of either of his models: "At the most basic level of explanation, behavior is assumed to be a function of salient information, or beliefs, relevant to the behavior." Kaiser et al. (1999, p.4) remark that, "[factual] knowledge should not be related with ecological behavior strongly because its influence is attenuated both by environmental attitude and intention." As indicated above, attitudes are moderate predictors of behavior and in order to have a

positive environmental attitude, an individual must first have the relevant knowledge to hold that attitude.

Gender Subpopulation Studies Regarding Environmental Literacy

Gender has been found to be correlated to environmental attitudes, though not consistently so. “The relationship between gender and environmental concerns has been more carefully theorized than other structural variations in environmental concern. “Women are generally more concerned than men” (Dietz 1998, p. 451). Eagles and Demare (1999) conducted an experiment with 6th grade students to find out if participation in an environmental summer camp would have an impact on their environmental attitudes. They found no significant difference from the pre-test to the post-test and attributed it to an environmental attitude “ceiling” because the participants already had moderate environmental attitudes. However, when analyzing their data, they did find that there was a significant difference between male and female students with regard to their moralistic attitudes but not in their ecologistic attitude. Scott and Willits (1994) found that females were more likely to exhibit environmentally protective consumer behaviors, but men were more likely to participate in environmental political action.

Gifford et al. (1982/83) found in their study of undergraduates that males scored higher in environmental knowledge than females and that more females than males reported they would do something about environmental problems. Likewise, Hausbeck et al. (1992) reported that females expressed more positive environmental attitudes than males, and males had slightly more environmental knowledge than females.

Summary

Several theories on how the various components leading to behavior interact have been presented (Azjen 1988, Azjen and Fishbein 1980, Hines et al. 1986/87, Marcinowski and Rehring 1995). There is the understanding through all of the theories that "there is not a simple progression from knowledge to informed behavior (Dillon and Gayford 1997, p. 283)." What can be ascertained is that the major components are knowledge, attitude and behavior. What types of knowledge (issue-based, factual, and skill-based) and attitude (self-efficacy, locus of control, perceived behavioral control, concern, and consciousness) variables really interact remains to be determined in future research. Several theories include situational factors and social influence (subjective norms). These factors have been omitted from the model used in this study (Figure 2-4) because external factors are not controllable by university environmental literacy programs. The purpose of this research is to show how the components that can be impacted by environmental literacy programs are related, so that when an environmental literacy program is established, changes in correlations and overall environmental literacy can be tracked.

Attitudes and knowledge have historically been found to have weak to moderate correlations. Behavior and attitudes have weak to moderate correlations dependent on what types of attitude (self-efficacy, locus of control, and consciousness) and behavior (self-reported or observed) are being related. Knowledge and behavior have been reported to have no or weak correlations. This is generally thought to be because the affect of knowledge is attenuated by attitudes, situational factors and subjective norms.

Gender differences in environmental attitude have been detected with females generally demonstrating more positive attitudes than males. Likewise, males have been

shown to have more environmental knowledge than females. No research studies were found that discussed differences in environmental attitudes, behaviors or knowledge in relation to class standing or in the range of ages present in a sample of typical undergraduate student.

CHAPTER 3
METHODS

The purpose of this study is to determine whether there is a correlation between the environmental literacy components of attitude, behavior and knowledge in undergraduate university students. In addition, this study will analyze if there is a difference in these correlations based on subpopulation categories of sex, class standing, and age. In this chapter, I will outline the steps taken during the study: 1) evaluation and adaptation of the Green's (1999) Modified Wisconsin Environmental Survey, 2) design of data collection and sampling methods and 3) statistical methods for analyzing the study data followed by a chapter summary.

Development of the Study Instrument

The Environmental Literacy Survey (ELS) (Appendix B) was adapted for use in measuring respondent environmental literacy levels from Green's (1999) Modified Wisconsin Environmental Survey (WES). The original instrument was adapted from the Wisconsin High School Student Environmental Survey, developed by the Wisconsin Center for Environmental Education. Though the survey was originally designed for use in measuring high school student environmental literacy, it has been successfully used by at least three researchers (Green 1999, Hsu and Roth 1998, and Todt 1997) to measure adult environmental literacy.

The instrument was used with the permission of Dr. Peggy Green, Broward County Community College. The ELS consists of three sections (affective, behavioral and cognitive) that are scored separately and then combined to indicate the respondent's environmental literacy level.

Instrument Validity

The instrument that the ELS is based on has been tested extensively for validity both for construction and content by the Wisconsin Center for Environmental Education. The content is based on the Environmental Literacy Framework that was developed by the Wisconsin Center for Environmental Education, which is very similar to the National Association for Environmental Education Guidelines. Pilot tests were conducted to test individual item reliability. A large statewide sample was then administered after which final modifications were made to the survey (Green 1999).

Instrument Reliability

The reliability of each subscale of the Wisconsin High School Student Environmental Survey was calculated based on the 1994 administration of the instrument by the Wisconsin Center for Environmental Education (Peri 1996). For the Affective Subscale, coefficient alpha equals 0.91; for the Behavior Subscale, coefficient alpha equals 0.88, and for Cognitive subscale, coefficient alpha equals 0.84. These numbers indicate that each section is reliable (Green 1999).

ELS Section Definitions

To reduce the use of technical jargon, I renamed the original ELS subsections to environmental attitude (affective), behavior, and knowledge (cognitive). Each subsection is described in the following sections for content and also scoring methodology.

Environmental attitude subsection

The environmental attitude section of the environmental literacy survey refers to the affective subscale from the modified Wisconsin Environmental Survey which was further modified to consist of 15 questions that measure the respondents' attitudes toward environmental and efficacy beliefs, some of which can be identified as behavioral intention items. The responses are scored utilizing a Likert-type scale (strongly agree to strongly disagree) with the least desired environmental attitude being assigned a zero, and the most preferred response being assigned a four. The higher a respondent's score, the higher the level of environmental attitudes in the respondent. The lowest possible total score is zero and the highest possible score is 60. It is worth noting that some of the statements are worded such that the most environmentally friendly answer is sometimes at one end of the scale and at other times at the other end of the scale. Thus, on some statements the responses are reverse coded.

Environmental behavior subsection

The environmental behavior section of the environmental literacy survey refers to the behavioral subscale from the modified Wisconsin Environmental survey, which was further modified to consist of 15 questions that measure the respondent's participation in environmental behaviors. The responses were scored utilizing a Likert-type scale (almost

always to never) with no demonstrated environmental behavioral response being assigned a zero, and the most demonstrated environmental behavior response being assigned a four. The higher the score, the more actively engaged the respondent is in environmental behaviors. The lowest possible total score is zero, and the highest possible total score is 60.

Environmental knowledge subsection

The environmental knowledge section of the environmental literacy survey refers to the cognitive subscale of the modified Wisconsin Environmental Survey that has been further modified to consist of 15 multiple-choice questions that measure the respondent's knowledge of basic ecological concepts, environmental problems, and action strategies. Correct responses are assigned a score of four and incorrect responses a score of zero. The lowest score is zero and the highest 60.

Environmental literacy composite score

Environmental literacy is determined by adding up the three scores from the three subscales for each respondent. The lowest possible score is zero, and the highest is 180. This score is only utilized to analyze differences in subpopulations and is not considered in the correlation analysis.

Study Design

Subjects

Respondents were selected from the undergraduate student population of the University of Florida. Respondents represent both science and non-science populations of the university, and a diversity in class standing/age. Demographic data was collected at the time of administration to enable subpopulation analysis of environmental literacy levels. The sample size was n=817.

Sample Size Determination

A priori determination of sample size was calculated for power of .95 and $\alpha = 0.05$ and the required sample size was n=468. The actual sample size for this study was n=817, exceeding the minimum required size by approximately a factor of 2.

Data Collection

Since it was not possible to perform a random selection of students, (the researcher had no authority or incentives to require completion of the survey), a representative sampling method was employed by selecting respondents from a variety of classes offered in diverse disciplines at UF- natural sciences (Wildlife Issues), social science (Political Science- several classes), engineering (Civil Engineering), technical school (Building Construction- several classes) and liberal arts (Introductory English classes). Some instructors required the respondents to complete the survey on in-class paper or on the internet. Others required completion of the survey outside of class time with an incentive of minimal extra credit. The researcher provided a list of respondents to instructors using the outside of class method.

To allow for easy access of the survey an on-line form was constructed and placed on-line at <http://grove.ufl.edu/~nck>. Respondents completed the survey and the response was e-mailed directly to the researcher. The online survey represented 80% of the respondents, allowing for a tremendous reduction in the amount of paper needed to conduct the survey. The survey took respondents approximately 15 minutes to complete on paper or on the web.

Data Analysis

The survey responses were entered into a worksheet in Excel 2000 that coded the responses based on the Likert-type scale employed for the attitude and behavioral sections, and for correct answers in the knowledge section. Composite scores for each section and then for the survey as a whole were then calculated.

Following coding, the data was imported into SPSS 10.0 for Windows for statistical analysis. Pearson's and Spearman's correlations were determined following tests to rule out multi-collinearity of the variables in each section. Based on the observed correlations, principal component analysis was undertaken to determine if specific factors or components were causing variability. ANOVA procedures were used to test differences in the subpopulations on each of the subsections and for an overall environmental literacy index. Unless noted otherwise, all tests were conducted at the $\alpha = .01$ level.

Correlations

A correlation coefficient describes the extent to which data points of two different variables, for example behavior and attitude, tend to fall along a straight line. As the points disperse away from a linear relationship, the correlation is said to be weaker and, conversely, as the points cluster closer to a straight line, the correlation is said to be stronger (Hinton 1995). All correlation coefficients return a value between –1 and 1. The sign of the number indicates the slope of the line. A correlation of 0 indicates that there is no correlation between the variables at all. A correlation of 1, regardless of sign, indicates that there is a perfect correlation between the variables. "In social sciences, correlations around 0.30 have been considered satisfactory and consistent with this practice, we would suggest that correlations below this level are usually of little practical value even if they are significant (Azjen and Fishbein 1980, p.99)." Jaeger (1983) cautions researchers to know what is typical for their type of research when determining whether a correlation is weak, strong or absent and not to arbitrarily abide by guidelines set by a statistical textbook. Further, Hurlburt (1994) states that correlation coefficients state the degree of the linear relationship between two variables and do not describe possible non-linear relationships that may exist. Hurlburt (1994) recommends examining a scatter plot of the two variables to visualize what type of relationship the variables have so that possible non-linear relationships can be detected.

There are several different methods for obtaining correlation coefficients depending on the type of data to be analyzed. For interval-level data, Jaeger (1983, p. 80) recommends that, "the Pearson correlation coefficient should always be used because it makes better use of the interval-level properties of data." Interval-level data means that the measurement scale is divided into equal units of measurement. The Pearson product-

moment correlation, *r*, uses the actual value of the data to determine the extent of the linear relationship or correlation.

Another commonly used method for determining correlations is the Spearman rank-order method, r_s. This method can be used for data that is measured at an ordinal (data that can not be guaranteed to be of equal measurements) or interval-level. Spearman's method does not use the actual values of the variables to determine the linear relationship but instead uses their relative ranks.

Both Spearman and Pearson's correlations are interpreted the same way and both methods were used to analyze the data for this study (see Chapter 4-Results and Analysis).

Principal Component Analysis

Principal component analysis (PCA) is indicated when "an investigator has assembled a set of items (say 20 to 50) designed to measure some type of construct (e.g., attitude toward educations, anxiety or sociability), (Stevens 1996, p. 362)". PCA is a multi-step process. First, the variables' covariance matrix is calculated. Eigenvalues, a measure of variance, are determined based on the covariance matrix. The component that has the largest eigenvalue, that is the one that explains the maximum variance, is the principal component. The number of components that can be generated for a model is usually the number of variables in the model. Conventionally, only components that have eigenvalues above 1 are considered. Successive components are uncorrelated to each other. According to Stevens (1996), a good component, with a sample size of 817, will have four or more loadings above 0.60, or about 10 or more low loadings of 0.40.

SPSS determines the number of components that are significant for a model (eigenvalues > 1) and generates a table of factor loadings for each variable for each component. Factor loadings are a mathematical relationship between the individual variable and the component. This indicates the variables that are loading, that is, that are well-related to each component. This allows the researcher to determine if there is a specific construct underlying a particular component (Stevens 1996). If the researcher can identify a construct for a component, then they have succeeded in narrowing down the number of factors in their model. The hope is that a few components will explain most of the variability in the model, for example four or five components should explain 75% of the variance. To determine which variables to keep in the model based on factor loading, Stevens (1996) recommends using only loadings that are greater than 0.40 for interpreting factors. For example, if there are 20 variables and PCA identified four components that loaded 16 of the variables, and this was readily explainable, the four variables that failed to load could be discarded.

Summary

To undertake this study, a series of steps were undertaken. First, the instrument was developed by evaluating the Wisconsin Environmental Survey and modifing it for use by undergraduate university students. Second, the study was designed employing a sampling methodology that ensured representation from a wide variety of academic majors and classifications. The survey was administered primarily by using the internet. This methodology resulted in a sample size of n=817 which was in excess of the n=468 required for a power of .95 and $\alpha = .05$. Finally, statistical methods used for data

analysis—Pearson's and Spearman's Correlations, ANOVA and Principal Component Analysis—were described.

CHAPTER 4
FINDINGS

This chapter will present results of the analysis of the data from the Environmental Literacy Survey (ELS). The survey sample and overall analysis of undergraduate environmental literacy at the University of Florida (UF) are described first, followed by presentation of the experimental data in the context of the two research hypotheses.

Survey Respondents Summary

There were 817 respondents to the Environmental Literacy Survey (ELS), representing a wide variety of academic majors. 51.6 % of the respondents were males and 48.4% were female. 68.2% were younger than 20 years of age, and 31.8% were 20 years of age or older. 49.7% of the respondents were freshmen, 24% sophomores, 14.7% juniors, and 11.6% seniors.

Undergraduate Environmental Literacy at UF

The overall mean score for environmental attitude section of the ELS was 42.3 (70.5%). The responses were normally distributed as shown in Figure 4-1. In order to put the mean scores in a true university context, a letter grade will also be assigned for each section of the ELS and for the overall ELS index score. A common grading scale employed by UF faculty is as follows: A (100-90%), B (89-80%), C (79-70%), D (69-

60%) and E (below 60%). On the basis of this generic grading scale, UF undergraduate students rate barely a C in environmental attitudes. Yet, the attitude component is the highest mean score of the ELS components.

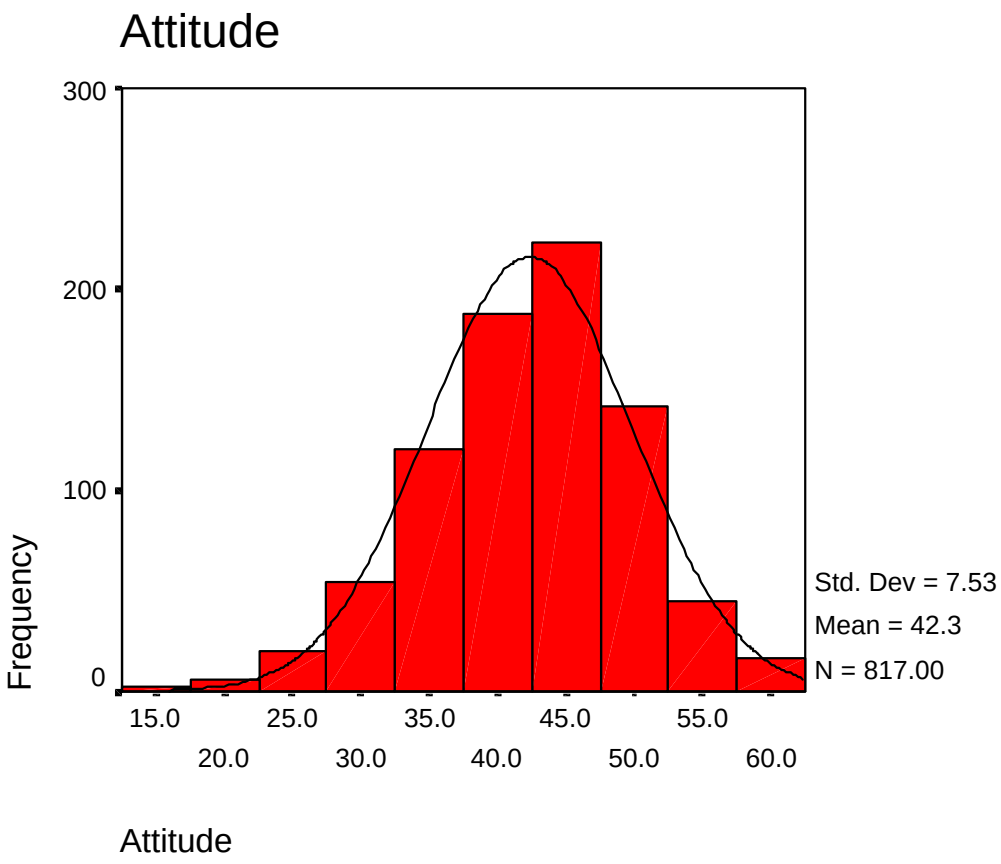

Figure 4-1. Histogram of the Attitude section of the Environmental Literacy Survey.

The mean of the behavior section of the ELS was distributed normally and had a mean of 23.4 (39%), (Figure 4-2). Undergraduate students perform environmental behaviors only 39% of the time thus receiving a solid E on the generic university grading scale. Behavior is the lowest scoring component of the ELS.

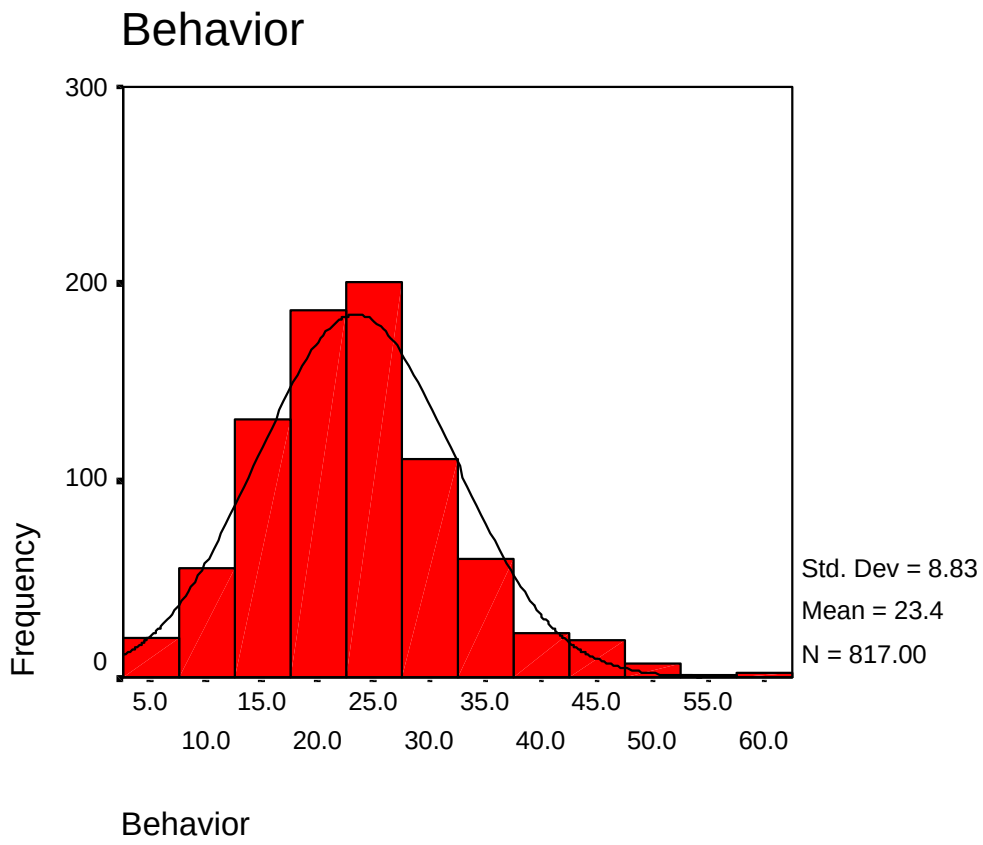

Figure 4-2. Histogram of the Behavior section of the Environmental Literacy Survey.

The mean of the knowledge section was distributed normally and had a mean value of 39.3 (66.5%), which is a D on the generic university grading scale (Figure 4-3). Knowledge is the median scoring component of the ELS.

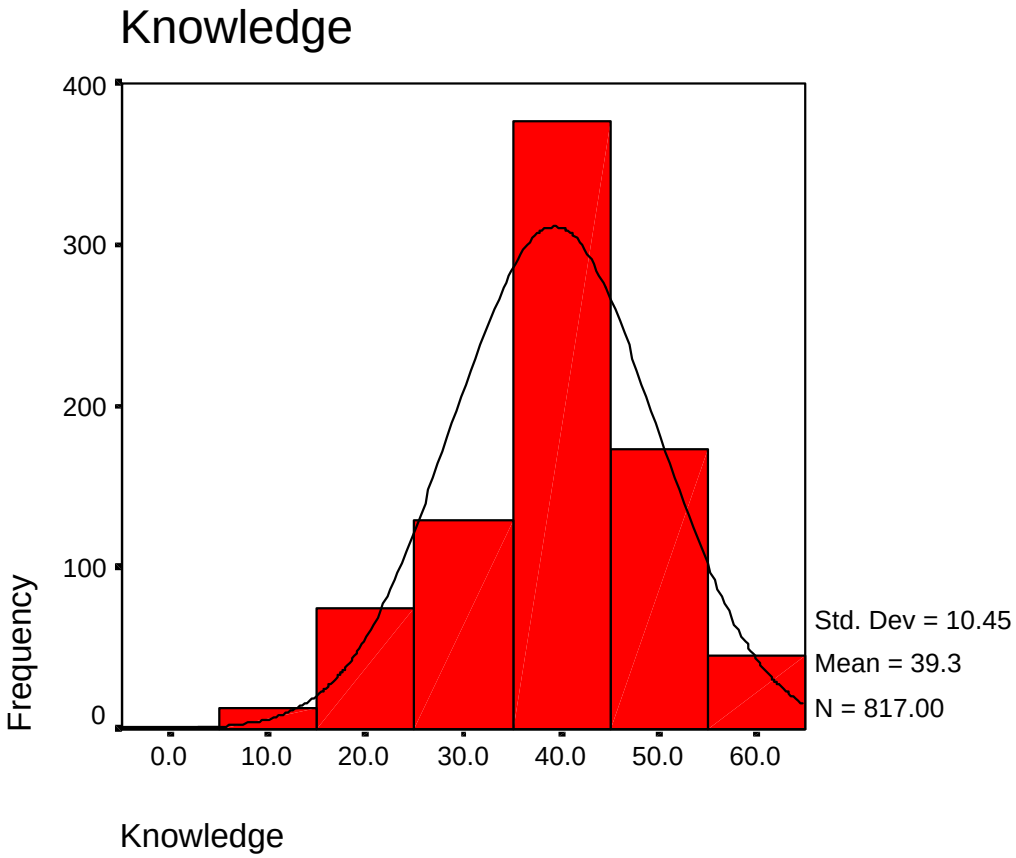

Figure 4-3. Histogram of the Knowledge section of the Environmental Literacy Survey.

The environmental literacy index score, which is the sum of the attitude, behavior and knowledge sections, had an overall mean of 105 (58.3%) giving undergraduates a rating of E on the generic university grading scale (Figure 4-4).

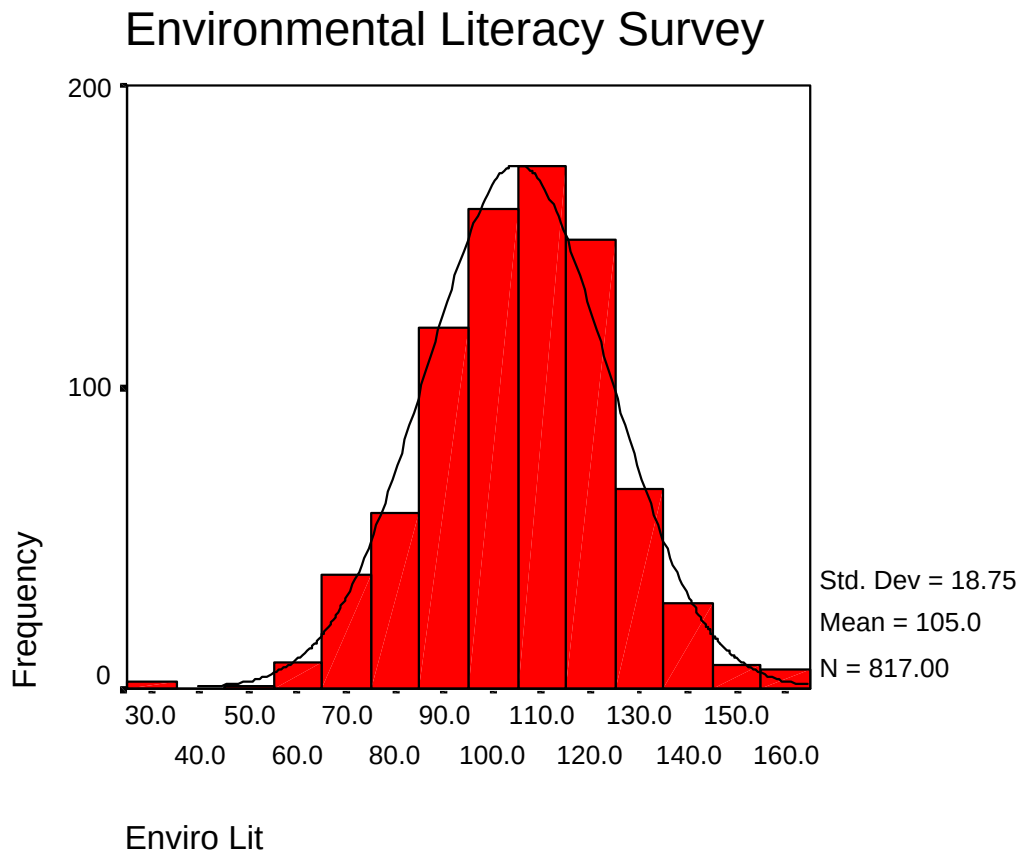

Figure 4-4. Histogram of the Environmental Literacy Survey.

The results of this study show a higher score for environmental attitudes, followed by intermediate knowledge and very low behavior. This trend is well documented in the literature. Scott and Willits (1994, p. 255) found in their study of Pennsylvanians that subjects expressed strong positive environmental attitudes but did not perform many environmental behaviors commented, "The observed low attitude-behavior linkage may be less a result of questioning wording or measurement error than a real disparity between words and deeds." Diekmann and Preisendorfer (1998) also noted considerable discrepancies between environmental attitudes and behaviors in their citizen survey of residents in Switzerland and Germany. Connell et al. (1999) in their study of Australian

youth also noted ambivalence in response to questions regarding personal action to protect the environment. Kuhlemeier et al. (1999) in their study of Dutch youth noted the same phenomena. Though this may be discouraging it is intuitive that unless people are experiencing cognitive dissonance, having a positive environmental attitude is a pre-condition to performing environmental behaviors.

> "Although people may be less likely to engage in environmentally protective behaviors than they are to express support for environmental principles, it never the less seems likely that those who hold the most supportive attitudes would be more inclined than those with less supportive attitudes to act in ways that protect the environment. (Scott and Willits 1994, p. 240)"

Thus it is not useless to continue to investigate and encourage positive environmental attitude despite the lack of a perfect correlation.

Summary

Undergraduates at UF have a moderately high environmental attitude (70.5%), followed by moderate knowledge (65.5%) and very low environmental behaviors (39%). It is worth noting that since the behaviors were self-reported rather than observed, actual behaviors are probably lower, perhaps much lower.

Research Question One

What will be the extent of the relationships of an individual's score on the separate components of the environmental literacy survey (knowledge/cognitive, attitudes/affective and behavior)?

Hypotheses

An individual's score on the knowledge section will correlate weakly to the score on the attitude section but not to the behavior section of the environmental literacy survey. The attitude section and the behavior section will be moderately correlated.

Results

Following tests to rule out multi-collinearity, correlations were calculated. The initial Pearson and Spearman correlations were all significant except for the behavior-knowledge Pearson's correlation, which was not significant. They indicated that there is a very weak correlation between knowledge and behaviors (r = not significant, r_s = .096), a weak to moderate correlation between knowledge and attitudes (r = .220, r_s = .202) and a moderate to strong correlation between attitudes and behavior (r = .480, r_s = .494). There was an insignificant relationship between knowledge and behavior. The results are presented graphically in Figure 4-5.

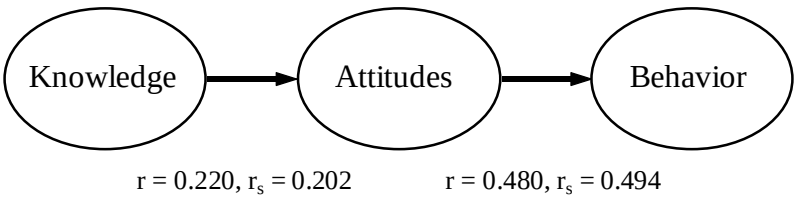

Figure 4-5. Relationships between environmental knowledge, attitudes and behaviors.

These correlations are consistent with values reported in the literature but in order to rule out any problems with specific variables, principal component analysis was performed for each section.

Principal Component Analysis

Based on the factor loading table for each section, I examined whether there was any connection between variables that did or did not load on each component that would warrant division of the sections into subsections, or omission of specific survey items because of correlations with other items that represented the same results. As described in Chapter 3, the point of principal component analysis is to group variables (or survey items) thematically to attempt to minimize the number of variables in an analysis.

Attitude section

In the attitude section, total variability explained by the three extracted components was 43.4% (Table 4-1) which is not as high as is usually hoped for with principal component analysis but there was a divisible relationship evident from the factor loading (Table 4-2). Items A1, A8, A14, and A15 (Appendix A) all failed to load highly on component 1. Upon examination of the content, it became evident that these statements, except for Item A1, are efficacy statements that relate directly to beliefs regarding behavioral control as described in Azjen's (1988) Model of Planned Behavior. The attitude section can be divided into an affective subsection and a perceived behavioral control subsection. This modification to the environmental literacy model will be addressed following presentation of the behavior and knowledge principal component analysis results.

Table 4-1. Total variance of attitude section explained.

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.874	25.829	25.829	3.874	25.829	25.829
2	1.401	9.343	35.172	1.401	9.343	35.172
3	1.235	8.236	43.408	1.235	8.236	43.408
4	.943	6.290	49.698			
5	.917	6.113	55.811			
6	.864	5.761	61.572			
7	.796	5.307	66.879			
8	.771	5.140	72.019			
9	.736	4.904	76.923			
10	.687	4.583	81.506			
11	.650	4.335	85.841			
12	.602	4.017	89.857			
13	.569	3.793	93.650			
14	.496	3.309	96.959			
15	.456	3.041	100.000			

Table 4-2. Component matrix: attitude section.

	Component		
	1	2	3
A7:	.667	3.882E-02	-.401
A9:	.582	-.355	1.953E-02
A3:	.570	.139	-.413
A13:	.567	-.351	.269
A12:	.565	5.138E-02	-8.37E-02
A10:	.560	-.353	.340
A6:	.549	9.008E-02	-5.07E-02
A2:	.516	.444	.173
A5:	.485	-.280	-.149
A11:	.466	-.412	-4.06E-02
A4:	.453	.118	-.449
A1:	.389	.499	.214
A8:	.375	.382	1.885E-02
A15:	.309	.374	.243
A14:	.447	2.734E-02	.588

Behavior section

In the behavior section, the total variability explained by the three extracted components is 51.11% (Table 4-3). The factor loadings did not meet the requirements given by Stevens (1996) of a good component (Table 4-4) as there were not several items loading above 0.60 or ten or more items loading above 0.40. Thus, in the behavioral section, no divisions or grouping of variables were warranted.

Table 4-3. Total variance of behavior section explained.

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.147	34.313	34.313	5.147	34.313	34.313
2	1.503	10.022	44.335	1.503	10.022	44.335
3	1.016	6.773	51.108	1.016	6.773	51.108
4	.942	6.280	57.388			
5	.825	5.503	62.891			
6	.767	5.116	68.007			
7	.685	4.568	72.574			
8	.642	4.277	76.851			
9	.605	4.032	80.884			
10	.587	3.911	84.795			
11	.537	3.582	88.377			
12	.483	3.220	91.597			
13	.458	3.056	94.653			
14	.426	2.840	97.493			
15	.376	2.507	100.000			

Table 4-4. Component score coefficient matrix: behavior section

	Component		
	1	2	3
B1:	.062	-.261	.502
B2:	.130	-.193	.147
B3:	.082	-.007	.457
B4:	.129	-.021	.306
B5:	.136	-.173	.113
B6:	.109	-.069	-.357
B7:	.119	-.038	-.033
B8:	.092	-.221	-.178
B9:	.133	-.128	-.249
B10:	.145	.034	-.094
B11:	.094	.387	.124
B12:	.116	.119	-.245
B13:	.135	-.057	-.228
B14:	.088	.437	.184
B15:	.101	.313	-.056

Knowledge section

In the knowledge section, the five extracted components accounted for 44.2% of the variability (Table 4-5). Like the behavior section, the knowledge section did not meet the requirements for a good component as there were no loadings above 0.20. Thus, no groupings of variables were warranted for the knowledge section.

Table 4-5. Total variance of knowledge section explained.

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.249	14.996	14.996	2.249	14.996	14.996
2	1.187	7.914	22.910	1.187	7.914	22.910
3	1.073	7.155	30.065	1.073	7.155	30.065
4	1.071	7.137	37.202	1.071	7.137	37.202
5	1.055	7.031	44.233	1.055	7.031	44.233
6	.994	6.624	50.857			
7	.925	6.164	57.021			
8	.899	5.997	63.018			
9	.867	5.783	68.801			
10	.848	5.656	74.457			
11	.829	5.525	79.982			
12	.804	5.362	85.344			
13	.780	5.198	90.543			
14	.724	4.828	95.371			
15	.694	4.629	100.000			

Table 4-6. Component score coefficient matrix: knowledge section.

	Component				
	1	2	3	4	5
C1:	.136	.077	.040	.095	-.461
C2:	.102	.419	.288	.111	-.132
C3:	.218	-.121	-.125	.057	.137
C4:	.171	.264	-.038	.320	.352
C5:	.184	.076	.210	-.407	-.124
C6:	.165	.296	.097	.097	-.303
C7:	.192	-.056	-.146	.307	.189
C8:	.227	-.353	-.136	.039	.009
C9:	.233	-.109	.019	-.061	-.181
C10:	.127	.118	-.221	-.249	.455
C11:	.137	.286	.064	-.425	.147
C12:	.174	-.214	-.418	-.098	-.358
C13:	.185	-.228	.352	-.302	.179
C14:	.173	.189	-.120	.310	.041
C15:	.076	-.338	.609	.305	.095

New Model Resulting from Principal Component Analysis

As indicated by the results of the principal component analysis of the attitude section, an additional component--perceived behavioral control--was added to the model. The original model contained a knowledge, behavior and attitude component. The attitude component contained statements regarding both self-efficacy (perceived behavioral control), and general attitudes towards the environment. It is evident that self-efficacy and general attitude statements should be separate components when it is possible in order to analyze their independent relationships with each other and with behavior.

The resulting model is essentially the same as the Theory of Planned Behavior (Azjen 1988) that was presented in the literature review (Chapter 2) without the subjective norm. It also is directly representative of the original four components of the environmental literacy framework proposed by Marcinowski and Rehring (1995) which were 1) cognitive, 2) affective, 3) self-efficacy and 4) behavior.

The resultant correlations are basically the same as the original ELS model, in that there was not a significant decrease in correlations caused by the addition of the perceived behavioral control component. The correlation between attitude and behavior is still moderate. The correlation between knowledge and attitudes is weak. The correlation between attitudes and perceived behavioral control are moderate as is the correlation between behavior and perceived behavioral control.

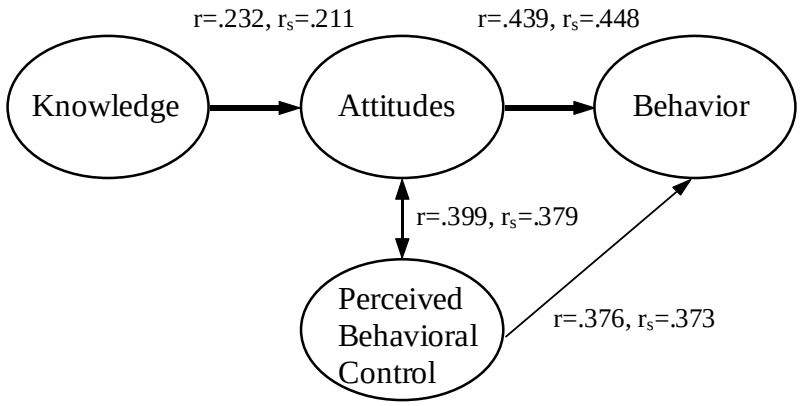

Figure 4-6. Model of environmental literacy as a result of principal component analysis.

Does this model actually describe anything more than the original proposed model in Figure 4-6 for universities engaged in environmental literacy programs? It indicates that there is a moderate correlation between attitudes, perceived behavioral control and behavior. However, as discussed in the literature review, a strong correlation is not expected between knowledge and behavior because the relationship is moderated by attitude, the correlation between attitude and knowledge is not substantial. This might indicate that even though knowledge may be the easiest component to address in a university environmental literacy program, that focusing on attitudes and perceived behavioral control as separate components may lead to the desired environmental behaviors. However since this experimental data was obtained from a university without a formal environmental education program, it is difficult to say whether or not knowledge may have a stronger correlation to behaviors if there is a directed environmental literacy program in place, and particularly if that program is focused on skills knowledge rather than factual knowledge.

Summary for Research Question One

As stated in my hypothesis, there is a weak to moderate correlation between knowledge and attitude. This is supported by other experiments mentioned in the literature review where knowledge and attitudes had a weak to moderate relationship (Bradley et al. 1997, Mangas and Martinez 1997, Kaiser et al. 1999, Petrzelka and Korsching 1996, Zimmerman 1996). Knowledge and behavior did not have a strong relationship in either model supporting the Kaiser et al. (1999) statement that knowledge and behavior will not have a strong correlation because the connection is attenuated by attitudes and intentions. There was also no significant relationship between perceived behavioral control and knowledge.

Attitudes and behaviors have a moderate to strong correlation, which supports the literature findings in other similar experiments with different subject groups such as school children (Bradley et al.1999), teachers (Hsu and Roth 1998) and the general population (Hines et al. 1986/87, Kaiser et al. 1999). The relationship between perceived behavioral control, attitudes and behavior was reported by Azjen (1988, p.132-133): "As a general rule, the more favorable the attitude and the subjective norm with respect to a behavior, and the greater the perceived behavioral control, the stronger should be the individual's intention to perform the behavior under consideration."

Research Question Two

Will there be a measurable difference in the subpopulations (male/female, class standing/age) scores on the three sections and total score?

Hypothesis

In the male/female subgroups, there will be no difference in the behavioral section. In the affective section, females will score higher whereas in the cognitive section males will score higher. There will be no significant difference in any of the sections based on class standing or age.

Gender subpopulation analysis

From the ANOVA table (Table 4-7), there was a significant difference in several of the environmental literacy sections based on gender. The mean attitude score for males was 41.44 (69.1%), whereas the mean female score was 43.36 (72.3%), (Table 4-8). This was a significant difference. Females have a significantly higher attitude than males as hypothesized. The mean knowledge score for males was 40.50 (67.5%), whereas the mean female score was 37.96 (63.3%), (Table 4-8). This difference was also significant. Thus, as hypothesized, males did have a significantly higher mean knowledge score than females.

Though, it was not hypothesized, there was a significant difference in behaviors at the $\alpha = .05$ level with a significance of $\alpha = .017$. Although this is not as stringent a level as is used for the analysis of the experimental data, it is noted because it is close to being significant at the $\alpha = .01$ level and is well within the $\alpha = .05$ level often used for social science experiments. Males had a mean behavior score of 22.69 (37.8%) and females had a mean behavior score of 24.16 (40.3%). Thus females had a significantly higher behavior mean than males.

Table 4-7. ANOVA by gender.

		Sum of Squares	df	Mean Square	F	Sig.
Attitude	Between Groups	748.067	1	748.067	13.400	.000
	Within Groups	45498.905	815	55.827		
	Total	46246.972	816			
Behavior	Between Groups	439.550	1	439.550	5.669	.017
	Within Groups	63190.000	815	77.534		
	Total	63629.550	816			
Knowledge	Between Groups	1316.444	1	1316.444	12.219	.000
	Within Groups	87803.086	815	107.734		
	Total	89119.530	816			
Enviro Lit	Between Groups	144.804	1	144.804	.412	.521
	Within Groups	286704.4	815	351.785		
	Total	286849.2	816			

Table 4-8. Mean component scores by gender.

Personal_Sex:		Attitude	Behavior	Knowledge	Enviro Lit
Male	Mean	41.44	22.69	40.50	104.63
	N	431	431	431	431
	Std. Deviation	7.85	8.70	10.46	18.73
	% of Total Sum	51.6%	51.2%	54.4%	52.6%
Female	Mean	43.36	24.16	37.96	105.48
	N	386	386	386	386
	Std. Deviation	7.03	8.92	10.28	18.79
	% of Total Sum	48.4%	48.8%	45.6%	47.4%
Total	Mean	42.35	23.39	39.30	105.03
	N	817	817	817	817
	Std. Deviation	7.53	8.83	10.45	18.75
	% of Total Sum	100.0%	100.0%	100.0%	100.0%

Class standing subpopulation analysis

Environmental literacy and the knowledge component were significant at the $\alpha = .01$ level when ANOVA was calculated based on class standing (Table 4-9). Freshmen had the lowest environmental knowledge score with a mean of 37.43 (62.4%), followed by seniors with a mean of 40.59 (67.7%), sophomores with a mean of 41.1 (68.5%) and juniors with a mean of 41.57 (69.3%), (Table 4-10). Though this was significant the percentage increase from highest to lowest was only 6.9%. All categories of class standings had no higher than a D on the generic university grading scale.

It is intuitive that freshmen would have the lowest knowledge score and that over time, and a few science courses, factual knowledge of environmental principals would increase. However, it is counter intuitive that following freshmen, the next lowest group in environmental knowledge was the senior group. A possible explanation for this may be that sophomores and juniors may take required science courses and thus score higher on the knowledge section while seniors are primarily enrolled in courses for their major. This would indicate that seniors who were previously enrolled as sophomores or juniors in required science classes have failed to retain the factual knowledge gained while enrolled. Further research is required to test these new hypotheses.

Table 4-9. ANOVA based on class standing

		Sum of Squares	df	Mean Square	F	Sig.
Attitude	Between Groups	451.305	3	150.435	2.671	.046
	Within Groups	45795.667	813	56.329		
	Total	46246.972	816			
Behavior	Between Groups	727.646	3	242.549	3.135	.025
	Within Groups	62901.904	813	77.370		
	Total	63629.550	816			
Knowledge	Between Groups	2876.870	3	958.957	9.040	.000
	Within Groups	86242.660	813	106.080		
	Total	89119.530	816			
Enviro Lit	Between Groups	8542.447	3	2847.482	8.318	.000
	Within Groups	278306.7	813	342.321		
	Total	286849.2	816			

Environmental literacy overall also was significantly different at the $\alpha = .01$ level (Table 4-9). Freshmen again had the lowest mean environmental literacy mean index score of 102.05 (56.7%), (Table 4-10) followed by sophomores with a mean index of 106.11 (59%), seniors with a mean index of 109.05 (60.6%) and juniors with a mean index of 110.18 (61.21%). Like the knowledge component, it appears that over time in university, undergraduates do increase their overall environmental literacy index. Though this increase, also akin to knowledge, only results in a difference of 4.5% from the maximum index score from juniors to the minimum index score from the freshmen. This suggests that adding an environmental literacy program could augment the natural increase in the environmental literacy index score that seems to result over time spent at university. The regression of the senior group in environmental knowledge should be further examined.

Table 4-10. Mean component scores by class standing

Class		Attitude	Behavior	Knowledge	Enviro Lit
Freshmen	Mean	41.84	22.79	37.43	102.05
	N	406	406	406	406
	Std. Deviation	7.06	8.40	10.33	18.31
	% of Total N	49.7%	49.7%	49.7%	49.7%
Junior	Mean	43.62	24.98	41.57	110.18
	N	120	120	120	120
	Std. Deviation	7.56	9.91	10.50	18.13
	% of Total N	14.7%	14.7%	14.7%	14.7%
Sophomore	Mean	42.05	22.90	41.16	106.11
	N	196	196	196	196
	Std. Deviation	8.22	8.44	9.77	19.09
	% of Total N	24.0%	24.0%	24.0%	24.0%
Senior	Mean	43.53	24.94	40.59	109.05
	N	95	95	95	95
	Std. Deviation	7.75	9.64	10.96	18.54
	% of Total N	11.6%	11.6%	11.6%	11.6%
Total	Mean	42.35	23.39	39.30	105.03
	N	817	817	817	817
	Std. Deviation	7.53	8.83	10.45	18.75
	% of Total N	100.0%	100.0%	100.0%	100.0%

As with the gender section above, there were two other components that were significantly different at the $\alpha = .05$ level but not at the $\alpha = .01$ level. These were the attitude and behavior sections of the ELS. As in the knowledge section and the environmental literacy index score, freshmen exhibited the lowest means in both the attitude and behavior section, followed by the sophomores, seniors and then juniors. This indicates, as mentioned above, that there is an inherent increase in environmental literacy while students are at university over a period of time.

Age subpopulation analysis

As with the class standing subpopulation analysis, there was a significant difference in all sections and with the environmental literacy index score when performed

at the α = .05 level and a significant difference if the behavior and environmental literacy index score at the α = .01 level (Table 4-11).

Table 4-11. ANOVA based on age.

			Sum of Squares	df	Mean Square	F	Sig.
Attitude	Between Groups	(Combined)	332.956	1	332.956	5.910	.015
	Within Groups		45914.016	815	56.336		
	Total		46246.972	816			
Behavior	Between Groups	(Combined)	530.857	1	530.857	6.857	.009
	Within Groups		63098.693	815	77.422		
	Total		63629.550	816			
Knowledge	Between Groups	(Combined)	707.096	1	707.096	6.518	.011
	Within Groups		88412.434	815	108.482		
	Total		89119.530	816			
Enviro Lit	Between Groups	(Combined)	4607.517	1	4607.517	13.305	.000
	Within Groups		282241.7	815	346.309		
	Total		286849.2	816			

In every section, the >20 subpopulation, survey respondents who are 21 years of age or older, mean scores were higher than the <20 subpopulation mean scores, survey respondents who are 20 years of age or older, (Table 4-12). In the attitude section, >20 had a mean score of 43.28 (72.1%) and <20 had a mean score of 41.91 (69.9%). In the behavior section, >20 had a mean score of 24.57 (41%) and the <20 had a mean score of 22.83 (38.1%). In the knowledge section, >20 had a mean score of 40.66 (67.8%) and the <20 had a mean score of 38.66 (64.4%). In then environmental literacy index score, > 20 had a mean index score of 108.51 (57.5%) and <20 had a mean score of 103.41 (57.5%).

Table 4-12. Mean component scores based on age.

age		Attitude	Behavior	Knowledge	Enviro Lit
<20	Mean	41.91	22.83	38.66	103.41
	N	557	557	557	557
	Std. Deviation	7.26	8.25	10.30	18.12
	% of Total N	68.2%	68.2%	68.2%	68.2%
>20	Mean	43.28	24.57	40.66	108.51
	N	260	260	260	260
	Std. Deviation	8.00	9.88	10.66	19.62
	% of Total N	31.8%	31.8%	31.8%	31.8%
Total	Mean	42.35	23.39	39.30	105.03
	N	817	817	817	817
	Std. Deviation	7.53	8.83	10.45	18.75
	% of Total N	100.0%	100.0%	100.0%	100.0%

This section follows the results of the class standing subpopulation analysis in that the older students, who presumably are also upper classmen, had higher scores in every section. Thus, there must be some increase in environmental literacy gained with time. It cannot be determined from this research if this effect is directly as a result of time spent in a university or if it is caused by some other unknown variable.

Summary

A portion of my research hypothesis was substantiated at the $\alpha = .01$ level, that is, that males did have a significantly higher knowledge component score, while females had a significantly higher attitude score. At the $\alpha = .05$ level, females also had a significantly higher behavioral score than males did. There was no significant difference in the overall environmental literacy index score in the gender subpopulation analysis.

The remaining part of my hypothesis was not substantiated in that significant differences were found in each component of environmental literacy at the $\alpha = .05$ level (and for most of the components at the $\alpha = .01$ level) and in the environmental literacy

index score as well, in the age and class standing subpopulation analysis of variance. This indicates that there may be some type of intrinsic increase in environmental literacy as time spent at university increases. This may be due to required science courses or an enhanced worldview. Further research is needed to test whether the difference is due to a university effect or to some other unexplained variable. This could be done by tracking a specific group of undergraduates, and another group of young people who are not undergraduate students, over a period of four years to distinguish if the increase in environmental literacy is due to aging, to university experience or both factors.

CHAPTER 5
DISCUSSION OF FINDINGS

This chapter will summarize the research findings, discuss the results, and suggest recommendations for further environmental literacy research in undergraduate university students.

Summary of Research Findings

Undergraduate Environmental Literacy at the University of Florida

The results of this study of undergraduate environmental literacy at UF were similar to other studies that showed that attitudes are highest, followed by lower knowledge and low behavior (Connell et al. 1999, Diekmann and Preisendorfer 1998, Kuhlemeier et al. 1999, Scott and Willits 1994, p. 255).

Environmental Literacy Component Correlation

The study attempted to answer the question: what will be the extent of the relationships of an individual's score on the separate components of the environmental literacy survey (knowledge/cognitive, attitudes/affective and behavior)? The initial correlations showed an insignificant relationship between knowledge and behavior. Knowledge and attitude had a weak correlation ($r=.220$, $r_s=.202$). Attitude and behavior components demonstrated a moderate correlation ($r=.480$, $r_s=.494$). These findings supported my hypothesis as well as results from other environmental literacy studies recounted in the literature review.

Principal component analysis (PCA) was also carried out on the data in order to ensure that there were no variables that could be discarded from the model based on a qualitative interpretation of the factor loadings. As a result of a component's factor loadings found in the attitude section, a model (Figure 4-6) was generated that contained an additional component that was partitioned from the attitude section—perceived behavioral control. This additional component was consistent with both the environmental literacy framework proposed by Marcinowski and Rehring (1995) and by Azjen (1988) minus the subjective norm component described in Chapter 2.

The correlations that were calculated for this model produced basically the same results as the initial correlations. Knowledge had an insignificant relationship to behavior and to perceived behavioral control. Knowledge also had a weak correlation with attitude ($r=.232$, $r_s=.211$). The relationship between attitude and behavior was still moderate ($r=.439$, $r_s=.448$). Behavior and perceived behavioral control also demonstrated a moderate correlation ($r=.376$, $r_s=.373$). Finally, attitude and perceived behavioral control had a moderate relationship ($r=.399$, $r_s=.379$).

Subpopulation Differences in Environmental Literacy

The study attempted to analyze differences in undergraduate subpopulation environmental literacy. Using ANOVA, in the gender subpopulation analysis, females had a significantly higher attitude score than males, while males had a significantly higher cognitive score. This supported my hypothesis and the studies presented in the literature review. At the $\alpha = .05$ level, there was also a significant difference in environmental behaviors with females scoring higher than males.

In the class-standing analysis, at the $\alpha = .01$ level, there was a significant difference in environmental knowledge and overall environmental literacy. In environmental knowledge, freshmen had the lowest score, followed by seniors, sophomores and juniors. In environmental literacy (the composite score comprised of the attitudes, behavior and knowledge components), freshmen had the lowest scores in each category, followed by sophomores, then seniors and finally juniors. At the $\alpha = .05$ level attitude and behavior were also significant. Again freshmen had the lowest attitudes and behaviors, followed by sophomores, seniors and then juniors. Interestingly, juniors scored the highest in every component. Seniors had the second lowest knowledge score after freshmen but exhibited higher attitudes, behaviors and overall environmental literacy than the sophomores. This trend cannot be adequately explained on the basis of this study. However, it seems that since freshmen scored the lowest in every category, that there is some increase in environmental literacy while in university. It is not possible to say whether this general trend of increased environmental literacy is as a result of taking science courses, simply growing older and more responsible or increased exposure about environmental issues through media sources such as television, newspapers, magazines and the internet. This still does not explain the regression in senior environmental knowledge.

In the age subpopulation, the results were essentially the same as for the class-standing analysis. There was a significant difference at the $\alpha = .01$ level in behavior and environmental literacy and at the $\alpha = .05$ level in knowledge and attitudes. The older group scored higher on every component.

Implications for Further Research

The results of this study suggest several implications for further research regarding environmental literacy in undergraduate university students.

1. Regarding the correlations between the components of environmental literacy, it would be interesting to study whether the correlations between knowledge and the other components increase based on a directed environmental literacy effort at a university. A study at a university with an established environmental literacy program already in place, such as at Tufts University or the University of Wisconsin at Stevens Point, would be good candidates for this type of study.

2. Should UF initiate a formal environmental literacy program, data could be gathered using the ELS to evaluate whether the relationship between the components of student environmental literacy changed as a result.

3. Further study should also be undertaken to analyze the impacts of subjective norms and situational factors on environmentally responsible behaviors of undergraduate university students.

4. Future studies of undergraduate environmental literacy would be more generalizable if students could be truly randomly selected.

5. Regarding the gain in environmental knowledge from freshmen to juniors followed by a regression in seniors could be further expanded to determine if the loss in environmental knowledge is due to specialized study in major courses as upperclassmen, indicating that retention of this type of knowledge does not occur simply based on general science courses. Data could also be gathered on whether all seniors exhibit this same response or if it is specific to non-science majors.

6. Concerning the progression indicated in environmental attitudes and behaviors from freshmen to seniors, and also between the under 20 and over 20 age groups, a longitudinal study of the same group of students over their four or five year time as undergraduates to determine if all students. This could be achieved by tracking a specific group of undergraduates, and another group of young people who are not undergraduate students, over a period of four years to distinguish if the increase in environmental literacy is due either to aging, or to university experience or both factors combined.

7. As more university environmental literacy programs are initiated, the development of a survey instrument specifically for this purpose which is valid, reliable and includes separate components for factual and skills based knowledge, a range of attitude components including self-efficacy,

and perceived behavioral control, and specific environmental behaviors is vital.

8. Since this study involved the use of a survey instrument with self-reported behaviors, further studies could be conducted using direct observation and interview methods for determining an individual student's environmental literacy. An analysis of how correlations gathered from this type of qualitative research differs from correlations gathered from quantitative studies such as this one could be conducted.

Summary

Further research is necessary to understand how the various components of environmental literacy in reality interact, particularly in different subpopulations, so that an effective course of action for environmental literacy programs can be established. Building on existing tendencies for environmental literacy to naturally increase, as was demonstrated by the class standing and age subpopulations, will allow students to deliberately engage in responsible environmental behavior.

APPENDIX
ENVIRONMENTAL LITERACY SURVEY

Hello. I am Nicole Kibert and I am a Graduate Student in the College of Natural Resources and Environment at the University of Florida. Dr. Thiele, Chair of Political Science, is my faculty supervisor. I am conducting a survey of students about their environmental literacy, attitudes and behaviors. I assure you that that your answers are completely confidential. This survey is not a part of the regular curriculum for this class and participation or non-participation will not affect your grade. The survey should only take about 15 minutes. You may stop the survey at any time. If you have questions about the survey, you can contact Nicole Kibert at 392-6755, e-mail nck@ufl.edu or Dr. Thiele at 392-0262, e-mail thiele@polisci.ufl.edu. If you have questions pertaining to your right as a participant, you can contact the UF Institutional Review Board at 392-0433 or through e-mail at IRB2@ufl.edu. Thanks for your participation!

Instructions for taking the survey: Today, if you agree to participate, you will be taking a survey that asks questions about what you know, think and do about environmental problems. Please answer the questions truthfully and to the best of your ability. Fill in only ONE answer for each question asked. There are three sections in the survey. Each section is different so please read the directions carefully before starting each section.

Instructions for Section A: Please indicate how <u>you feel</u> about each statement below. There are no right or wrong answers. Read each statement carefully. Circle the number in the space on your answer sheet for the number that best indicates the extent to which you agree or disagree with each statement, using the following key:

Strongly Agree	**Agree**	**No Opinion**	**Disagree**	**Strongly Disagree**
(1)	**(2)**	**(3)**	**(4)**	**(5)**

A1. When I am outside, I usually don't notice the natural things around me like flowers, trees, and clouds.

A2. I'm not interested in reading about nature or the environment.

A3. I think most of the concern about environmental problems has been exaggerated.

A4. A community's pollution regulations should not interfere with industrial growth and development.

A5. More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means that thing I purchase will cost more.

A6. I am not concerned about the fact that the world's deserts are increasing in size.

A7. There are already enough laws to protect the environment.

A8. I don't think that recycling is worth all the trouble it takes.

A9. More land should be set aside for wildlife habitats.

A10. I am concerned about how much waste is produced in this country.

A11. Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.

A12. I am not concerned about the rate of species extinction in the world.

A13. I am concerned about environmental health hazards such as those caused by air or water pollution.

A14. I believe that I can contribute to the solution of environmental issues by my actions.

A15. It's too hard to change my friends' minds about doing things to help the environment. (for example: recycling.)

Instruction for Section B: For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, there are no right or wrong answers. Circle the number on your answer sheet for the number that is closest to your answer, using the following key:

almost always	often	sometimes	almost never	never
(1)	(2)	(3)	(4)	(5)

B1. I turn off lights and appliances when they are not being used to conserve electricity.

B2. I talk to people that I notice doing something that harms the environment in an effort to persuade that person to stop the activity. (For example, try to talk a friend into recycling a soda can instead of throwing them in the trash.)

B3. I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.

B4. I make an effort to reduce the amount of goods I consume.

B5. I set a positive environmental example for my friends to follow.

B6. I support candidates for political offices who are concerned about environmental problems and issues.

B7. If I see and aluminum can on the ground when I'm out walking, I pick it up and take it with me.

B8. I recycle paper, glass and/or metal waste products at home or at school.

B9. I avoid purchasing products that have a negative impact on the environment.

B10. I talk to my family and friends about what they can do to help solve environmental problems.

B11. I write or call politicians to express my views about environmental issues.

B12. I make a point of reading newspaper and magazine articles about the environment.

B13. I purchase one product over another product because it is packaged in reusable, returnable or recyclable containers or packages.

B14. I send letters to the newspaper about environmental problems or issues.

B15. I have reported environmental problems or violations that I have noticed to the proper authorities.

Instructions for Section C: For each of the following questions, choose the best answer. Circle the number corresponding to your answer on your answer sheet.

C1. A food web consists of
1) the animals that eat other animals in a community.
2) all the herbivores and carnivores in an ecosystem.
3) many interconnected food chains.
4) all the consumers in an ecosystem.

C2. All of the same individual organisms that live on the ground in a particular forest share the same
1) niche.
2) habitat.
3) life-style.
4) food source.

C3. Wolves eat deer. Does this interaction have any beneficial effects on the deer population as a whole?
1) Yes, the wolves help keep the deer population size controlled.
2) No. The deer population is only harmed.
3) Yes, the wolves help keep the population strong since the fastest, most alert deer survive.
4) both (1) and (3).

C4. Based upon major ecological principles, we should conclude that
1) humans are a climax species that will last indefinitely.
2) the human species will soon become extinct; nothing we can do will prevent this.
3) the human species will last as long as there is a balanced eco-system that will support human life.
4) there is no way of predicting what will happen to the human species; ecological principles do not apply to humans.

C5. The process of photosynthesis in green plants
1) uses sunlight to burn energy in plants.
2) changes light energy into chemical energy.
3) changes chlorophyll into sugar.
4) is a process used to burn sugar stored in plants so the plants can grow.

C6. Which of the following terms is used to describe all of the natural living and nonliving interacting features of a given area?

1) habitat
2) community
3) biodiversity
4) ecosystem

C7. A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?

1) plant life
2) minnows
3) fish that eat insects and plants
4) fish-eating birds

C8. Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?

1) carrying capacity
2) species loading
3) non-sustainable growth
4) all of the above

C9. Some insecticides that were once effective in killing insects no longer work very well. This is because

1) new insect species develop every day.
2) the wrong kind of insecticides were used.
3) insects with natural resistance survived and multiplied.
4) the insects produced many more offspring than the insecticide could kill.

C10. Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in upper atmosphere?

1) nitrous oxide
2) methane
3) ozone
4) sulfur dioxide

C11. The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are

1) volcanoes and forest fires
2) petroleum refineries
3) automobiles and coal burning power plants
4) aerosol sprays and refrigerant leakage

C12. The rate of species' extinction is higher now than at any time since the period of the dinosaurs' extinction. The main cause of this rapid decline in biodiversity is
1) habitat alteration by humans
2) the illegal poaching or collecting of animals and plants.
3) changes in the Earth's atmosphere due to human activities.
4) hunting by humans for food or sport.

C13. A major nuclear accident occurred in 1986 at the _____ nuclear power plant.
1) Belgrade
2) Nagasaki
3) Chernobyl
4) Three Mile Island

C14. Which of the following is most likely to help endangered species?
1) Outlaw the sale or possession of endangered species or products made from them (skins, furs, ivory, etc.)
2) Create breeding programs in zoos for endangered animals.
3) Use farming methods which do not damage habitat.
4) Maintain large protected natural areas where they live.

C15. In the long term, which of the following would be the **best** way to lessen the problem of solid waste?
1) Incinerate waste materials
2) Reduce the amount of materials being consumed.
3) Reuse materials for other purposes rather than throwing them out.
4) Recycle materials that can be used again.

This is the end of the survey.

Thank you for your participation!

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BIOGRAPHICAL SKETCH

Nicole Courtney Kibert attended The George Washington University in Washington D.C. and completed her undergraduate studies in biology with a minor in art in May 1997. While still an undergraduate, she worked for The Neighbors Project, an AmeriCorps Serve & Learn Program, where she first learned about the importance of environmental literacy while working with 3rd and 4th graders at Seaton Elementary School in the Shaw neighborhood of Washington D.C. After graduation, she went on to serve as a Peace Corps Volunteer in the Former Yugoslav Republic of Macedonia. There she continued to teach environmental education to students of all ages. She learned that the environment is truly a global concern that crosses all types of boundaries—both physical and political.

She was born in Pittsburgh, Pennsylvania, and has lived in three states, three countries and a district. She hopes to continue to evolve into a true citizen of the world.