ENVIRONMENTAL DECISION-MAKING OF HIGH SCHOOL STUDENTS

by

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A Capstone submitted in partial fulfillment of the requirements for the degree of

Master of Arts in Education: Natural Science and Environmental Education

Hamline University

Saint Paul, Minnesota

April 2005

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ACKOWLEDGMENTS

I would like to thank my committee members for their help and support throughout the process of researching and writing this capstone project. Their comments, suggestions and encouragement have been invaluable and very much appreciated. The outcome of this project would not have been the same without them.

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Decisions, decisions. Every hour of every day we make decisions. Some decisions, like who to vote for in a presidential election, may have significant consequences. Others, such as what to eat for breakfast, are not as consequential. Or are they? Whether people realize it or not, almost every decision they make and action they take affects the environment in one way or another. A morning shower, driving to school or work, and shopping at the store, are all simple, everyday activities that have major impacts on the health of the environment. These activities use resources, cause pollution, and create waste. The impact each individual has on the environment is known as the person's Ecological Footprint (Wackernagel and Rees, 1995). The size of the Ecological Footprint one has depends on such factors as the number and types of goods purchased, the types of foods eaten, housing, and transportation.

The health of human beings and the health of the earth are unavoidably interconnected. It has been estimated that 25% of all preventable human health problems worldwide, and 7% of all human deaths, are caused by poor environmental conditions. Over the last 30 years, human activities have threatened the existence of 1130 species of mammals and 1183 species of birds. Human activities are also causing large tracts of forests to be lost, land degraded, ozone depleted, atmospheric carbon dioxide levels increased, and shortages of clean water (United Nations Environment Programme, 2002).

Individual citizens, industry, and politicians all play a part in the health of the environment. Individuals carry out destructive activities, such as when carbon dioxide is released while driving automobiles, fertilizer from lawns runs off into lakes and streams, and natural land is taken over for homes. The policies and practices of governments and

businesses also greatly affect the environment, such as through logging, mining and oil drilling, and laws regulating pollution emissions. Population growth and over consumption of goods and natural resources, political decisions and emphasis on socio-economics to the detriment of the environment have contributed to our environmental problems (Tikka, Kuitunen, and Tynys, 2000).

However, the practices and policies of governments, businesses, and individuals can also protect and sustain the environment (Oskamp, 2000). For example, if efforts to reduce ozone-depleting chemicals continue, it is estimated that the ozone layer will eventually recover. Also, due to tougher regulations and controls, air pollution levels have stabilized (United Nations Environment Programme, 2002).

Goals of Environmental Education

How do we get to a point where everyone is working toward a sustainable environment? In 1977 the United Nations convened an international conference that declared

> Education utilizing the findings of science and technology should play a leading role in creating an awareness and a better understanding of environmental problems. It must foster positive patterns of conduct towards the environment and nations' use of their resources….. (Environmental education) should prepare the individual for life through an understanding of the major problems of the contemporary world, and the provision of skills and attributes needed to

> play a productive role towards improving life and protecting the environment with due regard given to ethical values (Hungerford, Bluhm, Volk, and Ramsey (Eds.), 1998, p. 13).

And so, environmental education is seen as a major means of solving our environmental problems. The Tbilisi Declaration, as it has come to be called, outlined the goals, objectives, and guiding principles of environmental education. The goals endorsed by the declaration were

> 1. To foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;
> 2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment;
> 3. To create new patterns of behavior of individuals, groups and society as a whole towards the environment (Hungerford, Bluhm, Volk, and Ramsey (Eds.), 1998, p. 15).

Despite the international nature of the Tbilisi Declaration, not everyone agrees on what the goals of environmental education should be. Many environmental educators agree with Culen (1998) who states, "The primary goal of environmental education is to develop environmentally literate citizens and to promote responsible environmental

behavior" (p. 37). Some educators and researchers are concerned that when terms like "promote responsible environmental behavior" are used, it implies that students will be indoctrinated to behave in a specific way. Is this environmental education or is it environmental advocacy?

In discussing this debate, Jickling (2003) argues that environmental education, and education in general, is inherently value laden. He states,

> If we persistently refer to the environment as a 'resource', then we are implicitly reinforcing a human-centered perspective, a condition at odds with the emergence of new and more inclusive ethics. Again, the very words we select connote value (p. 22).

Differing values, along with differing interests, often create the environmental problem or issue. For example, draining a wetland for a housing development would affect the wildlife that lives in that wetland. Some people value natural places, while others value economic development and growth. This creates a problem of whether or not the wetland should be drained and the housing development built. Environmental educators suggest that instead of teaching specific behaviors, we should be teaching critical thinking and decision-making skills (Courtenay-Hall and Rogers, 2002; Salmon, 2000). Many would agree with Disinger (2001) who states, "It is important that all of us – as citizens of a democratic society – learn how to view environmental issues reflectively and intelligently and participate in the formulation of ecologically, economically, socially, and politically responsible environmental decisions" (A Road to Resolution? section, para 3).

Goals of Environmental Education in Minnesota

In Minnesota, environmental education goals were outlined as part of the Waste Management Act in 1998. In the act, Statute 115A.073 states that Minnesota's "pupils and citizens should be able to apply informed decision-making processes to maintain a sustainable lifestyle", and to "have access to information and experiences needed to make informed decisions about actions to take on environmental issues" (Landers, Naylon, & Drewes, 2002, p. 4). How do we ensure that Minnesotans and others are able to make these kinds of decisions?

Education is the key to providing the knowledge and skill students will need to make responsible decisions regarding the environment. In this study, I will try to determine what educational factors most affect environmental decision-making.

Review of Literature

The Tbilisi Declaration formally began what is considered environmental education. Since that time, researchers have been investigating people's knowledge, attitude, and behavior toward the environment, and how that knowledge, attitude and behavior changes through education. In this chapter, I examine some of the models and theories of environmental education and how they relate to environmental decision-making.

Decision Making and Behavior

It has been 27 years since the Tbilisi Declaration. How has environmental education tried to attain its stated goals? Most research has focused on the factors affecting responsible environmental behavior. As mentioned earlier, there is a debate as to whether or not we should be teaching specific environmental behaviors. However, all environmental organizations and educators agree that responsible environmental decision-making is important. The research on responsible environmental behaviors can be applied to environmental decision-making because behaviors often occur when a decision has been made. Recycling, buying a low mileage car, and belonging to an environmental organization are all examples of behaviors that require some forethought and making a conscious choice. In examining the predictors of responsible environmental behaviors, Marcinkowski (1998) considered environmental problem solving and responsible environmental behavior to be essentially the same.

Also, many of the models that describe the factors affecting environmental behavior are based on Ajzen and Fishbein's Theory of Reasoned Action (1980). As described by Gotch and Hall (2004), the Theory of Reasoned Action states that the intended behaviors

of a person are based on a cognitive decision making process. The person considers the options and consequences of each option, makes a decision, and then acts on the decision.

According to Kaplan's Reasonable Person Model (2000), "Humans can be seen as active, curious, problem-solving animals" (Reconceptualizing Human Nature: The Reasonable Person Model section, para 6). He believes that we get satisfaction out of trying to figure out what we can do to solve the world's problems. Therefore, much of the research on environmental behavior also applies to environmental decision-making. This leads to the question: what is the most effective method of reaching the goals of teaching informed environmental decision-making and actions?

Early Environmental Education Model

The first model describing the factors that affect responsible environmental behavior is the Knowledge-Attitude-Behavior Model. For many people, education equates with information and knowledge. As far back as 1976, educators have thought that people, who were knowledgeable about the environment and were aware of environmental issues, would have a positive attitude toward the environment and would make decisions that would benefit the environment (Marcinkowski, 1998). The model is graphically represented in Figure 1.

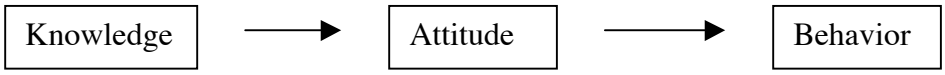

Figure 1. Knowledge-Attitude-Behavior Model (Marcinkowski, 1998)

Researchers are still searching for a strong relationship between knowledge, attitude and behavior (National Environmental Education Training Foundation, 2000, 1999). A

1997 report by the Independent Commission on Environmental Education recommended, "Environmental educators should place primary emphasis on the acquisition of knowledge" (Salmon, 2000, p. 7). However, the connection between knowledge, attitude, and behavior is very weak. In a Minnesota study (Murphy, 2002), researchers found that while many Minnesotans think that they are knowledgeable about the environment, only 36% of the respondents scored what the researchers termed a passing grade. Despite the lack of knowledge of the environment, most Minnesotans were found to have a favorable attitude toward the environment, and a majority of them behaved in ways that helped the environment at least part of the time. However, the researchers also found that no matter how knowledgeable people were about the environment, most Minnesotans performed pro-environmental behaviors only occasionally. A number of studies have examined the relationship between knowledge, attitude and behavior (Howe and Disinger, 1988; Marcinkowski, 1998; Nickerson, 2003; Finger, 1994; Hsu and Roth, 1999). They have found that general ecological knowledge appears to be a factor affecting environmental behavior, but information alone is not enough. Other factors in addition to knowledge and attitude must be in effect and are better predictors of responsible environmental behaviors.

Hines Model of Responsible Environmental Behavior

In a major revision of the traditional Knowledge-Attitude-Behavior model, Hines, Hungerford, and Tomera (1986-1987) devised a model in which attitude and knowledge of the environment, and of environmental issues, still played a role in determining responsible environmental behavior, but personality factors such as a person's locus of

control, and feelings of personal responsibility, played major roles as well. Additionally, Hines, et al. proposed that knowledge and skill in action strategies, along with situational variables, were factors in performing responsible environmental behaviors. Graphically, the model can be represented as in Figure 2.

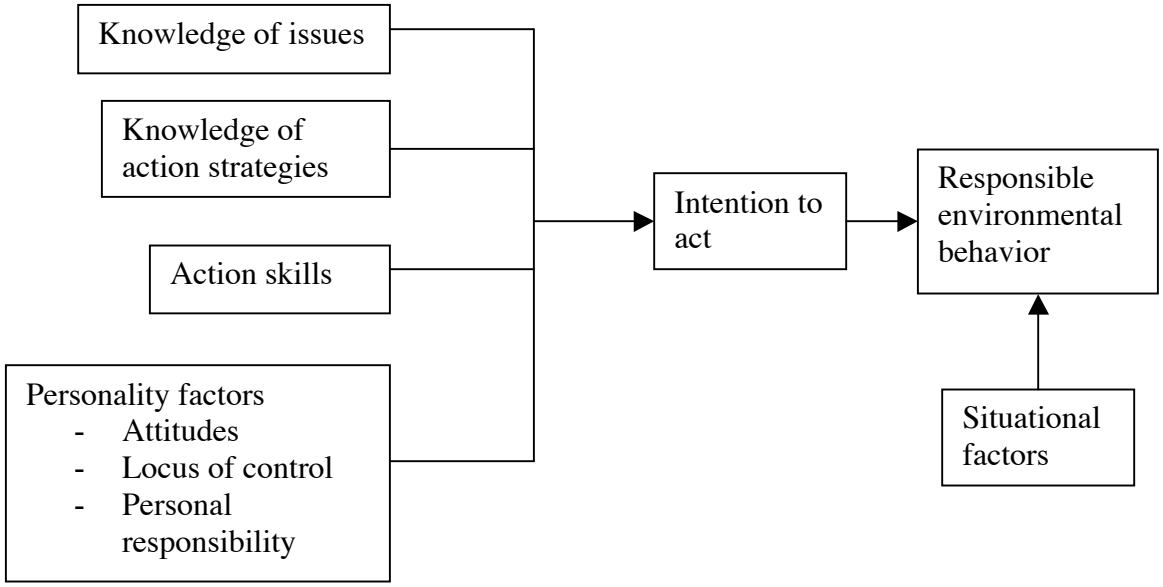

Figure 2. The Hines Model of Responsible Environmental Behavior (Adapted from Hungerford and Volk (1990) in Hungerford, Bluhm, Volk, and Ramsey, 1998, p. 259)

Locus of Control.

In the Hines Model of Responsible Environmental Behavior, the importance of multiple intrinsic factors is emphasized over environmental knowledge. One such factor is locus of control. Locus of control, or the ability to feel that one's actions can make a difference in the world, has been shown to affect environmental behavior (Marcinkowski, 1998; Hwang, Kim, and Jeng, 2000; Smith-Sebasto, 1995). One of the challenges of

environmental education is to convince people that what they do makes a difference (Nickerson, 2003). Kaplan (2000) cites a study by Allen and Ferrand (1999) that found that people who feel helpless and who feel that their behavior would not make a difference were less likely to perform environmentally responsible behaviors. As Maiteny (2002) states

> Sustaining green behavior in a highly consumeristic society can become so much of a strain that individuals sometimes take a sabbatical from it. They may also become demoralized at the enormity of the task and the apparent futility of their behavior-it seems like a mere drop in the ocean that makes little, if any, difference (p. 301).

This is an area that environmental educators may need to focus more on. If people feel that their decisions and behavior won't have an impact on bettering the environment, they may ask themselves, 'why even bother?' . If this is an attitude held by many people, then changing that attitude is an important key in developing environmentally responsible behavior.

Taking Action.

Another change the Hines Model of Responsible Environmental Behavior made is the addition of action strategies and action skills as factors affecting environmental behavior. They hypothesize that people need to be taught the behaviors or actions that could be performed to help the environment. For example, someone may be aware that global warming is a threat to the environment, and the person might be concerned about the

consequences of global warming, but not know what to do about it. If people don't know what behaviors can lessen global warming, they are unlikely to perform them. Several studies have shown that people with greater knowledge and skill in action strategies are more likely to perform responsible environmental behaviors (Hwang, Kim, and Jeng, 2000; Smith-Sebasto, 1995; Howe and Disinger 1988; Marcinkowski, 1998; Hsu and Roth, 1999). These studies also suggest that we need to give students knowledge and skill in analyzing issues, and more opportunities to decide what actions to take.

Hungerford and Volk Environmental Behavior Model

Hungerford and Volk (1990) modified the Hines Model of Responsible Environmental Behavior, adding additional factors and placing the factors into three categories; entry-level variables, ownership variables, and empowerment variables. Within each category, Hungerford and Volk further classified the variables as major and minor. The model is represented in Figure 3.

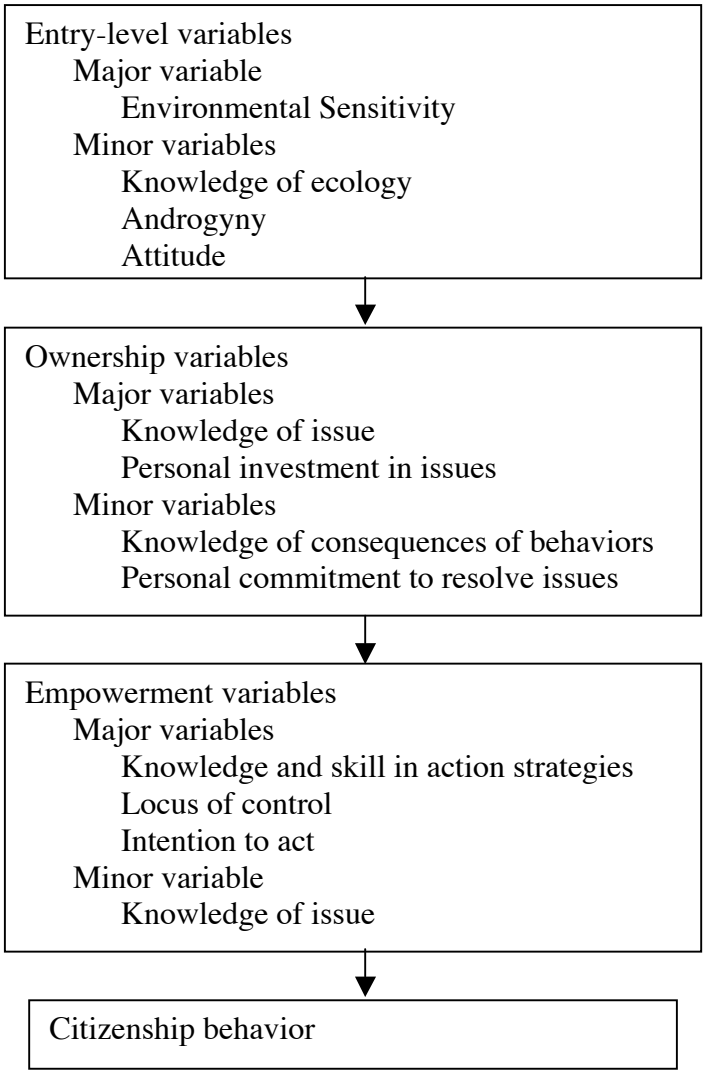

Figure 3. Environmental Behavior Model (Adapted from Hungerford and Volk (1990) in Hungerford, Bluhm, Volk, and Ramsey, 1998, p. 260)

Entry Level Variables.

The major entry-level variable is environmental sensitivity. Hungerford and Volk describe this as "an empathetic perspective toward the environment" (in Hungerford, Bluhm, Volk, and Ramsey, 1998, p. 261). In other words, environmental sensitivity is a measure of the extent to which people feel a connection to the environment and care what happens to it. In the 1949 classic, A Sand County Almanac, Aldo Leopold wrote about

the need for people to develop a land ethic. He wrote, “In short, a land ethic changes the role of Homo sapiens from conqueror of the land/community to plain member and citizen of it. It implies respect for his fellow members, and also respect for the community as such” (p. 204).

Chawla (1998) suggests changing the definition of environmental sensitivity to include a feeling of concern and interest in the environment. This sensitivity and concern often comes from the person’s experiences in nature and the outdoors (Sanger, 1997; Yerkes and Haras, 1997; Sivek, 2002; Chawla, 1999). There is some evidence that a person’s concern and connection to the environment may lead to more responsible environmental behavior (Bamberg, 2003; Chawla, 1998; Cottrell and Graefe, 1997; Vaske and Kobrin, 2001). However, just as increasing one’s knowledge of the environment does not necessarily make that person more pro-environmental, having a concern for the environment will not necessarily lead to a pro-environmental decision. As Finger states (1994)

> In my view, today’s major challenge for environmental educators stems from the fact that individuals are already highly aware and concerned when it comes to environmental issues and problems, yet do not display the corresponding environmental behaviors one could expect. (Introduction section, para 3).

According to Hungerford and Volk, environmental sensitivity is just a start. In addition to being environmentally sensitive, people must want to take action.

Ownership.

Jurin and Fortner (2002) speculate that the reason why people who say they are concerned about the environment, but don't act as if they are, is that their concern is just symbolic. Research by DeYoung (2000) has shown that the stronger the conviction concerning the environment, the more likely that attitude can predict behavior. Also, changes in behavior that come about as a result of strongly held inner beliefs are more likely to continue to be performed (Maiteny, 2002). This is part of what Hungerford and Volk (1990) term ownership. The ownership variables are ones that give importance to the issue for the person making the decision. The major variables here are knowledge of the issue and personal investment in the issue. The person needs to know what the issue is before it can be acted upon. However, knowing about the issue will not necessarily cause the person to act on it. Hungerford and Volk hypothesize that there must be a motivation to act on the issue.

This motivation, called ownership, is an internal motivation. Research by DeYoung (2000) seems to indicate that the most effective motivation "goes to the core of a person's needs or concerns" (Content based Evaluation section, para 4). If they see the problem as less important, it is easier for people to ignore the problem or just put it off. Several researchers (DeYoung, 2000; Kaplan, 2000; Oskamp, 2000) suggest that environmental education should focus on the positive, internal rewards people get from engaging in responsible environmental decision-making and behavior. When we focus on negative motivations, like fear of future disasters, or making personal sacrifices to save the earth, people are more likely to go into denial, and are less likely to do anything at all.

Empowerment.

The empowerment variables give people the feeling that their decisions and behavior can make a difference in the environment. These variables include knowledge and skill in action strategies, locus of control, and intention to act. Based on the research of others, Hungerford and Volk (1990) suggest that perceived ability to carry out environmental actions is one of the best predictors of responsible environmental behavior. It demonstrates that people believe that they have the power to act. The idea that once a decision to act in a certain way has been made, the person is very likely to actually follow through with the action, comes from the Theory of Reasoned Action mentioned earlier. Hungerford and Volk hypothesize that, using knowledge and skill in action strategies, the person is able to carry out the intended action.

Issue Investigation.

In order to accomplish the goal of responsible decision-making, Hungerford and Volk (1990) recommend combining knowledge and action strategies with issue investigation. In this process, the influence of one's beliefs and values in deciding an issue is considered along with other important information researched by the person. The North American Association of Environmental Education (1999) suggests that a major component of an effective environmental education program is identifying and investigating issues. They recommend teaching students to

1. Define and articulate the issue
2. Identify individuals and groups involved along with their perspectives, assumptions, and goals

3. Examine the context of the issue

4. Evaluate the consequences of the issue

5. Discuss the social, political, economic, and ethical implications of the issue

6. Project the likely consequences of failure to resolve the issue

7. Identify and evaluate alternative solutions (Guidelines for Twelfth Grade section, Strand 3)

After investigating the issue, the students make a decision and evaluate how the decision fits with their beliefs, values, and environmental ethic. There is some evidence that teaching issue investigation and action strategy skills can increase responsible environmental behavior (Culen and Volk, 2000; Hsu, 2004).

Kollmuss and Agyeman Model of Pro-environmental Behavior.

However, an intention to act does not necessarily lead to an action. There are barriers that can prevent the person from carrying out the intended behavior. Kollmuss and Agyeman (2002) developed a model that extensively examines these barriers. In this model, certain factors can either help or hinder responsible environmental behavior. For example, economics can be an incentive, such as when monetary incentives are given to people who recycle. Economics can also be a barrier, such as when products made from recycled materials cost more than the same product made from virgin materials. Kollmuss and Agyeman divide the factors affecting responsible environmental behavior into three primary categories; demographics, external factors, and internal factors. The factors are

1. Demographic factors
    a. Gender
    b. Level of education
2. External factors
    a. Institutional factors such as the availability of public transportation.
    b. Economic factors
    c. Social and cultural factors
3. Internal factors
    a. Motivation
    b. Environmental knowledge
    c. Values
    d. Attitudes
    e. Environmental awareness
    f. Emotional involvement
    g. Locus of Control
    h. Responsibility and priorities

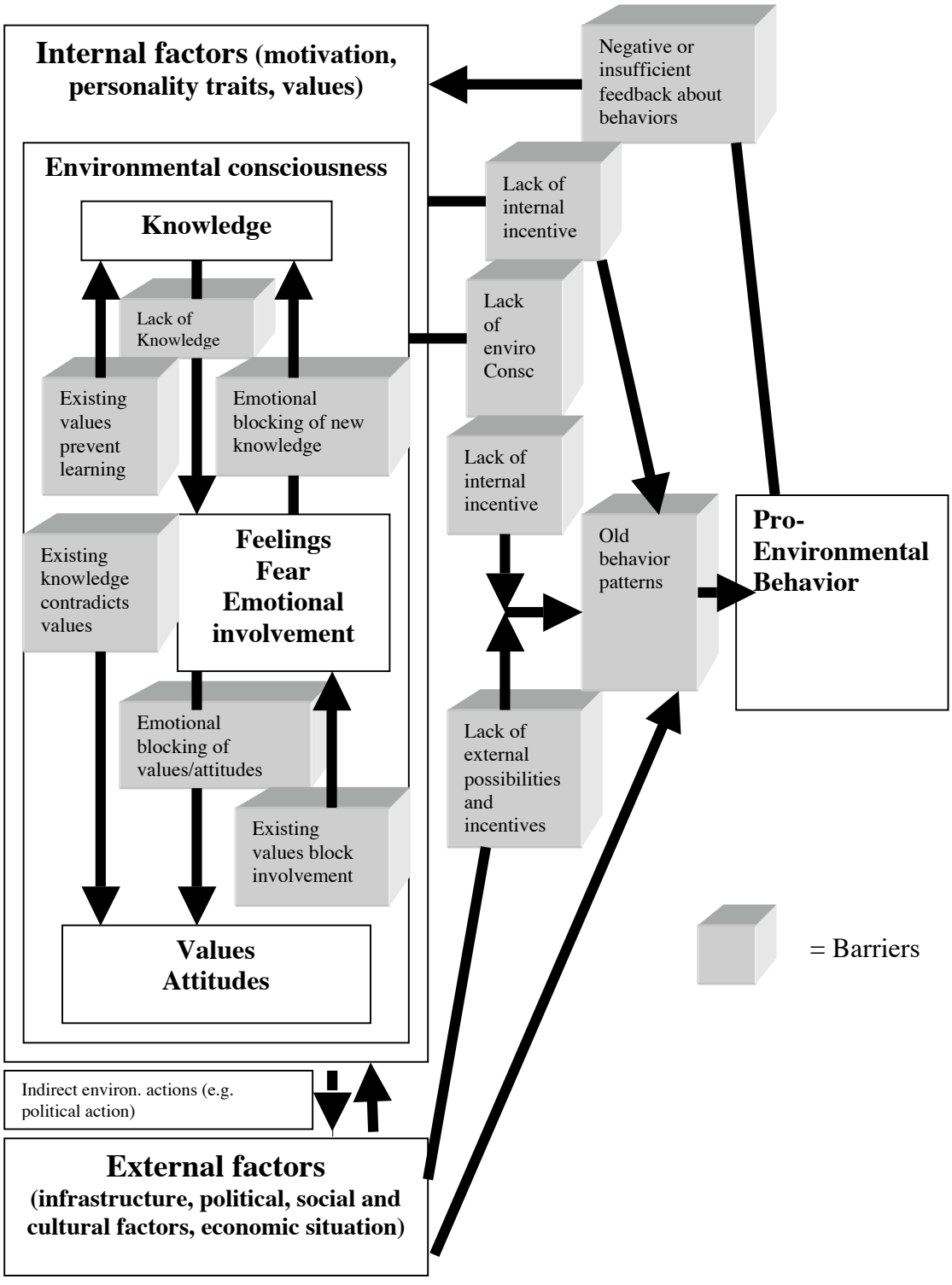

Figure 4. Model of Pro-environmental Behavior (Adapted from Kollmuss and Agyeman, 2002. p. 257)

External Factors.

External factors, particularly situational factors, have been found to be important barriers to responsible environmental behavior (Corraliza and Berenguer, 2000; Hwang, Kim, and Jeng, 2000). Situational variables are ones that the person has no direct control over. For example, someone may want to recycle boxboard, but if the waste haulers in the community do not take that type of product as a recyclable material, the person will not be able to recycle it. As another example, suppose a family lives in a particular place because of the quality of the school system, but the parents' jobs forces them to drive a great distance. Even if the family wanted to reduce the amount of driving that they did, they are limited by their situation. If there is a conflict between a person's internal beliefs and values and the situational condition, the external factors are likely to win (Corraliza and Berenguer, 2000).

Internal Factors.

As Figure 4 illustrates, Kollmuss and Agyeman suggest that the internal factors combine to form a "pro-environmental consciousness". To make decisions and take action, the person uses this consciousness, along with other personal values and traits, to analyze and evaluate the behavior. When a person evaluates the worth of an entity and judges it highly, that entity becomes a value for that person. These priorities become the person's value system (Rohan, 2000). The value system can either support, or be a barrier to a behavior.

When deciding how to act on an environmental issue, the beliefs and values held by the person influence the decision (Stern, 2000). According to Stern's value-belief-norm

theory of environmentalism, "personal moral norms are the main basis for an individual's general predisposition to pro-environmental action" (The Determinants of Environmentalism section, para 7). According to this theory, when considering whether or not to take action on an environmental problem, the individual will consider how the problem threatens what the person values, and how the action will lessen the threat. According to Tonn, English, and Travis (2000)

> To understand environmental decision-making, it is important to understand that we see the physical and social world around us through a prism of social construction. In other words, what we know as reality is filtered through socially-acquired concepts, words, values and beliefs (p. 166).

Similarly, Rohan (2000) states that, "all behavioral decisions ultimately should be traceable to personal value priorities" (p.270). According to Rohan, one's personal value system affects the way he or she views the world. This worldview then either directly affects the person's behavioral decision, or it affects the person's ideological value system or social value system, which then affects the behavioral decision. In a study of 15 to 16 year old students, Grace and Ratcliffe (2002) found that while the students used both scientific knowledge and personal values when making conservation issue decisions, they gave more weight to the values they held in making the decision.

Summary

In summary, there are many factors that contribute to environmental decision-making. Environmental education, as it is currently practiced in both formal and non-formal settings, consisting of "pushing more information, more knowledge, and more awareness" (Finger, 1994), will not necessarily lead to more environmentally responsible decisions and behaviors. External situational factors, internal beliefs and values, and the ability to analyze issues are more likely to have a bigger impact on the decision.

As stated earlier, most of the environmental education models focus on behavior. Because of the importance of the decision making process, I believe that an environmental education model focusing on decision-making is needed. This will not only help educators in designing environmental curriculum, it will avoid the advocacy vs. education controversy.

Method

Proposed Decision Making Model

Based on the models just described, I propose an environmental decision-making model. The model describes the primary factors, and the process, involved in making an environmental decision. The model incorporates many of the factors from the earlier models, but with a greater emphasis on beliefs and values. The factors are also arranged in a way that may mimic the thought process a person goes through when making a decision.

Stage One: Problem.

When making a decision, the person must start with an issue or problem to solve. Stage one of the model begins with issue awareness and knowledge of the issue. This awareness may come from the media, from a formal or non-formal educational setting, or from parents or peers. However, being aware that an issue exists is not enough to cause the person to act on the issue. I propose that the person's level of environmental concern and environmental sensitivity provide importance to the issue and determines whether or not the person will act any further.

As research is starting to show, environmental sensitivity includes a depth of concern for the environment. I believe that if someone's environmental sensitivity and depth of concern are high; the person will take the problem to the next step. If environmental sensitivity and depth of concern are low, the problem will likely be ignored or action toward it delayed.

Stage Two: Logical Analysis.

Once the person has the desire to consider the issue, stage two involves gathering the information needed to make the best decision. This includes using or gaining some knowledge of ecology, an in-depth knowledge of the issue, and knowledge and skill in issue investigation. Using this knowledge and skill, the person will determine the alternatives in the decision, and the consequences of each alternative. Again, research is beginning to show that knowledge and ability to analyze issues and think critically is an important part of decision-making and should be an important part of environmental education.

Stage Three: Values Filter.

In stage three, the person will take the alternatives and the consequences determined in stage two and filter them through internally held beliefs and values. If the consequences of a particular alternative favor a strongly held value, that alternative will be favored. If disparate alternatives favor different values, the alternative with the higher value will be favored. Even though research indicates that considering values is an inevitable part of decision making, it is largely ignored in environmental education. I believe this is the most important factor, and the most difficult part of decision-making. By the end of stage three, the person will have a decision or an intention to act. However, this is not the end.

Stage Four: Negotiating Barriers.

Even though the person may have an intention to act, no action may be taken. In stage four, locus of control, knowledge and skill in action strategies, and situational factors

come into play. These may act as barriers to action. If the person doesn't feel that the behavior or action will make a difference, or doesn't know how to act on the decision, nothing will be done. Even if the person wants to act, situational factors may be an obstacle. If these barriers are not present, the person is more likely to take action. As we have seen, locus of control, knowledge of action strategies, and situational factors are important in determining environmentally responsible behaviors. The model is represented in Figure 5.

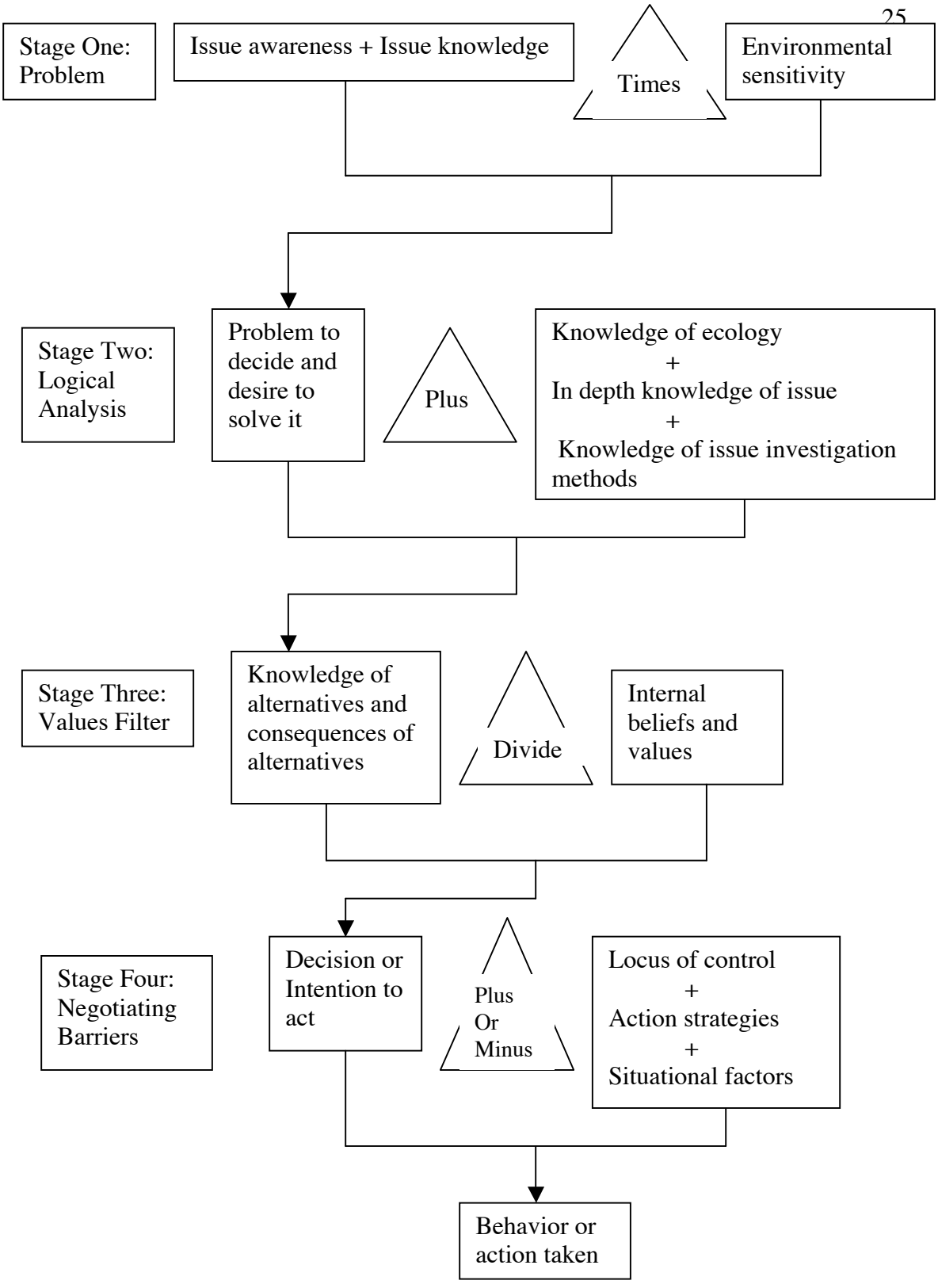

Figure 5. Four Stage Environmental Decision-Making Model

Hypothesis

If this model is an accurate depiction of the environmental decision making process, and is able to predict the making of responsible environmental decisions, I hypothesize the following.

> Hypothesis 1: The greater a person's environmental sensitivity and concern, and the more deeply they are held, the greater the desire to pursue a solution to an environmental problem will be.
>
> Hypothesis 2: The greater a person's level of knowledge of ecology, environmental issues, and ability to analyze issues, the greater the person's ability to consider alternatives and consequences of an environmental problem.
>
> Hypothesis 3: There will be very little correlation between a person's level of general ecological knowledge and whether or not a pro-environmental decision is made.
>
> Hypothesis 4: If someone has reverence for nature and the environment, and values making the world/environment a better place, the person will be more likely to make decisions that are environmentally responsible. This person will value what is good for the environment, even if it

means making some financial, business, or personal sacrifices.

Since I am primarily interested in decision-making and not actual behavior, I will not be testing a hypothesis regarding factors that affect intention to act. While this is an important question, it is beyond the scope of this study.

Survey Instrument

A survey instrument was developed to test these hypotheses. A copy of the survey is included in the appendix. The survey consisted of questions relating to environmental awareness and sensitivity, attitudes and values, locus of control, ecological knowledge, knowledge of environmental issues, and knowledge of issue investigation and action strategies. The knowledge questions were taken primarily from the 1994 Wisconsin High School Student Environmental Literacy Assessment (Champeau, 1997). Additional questions were taken from the Minnesota Report Card on Environmental Literacy survey (Murphy, 2002). The value questions were adapted from research by Vining and Tyler (1999). Vining and Tyler examined thousands of letters the public sent to the Forest Service regarding the management of a forest in Indiana. From these letters they developed a comprehensive taxonomy of values. I converted these stated values into Likert style questions.

The survey was divided into seven sections.

1. Decision-making scenarios
2. Ecological knowledge
3. Knowledge of issues

4. Knowledge of issue investigation and action strategies
5. Environmental sensitivity/interest/connection and concern
6. Environmental values and beliefs
7. Locus of control/ability to make changes

Section one contained five environmentally based scenarios. The scenarios were actual situations that had been reported in the media within the past year involving an environmental decision or action. The scenarios provided some basic information about the situation, and a few possible consequences of the decision. For each scenario, the participants were asked to answer three questions. First, the participants were asked about their desire to solve the presented scenario. Using Likert style options that were assigned point values from 1 to 4, a score was determined that represented the person's desire to make a decision or solve the problem. The score from each scenario was added together and averaged to form a Desire to Solve (DS) score.

Next, the participants were asked the extent to which they felt they were able to understand and consider the possible solutions for each scenario. Again, Likert style options were given and assigned 1 to 4 point values. The scores for this question were totaled, averaged, and referred to as the Problem Analysis (PA) score.

The survey participants were then provided with a pro-environmental statement regarding the scenario. They were asked whether or not they strongly agreed, agreed, disagreed, or strongly disagreed with the statement. The statements were worded so that agree and strongly agree were considered pro-environmental. The statements were scored 1 – 4, with the higher score given when pro-environmental choices were made. The

scores from this question were totaled, averaged, and referred to as the Pro-Environmental Decision (ProED) score.

Sections two through four had multiple-choice style questions to assess the participant's knowledge. The correct answers to these questions were determined by the Wisconsin Center for Environmental Education (Champeau, 1997) and The Minnesota Report Card on Environmental Literacy (Murphy, 2002) from which the questions were taken. A total number correct for each section was determined. The score from each section was also added together for each person to find a Total Knowledge score.

Sections five through seven of the survey had Likert style statements in which the participant could strongly agree, agree, disagree or strongly disagree. In sections one and two, most of the statements were worded so that agree and strongly agree were considered pro-environmental. A few of the questions were worded so that disagree and strongly disagree were considered pro-environmental. The statements were scored 1 – 4, with the higher score given when a pro-environmental choice was made. Section seven was also scored 1 – 4, with the higher score given to choices that indicated a willingness to act or the feeling that they could make a difference. The scores for each section were totaled and averaged for each participant.

Multiple regression equations were then used to determine which, if any, of the variables measured correlated with either a desire to solve the problems, understanding of the problems, or the likelihood of making a pro-environmental decision. If hypothesis one is correct, environmental sensitivity should be correlated with the DS score. If hypothesis two is correct, the total of knowledge of ecology, environmental issues, and issue

investigation should be correlated with the PS score. If hypothesis three and four are correct, environmental values, and not knowledge, should be correlated with the ProEd score.

Results

Demographics

The survey was given to 98 high school chemistry students in a suburban parochial school in Minnesota. Of the surveys that were returned, 15 were not completed and 17 had answers that were not usable. The unusable surveys had either unanswered questions, questions with two answers marked, or questions with answers written in. This left 66 surveys to be analyzed. There were 39 females and 27 males completing the 66 surveys. The average age of the participants was 16.42 years of age.

Ecological Knowledge

The eighteen questions in section two of the survey, Ecological Knowledge, determined the student's knowledge of such concepts as relationships between organisms, energy, and the environment. The average score on this section was 11.89 out of 18, or 66.06%. The scores ranged from 5 to 17 with a standard deviation of 2.70. The males and females had slightly different averages, scoring 11.67 and 12.05 respectively. The 66.06% overall average of the students in this study was higher than the average score of 56% correct that high school students scored on the 1994 Wisconsin Student Environmental Literacy Assessment (Champeau, 1997) from which most of the questions were taken. However, using a typical grading scale, this might be considered a grade of D. Despite the overall low average, in all questions, the correct answer was chosen more often than any other individual answer (Table 1). It might seem contradictory to have a low overall average and still have the correct answer be the most popular answer for each question. However, suppose for a particular question, choices A, B, and C were chosen

16 times each, and choice D, the correct answer, was chosen 18 times. While the correct answer was chosen more often than any other individual answer, overall only 18 of 66 answers were correct. The questions in which students did the poorest involved energy (#7), photosynthesis (#9), definition of an ecosystem (#10), bioaccumulation (#12), carrying capacity (#13), energy within a food chain (#16), and food web (#18). The questions and the frequencies for each answer can be found in Table 1. The table does not show two diagrams that were part of the questions. The diagrams can be found in the full survey located in the appendix.

Table 1. Ecological Knowledge survey questions and responses.

Questions	Answers (Correct answer in bold)	Frequency of response
1. A food web consists of	A. The animals that eat other animals in a community	5
	B. All the herbivores and carnivores in an ecosystem	2
	C. Many interconnected food chains	40
	D. All the consumers in an ecosystem	19
2. When two or more species attempt to use the same limited resource in an ecosystem, their interaction is called	A. Mutualism	6
	B. Competition	52
	C. Predation	5
	D. Commensalisms	2
3. Having sharp thorns can help a plant by keeping animals from eating it. This is an example of	A. Mutualism	2
	B. Adaptation	60
	C. Competition	0
	D. Commensalisms	4
4. All of the individual organisms that live on the ground in a particular forest share the same	A. Niche	8
	B. Habitat	52
	C. Life style	4
	D. Food source	2
5. The reason dead leaves and twigs don't build up in a forest from year to year is because	A. Non living elements such as wind and rain remove them	2
	B. Decomposers break them down into soil	47
	C. Animals eat them or use them to build nests	7
	D. None of the above	9

Table 1 continued

Questions	Answers (Correct answer in bold)	Frequency of response
6. Wolves often eat deer. Does this interaction have any beneficial effects on the deer population as a whole?	A. Yes, the wolves help keep the deer population size controlled.	9
	B. No. The deer population is usually only harmed.	4
	C. Yes, the wolves help keep the deer population strong since the fastest, most alert deer survive.	3
	D. Both (a) and (c).	50
7. The energy currently present	A. Is all the energy we will ever have.	6
	B. Can change form but is never destroyed.	38
	C. Can only be used once.	5
	D. Is mostly in the form of fossil fuel energy.	17
8. Based upon major ecological principles, we should conclude that	A. Humans are a climax species that will last indefinitely.	0
	B. The human species will soon become extinct; nothing we can do will prevent this.	0
	C. The human species will last as long as there is a balanced ecosystem that will support human life.	59
	D. There is no way of predicting what will happen to the human species; ecological principles do not apply to humans.	7
9. The process of photosynthesis in green plants	A. Uses sunlight to burn energy in plants.	7
	B. Changes light energy into chemical energy.	38
	C. Is a process used to burn sugar in plants so the plants can grow.	8
	D. Changes chlorophyll into sugar.	13

Table 1 continued

Questions	Answers (Correct answer in bold)	Frequency of response
10. Which of the following terms is used to describe all of the natural living and nonliving interacting features of a given area?	A. Habitat	14
	B. Community	7
	C. Biodiversity	7
	D. Ecosystem	38
11. Humans grow crops for food. Many species of these plants need certain species of insects (such as bees) to pollinate them. The pollinating insects often rely on the nectar they obtain from the plants for food. This is a good example of	**A. How organisms, including humans, are interdependent.**	43
	B. Commensalism between humans and other species.	8
	C. How humans manipulate their environment.	4
	D. A food web that includes humans.	11
12. A chemical, which tends to remain stored in body fat, contaminates a particular aquatic ecosystem. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?	A. Plant life	14
	B. Minnows	9
	C. Fish that eat insects and plants	20
	D. Fish eating birds	23

Table 1 continued

Questions	Answers (Correct answer in bold)	Frequency of response
13. Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?	**A. Carrying capacity**	26
	B. Species loading	5
	C. Non sustainable growth	9
	D. All of the above	24
14. In a small lake, a food chain was as follows: Sun to green algae to small crustaceans to fish. After many months of heavy snow covering the ice, most of the small crustaceans died. What is the best explanation for this?	**A. The algae population was cut off from its source of energy.**	51
	B. It was too cold for the crustaceans to survive.	7
	C. The fish ate most of the crustaceans.	6
	D. A disease killed most of the algae.	2
15. If carbon dioxide (CO_2) disappeared from the atmosphere, which of the following would be affected first?	**A. Plants**	57
	B. Animals	7
	C. Animals that eat other animals	0
	D. Decomposers	13
16. Each of the following food chains starts with the same amount of green plants. Assuming that the green plants are digestible by humans, which of the food chains would supply the most energy to humans?	**A. Green plants to humans.**	33
	B. Green plants to cattle to humans.	20
	C. Green plants to insects to fish to humans.	0
	D. Green plants to insects to small fish to larger fish to humans.	13
17. Some insecticides that were once effective in killing insects no longer work very well. This is because	A. New insect species develop every day.	4
	B. The wrong kinds of insecticides were used.	2
	C. Insects with natural resistance survived and multiplied.	52
	D. The insects produced many more offspring than the insecticide could kill.	7
18. Which of the food webs below would be affected the most if all of the mice were removed? (Note: the arrows point to the consumer of the organism in the food web.)	A. Food web (A).	12
	B. Food web (B).	27
	C. Neither would be affected.	9
	D. They would both be affected to the same degree.	18

Environmental Issue Knowledge

The sixteen environmental issue knowledge questions in section three examined the student's knowledge of environmental problems such as pollution, energy use, and ozone depletion. For the environmental issue knowledge questions, the average was 9.02 out of 16, or 56.38%. The scores ranged from 2 to 15 with a standard deviation of 2.62. This is only slightly better than the Wisconsin students who had an average score of 54% correct on the environmental issues questions. Again the females scored slightly higher than the males, 9.31 to 8.59 out of 16. Overall the students were not very knowledgeable about environmental issues and on a typical grading scale, this could be considered an F. There were two questions in which the correct answer was not the most popular choice (Table 2). One question involved the major source of potentially harmful chemicals accumulated by humans (#14). The other question involved the cause of global warming (#13). Other questions that students often answered incorrectly were questions involving acid rain emissions (#2), human population levels (#3), the cause of water pollution (#5), landfill material (#8), the cause of erosion (#11), and radon (#12). The questions and the frequencies for each answer can be found in Table 2.

Table 2. Environmental Issue Knowledge survey questions and responses.

Questions	Answers (Correct answer in bold)	Frequency of response
1 Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in the upper atmosphere?	A. Nitrous oxide	3
	B. Methane	6
	C. Ozone	50
	D. Sulfur dioxide	4
2. The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are	A. Volcanoes and forest fires.	4
	B. Petroleum refineries.	16
	C. Automobiles and coal burning power plants.	37
	D. Aerosol sprays and refrigerant leakage.	9
3. Which of the following is *not* true of the world's human population?	A. It is expected to double within your lifetime.	11
	B. It is declining in developed areas as the United States and Canada.	32
	C. Its increase has led to the extinction of many plant and animal species.	11
	D. The greatest rate of population growth is occurring in developing areas such as South America and Africa.	11
4. The future of food production as it is currently practiced in this country is in question because	A. Soil is being depleted by erosion.	2
	B. The use of synthetic chemical additives has become an issue,	5
	C. Agricultural land is being lost to development	4
	D. All of the above.	55
5. What is the *most common* cause of pollution of streams, rivers, and oceans?	A. Dumping of garbage by cities.	10
	B. Surface water running off yards, city streets, paved lots, and farm fields.	34
	C. Trash washed into the ocean from beaches.	2
	D. Waste dumped by factories.	20
6. 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	**A. Habitat alteration by humans.**	43
	B. The illegal poaching or collecting of animals and plants.	2
	C. Changes in the earth's atmosphere due to human activities.	18
	D. Hunting by humans for food or sport.	3
7. Which of the following do scientists feel is the least important contributors to the greenhouse effect?	A. Destruction of the earth's rainforests.	7
	B. Burning of fossil fuels, such as gasoline as oil.	4
	C. Increased use of hydroelectric power,	40
	D. Production of methane gas by cattle and rice paddies.	15

Table 2 continued

Questions	Answers (Correct answer in bold)	Frequency of response
8. Many communities are concerned about running out of room in their community trash dumps and landfills. What is the greatest source of landfill material?	A. Disposable diapers.	13
	B. Lawn and garden clippings, trimmings, and leaves.	8
	C. Paper products including newspapers, cardboard, and packing.	32
	D. Glass and plastic bottles and aluminum and steel cans.	13
9. Which of the following is a renewable resource?	A. Oil.	5
	B. Iron ore.	10
	C. Trees.	41
	D. Coal.	10
10. Which of the following results in the most serious waste or loss of our usable water?	A. Contamination by bacteria.	11
	B. Uncontrolled drainage.	5
	C. Careless usage.	48
	D. Improper storage.	2
11. Which of the following would be most likely to result in soil erosion?	A. An increase in nutrients added to the soil.	4
	B. The removal of vegetation.	30
	C. Contour plowing of hillsides.	17
	D. Aeration of the soil by bacteria.	15
12. Which of the following is a naturally occurring, invisible gas that can seep out of the ground into people's homes and cause serious heath problems?	A. Ethane.	20
	B. Krypton.	11
	C. Radon.	25
	D. Chlorofluorocarbon.	9
13. What is the main cause of global climate change, that is, the warming of the planet?	A. Sunlight radiating more strongly through a hole in the upper ozone layer.	35
	B. More carbon emissions from autos, homes, and industry.	22
	C. Increased activity from volcanoes worldwide.	2
	D. Global climate change is a myth.	7

Table 2 continued

Questions	Answers (Correct answer in bold)	Frequency of response
14. Some scientists have expressed concern that chemicals and certain minerals accumulate in the human body at dangerous levels. These chemicals and minerals enter the body primarily through	A. Breathing air.	30
	B. Living near toxic waste dumps.	9
	C. Household cleaning products.	15
	D. Drinking water.	12
15 How is most of the electricity in the U.S. generated?	**A. Burning fossil fuels such as coal and oil.**	44
	B. Nuclear power.	9
	C. Solar energy.	3
	D. Hydroelectric power plants.	8
16. Which of the following offers the most potential for reducing our immediate energy problems?	A. Geothermal power.	7
	B. Energy conservation.	50
	C. Biomass conversion.	3
	D. Tidal power.	6

Knowledge of Environmental Issue Investigation

There were six questions in section four pertaining to knowledge of environmental issue investigation methods and strategies (Table 3). The average score was 4.17 correct, or 69.5%. While this too was higher than the Wisconsin student average of 57% correct, it indicates a fair to poor knowledge of how to investigate environmental problems. The scores ranged from 1 to 6 with a standard deviation of 1.26. Once again, the females scored slightly higher than the males, 4.33 to 3.93. On one of the questions, an incorrect answer was the most popular answer. This was question number three which asked about the best way to reduce waste. The only other question that students had difficulty with

involved the best way to help endangered species (#2). The questions and frequency of response are indicated in Table 3.

Table 3. Knowledge of Issue Investigation and Action Strategies survey questions and responses.

Questions	Answers (Correct answer in bold)	Frequency of response
1 Having your household water tested is important if	A. You live in an old house.	3
	B. Your water comes from a well.	3
	C. You live in an agricultural area.	0
	D. All of the above	60
2. Which of the following is most likely to help endangered species?	A. Outlaw the sale or possession of endangered species or products made from them (skins, furs, ivory, etc.).	15
	B. Create breeding programs in zoos for endangered animals.	7
	C. Use farming methods that do not damage habitat.	10
	D. Maintain large protected natural areas where they live.	34
3. In the long term, which of the following would be the best way to lessen the problem of solid waste?	A. Incinerate waste materials.	2
	B. Reduce the amount of materials being consumed.	21
	C. Reuse materials for other purposes rather than throwing them out.	18
	D. Recycle materials that can be used again.	25
4. Which of the following would be the most effective method to influence a large number of people to take action about the environmental problem?	A. Advertise on the radio.	0
	B. Write letters to the newspaper.	5
	C. Go door to door and talk to people.	3
	D. Use a combination of the above.	58
5. If your student environmental club was concerned about an environmental issue, which of the following would be the best thing to do first?	A. Write and circulate a petition.	2
	B. Talk to other people about what they could do to help resolve the issue.	6
	C. Write to elected officials about your concern.	7
	D. Research the issue.	51
6. When deciding how to vote on an environmental issue that has come up in your community, it would be important to consider	**A. the risks and factors that impact the decision.**	51
	B. the way in which each political party encourages you to vote.	9
	C. the recommendations of environmental special interest groups.	4
	D. whether or not the issue affects you personally.	3

Environmental Sensitivity

There were 17 questions in section five assessing the students' level of environmental sensitivity (Table 4). The four possible Likert style responses, strongly disagree, disagree, agree, and strongly agree, were scored 1 to 4. A score of 4 was assigned to responses with the highest level of sensitivity and responses with the lowest level of sensitivity given a score of 1. The 17 sensitivity scores for each person were averaged. The averages ranged from 2.0 to 3.824. The average score for all of the environmental sensitivity questions was 2.90. An average above 2.5, the midway point between 1 and 4, would indicate that an individual was environmentally sensitive, and a score below 2.5 would indicate the individual was not environmentally sensitive. For every question, the average point value assigned was above the midway point of 2.5 out of 4. This indicates that, overall, the students are fairly sensitive to the environment.

The scores were also totaled. The maximum possible total score was 68 and the minimum possible total score was 17. The average total environmental sensitivity score was 49. 23. The total scores ranged from 34 to 65 with a standard deviation of 6.59. The average total score for females was 49.56 and the average score for males was 48.74. The environmental sensitivity statements and responses are given in Table 4. The numbers in bold indicate which response was considered most environmentally sensitive and was given the highest score.

Table 4. Environmental Sensitivity survey questions and responses.

Statements	Frequency of Response				Ave. score 1 to 4
	Strongly Disagree	Disagree	Agree	Strongly Agree	
1. I enjoy watching TV programs or reading about nature.	8	27	29	**2**	2.38
2. I enjoy outdoor activities in nature (such as any of the following: bird watching, camping, hiking, fishing or hunting).	7	9	32	**18**	2.92
3. I appreciate the beauty of nature.	2	2	38	**24**	3.27
4. I am concerned about saving the remaining wilderness areas left on earth.	1	10	41	**14**	3.03
5. It is important for humans to live in harmony with the natural environment.	1	3	42	**20**	3.23
6. I am not concerned about the rate of species extinction in the world.	**9**	38	15	4	2.79
7. I am concerned about environmental human health hazards such as those caused by air or water pollution.	0	12	44	**10**	2.97
8. I am concerned about how much waste is produced in this country.	1	13	36	**16**	3.02
9. I appreciate the forest environment and I am concerned about what happens to the earth's forests and how they are managed.	1	17	39	**9**	2.85
10. I think most of the concern about the environmental problems has been exaggerated.	**6**	35	22	3	2.67
11. Knowing about environmental problems and issues is important to me.	2	24	36	**4**	2.64

Table 4 continued

Statements	Frequency of Response				Ave. score 1 to 4
	Strongly Disagree	Disagree	Agree	Strongly Agree	
12. I think that damage to the atmosphere, including the ozone layer, is something that everyone should be concerned about.	2	8	40	**16**	3.06
13. I don't think nature or the environment affects me personally or my everyday life.	**13**	31	20	2	2.83
14. I like hearing the sounds of nature such as waves, leaves rustling, and birds calling when I'm outside.	5	6	33	**22**	3.09
15. I am concerned about the health and well being of wildlife.	0	12	44	**10**	2.97
16. I feel a connection to the natural world.	7	22	30	**7**	2.56
17. I have an appreciation and reverence for nature.	1	13	40	**12**	2.95

Environmental Values

The 17 environmental value questions assessed the students' level of reverence for nature and desire to help the environment (Table 5). The questions were scored similarly to the sensitivity questions. The average score for all value questions was 2.92 out of 4. The averages ranged from 2.12 to 3.76. Just as with the sensitivity questions, each question had an average score above 2.5. This indicates that the participants have fairly high pro-environmental values. The value scores were totaled and the average was 49.64. The totals ranged from 36 to 64 with a standard deviation of 5.43. The average total score was 50.62 for females and 48.22 for males. The environmental value statements and the

responses are given in Table 5. The numbers in bold indicate which response was given the highest score.

Table 5. Environmental Values survey questions and responses.

Statements	Frequency of Response				Ave. score 1 to 4
	Strongly Disagree	Disagree	Agree	Strongly Agree	
1. I feel good when I do something that improves the world around me.	2	3	47	**14**	3.11
2. It is my duty or moral obligation to help make the world a better place.	0	17	43	**6**	2.83
3. What I do to the environment affects everyone, so it would be socially irresponsible for me to do anything that harms the environment.	0	21	42	**3**	2.72
4. I would feel guilty if my children or great grandchildren had to live with environmental problems that my generation could have solved but didn't.	1	14	37	**14**	2.97
5. A community's pollution regulations should not interfere with industrial growth and development.	**6**	38	19	3	2.71
6. More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means that things that I purchase will cost more.	6	20	36	**4**	2.58
7. I believe that plants and animals exist to be used by humans.	**9**	34	20	3	2.74
8. I would oppose any environmental regulations that would restrict my way of life.	**5**	38	23	0	2.72
9. Humans have a responsibility to take care of the natural environment.	0	4	44	**18**	3.21
10. Nature has value for its own sake, not just because it is useful for humans.	1	7	42	**16**	3.11
11. When making decisions concerning the environment, my needs and wants come first.	**2**	38	24	2	2.61

Table 5 continued

Statements	Frequency of Response				Ave. score 1 to 4
	Strongly Disagree	Disagree	Agree	Strongly Agree	
12. There are already enough laws to protect the environment.	**9**	42	14	1	2.89
13. I don't think that recycling is worth all the trouble it takes.	**24**	36	4	2	3.24
14. Wilderness areas should be preserved and protected in their natural states without human interference.	1	9	42	**14**	3.05
15. It is important for humans to act in ways that maintain and improve the natural environment.	0	3	52	**11**	3.12
16. Humans need to take responsibility for the impact they have on the environment and current environmental problems.	0	6	49	**11**	3.08
17. People have a right to use the environment in any way they see fit.	**15**	35	13	3	2.94

Locus of Control

There were eight Locus of Control questions that assessed the degree to which the students felt that their decisions and behaviors could make a difference (Table 6). The four possible responses for each question were scored 1 to 4, with 1 assigned to responses that indicated little perceived ability to make a difference, and 4 assigned to responses that indicated a highly perceived ability to make a difference. The average score assigned to the individual questions was 2.55. The averages ranged from 1.50 to 3.25. Five of the eight questions had an average score over 2.5. The three questions with average scores below 2.5 were question four, which asked about the students' ability to change their friends' minds, question five concerning the enormity of environmental problems, and

question eight which involved getting into the habit of doing something about the environment. A score above 2.5 indicates a perceived ability to have an effect on environmental problems, and a score below 2.5 indicates the belief on the part of the student that what they do does not have much of an effect. The scores from this study indicate to me that the students feel that they can make a difference helping the environment, but that it is difficult.

The scores were also totaled. The lowest possible total score was 8 and the highest possible total score was 32. The average total score was 20.36. The totals ranged from 12 to 26 with a standard deviation of 2.56. Females had an average total score of 20.74 and males had an average total score of 19.81. The locus of control statements and the frequency of response are listed in Table 6. Again, the numbers in bold indicate which response was given the highest score.

Table 6. Locus of Control survey questions and responses.

Statements	Frequency of Response				Ave. score 1 to 4
	Strongly Disagree	Disagree	Agree	Strongly Agree	
1. Things that I do don't have much effect on the quality of the environment.	**4**	34	24	4	2.58
2. There is not much that I can do that will help solve environmental problems.	**5**	30	28	3	2.56
3. I believe that I can contribute to the solution of environmental issues by my actions.	2	17	44	**3**	2.73
4. It's too hard to change my friends' minds about doing things to help the environment (for example, recycling).	**1**	29	34	2	2.44

Table 6 continued

Statements	Frequency of Response				Ave. score 1 to 4
	Strongly Disagree	Disagree	Agree	Strongly Agree	
5. Environmental problems are too big to be solved by one person.	**3**	11	35	17	2.00
6. It will take many years before any environmental problems get really bad, and by then science/technology will have found a solution.	**7**	41	17	1	2.82
7. Environmental problems are going to occur no matter what we do, so there is no sense in trying to solve them.	**17**	38	11	0	3.09
8. I would like to do something about the environment, but I just haven't gotten into the habit of doing anything about it.	**2**	11	48	5	2.15

Decision-making Scenarios

As described earlier, students were given five environmental scenarios in which they were to make a decision. First, for each scenario, students were asked how much they cared whether or not the problem was solved. The responses were scored 1 to 4, with the higher score given to the response that indicated a greater desire to solve the problem. The responses were used to create a Desire to Solve (DS) score (Table 7). The overall DS score averages ranged from 1.60 to 4.00, with an overall average score of 2.74. Each scenario had an average score above 2.5 out of 4. This indicates an overall willingness to solve the problems described in the scenarios. The average of the total DS scores was 13.68. The totals ranged from 8 to 20 with a standard deviation of 2.73.

For each scenario, the students were also asked to what extent they understood the pros and cons of the scenario. The responses were scored using the same 1 to 4 scoring system described earlier. The scores were averaged to create a Problem Analysis (PA) score. The PA scores ranged from 1.80 to 3.80 with an overall average of 2.89. Each of the individual scenarios had an average PA score above 2.5. This indicates that overall, the students felt that they understood the scenarios and the pros and cons involved in each one. The scores were also totaled. The average total PA score was 14.45. The scores ranged from 9 to 19 with a standard deviation of 2.09.

Finally, the students were given a pro-environmental solution to each scenario and asked if they strongly agreed, agreed, disagreed, or strongly disagreed with the solution. The responses were once again scored on a 4-point scale, with the higher score given to the most pro-environmental response. The responses for the five scenarios were averaged to create a Pro-Environmental Decision (ProED) score. The overall average score for the individual scenarios was 2.73. The averages ranged from 1.60 to 4.00. This indicates that overall, the students made pro-environmental choices. The average score of four of the five scenarios was above 2.5. In each of these scenarios, a majority of the students made a pro-environmental choice. The only scenario with an average below 2.5 was scenario five with an average score of 2.32. The decision for scenario five involved whether or not the student would be willing to consider changing transportation/driving habits. Most of the students, 38 out of 66, would not consider changing their transportation/driving habits. For this scenario, most students did not make a pro-environmental choice.

The scores were totaled and the average total ProED score was 13.67 out of a possible maximum of 20. The totals ranged from 8 to 20, with a standard deviation of 2.47. The scenario responses are given in Table 7. In the table, the bold number indicates the most pro-environmental response and the one given the highest point value. The scenarios themselves are not given in the table. See the full survey in the appendix for the scenarios.

Table 7. Decision Making Scenario questions and responses.

Scenario 1					
Do you care whether or not this problem is solved?	Don't care at all	Care very little	Care some	**Care very much**	Ave. 1 to 4 (DS score)
	4	17	39	**6**	2.71
To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?	Not at all	A little	Pretty well	**A great deal**	Ave. 1 to 4 (PA score)
	1	17	38	**10**	2.86
People who fish should be required to use lead-free tackle.	Strongly disagree	Disagree	Agree	**Strongly Agree**	Ave. 1 to 4 (ProEd score)
	3	16	38	**9**	2.80

Table 7 continued

Scenario 2					
Do you care whether or not this problem is solved?	Don't care at all	Care very little	Care some	**Care very much**	Ave. 1 to 4 (DS score)
	7	21	29	**9**	2.61
To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?	Not at all	A little	Pretty well	**A great deal**	Ave. 1 to 4 (PA score)
	2	23	33	**8**	2.71
The proposed rule should be implemented.	Strongly disagree	Disagree	Agree	**Strongly Agree**	Ave. 1 to 4 (ProEd score)
	5	14	38	**9**	2.77

Scenario 3					
Do you care whether or not this problem is solved?	Don't care at all	Care very little	Care some	**Care very much**	Ave. 1 to 4 (DS score)
	1	19	33	**13**	2.88
To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?	Not at all	A little	Pretty well	**A great deal**	Ave. 1 to 4 (PA score)
	3	17	35	**11**	2.82
The phase out of methyl bromide should continue without delay.	Strongly disagree	Disagree	Agree	**Strongly Agree**	Ave. 1 to 4 (ProEd score)
	3	16	35	**12**	2.85

Table 7 continued

Scenario 4					
Do you care whether or not this problem is solved?	Don't care at all	Care very little	Care some	**Care very much**	Ave. 1 to 4 (DS score)
	3	20	31	**12**	2.79
To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?	Not at all	A little	Pretty well	**A great deal**	Ave. 1 to 4 (PA score)
	1	18	32	**15**	2.92
The United States should adopt a system similar to the Swiss System.	Strongly disagree	Disagree	Agree	**Strongly Agree**	Ave. 1 to 4 (ProEd score)
	3	11	40	**12**	2.92

Scenario 5					
Do you care whether or not this problem is solved?	Don't care at all	Care very little	Care some	**Care very much**	Ave. 1 to 4 (DS score)
	9	13	33	**11**	2.70
To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?	Not at all	A little	Pretty well	**A great deal**	Ave. 1 to 4 (PA score)
	1	12	30	**23**	3.14
I am willing to do at least four of these five suggestions.	Strongly disagree	Disagree	Agree	**Strongly Agree**	Ave. 1 to 4 (ProEd score)
	12	26	23	**5**	2.32

Hypothesis Tests

Hypothesis One.

According to the proposed decision-making model, the more environmentally sensitive a person is, the more likely that person will want to find a solution to an

environmental problem. To test this hypothesis, a multiple regression was completed with the Desire to Solve (DS) score as the dependent variable and ecological knowledge, environmental issue knowledge, environmental issue investigation knowledge, environmental sensitivity, environmental values, and locus of control as the independent variables. Table 8 shows the least squares estimates from the multiple-regression equation.

Table 8. Desire to Solve Multiple Regression data

Variable	Coefficient	Std. Error	t value	One-sided p value
Intercept	-3.1288	2.9923	1.0456	0.1500
Ecological Knowledge	0.0331	0.1091	0.3030	0.3815
Issue Knowledge	0.1159	0.1238	0.9356	0.1766
Strategy Knowledge	-0.1617	0.2413	0.6699	0.2528
Environmental Sensitivity	0.2057	0.0620	3.3206	0.0008
Environmental Values	0.0385	0.0746	0.5163	0.3038
Locus of Control	0.1968	0.1134	1.7355	0.0439

The coefficient of determination (r^2) for the regression is 0.4449. This indicates that the above variables account for 44.49% of the variability of the DS score. With 59 degrees of freedom, the critical t-value at p = 0.950 is 2.001. For the variables, ecological knowledge, issue knowledge, strategy knowledge, environmental values, and locus of control, the t-value is less than t-critical. Therefore, the null hypothesis, that the coefficients are zero, cannot be rejected. For the variable ecological sensitivity, the t-

value is greater than t-critical. Therefore the null hypothesis, that the coefficient is zero, can be rejected. This means that environmental sensitivity, as measured in this survey, is correlated with the desire to solve the presented scenarios. The greater the environmental sensitivity, the more likely the person will want to solve the problem. None of the other variables correlated with a desire to solve the problems. A scatter plot of DS vs. environmental sensitivity is shown in Figure 6. The correlation coefficient (r) for this simple regression is 0.6164, indicating a moderate correlation between these two variables. An r^2 of 0.3799 indicates that environmental sensitivity accounts for about 38% of the variability of the DS score.

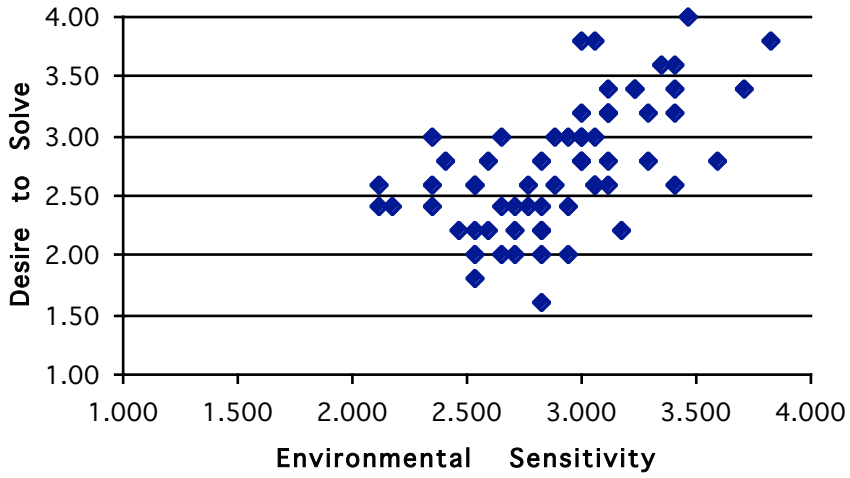

Figure 6. Desire to Solve vs. Environmental Sensitivity

Most of the points on the scatter plot appear quite close to being linear. However, there is a group of points with an environmental sensitivity below 2.5 and a DS score close to or above 2.5 that seem to be far off from the other points. This DS score is above what might be expected. It is likely that there are other, untested, variables affecting the

DS score. Despite this, the data support the hypothesis that the more environmentally sensitive a person is, the more likely that person will want to find a solution to an environmental problem.

Hypothesis Two.

The proposed decision-making model predicts that the more knowledgeable a person is with regard to ecology, environmental issues, and environmental problem solving strategies, the better the person will be able to analyze a given environmental problem. To test hypothesis two, a multiple regression was run with the Problem Analysis (PA) Score as the dependent variable and environmental sensitivity, environmental values, locus of control, and total knowledge as the independent variables. The total knowledge variable is a sum of the scores from the Ecological Knowledge, Environmental Issues Knowledge, and Issue Investigation Knowledge sections of the survey. The regression data are given in Table 9.

Table 9. Problem Analysis Multiple Regression data.

Variable	Coefficient	Std. Error	t value	One-sided p value
Intercept	14.8111	2.6790	5.5285	0.0000
Total Knowledge	0.1301	0.0554	2.3466	0.0111
Environmental Sensitivity	0.0044	0.0582	0.0757	0.4700
Environmental Values	-0.0973	0.0697	1.2521	0.1077
Locus of Control	0.0245	0.1078	0.2271	0.4105

The coefficient of determination (r^2) for this regression is 0.1110. This indicates that only 11.1% of the variability of the PA score can be explained by these variables. The variable total knowledge has a t-value greater than the t-critical value of 2.001. The null hypothesis, that the coefficient is zero, can be rejected. Therefore, the total knowledge of ecology, environmental issues, and environmental issue investigation, as measured in this survey is correlated with the PA score. The greater the total knowledge of ecology, environmental issues, and issue investigation, the more the person may feel that he or she understands the pros and cons of an issue. A scatter plot of Problem Analysis vs. Knowledge Total is given in Figure 7. The correlation coefficient for this simple regression is 0.2651, indicating a small but significant correlation between these two variables. Therefore the data seem to support hypothesis two that the greater the level of knowledge, the greater the person's ability to consider the alternatives and consequences of an environmental problem.

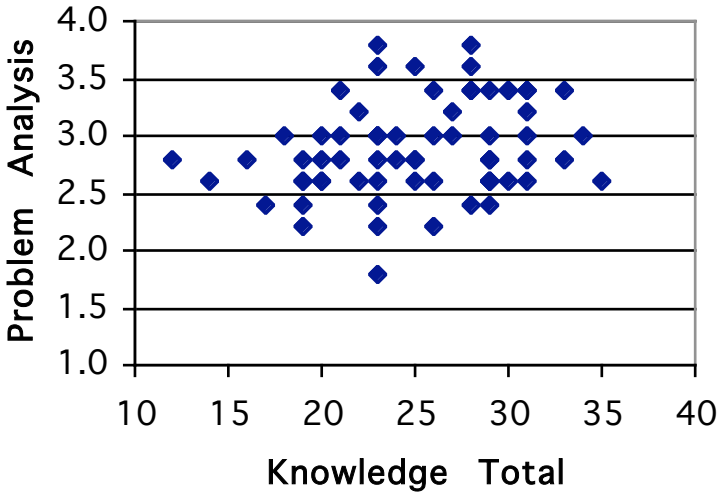

Figure 7. Problem Analysis vs. Knowledge Total

Hypotheses Three and Four.

The final two hypotheses involve the factors that affect whether or not the person will make a pro-environmental decision. The proposed decision-making model predicts that environmental values, and not amount of knowledge, affect whether or not a decision is pro-environmental. To test these hypotheses, a multiple regression was run with the Pro-Environmental Decision (ProED) score as the dependent variable and ecological knowledge, environmental issue knowledge, environmental strategy knowledge, environmental sensitivity, environmental values, and locus of control as the independent variables. The data from the regression are shown in Table 10.

Table 10. Pro-environmental Decision Multiple Regression.

Variable	Coefficient	Std. Error	t value	One-sided p value
Intercept	0.0394	2.7731	0.0142	0.4944
Ecological Knowledge	-0.0177	0.1012	0.1754	0.4307
Issue Knowledge	-0.0964	0.1148	0.8398	0.2022
Strategy Knowledge	0.0847	0.2237	0.3788	0.3531
Environmental Sensitivity	0.0869	0.0574	1.5142	0.0677
Environmental Values	0.2270	0.0691	3.2855	0.0009
Locus of Control	-0.0587	0.1051	0.5584	0.2894

The coefficient of determination (r^2) for this regression is 0.4180. This indicates that 41.8 % of the variability of the ProED score can be explained by these variables. However, of these variables, only one, environmental values, has a t-value greater than the t-critical value of 2.001. The null hypothesis can be rejected only for the environmental values variable. Therefore, of the variables measured, only environmental values, as measured in the survey, correlates with the Pro-Environmental Decision score. Therefore the more pro-environmental a person's values, the more likely that person will make a pro-environmental decision. A scatter plot of ProED vs. environmental values is shown in Figure 8. The correlation coefficient for this simple regression is 0.6177, indicating that there is a moderate correlation between these two variables.

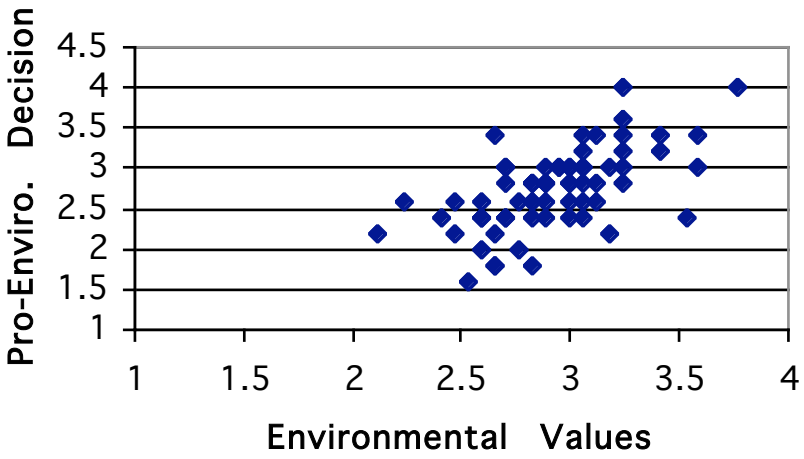

Figure 8. Pro-environmental Decision results vs. environmental values for students

The points, for the most part, are linear. There are single points that appear to stray from the major grouping of points. This is most likely because there are other variables, such as situational variables, that affect the decision. Situational factors were not tested in this study. The data seem to support the hypothesis that the more pro-environmental a person's values, the more likely the person will make a pro-environmental decision. The data also support the hypothesis that higher levels of environmental knowledge will not affect whether of not a person makes a pro-environmental decision.

Conclusions

Many of the decisions people make everyday have an impact on the environment. The goal of environmental education is to help people make decisions that protect the environment from harm. Researchers in environmental education have produced a number of models that describe the factors that affect the decisions that lead to environmentally responsible behavior. These factors include knowledge of ecology, knowledge of environmental issues, environmental attitudes, environmental sensitivity, environmental values, knowledge and skill in issue analysis and action strategies, locus of control and situational variables.

Most environmental education programs focus on knowledge. However, environmental knowledge has been found to have only a slight effect on environmental behavior. If environmental educators want to reach the goal of teaching students to make environmentally responsible decisions, the focus must change. This study attempted to determine the role the variables mentioned above play in environmental decision-making.

Based on previous research, a four stage environmental decision-making model was proposed. In stage one, the person must recognize that a problem exists, and also have a desire to solve the problem. The desire to solve the problem, it was hypothesized, is driven by the person's environmental sensitivity. The greater the person's connection to the environment and the deeper the level of care for the environment, the more likely the person will want to solve the environmental problem. Once there is a desire to solve the problem, the person will move on to stage two. In stage two, the problem is analyzed. Alternative solutions and possible consequences of those alternatives are generated. It

was hypothesized that the more knowledgeable the person is in terms of ecology, environmental issues, and methods of investigating issues, the more prepared the person will be to analyze the issue. In stage three, the alternative solutions to the problem generated in stage two are filtered through the beliefs and values held by the person. It was hypothesized that people who held highly pro-environmental values would be more likely to make pro-environmental decisions. The final stage is negotiating barriers. It was proposed that locus of control, knowledge and skill in action strategies, and situational factors would either help or hinder the person from putting the decision into action.

A survey was created to test the components of the model. The survey was given to 98 chemistry students at a private suburban high school. The survey measured the student's knowledge of ecology, knowledge of environmental issues, environmental sensitivity, environmental values, knowledge of issue investigation strategies, and locus of control. The students were also presented with five environmental scenarios on which they were to make a decision. In addition to making a decision, the students were asked to rate their level of desire to solve the problems, and to rate the degree to which they felt they understood the problems.

When making an environmental decision, there must first be an issue or problem to solve. Overall, the students were not very knowledgeable about environmental issues. They averaged 56% correct on a test of general environmental issue knowledge. This was very similar to the average on a similar test by Wisconsin High School students. For this study, the students were also presented with five specific environmental issues or scenarios upon which to make a decision. What determines whether or not the student

wants to solve the problem? Using a multiple regression analysis, it was found that environmental sensitivity was positively correlated with a desire to solve the presented environmental problems. This supports stage one of the proposed model. Knowledge of an environmental issue is not enough to get students interested in solving the problem. Students also need to be sensitive to the environment and care about what happens to it. The greater the sensitivity to the environment, the greater the person's desire to solve environmental problems.

However, the correlation was not 100%. Environmental sensitivity was found to account for 38% of the variability of the desire to solve the problems. One factor that might affect the desire to solve the problem is how much the students knew about the specific issue. The students were only given some basic information about each issue in the scenario. It is possible that more information may have given importance to the issue in the students' minds.

Another factor that may account for some of the variability is whether or not the student feels personally affected by the issue. I suspect that if the student did not feel personally affected by the issue, the student may not care about the problem, particularly if the student was only moderately sensitive to the environment. For example, one of the scenarios involved whether or not lead fishing tackle should be outlawed. Students who enjoy fishing might feel that they have a bigger stake in the outcome of this issue and have had a greater interest in the problem. Students who did not fish may not have cared as much, even if they had a general overall sensitivity to the environment.

Stage two of the proposed model was supported by another multiple regression analysis. Once students have a desire to solve an environmental problem, they must analyze it. It was found that students with a higher level of total knowledge of ecology, environmental issues, and issue investigation were more likely to report that they understood the pros and cons of the presented problems. This indicates that, while knowledge has not been found to directly correlate to environmentally responsible decisions and behavior, knowledge is important in helping the student analyze the problem and think critically. Individually, the three types of knowledge measured, knowledge of ecology, knowledge of general environmental issues, and knowledge of investigation strategies, did not correlate with a perceived better understanding of the problem. The correlation between understanding the pros and cons of the problem and the total of all three knowledge types indicates that all three are important and work together to help the student analyze the problem.

However, the correlation was not strong. The correlation coefficient for this relationship was only 0.2651. A weakness of this study is that it did not measure how much the students actually knew about the specific issue in the scenario, it only asked them if they felt that they understood the problem. Students may think that they understand the pros and cons of an issue when in fact they do not. Also, there were relatively few questions in the survey concerning the student's knowledge of the methods of issue analysis. The six questions in the Issue Analysis and Actions Strategies section may not have adequately measured the student's ability to think through the problem. This is an area of research in which more work needs to be done.

Stage three of the model was also supported by a multiple regression analysis. When choosing a solution to a problem, the solutions are filtered through the beliefs and values held by the student. Students with a highly pro-environmental set of values were more likely to make pro-environmental decisions. The correlation was fairly strong with a correlation coefficient of 0.6177, and an r^2 of 0.3816. None of the other variables were correlated with making environmentally responsible decisions, including environmental sensitivity, locus of control, or any of the knowledge variables. This indicates that, in order to accomplish the environmental education goal of helping students be better decision makers, environmental values must play a part. The results of this study support research by others that people often use values when making decisions rather than knowledge (Bell and Lederman, 2003; Grace and Ratcliffe, 2002)

Implications

This study demonstrates that values are an important part of making environmental decisions. What do the results imply about environmental education? Does it mean that values should be taught in school? Fien (1997) believes that educators should indeed teach students an ethic of care. He states that teachers should adopt a "committed stance in teaching young people an ethic of care so that they may participate in the personal and social changes needed to advance the transition towards a healthy and sustainable world" (p. 438). Other environmental educators and researchers agree that to attain the goals of environmental education, values education needs to be incorporated into the curriculum (Bell & Lederman, 2003; Pooley & O'Connor, 2000). There is some

evidence that values can be changed through environmental education (McMillan, Wright, and Beasley, 2004).

A barrier to this type of education is the concern that teaching values may be paramount to indoctrination, and that it has no place in a democratic society. An example of this concern comes from the book Facts, Not Fear: A parent's guide to teaching children about the environment (Sanera & Shaw, 1996). In a summary of the criticisms of environmental education, Dissinger (2001) describes how Sanera and Shaw charge that environmental educators are trying to "impose environmentalist values on impressionable school children" (Goring Oxen, para 2). In a commentary in the St. Paul Pioneer Press (December 30, 2004, Opinion page), Shaw contends that children are learning anti-human and anti-technology attitudes and are coming home and condemning their parents for behaviors that harms the earth.

Fien (1997) however, argues that

> Firstly, in relation to values, the role of the teacher needs to be a pro-active one. This involves planning learning experiences which promote the conscious adoption of an ethic of care and encouraging students to engage in active ongoing reflection on it by consciously seeking consistency between the values or principles that are parts of it. Secondly, in relation to formation of attitudes, the teacher's role needs to be more circumspect. The role of the committed educator is not to tell students how their values

> should be applied on particular issues or how they should act as a result. Thus, while teachers have a responsibility to promote particular values, they do not have a license to direct the attitudes that can be formed from these values (p. 445).

The North American Association of Environmental Education, in their Guidelines for Learning: K-12 (1999), recommend having students evaluate their personal beliefs and values, and examine whether or not the decisions they make are consistent with their own environmental ethic. In a summary of research into decision-making, Arvai et al (2004) recommend teaching decision making skills that include identifying one's values and using those values to create objectives to be reached by the decision. Teaching children the value of taking care of the earth, and to be aware of their values and to evaluate whether or not decisions they make are consistent with those values, meshes with the goals of environmental education and my proposed decision-making model.

Limitations

Since environmental values accounted for about 38% of the variability of the pro-environmental decisions, there must be other variables also at work. It's possible that the correlation was not higher because of situational factors. According to the proposed model, situational factors become important in the fourth stage when the person is trying to put the decision into action. It is possible that situational factors may begin to have an effect in the third stage when the person is trying to make a decision. For example, in the fifth scenario of the survey, students were asked if they would be willing to consider

changing their driving habits because of the effect cars have on global warming. A majority of students said they were not willing to do this. For all of the other scenarios, a majority of students made a pro-environmental decision. It might be that, even for students with pro-environmental values, they feel that making changes in their driving habits would restrict their life style too much. This situational factor may not only be blocking the action taken, but may also be affecting the decision itself.

Recommendations for future research

While this study shows that values are important in decision-making, it does not indicate whether or not being aware of one's values makes a difference in the decision one makes. If, after taking the part of the survey on environmental values, the students spent time reflecting on those values, and then took the part of the survey on making decisions, would their choices have been any different? Or, if the students were asked to consciously determine whether or not the solution to the presented problem was consistent with their values, would their choices have been any different? More research needs to be done on how the knowledge of one's environmental values and ethics affects environmental decisions.

More research also needs to be done on how one obtains environmental values and what causes those values to change. Research has found that environmental sensitivity develops through experiences in the outdoors, and through mentors such as parents and teachers (Chawla, 1998; Finger 1994; Sivek, 2002). I suspect that since environmental sensitivity and environmental values are closely related, they may develop in the same way. More research is needed to determine this.

In summary, to help students make responsible environmental decisions, we need to

1. make students aware of issues regarding the environment
2. help students develop sensitivity to the environment and an ethic of stewardship
3. give students the knowledge and tools they need to understand how the world works and how to analyze problems
4. help students become aware of their values and encourage them to use those values when making decisions
5. help students negotiate barriers that may prevent them from carrying out their decisions

We need to have a greater emphasis on the role of values, and provide more opportunities to analyze issues and make decisions. This is the direction I think environmental education should be taking.

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Appendix

Environmental Decision-Making: Survey Instrument

This survey is designed to examine your knowledge, attitude, and behavior regarding the environment. Please answer each question honestly and to the best of your ability.

I. Decision-making Scenarios

The following are several situations that have been in the news involving the environment. Read each situation and then indicate to what extent you agree or disagree with the statement following the situation. Please use the provided answer sheet.

1. Fishing is big business in the United States. In Minnesota alone, 2.1 million people fish. They buy fishing licenses, boats, tackle, and bait. They are also a large part of the tourist industry. Most fishermen use lead sinkers and jigs. Studies of loon deaths in several states indicate that between 25% and 85% of them died by ingesting lead sinkers or jigs. A jig or sinker as small as 1/16 – ounce can kill a loon. The loons appear to be picking up the lead by either ingesting fish or minnows with lead tackle in them, or by picking them up from the lake bottom when they are getting pebbles to help with digestion. No studies in Minnesota have been done to show how the use of lead sinkers and jigs affect the population of the 12,000 loons that nest here. Lead-free jigs and sinkers are currently available in some stores. Since the material used is not as dense as lead, the lead-free tackle is about twice the size of similar weight tackle. The lead-free tackle is also about twice the cost of similar weight lead tackle. (Minnesota Conservation Volunteer, Vol. 66, No. 388).

    a) Do you care whether or not this problem is solved?

    b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

    c) People who fish should be required to use lead-free tackle.

2. The Minnehaha Creek Watershed District, which includes the cities of Edina, Golden Valley, Hopkins, Minnetonka, St. Louis Park, Plymouth, Orono, Minneapolis, and Wayzata proposed a rule that would put some restrictions on property bordered by bodies of water. The proposed rule would require property owners to put a buffer of natural, unmowed vegetation between the resident's backyards and the body of water. Under the proposed rule, if a resident makes improvements to their property that affects the impervious structures on the property (structures that don't let water soak into the ground such as driveways, houses, and garages), the buffer area must be increased. The proposed rule is intended to "stabilize the shoreline, prevent erosion, protect the water from pollutants, stabilize the water level and temperature, and prevent aquatic and other natural habitat'. (Sun Current, April 1, 2004).

    a) Do you care whether or not this problem is solved?

    b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

    c) The proposed rule should be implemented.

3. Methyl bromide is a highly toxic gas that is used to kill pests such as insects and weeds in farm fields and on crops being stored, exported or imported. Based on scientific information, the United Nations has determined that methyl bromide depletes the ozone layer. There is currently no single alternative for methyl bromide. However, several possibilities are being researched and developed. It most likely will take several different chemicals to replace all of the uses of methyl bromide. The Montreal Protocol and the Clean Air Act describe the phase out of the use of methyl bromide in developed countries. It has been argued that U.S. farmers will be at a disadvantage when competing against developing countries that are not part of the phase out. There are several politicians who are trying to delay this phase out. (USDA Agricultural Research Service, www.ars.usda.gov/is/mb/mebrweb.htm)

    a) Do you care whether or not this problem is solved?

    b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

    c) The phase out of methyl bromide should continue without delay.

4. A much smaller percentage of the solid waste generated in Switzerland ends up in landfills than the waste generated in the United States. The Swiss waste management system includes selling special 7.7-gallon bags that must be used for disposing of non-recyclable waste. The cost of the bags is in addition to a flat fee they must pay for garbage handling. The less waste a household receives in packaging, and the more a household recycles, the more a household can save in waste disposal costs. In addition, if someone buys an electronic device, they can leave any unwanted packaging at the store, and the store must dispose of it. The electronic stores must also take any old electronic equipment for disposal. Also, burnable material can no longer be put in landfills in Switzerland. If these materials cannot be recycled, they are burned for energy. Many Swiss bring their own reusable bags to the store to put purchases in because stores charge 15 – 20 cents per bag. (E: The Environmental Magazine, March – April 2003). Proponents of this system say that it encourages recycling, and reduces wasteful packaging by manufacturers. Opponents say that the system is costly and inconvenient for consumers, stores, and manufacturers. There is also the possibility of an increase in illegal dumping of garbage.

    a) Do you care whether or not this problem is solved?

    b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

    c) The United States should adopt a system similar to the Swiss System.

5. According to the book The Consumer's Guide to Effective Environmental Choices: Practical Advice From The Union of Concerned Scientists, by Brower and Leon, "personal use of cars and light trucks is the single most damaging consumer behavior". They describe five behaviors related to transportation that they believe would make a significant difference in the environment. The behaviors are to,
   1. choose a place to live that reduces the need to drive
   2. think twice before purchasing another car
   3. choose a fuel-efficient, low-polluting car
   4. set concrete goals for reducing your travel
   5. whenever practical, walk, bicycle, or take public transportation.

   a) Do you care whether or not this problem is solved?

   b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

   c) I am willing to do at least four of these five suggestions.

II. Ecological knowledge

The following questions will examine your knowledge of ecology and the environment. Please select the correct answer for each.

1. A food web consists of
    A. The animals that eat other animals in a community
    B. All the herbivores and carnivores in an ecosystem
    C. Many interconnected food chains
    D. All the consumers in an ecosystem

2. When two or more species attempt to use the same limited resource in an ecosystem, their interaction is called
    A. Mutualism
    B. Competition
    C. Predation
    D. Commensalisms

3. Having sharp thorns can help a plant by keeping animals from eating it. This is an example of
    A. Mutualism
    B. Adaptation
    C. Competition
    D. Commensalisms

4. All of the individual organisms that live on the ground in a particular forest share the same
    A. Niche
    B. Habitat
    C. Life-style
    D. Food source

5. The reason dead leaves and twigs don't build up in a forest from year to year is because
    A. Non-living elements such as wind and rain remove them
    B. Decomposers break them down into soil
    C. Animals eat them or use them to build nests
    D. None of the above

6. Wolves often eat deer. Does this interaction have any beneficial effects on the deer population as a whole?
    A. Yes, the wolves help keep the deer population size controlled.
    B. No. The deer population is usually only harmed.
    C. Yes, the wolves help keep the deer population strong since the fastest, most alert deer survive.
    D. Both (a) and (c).

7. The energy currently present
    A. Is all the energy we will ever have.
    B. Can change form but is never destroyed.
    C. Can only be used once.
    D. Is mostly in the form of fossil fuel energy.

8. Based upon major ecological principles, we should conclude that
    A. Humans are a climax species that will last indefinitely.
    B. The human species will soon become extinct; nothing we can do will prevent this.
    C. The human species will last as long as there is a balanced ecosystem that will support human life.
    D. There is no way of predicting what will happen to the human species; ecological principles do not apply to humans.

9. The process of photosynthesis in green plants
    A. Uses sunlight to burn energy in plants.
    B. Changes light energy into chemical energy.
    C. Is a process used to burn sugar in plants so the plants can grow.
    D. Changes chlorophyll into sugar.

10. Which of the following terms is used to describe all of the natural living and nonliving interacting features of a given area?
    A. Habitat
    B. Community
    C. Biodiversity
    D. Ecosystem

11. Humans grow crops for food. Many species of these plants need certain species of insects (such as bees) to pollinate them. The pollinating insects often rely on the nectar they obtain from the plants for food. This is a good example of
    A. How organisms, including humans, are interdependent.
    B. Commensalism between humans and other species.
    C. How humans manipulate their environment.
    D. A food web that includes humans.

12. A chemical, which tends to remain stored in body fat, contaminates a particular aquatic ecosystem. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?
    A. Plant life
    B. Minnows
    C. Fish that eat insects and plants
    D. Fish-eating birds

13. Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?
    A. Carrying capacity
    B. Species loading
    C. Non-sustainable growth
    D. All of the above

14. In a small lake, a food chain was as follows:

Sun ⟶ green algae ⟶ small crustaceans ⟶ fish

After many months of heavy snow covering the ice, most of the small crustaceans died. What is the best explanation for this?

    A. The algae population was cut off from its source of energy.
    B. It was too cold for the crustaceans to survive.
    C. The fish ate most of the crustaceans.
    D. A disease killed most of the algae.

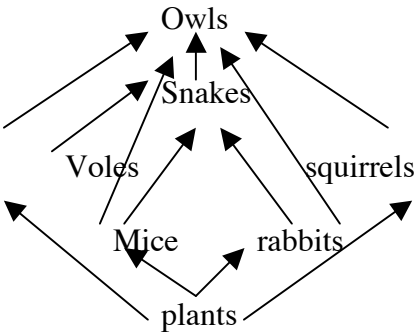
15. If carbon dioxide (CO_2) disappeared from the atmosphere, which of the following would be affected first?
    A. Plants
    B. Animals
    C. Animals that eat other animals
    D. Decomposers

16. Each of the following food chains starts with the same amount of green plants. Assuming that the green plants are digestible by humans, which of the food chains would supply the most energy to humans?
    A. Green plants to humans.
    B. Green plants to cattle to humans.
    C. Green plants to insects to fish to humans.
    D. Green plants to insects to small fish to larger fish to humans.

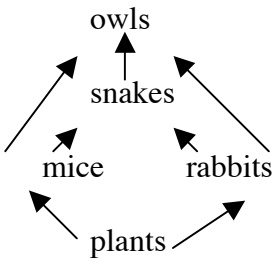
17. Some insecticides that were once effective in killing insects no longer work very well. This is because
    A. New insects species develop every day.
    B. The wrong kinds of insecticides were used.
    C. Insects with natural resistance survived and multiplied.
    D. The insects produced many more offspring than the insecticide could kill.

18. Which of the food webs below would be affected the most if all of the mice were removed? (Note: the arrows point to the consumer of the organism in the food web.)

Food Web (A)



Food Web (B)



    A. Food web (A).
    B. Food web (B).
    C. Neither would be affected.
    D. They would both be affected to the same degree.

III. Knowledge of Issues

1. Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in the upper atmosphere?
    A. Nitrous oxide
    B. Methane
    C. Ozone
    D. Sulfur dioxide

2. The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are
    A. Volcanoes and forest fires.
    B. Petroleum refineries.
    C. Automobiles and coal burning power plants.
    D. Aerosol sprays and refrigerant leakage.

3. Which of the following is *not* true of the world's human population?
    A. It is expected to double within your lifetime.
    B. It is declining in developed areas as the United States and Canada.
    C. Its increase has led to the extinction of many plant and animal species.
    D. The greatest rate of population growth is occurring in developing areas such as South America and Africa.

4. The future of food production as it is currently practiced in this country is in question because
    A. Soil is being depleted by erosion.
    B. The use of synthetic chemical additives has become an issue,
    C. Agricultural land is being lost to development
    D. All of the above.

5. What is the *most common* cause of pollution of streams, rivers, and oceans?
    A. Dumping of garbage by cities.
    B. Surface water running off yards, city streets, paved lots, and farm fields.
    C. Trash washed into the ocean from beaches.
    D. Waste dumped by factories.

6. 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
    A. Habitat alteration by humans.
    B. The illegal poaching or collecting of animals and plants.
    C. Changes in the earth's atmosphere due to human activities.
    D. Hunting by humans for food or sport.

7. Which of the following do scientists feel is the least important contributors to the greenhouse effect?
    A. Destruction of the earth's rainforests.
    B. Burning of fossil fuels, such as gasoline as oil.
    C. Increased use of hydroelectric power,
    D. Production of methane gas by cattle and rice paddies.

8. Many communities are concerned about running out of room in their community trash dumps and landfills. What is the greatest source of landfill material?
    A. Disposable diapers.
    B. Lawn and garden clippings, trimmings, and leaves.
    C. Paper products including newspapers, cardboard, and packing.
    D. Glass and plastic bottles and aluminum and steel cans.

9. Which of the following is a renewable resource?
    A. Oil.
    B. Iron ore.
    C. Trees.
    D. Coal.

10. Which of the following results in the most serious waste or loss of our usable water?
    A. Contamination by bacteria.
    B. Uncontrolled drainage.
    C. Careless usage.
    D. Improper storage.

11. Which of the following would be most likely to result in soil erosion?
    A. An increase in nutrients added to the soil.
    B. The removal of vegetation.
    C. Contour plowing of hillsides.
    D. Aeration of the soil by bacteria.

12. Which of the following is a naturally occurring, invisible gas that can seep out of the ground into people's homes and cause serious heath problems?
    A. Ethane.
    B. Krypton.
    C. Radon.
    D. Chlorofluorocarbon.

13. What is the main cause of global climate change, that is, the warming of the planet?
    A. Sunlight radiating more strongly through a hole in the upper ozone layer.
    B. More carbon emissions from autos, homes, and industry.
    C. Increased activity from volcanoes worldwide.
    D. Global climate change is a myth.

14. Some scientists have expressed concern that chemicals and certain minerals accumulate in the human body at dangerous levels. These chemicals and minerals enter the body primarily through
    A. Breathing air.
    B. Living near toxic waste dumps.
    C. Household cleaning products.
    D. Drinking water.

15. How is most of the electricity in the U.S. generated?
    A. Burning fossil fuels such as coal and oil.
    B. Nuclear power.
    C. Solar energy.
    D. Hydroelectric power plants.

16. Which of the following offers the most potential for reducing our immediate energy problems?
    A. Geothermal power.
    B. Energy conservation.
    C. Biomass conversion.
    D. Tidal power.

IV. Knowledge of issue investigation and action strategies

1. Having your household water tested is important if
    A. You live in an old house.
    B. Your water comes from a well.
    C. You live in an agricultural area.
    D. All of the above

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

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

4. Which of the following would be the most effective method to influence a large number of people to take action about the environmental problem?
    A. Advertise on the radio.
    B. Write letters to the newspaper.
    C. Go door to door and talk to people.
    D. Use a combination of the above.

5. If your student environmental club was concerned about an environmental issue, which of the following would be the best thing to do first?
    A. Write and circulate a petition.
    B. Talk to other people about what they could do to help resolve the issue.
    C. Write to elected officials about your concern.
    D. Research the issue.

6. When deciding how to vote on an environmental issue that has come up in your community, it would be important to consider
    A. the risks and factors that impact the decision.
    B. the way in which each political party encourages you to vote.
    C. the recommendations of environmental special interest groups.
    D. whether or not the issue affects you personally.

V. Environmental sensitivity/interest/connection and concern

The following statements concern people's attitude towards the environment. Please indicate to what extent you agree or disagree with each statement. There are no wrong answers as long as you answer them honestly. Answer the questions based on how *you* feel, not how others feel, or how you think others think you should feel.

1. I enjoy watching TV programs or reading about nature.

2. I enjoy outdoor activities in nature (such as any of the following: bird watching, camping, hiking, fishing or hunting).

3. I appreciate the beauty of nature.

4. I am concerned about saving the remaining wilderness areas left on earth.

5. It is important for humans to live in harmony with the natural environment.

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

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

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

9. I appreciate the forest environment and I am concerned about what happens to the earth's forests and how they are managed.

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

11. Knowing about environmental problems and issues is important to me.

12. I think that damage to the atmosphere, including the ozone layer, is something that everyone should be concerned about.

13. I don't think nature or the environment affects me personally or my everyday life.

14. I like hearing the sounds of nature such as waves, leaves rustling, and birds calling when I'm outside.

15. I am concerned about the health and well being of wildlife.

16. I feel a connection to the natural world.

17. I have an appreciation and reverence for nature.

VI. Values and beliefs concerning personal needs/environment needs/willingness to make sacrifices/self interest

1. I feel good when I do something that improves the world around me.

2. It is my duty or moral obligation to help make the world a better place.

3. What I do to the environment affects everyone, so it would be socially irresponsible for me to do anything that harms the environment.

4. I would feel guilty if my children or great grandchildren had to live with environmental problems that my generation could have solved but didn't.

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

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

7. I believe that plants and animals exist to be used by humans.
8. I would oppose any environmental regulations that would restrict my way of life.
9. Humans have a responsibility to take care of the natural environment.
10. Nature has value for its own sake, not just because it is useful for humans.
11. When making decisions concerning the environment, my needs and wants come first.
12. There are already enough laws to protect the environment.
13. I don't think that recycling is worth all the trouble it takes.
14. Wilderness areas should be preserved and protected in their natural states without human interference.
15. It is important for humans to act in ways that maintain and improve the natural environment.
16. Humans need to take responsibility for the impact they have on the environment and current environmental problems.
17. People have a right to use the environment in any way they see fit.

VII. Locus of Control/ability to make changes

1. Things that I do don't have much effect on the quality of the environment.
2. There is not much that I can do that will help solve environmental problems.
3. I believe that I can contribute to the solution of environmental issues by my actions.
4. It's too hard to change my friends' minds about doing things to help the environment (for example, recycling).
5. Environmental problems are too big to be solved by one person.

6. It will take many years before any environmental problems get really bad, and by then science/technology will have found a solution.

7. Environmental problems are going to occur no matter what we do, so there is no sense in trying to solve them.

8. I would like to do something about the environment, but I just haven't gotten into the habit of doing anything about it.

VIII. Demographics

1. Gender
   A. Female

   B. Male

2. Age
   A. 15
   B. 16
   C. 17
   D. 18

Answer Sheet

I. After reading each situation, please respond to each of the statements below. Circle the choice that best fits your decision, opinion, or feelings.

1. a) Do you care whether or not this problem is solved?

   Don't care at all Care very little Care some Care very much

   b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

   Not at all a little Pretty well A great deal

   c) People who fish should be required to use lead-free tackle.

   Strongly disagree Disagree Agree Strongly agree

2. a) Do you care whether or not this problem is solved?

   Don't care at all Care very little Care some Care very much

   b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

   Not at all a little Pretty well A great deal

   c) The proposed rule should be implemented.

   Strongly disagree Disagree Agree Strongly agree

3. a) Do you care whether or not this problem is solved?

Don't care at all Care very little Care some Care very much

b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

Not at all a little Pretty well A great deal

c) The phase out of methyl bromide should continue without delay.

Strongly disagree Disagree Agree Strongly agree

4. a) Do you care whether or not this problem is solved?

Don't care at all Care very little Care some Care very much

b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

Not at all a little Pretty well A great deal

c) The United States should adopt a system similar to the Swiss System.

Strongly disagree Disagree Agree Strongly agree

5. a) Do you care whether or not this problem is solved?

Don't care at all Care very little Care some Care very much

b) To what extent do you feel you are able to understand and consider the pros and cons involved in this problem?

Not at all a little Pretty well A great deal

c) I am willing to do at least four of these five suggestions.

Strongly disagree Disagree Agree Strongly agree

II. The following questions will examine your knowledge of ecology and the environment. Please select the correct answer for each.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D
10. A B C D
11. A B C D
12. A B C D
13. A B C D
14. A B C D
15. A B C D
16. A B C D
17. A B C D
18. A B C D

III. The following questions will examine your knowledge of environmental issues. Please select the correct answer for each.

1. A B C D
2. A B C D
3. A B C D
4. A B C D
5. A B C D
6. A B C D
7. A B C D
8. A B C D
9. A B C D
10. A B C D
11. A B C D
12. A B C D
13. A B C D
14. A B C D
15. A B C D
16. A B C D

IV. The following questions will examine your knowledge of issue investigation. Please select the correct answer for each.

1. A B C D
2. A B C D

3. A B C D

4. A B C D

5. A B C D

6. A B C D

V. Please circle the answer that indicates to what extent you agree or disagree with each statement in the survey. There are no wrong answers as long as you answer them honestly. Answer the questions based on how *you* feel, not how others feel, or how you think others think you should feel.

SD = Strongly Disagree
D = Disagree
A = Agree
SA = Strongly Agree

1. SD D A SA

2. SD D A SA

3. SD D A SA

4. SD D A SA

5. SD D A SA

6. SD D A SA

7. SD D A SA

8. SD D A SA

9. SD D A SA

10. SD D A SA

11. SD D A SA

12. SD D A SA

13. SD D A SA

14. SD D A SA

15. SD D A SA

16. SD D A SA

17. SD D A SA

VI. Please circle the answer that indicates to what extent you agree or disagree with each statement in the survey. There are no wrong answers as long as you answer them honestly. Answer the questions based on how *you* feel, not how others feel, or how you think others think you should feel.

SD = Strongly Disagree
D = Disagree
A = Agree
SA = Strongly Agree

1. SD D A SA

2. SD D A SA

3. SD D A SA

4. SD D A SA

5. SD D A SA

6. SD D A SA

7. SD D A SA

8. SD D A SA

9. SD D A SA

10. SD D A SA

11. SD D A SA

12. SD D A SA

13. SD D A SA

14. SD D A SA

15. SD D A SA

16. SD D A SA

17. SD D A SA

VII. Please circle the answer that indicates to what extent you agree or disagree with each statement in the survey. There are no wrong answers as long as you answer them honestly. Answer the questions based on how *you* feel, not how others feel, or how you think others think you should feel.

SD = Strongly Disagree
D = Disagree
A = Agree
SA = Strongly Agree

1. SD D A SA

2. SD D A SA

3. SD D A SA

4. SD D A SA

5. SD D A SA

6. SD D A SA

7. SD D A SA

8. SD D A SA

VIII Demographics

1. A. Female B. Male

2. A. 15 B. 16 C. 17 D. 18