Quantifying and Understanding Ecological Literacy: A Study of First Year Students at Liberal Arts Institutions

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Quantifying and Understanding Ecological Literacy

A study of first year students at liberal arts institutions

By
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Submitted in partial fulfillment of Honors Requirements for the Department of Environmental Studies

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ABSTRACT

Ecological literacy measures a person’s knowledge of ecological systems, care for their immediate and global environment, and level of action to reduce his or her personal and communal impact on the environment. This study investigates the level of ecological literacy of first year students who entered seven liberal arts colleges in Pennsylvania in the fall of 2013. The institutions included in the study are Allegheny College, Bryn Mawr College, Bucknell University, Dickinson College, Gettysburg College, Haverford College, and Swarthmore College. 426 students were surveyed during their first three months of college, and the data was processed to quantify the number of students who are ecologically literate and to examine the potential triggers for and pathways towards ecological literacy.

The study shows that 58 percent of students have some level of ecological literacy while the remaining students are ecologically illiterate. In addition to questions that tested for ecological literacy, the survey collected demographic information and gauged a student’s level of exposure to nature. This study does not find that these factors are predictors of a person’s level of ecological literacy. Between the three sections of ecological literacy, a student’s level of care does correlate with a student’s level of action, but neither action nor caring correlate with knowledge. The aim of this research is to support schools in better catering their sustainability efforts towards students with low levels of ecological literacy, so all students who reach the undergraduate level of education will leave the educational system with a basic understanding of the major environmental issues facing today’s world, a feeling of responsibility to address these challenges, and the competencies to contribute positively towards building a more sustainable society.
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INTRODUCTION

The objective of this research project is to quantify the level of ecological literacy of first year college students at seven liberal arts institutions in Pennsylvania. Using this data, the study identifies connections between ecological literacy and demographic information and a person’s exposure to nature. This study breaks down ecological literacy into three sections and shows where students’ strengths and weaknesses are in terms of ecological literacy. Since first year students will be at their college or university for four years, the institutions have the opportunity to empower students to strengthen their ecological literacy, an essential skill and knowledge set given the current environmental challenges facing the country and the world. At the college programming level, this study provides preliminary data for colleges and universities to understand the ecological literacy of their incoming class which might provide impetus for schools to more intentionally address the severe lack of highly literate students. In a broader sense, the study exposes a missing link in the educational system – ecological literacy. This lacking form of literacy could lead to detrimental impacts in terms of continued inaction on climate change and other environmental issues.

Defining Ecological Literacy

Ecological literacy draws it meaning from multiple time periods and scholars (Hardin 1993; Orr 1992; Bruyer 2008; Cherrett 1989). For this reason, it is essential to define ecological literacy as it pertains to this study. In his book *Ecological Literacy*, David Orr references the language of Garrett Hardin, the ecologist who famously discussed the tragedy of the commons. Hardin stated that ecological literacy is one’s ability to ask “what then?”
(Orr 1992). Implicit in this statement are the concepts of systems thinking and reflection on how one’s actions impact the greater community now and in the future. Orr (1992) develops section of ecological literacy for his definition. According to Orr, an ecologically literate person should have a basic understanding of ecology and sustainability in addition to the desire and tools to solve environmental problems. To Orr, sustainability is a dynamic word. Sustainability is a call to humans to find alternatives to everything people do now; these alternatives must have a less negative impact on the environment and on other people. Orr’s main tenants required to move society towards ecological sustainability include competent citizens who understand the place they live, community based work to increase competent citizenry, an understanding of nature as a model for how humans can waste less and become more resilient, and an understanding that there are limits to growth, but not development (Orr 1992). In defining ecological literacy, a person needs to have knowledge of ecological systems, a drive to, not only just know about the systems, but also feel a responsibility towards them, and finally the skills to act upon this knowledge and responsibility.

McBride (2011) synthesized over 1,000 perspectives of ecologists and other environmental scientists on ecological literacy and found that there are six common dimensions behind respondent’s perceptions of ecological literacy many of which align with Orr’s definition. These dimensions are cycles and webs; ecosystem services; negative human impacts; critical thinking and applications; the nature of ecological science; and biogeography. Thus, McBride’s definition also includes knowledge and human interaction with ecological systems. Interestingly, both ecologists, exemplified by those interviewed by McBride, and David Orr who is a theorist come to a cohesive agreement on the multiple axis of ecological literacy.
In Bruyere’s (2008) analysis of definitions of ecological literacy, he identifies that although varied definitions of ecological literacy exist, commonalities run through the literature. The similarities boil down to three components, knowledge, affect, and behavior which must fuse to make an ecologically literate person (Bruyere 2008; Orr, 1992). Each of these three components are emphasized or implied in different definitions. In some definitions knowledge is the primary emphasis while in others people’s actions are weighted higher than people’s knowledge. For the purpose of this study, the areas of ecological literacy are considered of equal importance, and a person must have knowledge, they must feel a connection to the issues, and they must exhibit sustainable behaviors. Knowledge alone is not enough to constitute ecological literacy.

The three sections of ecological literacy used in this paper are caring, knowledge, and practical competency (Orr 1992). Caring gauges a person’s level of compassion for environmental protection and social justice. A caring person, in this context, feels a desire to and responsible for reducing their personal and communal impact on ecological systems. This section is reflective of a person’s mindset, not actions. Knowledge represents an understanding of ecological principals and humans interactions with their built and natural environments. According to Cherrett (1989), an ecologically literate person would have an understanding of imperative ecological concepts such as ecosystem succession, energy flow, materials cycling, ecological adaptation, food webs, carrying capacity, and species diversity. Practical competency is the actions taken by individuals to build sustainability communities. These actions can take a variety of forms. Some actions are subconscious while some are intentional. Some take no effort while some take significant efforts. Still, some are on a personal level such as being a conscious consumer of water and electricity and some are on a
community level organizing groups around environmental or social issues or working for an organization on environmental issues. In this study, an ecological literate person is one who meets a baseline level of the three sections: caring about environmental issues, knowledge of ecological systems, and practical competency necessary to take actions to contribute to a more sustainable world.

**Past Studies**

After David Orr popularized the term ecological literacy in the early 1990s, understanding and measuring ecological literacy saw increased scholarly interest. There are two main routes of study in this research area, theoretical work and survey work. The theoretical area looks at teaching pedagogies and ecological literacy. Orr’s work represents this field of study and is based on examining the intersect of societal structure and ecological literacy.

Survey work has been conducted to interpret the levels of ecological literacy of a range of demographics from minority students in the Netherlands to the entire University of Iceland. The survey-based studies discussed below inform the content and structure of the survey upon which this study is based.

In 2005, Coyle produced the results of a ten-year study conducted by the National Environmental Education and Training Foundation and Roper Research, “Environmental Literacy in America.” The National Science Foundation’s Advisory Committee for Environmental Research and Education carried out this study because they wanted to understand what the public knows about environmental issues. The committee was driven to conduct this study based on their common knowledge that there is an increasing need for people to understand complex environmental issues and the role the individual plays in
decision-making about the environment. There is a need for people to be better informed, and a need to have baseline data (Coyle 2005).

Coyle’s (2005), results show that “most Americans believe they know more about the environment than they actually do.” The study also found that awareness of environmental issues is high, and the American public is in favor of the idea of environmental education. In assessing correlations between knowledge and behavior, the study found that environmental knowledge correlates significantly with sustainable behavior. However, knowledge does not correlate with sustainable behaviors that necessitate greater changes in behavior, and it does not correlate with “lasting environmental stewardship” meaning that people do not fully incorporate environmental impacts into their day-to-day decision making in the short and long term (Coyle 2005). The researchers constructed levels of knowledge to categorize respondents. If every person in the United States met the level “personal conduct knowledge” which means a basic level of awareness, knowledge, and action, about $75 billion less would be spent on energy, water, and healthcare costs each year (Coyle 2005). This suggests that ecological literacy matters because people and countries have the potential to save significant amounts of money. Given the results of this study, recommendations include spreading environmental education to professionals; developing curriculums for educational institutions aside from schools; and improving online environmental education dissemination and tools.

In 2001, Morrone et al. produced a study that developed a survey instrument to test the sections of ecological literacy. The sections included knowledge, attitudes, sensitivities, and personal beliefs. The personal beliefs sections correlated with a person’s worldview of the environment. Morrone et al. defined worldview using the environmental psychology definitions: the dominate social paradigm (DSP) which is a “progrowth, faith in science and
technology, advocate of hands-off approach to government, and belief in resource
abundance” ideology and the new environmental paradigm (NEP) which is the opposite of
the DSP (2001). This survey was administered to four sample groups throughout Ohio which
represented different demographic categories. The study found that there is not a correlation
between knowledge and a concern for the environment. This research revealed that
worldview is a stronger indicator for concern for the environment than knowledge. Ohioans
also knew more about global environmental issues than local environmental issues (Morrone
et al. 2001). This study suggests that in order to increase ecological literacy people’s central
ideologies need to be altered rather than their level of ecological knowledge.

Bruyere (2008) studies The Effect of Environmental Education on the Ecological
Literacy of First-Year College Students. The aim of the study is to assess which sustainable
behaviors are influenced by knowledge of environmental systems and issues and which
behaviors are not impacted by this same knowledge set. The study conducted at Colorado
State University surveyed 136 first-year students in first year seminar classes where the
professors allowed the researchers to give a presentation and conduct the survey. Each class
in the sample took the pre-survey, and the control classes took the post-survey after no
change in their class curriculum. The test classes underwent two environmental education
lessons, and then took the post-survey. Bruyere (2008) found that overall “as individuals
learn about ecological principles, biological cycles, and environmental systems, their
environmental attitudes become more favorable and many of their environmental behaviors
become more frequent.” Consumer decisions stood out as an area where a significant number
of participants shifted their views in favor of a more environmentally conscious outlook. This
study concludes that knowledge is a predictor of action, or at least a sub-set of actions;
however, the study did not retest the students after a longer period of time to measure if they retained this new environmentally aware outlook. This study does not address if formal education impacts people to change their habits in the longer term.

In 2010, the University of Iceland conducted an evaluation of ecological literacy of their faculty, staff, and students to collect baseline knowledge to inform their sustainability policy. The research was conducted via an online survey distributed to every person with a University of Iceland email account. The survey contained five sections, demographic information, environmental attitudes, sustainable behaviors, environmental values, and visions for the University (Davidson 2010). The trends indicate that the older the participant, the better they did on the survey. Students, faculty, and staff from outside Iceland generally performed better on the survey except on the background knowledge section where nationality did not play a role (Davidson 2010). The final portion of this study discusses development plans for a sustainability program based off of these results. This is an example of how studying ecological literacy is applicable to school’s sustainability programming.

Given the studies discussed above, no consensus exists on predictors of ecological literacy. While some past studies have indicated that bolstering environmental education will increase ecological literacy, others have said that knowledge matters less than a person’s worldview. Further, while the University of Iceland intends to build a sustainability program as a result of their ecological literacy research, other scholars (Coyle 2005; Louv 2008) suggest that informal education will yield more ecologically literate people than work inside of structured institutions. According to the studies above, it seems that people take thousands of different and unidentified routes towards ecological literacy, and when comparing studies,
the trends are vague. Thus, it is challenging to identify triggers which empower people to become ecologically literate.

**Achieving Ecological Literacy**

In McBride’s (2011) study, the ecologists interviewed and surveyed recognized five means through which people achieve ecological literacy. The first is education by mass media. Media via television and internet are powerful tools of communication that can be harnessed to spread general awareness of environmental issues or ecological concepts. Wide-reaching media does not create an ecologically literate person, but it has the power to expose people to ecological concepts who would not otherwise receive this initial exposure. From this initial exposure, a person might seek further knowledge or be more receptive to future experiences related to the given mass media exposure. One example of this method is the *Planet Earth* series.

Another trigger suggested was formal education. Strictly incorporating ecological knowledge into curriculum is understood to be insufficient; however, programs do have the ability to shape an experience which incorporate building knowledge, and caring and teaching skills which empower people to take action. In *Earth in Mind*, David Orr (2004) suggests a complete overhaul of the educational system and the educational ranking system in order to adequately include environmental education. He suggests that schools should be judged upon the carbon footprint of their students, how the institution disposes of its waste, the percentage of graduates who have a basic understanding of ecological principles, sustainable investment of the school’s money, and how graduates contribute to a more sustainable world, rather than the student to teacher ratio and retention rates. If the criteria for
a formal education institution shifted to Orr’s criteria, only then would it sufficiently build ecologically literate citizens.

Ecologists also identified financial incentives as a trigger for achieving ecological literacy (McBride 2011). When a person is monetarily rewarded for actions which positively impact the environment, this incentivizes good behavior despite a person’s reason for taking that action. Cognitive dissonance, or stress due to inconsistency in one’s actions and attitude, leads to reconciliation of one’s attitudes with the actions (Festinger 1957). This means that if a person is incentivized with money to make sustainable behavioral changes, then their attitude will follow their change in behavior. People might begin by simply caring that they save money, but once the behavior is entrenched in their lifestyle, they come to the realization that acting in an environmentally conscious way has become an additional mindset. For example, a student uses a reusable mug because it saves him or her 50 cents per cup of coffee. This becomes a habit. The person then begins to understand the positive environmental impacts of the decision which was originally only made to save money.

The fourth pathway to ecological literacy is active engagement with the environment or outside the classroom environmental education. Richard Louv (2008) argues that a child’s exposure to nature is not only important for the person’s understanding of ecological systems, but also for the trajectory of communities and society. The generation growing up today is the first generation that spends more time with technology than with nature. Louv and a group of scientists are attempting to measure and find significance in the “de-natured childhood.” No baseline data exists from the past, so levels of caring for and knowledge about the environment cannot be compared. Louv declares that most children in the United States today suffer from “nature-deficit disorder” or “the human costs of alienation from
nature, among them: diminished use of the senses, attention difficulties, and higher rates of physical and emotional illnesses.” In understanding deficit, one can also look at abundance. If children are exposed to an abundance of nature, then they will formulate different physical connections to nature and to the rest of the world.

The final pathway identified by McBride (2011) is outreach by scientists. When people learn directly from the authorities that conduct the research, they may be more connected to it than if they read the information in a news article or in a book. More broadly, scientists need to more effectively communicate their science, and workshops on communicating for ecologists would bolster the effectiveness of communicating that the ecologists and scientists do take on. This would increase the number of people who listen and absorb the knowledge from the scientists. This trigger, one of knowledge, is not necessarily strong enough to encourage someone to become ecologically literate as studies such as Coyle (2005) and Morrone et al. (2001) reaffirm.

**The Greater Context of Ecological Literacy**

If a greater number of people or decision makers are ecologically literate, what does this achieve? An ecologically literate person will make decisions and take actions with environmental issues in mind which is an essential skill given the environmental issues facing the world today.

In 2013, the Intergovernmental Panel on Climate Change released the Fifth Assessment Report on the science of climate change. This report, which compiles the strongest climate science from around the world, states that “warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia” (IPCC 2013). The IPCC report, *Climate Change 2014: Impacts,*
Adaptation, and Vulnerability, states that “in recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans.” Climate change is occurring and its impacts are not only predicted for the future, but they are also affecting people now. Despite this level of knowledge on climate change, international negotiations on climate change have yet to yield mitigation commitments from every country in the world most prominently, the United States. Domestically, the United States does not regulate greenhouse gas emissions except through vehicle standards, and the mainstream dialogue on climate change has not overcome the hurdle of whether climate change is a belief one can hold or a fact that one must accept.

There is a vast disconnect between the scientific understanding and the low level of action taken by individuals, governments, corporations, and institutions to combat climate change. One possible means to decrease this gap would be to increase people’s ecological literacy because it incorporates not only a person’s knowledge, but also their caring and the actions they take. Additionally, it may be important to focus on the ecological literacy of policy makers and corporate decision makers because it is clear through their inaction that these leaders, overall, do not have the level of ecological literacy which would require them to think about the environmental consequences of their decisions in addition to the economic and social consequences.

METHODS

Survey Design

In order to collect baseline data on the ecological literacy of first year college students in Pennsylvania, a five-part survey was developed (Appendix 1). The survey questions were in part drawn from survey studies conducted in the past (Morrone et al. 2001; Coyle 2005;
Bruyere 2008; Davidson 2010), and were in part crafted by the researcher. The survey tested first year students’ level of ecological literacy and their exposure to nature, and collected their demographic information (Figure 10). These sections were chosen because one goal of the project was to see if a person’s exposure to nature as a child can serve as a predictor of his or her ecological literacy and to see if any sectors of the population have a higher level of ecological literacy than another sector. If these trends do exist, it could lead to further investigation of why this is the case and how ecological literacy can be increased given the known pockets of ecological illiteracy.

Section one provided twelve statements, and asked students to rate their agreement with each statement on a Likert scale that ranged from strongly disagree (1) to strongly agree (5). This gauged a student’s level of care about environmental issues. Caring is defined as a person’s level of compassion for environmental protection and social justice. A caring person feels a desire to and responsible for reducing their personal and communal impact on ecological systems. So a person with a low level of caring does not feel that their life impacts or is impacted by the natural environment around them. This person feels that the business-as-usual trajectory today does not need to be changed or challenged because of the ills it inflicts upon the environment. The major areas covered by the statements are personal responsibility to the environment, views of rules and regulations to protect the environment, and perceptions of waste. This section was places as the first section of the survey because there are no right or wrong answers making respondents comfortable as they begin the survey.

Section two contained nine statements about students’ actions in relation to environmental issues. The responses to this section correlate with a student’s practical
competency. The statements can be grouped into sections marked by the level of mindfulness and effort required of a person to take the action. A student with a low level of practical competency does not take actions which would reduce their negative impact on the environment. A person with a high level of practical competency has embedded sustainable actions into his or her everyday life and makes an effort to bring people together around issues of the environment and sustainability. Two statements fall under the simple section of practical competency; they take little to no additional effort or mindfulness to complete the action. An example of a simple action is turning off the lights when one leaves the room. Basic action statements require some effort on the part of the individual to take time to carry out the action and some mindfulness because if the person did not think the action was valuable, they would not carry it out. Using a reusable water bottle and coffee cup instead of the disposable option indicates that a person made the effort to clean their vessel and carry it with them throughout the day. A person might do this for a variety of reasons including convenience, to save money, or for the environment, but regardless of their motive, the action takes some effort and mindfulness.

Moderate statements assess if a person puts time and effort into seeking alternative actions to the most convenient option because of its environmental impacts. This requires a person to intentionally think about how their actions impact the environment. For example, a person who walks, takes the bus, bikes, or carpools instead of driving a personal vehicle has made a more significant decision which reduces their environmental impact and is backed with time and effort in favor of the environment.

A complex action statement means that a person has committed substantial time and effort to work on environmental issues not only personally, but also as a leader in their
community. For example, a person who has worked or volunteered with an organization on an environmental issue or a person who has organized students to work on an environmental issue has participated in action with significant challenges. Students ranked their commitment to each action on a Likert scale ranging from *Never* (1) to *Always* (5). This section was placed as the second section because, again, it does not have right or wrong answers and the questions can be answered quickly.

The third section asked knowledge questions. Morrone et al. (2001) created a working group of ten environmental education experts from across the United States to establish the most important ecological principle that people should know about in order to be considered ecologically literate. Additionally, Orr (1992) provides a list with a similar group of principles. The main principles guided the compilation of questions used in the final survey. These main principles established in Morrone et al. (2001) and Orr are (1) biogeography, an understanding of species and their habitats; (2) the earth as a biosphere meaning the way that earth systems work together including climate change and global pollution; (3) ecological energetics also know as energy sources; (4) carrying capacity; (5) ecosystem succession which looks at human caused and natural land use change; (6) biotic interactions or the relationships between species in a given ecosystem; (7) biodiversity and the threats to biodiversity; and (8) material cycling including the water cycle and the food web (Morrone et al. 2001). David Orr also discusses the laws of thermodynamics and ecosystem services. Each of these areas of ecology is explicit or implicit in at least one of the twelve knowledge questions. The questions also ranged in difficulty (Table 1).

<table>
<thead>
<tr>
<th>Level of difficulty</th>
<th>Necessary Knowledge</th>
<th>Knowledge question numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An ability to reason, but little prior knowledge of ecological systems necessary</td>
<td>22</td>
</tr>
</tbody>
</table>
2 Slight knowledge of ecological systems necessary 28, 32, and 33
3 Must understand basic ecological principles 24, 27, and 29
4 Must understand more advanced ecological principles 26, 30, and 31
5 Requires significant awareness of current environmental issues 23 and 25

Table 1: Level of Difficulty of Knowledge Questions
(See Appendix 1 for the questions which correlate with the numbers in the column, “knowledge question numbers”)

The questions in this section were multiple choice, and only one answer was correct for each question. This section was placed as the third section because it has correct and incorrect answers which require students to respond with answers external to their personal behavior and beliefs. If these questions had come first, they may have discouraged participants and if they were last, the participant may not have completed the section.

The fourth section assessed student’s exposure to nature, and it contained only three statements. The statements gathered information to see if students who had greater exposure to nature as a child have a higher level of ecological literacy than students who did not have exposure to nature. The students had three options to respond to each statement about amount of time they spent doing each activity described by the survey: very little time, some time, or a lot of time. This is the first section of personal descriptive information collected about the students.

The fifth section of the survey collects standard demographic information about the students. Where possible the questions mimic the options provided by the US Census. Students answered these questions with a combination of check boxes and fill in the blank spaces. The demographic information sections were placed last on the survey because the researcher did not want students thinking about how their demographic information might be
used while filling out the rest of the survey. This ordering provides for more authentic responses.

**Survey Implementation**

Once the survey was devised, a pilot study was run with a first year seminar class at Dickinson College to test the length of the survey and the clarity of the statements and questions. The survey took the students approximately five minutes to fill out, and students did not have questions about any of the statements or questions. Four Dickinson faculty and staff members from four different departments also reviewed the survey both before and after the pilot study.

Once IRB approval was obtained from Dickinson College (see Appendix 2 for IRB exemption approval from Dickinson College and Bryn Mawr College), the researcher contacted environmental studies professors at eleven colleges and universities in Pennsylvania that offer a liberal arts education. The colleges contacted were Allegheny, Bryn Mawr, Bucknell, Dickinson, Franklin and Marshall, Gettysburg, Haverford, Lafayette, Muhlenberg, Swarthmore, and Ursinus. Some of the contacted professors did not respond to email and some said that they could not help, but the majority of the environmental studies professors connected the researcher via email to the IRB officers, first year seminar deans, or other professors at the respective college who would be best fit to connect the researcher to a sample of first year students no necessarily associated with the environmental studies department. Professors, provosts, and deans at eight of the eleven colleges and universities administered the surveys to their first year seminar classes or their school’s equivalency. The participating colleges were Allegheny, Bryn Mawr, Bucknell, Dickinson, Gettysburg, Haverford, Swarthmore, and Ursinus. The surveys were mailed or emailed to the professor
administering the survey. The five-minute surveys were distributed in classes on paper during the Fall 2013 semester, the first semester of the students’ first year of college. Less than 20 of the Bucknell surveys were filed out during the first week of the second semester and are an exception to the above statement. The participating classes ranged significantly in subject matter, and covered humanities, social sciences, and lab sciences courses. A total of 424 first year students took the survey.

**Survey Analysis**

As the surveys were mailed back to Dickinson, they were assigned a unique code and entered into a database which recorded each students’ response to every question. Once all of the surveys were entered into the database, a scheme was developed to decide which surveys could be considered in the analysis. 102 of the participants did not take the correct version of the survey, so those surveys were discarded. If a participant left a caring question or a practical competency question blank, their survey was removed from the study. This is because there is no way to assume what the response would be. If a participant left a knowledge question blank, the question was marked incorrect and the survey was retained in the database. This assumes that if a student leaves a question blank, he or she does not know the answer. Participants who did not respond to portions of the demographic information were also retained in the database because the regression model ignores blank sections and only uses the entry when it is not blank. Thus, if a person did not enter ethnicity/race, they can still be included in all the other models. After reviewing and assessing the data, the sample size decreased to 285 surveys.

The survey questions and statements were also reassessed to ensure that each one was an accurate measurement of the section’s objective. In section one, statements two and four
were removed because the level to which one agrees with the statement does not necessarily correlate with the amount that they care about environmental issues. All statements remained in section two. In section three, number 32 was removed because the correct answer should have stated “synthetic pesticides,” not just “pesticides” because organic pesticides are legitimate to use on United State Department of Agriculture (USDA) certified organic farms. All demographic questions were retained.

A sample size of 285 surveys from seven colleges and universities was used in the analysis of the data. The students had over 30 prospective majors and were from 30 different states and 16 different countries outside North America.

First, an overall scale of ecological literacy was devised. The scale was created based off of a standard grading scheme. The scale includes both ecological illiteracy and levels of ecological literacy (Table 2). In order to be considered ecologically literate, a student must meet a threshold of over 60 percent on each of the three sections, caring, knowledge, and practical competency. All students who fall below 60 percent in one of the areas receive the equivalent of an ‘F’ and are considered to not have a high enough combination of knowledge, caring, and practical competency to be literate. From 60 percent to 100 percent the levels were broken up into 10 percent ranges just like a standard grading rubric. Low would be the equivalent of a ‘D,’ Basic is a ‘C,’ Standard is a ‘B,’ and High would be the equivalent of an ‘A.’ This method was chosen because it is well understood by not only academics, but also the average student or adult.

<table>
<thead>
<tr>
<th>Level of Ecological Literacy</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>Below 60%</td>
</tr>
<tr>
<td>Low</td>
<td>60-69.9%</td>
</tr>
<tr>
<td>Basic</td>
<td>70-79.9%</td>
</tr>
<tr>
<td>Standard</td>
<td>80-89.9%</td>
</tr>
<tr>
<td>High</td>
<td>90-100%</td>
</tr>
</tbody>
</table>
Table 2: Levels of ecological literacy

The Likert scales used in the *Caring* and *Practical Competency* sections were assigned percentage values which best described the person’s level of caring or action.

Tables 3 and 4 show the values assigned to the Likert scales, and provide the justifications for each value as they associate with the levels of ecological literacy indicated in Table 2. The Likert scale values in the database were converted to the percentage assigned before beginning analysis. Table 5 shows the percentage assigned to the knowledge section. The percentages are based on the number of questions the student answered correctly.

<table>
<thead>
<tr>
<th>Likert scale</th>
<th>Associated description</th>
<th>Percent assigned</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Strongly Disagree</td>
<td>0</td>
<td>The student does not care at all, so the score associates with illiterate.</td>
</tr>
<tr>
<td>2</td>
<td>Disagree</td>
<td>15</td>
<td>The student does not care, but does not disagree passionately.</td>
</tr>
<tr>
<td>3</td>
<td>Neither Agree nor Disagree</td>
<td>60</td>
<td>The student does not have an opinion, which places he/she at the minimum score necessary to be considered literate.</td>
</tr>
<tr>
<td>4</td>
<td>Agree</td>
<td>85</td>
<td>The student agrees, but not passionately which indicates that the student meets standard ecological literacy</td>
</tr>
<tr>
<td>5</td>
<td>Strongly Agree</td>
<td>100</td>
<td>The student cares passionately.</td>
</tr>
</tbody>
</table>

Table 3: Caring Likert scale

<table>
<thead>
<tr>
<th>Likert scale</th>
<th>Associated description</th>
<th>Percent assigned</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Never</td>
<td>0</td>
<td>The student takes no action and is considered ecologically illiterate</td>
</tr>
<tr>
<td>2</td>
<td>Seldom</td>
<td>60</td>
<td>The student takes very little action placing he/she at the minimum score necessary to be considered literate.</td>
</tr>
<tr>
<td>3</td>
<td>Sometimes</td>
<td>70</td>
<td>The student takes action on occasion meeting the top threshold of basic ecological literacy</td>
</tr>
<tr>
<td>4</td>
<td>Often</td>
<td>90</td>
<td>The student takes action meeting the top threshold of standard of ecological literacy.</td>
</tr>
<tr>
<td>5</td>
<td>Always</td>
<td>100</td>
<td>The student exhibits exemplary action and has a high level of ecological literacy.</td>
</tr>
</tbody>
</table>

Table 4: Practical Competency Likert Scale
<table>
<thead>
<tr>
<th>Number correct</th>
<th>Percent associated</th>
<th>Justification (See Table 1 for reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-11</td>
<td>100</td>
<td>The student answered all the questions correctly or answered one question incorrectly. This indicates a high level of ecological literacy.</td>
</tr>
<tr>
<td>9</td>
<td>90</td>
<td>The student answered all but the level 5 questions correctly indicating that the student meets the standard of ecological literacy.</td>
</tr>
<tr>
<td>7-8</td>
<td>80</td>
<td>The student incorrectly answered the level 5 and some of the level 4 questions which places them at the minimum level of knowledge needed to be considered at the standard level.</td>
</tr>
<tr>
<td>5-6</td>
<td>60</td>
<td>The student incorrectly answered level 5, level 4, and some of the level 3 questions. They meet the minimum level of literacy necessary to be considered ecologically literate.</td>
</tr>
<tr>
<td>3-4</td>
<td>40</td>
<td>The student incorrectly answered level 5, level 4, level 3, and some level two questions. The student is ecologically illiterate.</td>
</tr>
<tr>
<td>0-2</td>
<td>0</td>
<td>The student correctly answered only the most basic questions. The student is ecologically illiterate.</td>
</tr>
</tbody>
</table>

Table 5: Knowledge Question Scoring

The demographic information from the surveys was first compiled in the database in full. The responses about exposure to nature were averaged to give a student’s average exposure to nature. In order to see if any of the pieces of demographic information are predictors of a student’s level of ecological literacy, they must be binary variable. Where the information was not already in binary form, categories were combined to decrease the number of variables. The data analysis was then conducted in Excel and Minitab Statistical Program.

RESULTS

Levels of Ecological Literacy

The majority of first year students in the sample have a basic or low level of ecological literacy or are considered to be ecologically illiterate. Illiterate means that a student does not have enough knowledge, caring, or practical competency to make decisions and live in a way that has a minimum impact on the environment and a maximum positive impact on the community. Figure 1 shows the overall ecological literacy level of the students.
Figure 2 breaks down literacy levels into the categories delineated in Table 2. Although less than half of students are considered ecologically illiterate, an additional 31 percent of students fall in the basic or low ecological literate categories. In total, 73 percent of students have basic or low literacy or are ecologically illiterate.

Figure 3 shows ecological literacy by section. The graph reveals the number of students who met each level of literacy in each section. A student needed to have a score of at least 60 percent in each section to be considered ecologically literate. This graph shows where students struggled and where they excelled.
The next step was to gauge the ecological literacy level of first year students at each institution. For each section, all the students’ scores were averaged together for each respective school generating the level of ecological literacy in each section for each school. The results of this computation, in Figure 4 and 5, show that there is the highest percentage of caring at each school. Haverford has the highest average caring percentage at 89 percent and Gettysburg has the lowest average caring percentage at 82 percent. This places all of the schools in the standard ecological literacy section for the caring. Bryn Mawr placed the highest in the practical competency section with an average practical competency percentage of 71 percent. Gettysburg has the lowest average practical competency percentage at 61 percent. For this section, all schools except Bryn Mawr fell in the basic level of ecological literacy. For the knowledge section, Bucknell had the highest average knowledge percentage with 80 percent, and Allegheny has the lower average knowledge percentage with 63 percent. Allegheny, Bryn Mawr, Dickinson, and Gettysburg all fall in the low ecological literacy

![Level of Ecological Literacy by Survey Section](image-url)

Figure 3: Ecological literacy by sub-section
level, Swarthmore and Haverford each fall in the basic level, and Bucknell meets the bottom threshold for standard level. These results come from varying sample sizes, depicted in Figure 6, so for the smaller sample sizes, the survey should be more widely distributed before these results can be considered meaningful for the individual institutions.

Figure 4: Ecological literacy by section by college and university
Predictors and Indicators of Ecological Literacy

The survey response graphs (Figures 7-9) represent the raw data collected from the surveys. The “Survey Question Number” on the X axis of each of the graphs correlates to the survey question number which can be found in Appendix 1. The Survey Responses: Caring graph (Figure 7) shows that overall the majority of students answered that they agree or strongly agree with all of the caring statement except number two which asks a question which a disagree response would indicate a higher level of caring. The results from the practical competency section are more varied in their distribution than the caring questions (Figure 8). The Survey Responses: Knowledge graph (Figure 9) shows the percentage of students that answered each question correctly. There were no questions where over 90 percent of students answered the question correctly. On four questions, over 70 percent of students answered them correctly. On questions 23, 25 and 31, less than half of the students
gave the correct answer. The average number of questions that a student answered correctly was 6.5 questions out of 11 or 58 percent.

Figure 7: Raw results from the caring section of the survey

Figure 8: Raw results from the practical competency section of the survey
Figure 9: Raw results from the knowledge section of the survey

Demographic information was collected to see if any single aspect of demographic information or combination of factors impacts a person’s ecological literacy. The demographic information questions included in the survey can be found in Appendix 1. Figure 10 shows the breakdown of the demographic information collected. Additionally, each student’s exposure to nature was assessed based on three questions about informal and structured time spent outside growing up. Figure 11 portrays the number of students who responded to each question with each response. A student’s exposure to nature was calculated by averaging the responses to the three questions. Students overwhelmingly answered that they have had a high level of exposure to nature. The average of all the students’ total exposure to nature was 2.61 out of three. Only four students answered all three questions with a one indicating that they spent very little time outside growing up, and two additional students answered with a one for two of the three questions.
Figure 10: Demographic information collected
The demographic information was reassessed and compiled in a way that allowed for statistical analysis using Minitab statistical program. This consolidation was based on the sample sizes present for each demographic category as well as the combination of like categories. For race/ethnicity, white was set as one category and non-white was set as the second category, and an option was left open to include international students as a third category. The education section combined the option private school and the option both private and public school, so the categories became at least some private schooling and all public schooling. The family income section was divided into two sections with a break at $100,000 per year. Household religion can be analyzed in three ways based on the sample sizes. The breakdowns are Catholic versus not Catholic, Protestant versus not Protestant, and no religion versus religion.

In Minitab, regressions were run to illuminate relationships between the three aspects of ecological literacy and the impact of the demographic information. Table 6 shows the
results of the regression models for the sections of ecological literacy as well as the ability of each section to predict total ecological literacy. The model is the variable that is being tested as a predictor, and the response is what is being predicted by the model. Each of the regression models in table 6 is linear, so the inverse of each relationship yields the same results. Figure 12 shows the relationship between caring and practical competency.

<table>
<thead>
<tr>
<th>Model</th>
<th>Response</th>
<th>p-value</th>
<th>(r^2)</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caring</td>
<td>Practical competency</td>
<td>0.000</td>
<td>25.41%</td>
<td>caring = 0.577831 + 0.388297 (practical competency)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Caring</td>
<td>0.065</td>
<td>1.20%</td>
<td>caring = 0.796984 + 0.0567953 (knowledge)</td>
</tr>
<tr>
<td>Practical</td>
<td>Knowledge</td>
<td>0.358</td>
<td>0.30%</td>
<td>knowledge = 0.538625 + 0.0723 (practical competency)</td>
</tr>
<tr>
<td>Competency</td>
<td>Caring</td>
<td>0.000</td>
<td>20.75%</td>
<td>Ecological literacy = 0.351576 + 0.446678 (caring)</td>
</tr>
<tr>
<td>Practical</td>
<td>Ecological literacy</td>
<td>0.000</td>
<td>20.34%</td>
<td>Ecological literacy = 0.498717 + 0.340658 (practical competency)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Ecological literacy</td>
<td>0.000</td>
<td>25.19%</td>
<td>Ecological literacy = 0.551545 + 0.255413 (knowledge)</td>
</tr>
</tbody>
</table>

Table 6: Regression model outputs for sections of ecological literacy

Figure 12: Caring and practical competency as predictors for each other

Correlations were not detected between demographic information and sections of ecological literacy or overall ecological literacy. Although p-values showed that there is
statistical significance to suggest that the null hypothesis, that there is no relationship, is not correct, the extremely low $r^2$ values show that there is little to no practical significance. The models do not provide an equation which would accurately gauge the area of ecological literacy attempting to be predicted. The highest $r^2$ value obtained in testing these regression models was 5.72 percent for using female as the model and knowledge as the response. Even when a regression is run with a combination of variables, the $r^2$ value is still below 10 percent. Similarly, a person’s exposure to nature does not correlate with their overall ecological literacy (Table 7).

<table>
<thead>
<tr>
<th>Model</th>
<th>Response</th>
<th>p-value</th>
<th>$r^2$</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure to Nature</td>
<td>Ecological literacy</td>
<td>0.236</td>
<td>0.51%</td>
<td>ecological literacy = $0.681824 + 0.0170726$ (exposure to nature)</td>
</tr>
<tr>
<td></td>
<td>Caring</td>
<td>0.144</td>
<td>0.77%</td>
<td>caring = $0.779525 + 0.0216454$ (exposure to nature)</td>
</tr>
<tr>
<td></td>
<td>Practical competency</td>
<td>0.096</td>
<td>1.00%</td>
<td>practical competency = $0.583368 + 0.0316371$ (exposure to nature)</td>
</tr>
<tr>
<td></td>
<td>Knowledge</td>
<td>0.010</td>
<td>2.36%</td>
<td>knowledge = $0.418768 + 0.0647496$ (exposure to nature)</td>
</tr>
</tbody>
</table>

Table 7: Regression model outputs for exposure to nature and ecological literacy

**DISCUSSION**

**Overall Ecological Literacy**

More than half of incoming first years at the seven liberal arts colleges and universities included in the study have some level of ecological literacy. 27 percent of the students have standard or high levels of literacy. This suggests that overall students are not entering college with the level of ecological literacy which would inform their worldview or decision making process. David Orr (2004) argues that, although it is bad that students enter college with a low level of ecological literacy, it is even more unacceptable that they leave
college without a strong concept of each aspect of ecological literacy. Thus, colleges have a significant task to take on.

This baseline data shows that there is significant work to be done to increase ecological literacy levels before students enter higher education as well. This is especially important because, in 2013, only 65.9 percent of high school seniors in the United States enrolled in a college or university, which means that 34.1 percent of students probably have the same average level of literacy or lower that the students surveyed in this study, and they will not experience the rise in attention to ecological literacy in college (Bureau of Labor Statistics, 2014). This is a barrier to sustainability work in communities, across states, and at the federal level because if people do not know, care, or take sustainable actions, then issues such as climate change are more difficult to adequately address.

**College Comparisons**

The levels of ecological literacy of first year students separated by institution did not reveal significant differences between any of the schools. In the caring and practical competency sections, there was a difference of less than 10 percent between the average percentages that a student at the highest school received versus the school with the lowest score. In the knowledge section, the gap ranged about 20 percent which means that there is some knowledge gap between the highest and the lowest schools. Given the large range in samples sizes from the different schools, more data from the schools with small sample sizes would provide more concrete evidence that the schools have incoming students with similar levels of ecological literacy or differing levels of ecological literacy. The results suggest that no school is broadly attracting students with a higher level of ecological literacy.
Dickinson, in particular, has shifted its focus in the last decade to make sustainability a defining feature of a Dickinson education. This study does not show how student’s ecological literacy changes during his or her time at an institution which is Dickinson’s focus. However, it is interesting to note that despite Dickinson’s strong ratings for sustainability from the Princeton Review and Sierra Club, this study does not show that Dickinson’s incoming first year students have a higher level of ecological literacy than students entering a school with less of a focus on sustainability.

**Survey Question Analysis**

A student’s overall level of ecological literacy provides baseline data for more studies to be conducted and as impetus for schools to take on the challenge of creating an ecologically literate citizenry. However, the pathways to empowering people to become ecologically literate represent a significant barrier to intentionally working towards greater ecological literacy as a community or society.

The student’s responses to each survey question suggest trends for each section of ecological literacy. The survey questions not only lead to an overall number for ecological literacy, but there is a gradient of question difficulty or level of commitment to ideas or actions imbedded in each section of the survey. The responses show where incoming students stand on issues of the environment and sustainability as well as their knowledge of ecological systems and people’s interactions with those systems.

The first section of the survey asked questions pertaining to a person’s level of caring, and the major areas covered by the questions are personal responsibility to the environment, views of rules and regulations to protect the environment, and perceptions of waste. Question 1 states, *I feel a responsibility to reduce the impact I make on the environment*, to which
students overwhelmingly responded agree and strongly agree. When given the statement, *one person's actions do not make a difference when it comes to environmental issues*, most students stated that they disagreed or strongly disagreed with this sentiment. These questions provide a glimpse into how a student views him or herself in relation to environmental issues. These results represent a positive trend that students do see that their actions are interconnected with environmental issues.

Six of the statements in the caring section, or 50 percent of the questions, ask students how they feel about potential regulations which would increase environmental protection, address environmental health concerns, and mitigate climate change. Two sets of questions give a condition in the first question, and the second question asks if the student would still agree with the given condition if it cost additional money. Statements five says that *electricity should be produced by renewable energy in order to move away from fossil fuel energy* and statement six adds *even if it increases current energy costs*. The differences between these two answers show the role of an additional value entered into the equation. On question six, the number of strongly agrees decreased by 56 students, the agrees decreased by 11 students, the sometimes increased by 45 students, the disagrees increased by 16 students, and the strongly disagrees increased from one to five students. This shift, which is apparent, but not overwhelming, shows that some people value renewable energy just when it preforms favorably in the economy, but most students stated that they value renewable energy regardless of the cost. The second pair of statements regards regulating factory emissions. The majority of student responded that with or without the condition of money, *factory emissions should be regulated*. This data indicates that environmental conditions are on par...
with economic concerns in the minds of the majority of incoming first year students in the study.

The remaining questions in the caring section asked students to what extent they are concerned about waste in terms of energy, water, and disposable items. There is a general increasing trend from strongly disagree to strongly agree for each of these questions. Since these questions do not require action, but instead ask if a student thinks about waste in their day-to-day lives, the responses for each question follow the shape of a left skewed bell curve. If caring alone indicated ecological literacy, the incoming students would have an overall strong profile.

The practical competency section saw more varying trends than the caring section. In this section, the statements span a gradient of types of actions, some which require very little action and some which indicate that a person has committed a significant portion of their time to work around environmental issues. One of the simple actions, shutting off the lights, has a clear left skewed bell curve and the other simple question on recycling has a clear majority in the agree and strongly agree sections. The basic questions show similar trends to the simple questions; most of the students agree or strongly agree with the statements.

The results from two of the three moderate statements, *I [use sustainable forms of transportation] instead of driving a personal vehicle when possible* and *I inform myself about local, state, national, or global issues related to the environment*, are almost perfect bell curves. This shows that as actions take more concerted efforts on the part of the student, equal numbers of the students take the action as the number of students who do not take the action. The third moderately ranked question, *I turn the water off while soaping in the shower*, saw the vast majority of students answer never. This result is in strong contrast to
students’ responses to the statement in the caring section, *it concerns me when people leave the tap water running unnecessarily*, where over 120 students, or over 40 percent of students, stated that they strongly agreed. Over 160 students said that they never turned the water off while soaping which is an example of superfluous use of water from a water conservation perspective. This is a direct example of a student’s capacity to care, but lack of action which one might expect in response to their indication of care.

The most difficult actions are ones that involve collective action rather than individual action. A person’s initiative to partake in communal actions shows a level of commitment much greater than any of the other statements in this section. The statement, *in the past 4 years, I have worked/volunteered with an organization on an environmental issue*, received equal responses in the never, seldom, and sometimes categories, and under forty total students answered that they often or always took this action. The response to the statement, *I have organized students to work on a campus, local, or global environment issues*, was even starker with fewer than 30 students responding that they take this action often or always. About 180 students, or just over 60 percent of students, have never shown leadership around an environmental issue. The responses to these statements reflect the challenge of collective action and pinpoint the existing rhetoric that individualistic actions can amount to solving environmental issues without collective action.

The results from this section of the survey suggest that efforts to increase students’ actions should be on moderately difficult actions and collective action because most students already take on the simple and basic statements. This presents a more difficult job for sustainability coordinators and other people on a college campus that might work towards
heightening student’s ecological literacy, but it would yield more ecologically literate students if successful.

Knowledge is the final leg of ecological literacy. The difficulty levels in Table 1 generally alight with the percentage of student who answered each question correctly. However, the highest percentage of students answered the question about the ozone layer correctly and that question was ranked in the forth tier of difficulty. The remaining tier four and five questions were the questions which the lowest percentage of students answered correctly. The question with the lowest percentage of students who gave the correct answer asked, *how many degrees has the average surface temperature of the earth warmed since the industrial revolution?* The second question about climate change was also among the lowest three questions. This is the only category which distinctly stands out as an area which needs attention. Less than 70 percent of students answered the question about renewable versus non-renewable resources correctly. This raises additional concern because this question was intended to be the easiest question in the knowledge section. Only two students, or 0.7 percent of student, answered all eleven questions correctly.

This section suggests that most students are not receiving or are not retaining information they learn about ecological systems. This means that college program, which want to produce ecologically literate student, need to infused elements of ecology into the program beyond ecology classes. The challenge here is that there are not clear trends of what students know and what they do not know other than the evidence that they have knowledge of the role of the ozone layer and they do not have knowledge of climate change.

**Predictors or not?**
The results of this study showed that no category of demographic information could be used as a predictor for ecological literacy or any of the sub-sections of ecological literacy. Given a larger sample size, it is possible that predictors might have emerged. It is also possible that if the people surveyed were not students at liberal arts colleges, then demographic information might make a stronger predictor of ecological literacy. This lack of results provides space for a discussion of stereotypes and complex triggers. The type of environment a student comes from, a student’s religion, or a student’s race cannot predict their level of ecological literacy which shows that they are all as likely to care, know, and act around environmental issues as they are to not care, not know, and not act. If demographic information cannot predict ecological literacy, then is there another tool? Perhaps open responses to questions that would aim to understand worldview and experience during upbringing would better correlate to student’s current levels of ecological literacy. This study suggests that predictors must be a function of a more complex matrix of life influences. This result means that sustainability programs should not necessarily cater to students from the city versus students from the suburbs or even students who have taken a class which discusses environmental issues versus a student who has not.

**Nature as a predictor of ecological literacy**

Theorists and authors from Thoreau to Louv discuss the impact of nature on the mind, soul, and body. Nature, as Louv explains throughout his book, *Last Child in the Woods*, has healing powers unlike conventional medicine for diagnosable diseases. People who connect with the natural world are said to have a deeper understanding of it and a stronger connection to it. Thoreau might argue that if a person is in touch with nature, they are ecologically literate. According to the results of this study, almost all students reported spending time

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outside as children, but since student’s levels of ecological literacy varied so significantly, and just under 50 percent of students are ecologically illiterate, it makes since that no practical significance was found using nature as a predictor of ecological literacy. The data collection may not have been extensive enough to truly differentiate students’ gradient of exposure to the outdoors or perhaps the general student bodies at the surveyed schools had high exposure to nature. For these reasons, it cannot be used as a predictor for ecological literacy.

**Predictors within ecological literacy**

Demographic information does not prove to predict ecological literacy, but can the different sections of ecological literacy predict each other or predict the whole? The results show that practical competency can be a predictor of caring and caring can be a predictor of practical competency. The trend is positive which means that as someone’s caring increases his or her actions increase as well. Knowledge is not a predictor of either caring or practical competency which means that traditional education will not increase overall ecological literacy. This suggests that people are not caring based off of their knowledge, but something else. People might be acting based off of their level of care, but it is not based on knowledge of ecological systems. Does it matter if people have knowledge of the system their actions impact? On one hand, as long as the person takes actions which inflict less of an impact, this is a positive step. On the other hand, is it possible that a person’s actions are less likely to move from the simple actions to moderate and complex actions if they do not have knowledge? If people are taking the difficult actions such as working for an environmental organization or organizing students and they do not have a base level of knowledge of
ecological systems, this might promote a movement that is based on emotion rather than science which does not have the power to challenge and change policy.

Given one of the three sections of ecological literacy, a model can be built to project a student’s overall literacy. This means that if a students’ level of caring is known, the model can predict their level of ecological literacy. This does not provide evidence of what triggers ecological literacy, but it does indicate that the three areas of ecological literacy are intertwined.

CONCLUSION

Room to grow

Colleges and universities create a unique space and time for students to grow intellectually, personally, and interpersonally. This study shows that there is significant room for improvement in terms of growth in ecological literacy. The majority of students do not have a standard or high level of ecological literacy. If colleges and universities intentionally work to build students’ ecological literacy though traditional education in addition to other programming, students’ overall ecological literacy could increase significantly. Colleges and universities are preparing students to enter a society laden with environmental challenges, so it should be in the interest of colleges which value producing leaders to more intentionally build ecological literacy into the student experience.

Triggers of ecological literacy

This study tested for basic triggers of ecological literacy and found that demographic information does not serve as a predictor of ecological literacy among first year college students. Students’ experiences that cannot be summed up in their demographic information might serve as a stronger indicator of their ecological literacy. Morrone et al. (2001) found
that a person’s worldview is a much stronger indicator of ecological literacy than demographic information. Another potential trigger of ecological literacy is stronger non-traditional educational experiences. Through these experiences it is possible that people are able to better link the three areas of ecological literacy. For example, giving students an opportunity to work on a farm and eat the food that they harvest gives students a space to learn about agriculture; connects the students with the work because they are in the field, not at a desk; and provides students will an opportunity to take an action and replicate that action. Personal narratives of experiences with environmental issues hold influential power over not only that student, but also the people who hear the story. When people attach a face or a family to an environmental issue it becomes less abstract. Programs that integrate caring, knowledge, and action have the potential to greatly enhance a student’s ecological literacy and the ecological literacy of the people around that person. This study suggests that students’ pathways to ecological literacy are varying and complex. More research is needed to draw closer to a consensus on what causes ecological literacy.

**Expanding on this study**

This study provides baselines data which creates a springboard for further research project. The lack of predictors generated from this study suggests that more research ought to be conducted to tease out other potential indicators. A project could continue to collect data on first year students at the same schools to see if trends change over time. The same class of students could be surveyed in the spring of their senior year to see if students’ level of ecological literacy changes significantly during their time in college. Looking at this data between the different schools would provide information about what programs work to increase ecological literacy. The survey could also be applied to different types of colleges
and universities such as research universities, community colleges, state colleges, or schools which promote sustainability as a defining area of the school. To address the question of more complex triggers, focus groups could be held to create a forum for open-ended responses to questions about caring, acting, and knowledge. Each of these studies would contribute to the body of scholarship on ecological literacy and potentially help colleges and universities to strengthen programs which would increase students’ levels of ecological literacy.
REFERENCES


Davidson, Mary Frances. 2010. “Ecological Literacy Evaluation of the University of Iceland Faculty, Staff, and Students; Implications for a University Sustainability Policy.” University of Iceland. 1-153.


ACKNOWLEDGEMENTS

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APPENDIX

Appendix 1

Ecological Literacy Survey for First Year College Students

Dear participant,

The following questionnaire is part of a Dickinson College senior research project. The questionnaire should take about 5 minutes to fill out, and the answers you provide will not be connected back to you in any way. By filling out the survey, you give consent to the researcher to study the information you provide. You can stop responding to the survey at any time, if you do not wish to continue. Your honest and complete answers are important to the success of this project and are much appreciated.

Thank you,
Anna McGinn
Dickinson College ’14
mcginna@dickinson.edu

Michael Beevers, PhD
Dickinson College, Assistant Professor of Environmental Studies
beeversm@dickinson.edu

Please read the following statements carefully and circle the number that best corresponds with your opinion on the statement.

### Sub-section 1: Caring

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel a responsibility to reduce the impact I make on the environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>One person's actions do not make a difference when it comes to environmental issues.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fines ought to be charged to people who litter in public spaces.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>It is possible to improve environmental, social, and economic problems in the world simultaneously.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Electricity should be produced by renewable energy in order to move away from fossil fuel energy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Industries should be required to prove that they safely dispose of hazardous waste materials.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Factory emissions should be regulated.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Factory emissions should be regulated even if it increases the price of products.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>To reduce waste, the use of plastic packaging should be kept to a minimum.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Please read the following statements carefully and circle the number that best corresponds with your opinion on the statement.

### Sub-section 2: Practical competency

<table>
<thead>
<tr>
<th>Statement</th>
<th>Never</th>
<th>Seldom</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the past 4 years, I have worked/volunteered with an organization on an environmental issue.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>When I finish using an item that can be recycled, I carry it with me until I find a recycling bin.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I separate recyclable items from items that go to the landfill.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I have organized students to work on a campus, local, or global environmental issue.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
### Sub-section 3: Knowledge

<table>
<thead>
<tr>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I walk, bus, bike or carpool instead of driving a personal vehicle when possible.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I shut lights off when I leave a room.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I turn the water off while soaping in the shower.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I use a reusable water bottle and coffee cup.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I inform myself about local, state, national, or global issues related to the environment.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**On a human timescale, which of the following is a renewable resource?**

A. Coal
B. Gasoline
C. Iron Ore
D. Timber

**What is the international agreement that attempted to regulate the amount of greenhouse gasses which nations produce?**

A. The Kyoto Protocol
B. The Montreal Protocol
C. The Basel Convention
D. I do not know

**Approximately what percent of the earth's water is available as fresh drinking water?**

A. More than 90%
B. Around 45%
C. Around 20%
D. Less than 3%

**How many degrees has the average surface temperature of the earth warmed since the industrial revolution?**

A. 10°C
B. 5.5°C
C. 2°C
D. 0.85°C

**What does the ozone layer protect us from?**

A. Acid Rain
B. Global Warming
C. Harmful, cancer-causing solar radiation
D. Sudden changes in temperature

**Burning fuel in Pennsylvania to heat homes, operate cars, and produce electricity contributes to air pollution:**

A. Only in the city where it is burned
B. Throughout Pennsylvania and neighboring states
C. Globally
D. Not at all

**Where does most of the garbage in the U.S. end up?**

A. In the oceans
B. Disposed of through incinerators
C. At recycling centers
D. In landfills

---

For a person to get the most food energy out of 100lbs. of vegetables and grain the person should:

A. Eat the vegetables and grains
B. Feed the vegetables and grain to an animal and eat the meat
C. Feed the vegetables and grain to a cow to produce milk and drink the milk
D. Feed the vegetables and grain to a cow to produce milk, feed the milk to an animal, and eat the meat

Deer have no natural predators in a park and rangers observe deer eating all the same plants in the park. One step to restoring a healthy ecosystem is to:

A. Decrease the number of deer in the park
B. Bring in extra food for the deer
C. Introduce additional plant species
D. Take no action

DDT, a toxic chemical, can be found in very low levels in Great Lakes waters. DDT is taken up by small shellfish that live in the water. Which species will have the highest level of DDT in its body?

A. The grasses that house the shellfish
B. The shellfish
C. The fish that eat the shellfish
D. Birds that eat the fish

What is one qualification of USDA certified organic produce?

A. It is grown locally
B. It is grown in high quality soils
C. It is grown without the use of pesticides
D. It is grown at a small farm

What is a watershed?

A. The area of land where all of the water that is under it or drains off of it goes into the same place
B. A region with a wet climate for the majority of the year
C. Water that is stored underground
D. The name for the largest river in the area
Please read the following questions carefully and circle the number that best corresponds with your response.

**Sub-section 4: Exposure to nature**

<table>
<thead>
<tr>
<th>Question</th>
<th>Very little</th>
<th>Some</th>
<th>A lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much time did you spend playing outside growing up?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>To what extent was the outdoors a part of your childhood?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>To what extent have you received outdoor education (ex: camps, clubs, courses, trips etc.)?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Please read the following statements and respond by checking on the most applicable line. Fill in the blanks when prompted.

**Year you were born: ____________**

**Gender:**

___ Female  ___ Male  ___ Other

**Race/Ethnicity (Please check all that apply):**

___ American Indian or Alaska Native
___ Asian American
___ Black or African American
___ Hispanic or Latino
___ Native Hawaiian or Other Pacific Islander
___ White

**International Student:**

**Country:** ______________________

**Education (K-12, Specify grades, if both apply)**

___ Private
___ Public

**Family income level in US $/year:**

___ Under $20,000
___ $20,000-$49,999
___ $50,000-$74,999
___ $75,000-$99,999
___ $100,000-$150,000
___ Over $150,000

**Household’s Religious Affiliation:**

___ Protestant Christian
___ Roman Catholic
___ Evangelical Christian
___ Jewish
___ Muslim
___ Hindu
___ Buddhist
___ Other (please specify) ______________________
___ None

**What best describes the place you grew up?**

___ Urban  ___ Suburban  ___ Rural

**State:** ________________

Are you currently taking a class which discusses environmental issues?

___ Yes
___ No

What is your prospective major (if known): ________________
Appendix 2

IRB approval from Dickinson College (accepted at all schools except Bryn Mawr), and Bryn Mawr IRB approval can be found below.

<table>
<thead>
<tr>
<th>Dickinson IRB</th>
<th>Protocol Exemption Notification</th>
</tr>
</thead>
<tbody>
<tr>
<td>To: Anna McGinn</td>
<td>From: J.A. Skelton, IRB Chair</td>
</tr>
<tr>
<td>From: J.A. Skelton, IRB Chair</td>
<td>Subject: Protocol #116</td>
</tr>
<tr>
<td>Subject: Protocol #116</td>
<td>Date: 11/05/2013</td>
</tr>
</tbody>
</table>

The protocol **116. Ecological Literacy Research** has been verified by the Dickinson College Institutional Review Board as **Exempt** according to 45CFR46.101(b)(1): Educational Practices on 11/05/2013.

Please note that changes to your protocol may affect its exempt status. Please contact me directly to discuss any changes you may contemplate.

Thanks,

J.A. Skelton, IRB Chair
skelton@dickinson.edu
November 18, 2013
Anna McGinn
Dickinson College

Re: R14-017 – Ecological literacy of first year college students

Dear Anna:

The IRB confirmed the exempt status of the above research. The exempt category is 46.101(b)(2- anonymous survey data). Data collection and analysis may proceed.

We wish you the best of luck with your thesis research.

Sincerely,

Leslie B. Alexander, Ph.D.
Professor and Chair
Bryn Mawr College IRB

Cc: Professor Michael Beevers
    Judith Balthazar – Dean of Studies
    & Interim Dean of Bryn Mawr College