Investigating Impacts on the Environmental Literacy of Secondary School Students Attending a Summer Science Program

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INVESTIGATING IMPACTS ON THE ENVIRONMENTAL LITERACY
OF SECONDARY SCHOOL STUDENTS ATTENDING
A SUMMER SCIENCE PROGRAM

by

Marissa Nolan

A thesis
submitted in partial fulfillment
of the requirements for the
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Abstract


An environmentally literate public is crucial for combatting our world’s problems. This study evaluated impacts from the State University of New York College of Environmental Science and Forestry’s Outreach Department’s program: Summer Camps Investigating Ecology in Neighborhood and City Environments (SCIENCE). Environmental literacy was assessed by administering pre-, post-, and follow-up tests to both SCIENCE participants and a comparison group. Counselors were interviewed to determine how their expectations matched participants’ performance. Environmental attitude scores were higher for SCIENCE versus the comparison group, but attitude scores did not increase over the program. Environmental knowledge was higher at the end of the program for both SCIENCE and the comparison group, but gains in environmental knowledge did not differ between them. Counselors understand they had limited impacts but still overestimated the scores participants would receive. These results add to the understanding of how best to increase environmental literacy with non-formal education experiences.

Key words: environmental literacy, environmental knowledge, environmental attitude, non-formal education, pre-test, post-test, follow-up test

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CHAPTER 1: INTRODUCTION

OVERVIEW

The multitude of environmental problems today need an environmentally literate population to solve (Dieu-Hang, Grafton, Martínez-Espiñeira, & García-Valiñas, 2017; Paço & Lavrador, 2017; UNESCO, 1975). Environmental education can inform people of these issues, what they can do to help, and why the environment is important (Bogner, 1998; Dehart Hurd, 1958; Pooley & O’Connor, 2000; Tucker & Izadpanahi, 2017). Environmental education comes in many forms, from formal school curricula to informal, spontaneous interactions (UNESCO, 1975; UNESCO & UNEP, 1978). Because of the lack of adoption of environmental topics in schools, non-formal experiences are inordinately important for increasing environmental literacy (Ozdemir, 2010). Non-formal education experiences are structured, but also voluntary (UNESCO, 1993). They mainly occur in informal settings outside the classroom. These can come in many forms, such as, structured talks at a zoo, ranger programs in a park, or a science camp during the summer (UNESCO, 1993).

IMPORTANCE OF ENVIRONMENTAL LITERACY

Having an environmentally literate population is important for several reasons. Without it people are unaware of the problems our planet faces and how these issues will affect their health, livelihood, and environment (Dieu-Hang et al., 2017; Paço & Lavrador, 2017; UNESCO, 1975). A recent report by the National Environmental Education Foundation (NEEF, 2015) found 85% of adults are concerned about their health and their family’s health, but only 53% believe their health is tied to their environment. In the same 2015 report, NEEF cites a Gallup poll that asked how worried people were about environmental problems in 2000 and again in 2011 (Jones, 2011;
Every environmental concern in question had declined in the percentage of people worried about it (Jones, 2011). Some concerns, like water and air pollution, declined by more than 20 percentage points. NEEF hypothesized concern for the environment were surpassed by economic concerns. In a separate poll, Gallup had asked each year from 2000 to 2011 which should be the higher priority, the environment or the economy. In 2000, people prioritized the environment by a two-to-one margin, but each year the environment slipped, and the economy gained. In 2009, after the recession, the economy became a higher priority for the majority of people polled, and it continued to climb. In 2011, the environment was at a low, with only 28% of people saying it was the higher priority, compared to 67% back in 2000 (Jones, 2011). People think the environment is in better shape now than a decade ago. They believe many environmental problems are solved and do not grasp how environmental health affects their own (NEEF, 2015).

With an environmentally literate population, proper measures can be taken to decrease environmental problems (Barak, 2009; Paço & Lavrador, 2017; UNESCO, 1975). People also need to understand which measures help mitigate and relieve these problems and which will worsen them (Barak, 2009). Before people are prompted into action they need to feel compelled (Ertekin & Yüksel, 2014; Foster & Shiel-Rolle, 2011; Tucker & Izadpanahi, 2017; Zareie & Jafari Navimipour, 2016). Action might be in people’s best interest but if they are unaware of the need, they will stand idle (Barak, 2009; Lu & Wang, 2018; Zareie & Jafari Navimipour, 2016). Increasing environmental literacy is one act needed to combat anthropogenic problems our environment faces (UNESCO & UNEP, 1978; Zareie & Jafari Navimipour, 2016).

Some anthropogenic problems facing us today are climate change and overfishing (Azevedo, Leal, & Horta, 2017; Gupta, 2017). Climate change is driven by greenhouse gas
emissions from everyday activities (Azevedo et al., 2017). Understanding how electricity usage or carbon outputs from flying contribute to climate change can lead to modifying behaviors in an effort to reduce personal emissions (Dieu-Hang et al., 2017; Lu & Wang, 2018). Another environmental problem that people can combat is overfishing (Gupta, 2017). Desirable fish species, like bluefin tuna or shark, are caught at unsustainable rates. This can cause populations to decline dramatically and for ecosystems and fisheries to collapse (Gupta, 2017; Starr et al., 2016). There are numerous species in decline that are not protected and still being sold for food (Starr et al., 2016). If a consumer understands the plight of these species and knows some alternative fish sources, they can choose to avoid threatened species (Gupta, 2017).

DIFFICULTIES FOR ENVIRONMENTAL LITERACY

Environmental education has become political and environmental science is often discredited as propaganda (Trimble, 2007). One hurdle for increasing environmental literacy is understanding science and trusting scientists (Dehart Hurd, 1958; Englund, Olofsson, & Price, 2017). It is important to know how science works and how scientists use the scientific method (Antink-Meyer, Bartos, Lederman, & Lederman, 2016). The public should understand that if scientists disagree over the interpretation of results, it does not make their findings invalid (Dyehouse et al., 2017; Pothitou, Hanna, & Chalvatzis, 2016). Understanding how scientists work will increase acceptance of scientists and their discoveries (Antink-Meyer et al., 2016; Lederman et al., 2014).

Specifically in the United States students’ interest in science has waned and performances on standardized tests have fallen in past decades (Bhattacharyya, Nathaniel, & Mead, 2011; Bischoff, Castendyk, Gallagher, Schaumloffel, & Labroo, 2008). Similarly, interest and test
scores trail those from other countries (Bhattacharyya et al., 2011; Bischoff et al., 2008). The Organization for Economic Co-operation and Development (OECD), in its 2015 Programme for International Student Assessment (PISA), ranked the United States 15th out of 35 member countries and 21st out of the 44 countries included in the assessment (OECD, 2016a). The United States’ performance in science has hovered around the OECD average since 2006, and fallen in comparison to countries like Canada and Germany (OECD, 2016b). To stay competitive in the global economy science literacy is increasingly important (Bhattacharyya et al., 2011). A vacuum is forming in science fields and students need to be motivated to get science degrees and follow science career paths (Ardoin, Bowers, Roth, & Holthuis, 2017; Bischoff et al., 2008). Science curricula in the United States need to be reformed to keep up with global demands, but change on a policy level is slow (Bhattacharyya et al., 2011). Scientific breakthroughs require different expertise and skills all the time (Ardoin et al., 2017; Dehart Hurd, 1958). Sixty years ago, Dehart Hurd (1958) was already anticipating new skills and expertise would be needed for each new wave of discovery. Today technology changes at an ever-increasing pace. To compete in the current scientific community students not only need to understand how to use a computer but how to create computer programs (Englund et al., 2017). The technologies people will have to learn in the future have not yet been conceived (Englund et al., 2017). Education needs to adapt or students will not have the background for making the next wave of discoveries (Ardoin et al., 2017). Numerous acts of legislation and campaigns from non-profits were created in recent decades to revitalize the science curriculum and science teachers’ training to bridge the gap between the need for science education and the reality of it (Dehart Hurd, 1958).
FIELD OF ENVIRONMENTAL EDUCATION AND LIMITATIONS

Environmental education is not a new field, but it is growing quickly (Ardoin et al., 2017). It is imperative to increase environmental literacy throughout the world and across generations (Dieu-Hang et al., 2017; Paço & Lavrador, 2017; UNESCO, 1975). Creating change on a scale needed to combat today’s environmental crises requires an informed and passionate population (Ertekin & Yüksel, 2014; Foster & Shiel-Rolle, 2011; Tucker & Izadpanahi, 2017; Zareie & Jafari Navimipour, 2016). To make sure environmental educators have the most impact they must use all paths available to them, advocating for policy requiring environmental education, focusing on increasing attitude and behavior as well as knowledge, and utilizing non-formal education experiences (Ardoin et al., 2017; Bischoff et al., 2008).

There have been an increasing number of studies on environmental education and environmental literacy conducted around the world, especially within the past five years (Ardoin et al., 2017). Despite this increase, there are holes in the body of research. Most focus on middle school students within a short time frame (six months or less) with no follow-up investigation (Ardoin et al., 2017). Sweeping change in opinions or shifts in career aspirations are unlikely during the short time spans of these programs, but most claim an increase in environmental knowledge by the end of the program (Antink-Meyer et al., 2016; Bhattacharyya et al., 2011). Testing participants directly after a program almost ensures an increase in knowledge will be found (Bogner, 1998). The lack of follow-up in the majority of studies prevents the lasting power of these programs from being evaluated (Bogner, 1998). However, they can open participants’ imaginations and engender a better attitude toward science (Antink-Meyer et al., 2016; Bhattacharyya et al., 2011). Instead of focusing on knowledge gained or behaviors altered,
success can come from simply exposing participants to a new view of science and nature (Bhattacharyya et al., 2011; Lu & Wang, 2018).

Another study design component missing from most environmental education evaluations is a comparison group (Long, 2014; Paço & Lavrador, 2017). A comparison group helps to understand if the increase in environmental literacy found in higher post-test scores comes from the success of the program’s education (Sanacora, 2017). Scores on pre-tests, post-tests, and follow-up tests can be compared and analyzed along with the scores of participants attending the science program (Sanacora, 2017).

Almost all studies focus solely on the students’ experience and give little regard to the people imparting the information (Ardoin et al., 2017). The educators are responsible for teaching the participants and increasing their environmental literacy (Loret de Mola & Mendez, 2014; Munson, 1997). If they are overly optimistic or pessimistic about how much of an impact they have, the education could be hindered (DeGraaf & Glover, 2003; Munson, 1997). An overly optimistic teacher can delve into too much detail making participants tune out information, however, an overly pessimistic one can have a defeatist attitude that prevents participants from caring (Loret de Mola & Mendez, 2014; Munson, 1997). Either way, if they are mistaken about their perceived effectiveness, their actual effectiveness could be impacted (DeGraaf & Glover, 2003). This study interviewed the counselors to see what expectations they held. Based on findings of the study, future training instructions could be changed to prevent counselors from overestimating or underestimating their impact (DeGraaf & Glover, 2003; Loret de Mola & Mendez, 2014).
STUDY OBJECTIVES

The focus of this thesis is a summer education program administered by the State University of New York College of Environmental Science and Forestry Outreach Department: Summer Camps Investigating Ecology in Neighborhood and City Environments (SCIENCE). The Town of Onondaga Department of Parks and Recreation’s summer program, Playgrounds, was used as the comparison group. Pre-, post-, and follow-up tests were administered in the same manner to both participant groups. The quasi-experimental design has enabled this study to analyze the impact that SCIENCE’s environmental programming has on Syracuse area youth’s environmental literacy. SCIENCE’s focus on experiential learning can increase the impact it has on changing attitudes. The main research questions of this study, followed by their hypotheses, are:

1. Is there an increase in the environmental knowledge and attitude of participants after attending the science summer program?
   a. H1: Environmental attitude post-test scores of participants who attended the science summer program will be higher than their pre-test score.
   H2: Environmental knowledge post-test scores of participants who attended the science summer program will be higher than their pre-test score.
   b. Is there a long-term (2 month) retention of environmental knowledge and attitude after the summer program?
   H3: Environmental attitude post-test scores of participants who attended the science summer program will not be different from their follow-up score.
   H4: Environmental knowledge post-test scores of participants who attended the science summer program will not be different from their follow-up score.
c. Do participants who went to the science summer program have a higher environmental knowledge and attitude score than those who did not attend a science summer program?

H5: The difference in environmental attitude pre-, post-, and follow-up test scores of participants who attended a science summer program will be greater than scores of those who did not attend a science program.

H6: The change in environmental knowledge pre- post- and follow-up test scores of participants who attended a science summer program will be greater than scores of those who did not attend a science program.

2. What impact do the science program counselors expect to have on participants’ environmental literacy? Do counselor expectations match the outcome of the science program’s participants’ scores?

H7: Counselors at a science summer program will not accurately predict how well their students do on environmental literacy post-tests or follow-up tests.

These hypotheses and this study design are based upon a theoretical framework (Figure 1). There is a debate in the field of environmental education over the link between knowledge, attitude, and behavior (Paço & Lavrador, 2017). Traditional fact-based learning from formal education increases knowledge but does not affect attitude and behavior (Ardoin et al., 2017; Paço & Lavrador, 2017). Therefore, the impacts of experiential learning needed to be studied. Experiential learning has been shown to impact all three by exposing participants to new experiences and leaving them with a positive feeling towards the environment and nature.
(Pooley & O’Connor, 2000). Comparing changes in environmental knowledge, attitude, and behavior from non-formal environmental education and no environmental education would allow the impact of experiential learning to be analyzed.

![Diagram](image)

**Figure 1.** Based on the review of the literature, the theoretical framework for this study was created. It shows how non-formal education better increases environmental knowledge, attitude, and behavior than formal education and no environmental education. A thicker arrow indicates a stronger relationship, a dotted arrow a very weak relationship, and an “X” a lack of relationship.
CHAPTER 2: LITERATURE REVIEW

OVERVIEW

Environmental literacy is a measure of the degree one understands the natural world and the sciences that study it (UNESCO, 1975; UNESCO & UNEP, 1978). Environmental literacy is a broad term encompassing both environmental knowledge and pro-environmental attitude (UNESCO, 1975; UNESCO & UNEP, 1978). The goal of environmental education is not just to teach about the environment, but to shape attitudes and increase pro-environmental behaviors (Bogner, 1998; Dieu-Hang et al., 2017; Dyehouse et al., 2017; Eastep, Cachelin, & Sibthorp, 2011; Hsu, 2004; Lu & Wang, 2018; Paço & Lavrador, 2017). This literature review first investigates the current state of environmental education in schools. Then the ongoing controversy over knowledge’s impact on attitude and behavior is explored. Next, how non-formal education can aid in increasing environmental literacy is examined and finally the limitations in the current research is addressed.

ENVIRONMENTAL EDUCATION IN SCHOOLS

Environmental curricula are not included in most schools (Dyehouse et al., 2017). Some states do have environmental literacy plans in place; New York is not one of them. New York is in the process of developing an environmental literacy plan, but it is far from implementation (New York State Outdoor Education Association, 2013). The federal government has made some strides to incentivize states to create these plans, but it is not a part of the federally mandated curriculum (Chesapeake Bay Foundation, 2016). This lack of formal education avenues puts the onus of increasing environmental literacy on outside establishments (Barak, 2009; Dehart Hurd,
Non-formal education institutions such as zoos, aquaria, museums, science organizations, and science camps are some examples (Bhattacharyya et al., 2011). Camps in particular are helpful in reaching people generally dissuaded from science and nurture their interest in a more personal environment. They show the fun applications of science with hands on learning (Bhattacharyya et al., 2011).

Stevenson (2007) compared environmental education classroom methods in Australia and the United States and found they had similar problems. In the classroom, a teacher focuses on facts and must stick to the same pre-determined pedagogy for every student. However, to connect students to the ideas presented there needs to be more flexibility and individualism. Because the broad concepts in environmental education can be difficult to grasp, it is beneficial to relate them to smaller scale examples, so students can understand their personal impacts. Stevenson relates mountain biking off-trail and the subsequent soil erosion with larger-scale desertification. This explanation of actions and repercussions is more difficult to do in a classroom than out in nature. The arduous curriculum approval process also limits quick changes to be made when new discoveries happen. Environmental science is a relatively new field that has yet to find solutions to most of the problems identified (Stevenson, 2007). Non-formal education can better address environmental education and the shortcomings in common classroom methods (Bhattacharyya et al., 2011).

Including environmental literacy in curriculum standards causes a new problem for schools: more topics in the same space and now teachers must pick and choose (Dehart Hurd, 1958). Should they delve into a few to allow for a comprehensive understanding or touch on many issues but only scratching the surface? Depth of knowledge should not be overlooked in search of breadth of knowledge. Studies have shown focusing on a few topics in greater detail is
more likely to have a lasting impact on knowledge and attitude than covering a multitude of concepts briefly (Paço & Lavrador, 2017). People need to make a connection to material before they remember it and before it can effect changes in attitude and behavior (Dyehouse et al., 2017; Paço & Lavrador, 2017; Pooley & O’Connor, 2000). That connection is more likely with a more focused, in depth curriculum (Pooley & O’Connor, 2000). Non-formal education can help with covering an expanding curriculum and can increase breadth and depth of subjects that school time constraints have cut (Dehart Hurd, 1958).

DEBATING THE LINK BETWEEN ATTITUDE AND KNOWLEDGE

There is conflicting research on the relationship between people’s knowledge of environmental issues, their attitudes towards the environment, and their behaviors (Paço & Lavrador, 2017). The efficacy of increasing pro-environmental attitudes and behaviors by increasing knowledge is debated (Paço & Lavrador, 2017). Despite what seems like an obvious link, some studies have found that environmental knowledge and attitude are independent (Alwitt & Pitts, 1996; Cotton, Miller, Winter, Bailey, & Sterling, 2015; Drayson, Bone, & Agombar, 2014; Moisander, 2007; Paço & Lavrador, 2017; Pothitou et al., 2016; Thøgersen, 1999; Uusitalo, 1989, 1990). There are many studies finding no correlation between higher environmental knowledge and a positive environmental attitude and only weak correlation between environmental knowledge and pro-environmental behaviors or attitude and pro-environmental behaviors (Paço & Lavrador, 2017). Paço and Lavrador (2017) suggest the correlations increase if specific knowledge is focused on instead of general themes, supporting the idea to focus on depth not breadth of knowledge. In their study, a questionnaire on energy consumption was used to evaluate environmental knowledge, attitude, and behavior (Paço & Lavrador, 2017). They did not find a relationship between knowledge and attitude nor
knowledge and behavior and only a weak link between attitude and behavior (Paço & Lavrador, 2017)

It takes time to change environmental worldviews, as they are deeply rooted beliefs and therefore slow to evolve (Dyehouse et al., 2017; Manoli, Johnson, & Dunlap, 2007). Focusing on one topic at a time, in order to avoid swarming students with multiple concepts, seems to more effectively increase environmental literacy (Pooley & O’Connor, 2000). The mantra of environmental education is that people only care about what they know, but that may not be the case (Ardoin et al., 2017; Paço & Lavrador, 2017). People with high environmental knowledge can have a low environmental attitude (Dyehouse et al., 2017; Paço & Lavrador, 2017). Conversely, those with low environmental knowledge have been found to have a high positive attitude and more likely to perform pro-environmental behaviors (Dyehouse et al., 2017; Paço & Lavrador, 2017).

On the other side of the debate are a plethora of studies finding a link between environmental knowledge, attitude, and behavior (Tucker & Izadpanahi, 2017). Several studies demonstrate environmental knowledge increases positive environmental attitude which then promotes action with pro-environmental behaviors (Ballantyne & Packer, 2005; Flamm, 2009; Kaiser, Wolfing, & Fuhrer, 1999; Kotchen & Reiling, 2000; Lynne & Rola, 1988; Oreg & Katz-Gerro, 2006; Polonsky, Vocino, Grau, Garma, & Ferdous, 2012; Pooley & O’Connor, 2000). Studies focusing on consumer habits find people will not spend money on more costly environmental options unless they have an understanding of environmental science and the necessity to decrease their carbon footprint (Dieu-Hang et al., 2017; Lu & Wang, 2018; Pothitou et al., 2016; Tucker & Izadpanahi, 2017; Zareie & Jafari Navimipour, 2016). Dieu-Hang et al. (2017) found the likeliness of adopting water and energy efficient appliances increased if the
person understood the labeling process and the benefits of water and energy conservation. However, there was a chance people were incentivized by saving money and not environmental awareness (Dieu-Hang et al., 2017). Lu and Wang (2018) found a lack of environmental knowledge can decrease pro-environmental behaviors in their study on paying carbon-offsets for air travel. A lack of knowledge was a barrier to action, people would not pay a carbon offset if they did not understand the benefit (Lu & Wang, 2018).

Knowledge can also impact a person’s perception of convenience (Pothitou et al., 2016). Pothitou et al. (2016) found if people understood the negative effects of greenhouse gas emissions, they were more likely to change their behaviors. These changes were not viewed as inconvenient, in contrast the same actions were seen as too difficult by those less knowledgeable (Pothitou et al., 2016). Zareie and Jafari Navimipour (2016) studied if environmental education given remotely using technology can impact behavior as well. They found the customizability of the e-learning can increase pro-environmental behavior and is important for spurring people into action against environmental problems. Environmental awareness, values, skills, and responsibility along with public information all feed into creating environmental behaviors (Zareie & Jafari Navimipour, 2016).

Given the complex and conflicting understanding of the relationship between behavior, attitude, and knowledge, educators and curriculum developers are left with a difficult task (Paço & Lavrador, 2017). They must determine areas of focus and what kinds of experiences should be integrated into science education programs to get the desired results of increasing pro-environmental behaviors (Bogner, 1998). Knowledge has shown to affect behavior, but usually in conjunction with other factors (Pooley & O’Connor, 2000). Experiential learning has more power to change attitudes and leave lasting impressions (Bogner, 1998). Environmental
education can use experiential learning to not only focus on knowledge and hope attitude and behavior will follow, but to actively influence attitude itself (Pothitou et al., 2016). It takes a concerted effort on all fronts to change people’s beliefs and actions (Dyehouse et al., 2017; Pothitou et al., 2016).

ENVIRONMENTAL LITERACY AND NON-FORMAL EDUCATION

Non-formal education can better incorporate attitude and behavior changes since most programs are active (Calogiuri, 2016). One of the most effective tools non-formal education has is being in nature (Calogiuri, 2016; Louv, 2008). When nature experiences are incorporated into curriculum, students have a higher level of understanding and awareness of their environment (Louv, 2008; Ozdemir, 2010). Access and use of natural areas as a child can increase the likelihood of recreating outside and having more positive feelings of nature as an adult (Calogiuri, 2016; Louv, 2008). Children’s environmental behavior and attitude can shape their actions and feelings later as adults (Manoli et al., 2007). Children’s environmental attitude can be more difficult to decipher since most scales are designed for adults and need to be modified for children (Manoli et al., 2007). New metrics can allow for the more effective studying of children’s attitude and predict how it might change their behaviors as adults (Manoli et al., 2007).

LIMITATIONS OF ENVIRONMENTAL LITERACY RESEARCH

Evaluating the impacts of non-formal education can be challenging and most study designs are similar. Participants are tested at the beginning of the program and again at the end, utilizing the common pre-test/post-test study design (Ardoin et al., 2017; Aydede-Yalcin, 2016;
Dann & Schroeder, 2015; Derman, Sahin, & Hacieminoglu Esme, 2016; Eastep et al., 2011; Ertekin & Yüksel, 2014; Foster & Shiel-Rolle, 2011; Hsu, 2004). Evaluations can be strictly knowledge based or involve more general questions about environmental attitudes and behaviors (Ardoin et al., 2017; Watson, 2014). It is assumed a significant increase in pre- and post-test performance determines how effective the program is (Ardoin et al., 2017). All studies found in the literature show an improvement when comparing a child’s environmental literacy before and after a program (Ardoin et al., 2017; Aydede-Yalcin, 2016; Dann & Schroeder, 2015; Derman et al., 2016; Eastep et al., 2011; Ertekin & Yüksel, 2014; Foster & Shiel-Rolle, 2011; Hsu, 2004).

Ardoin et al. (2017) analyzed peer-reviewed literature and most of the 119 articles included reported their program increased environmental literacy. However, children are rarely tested again months later to measure if the impact is lasting (Ardoin et al., 2017; Hsu, 2004). Ardoin et al. (2017) thought there was a need for delayed follow-up tests and studies should not rely on post-tests administered immediately at the close of a program. Some studies will explain that measuring only the short-term change in participants’ knowledge is a limitation (Antink-Meyer et al., 2016). In the two week long program Antink-Meyer et al. (2016) studied, there were only minimal gains in understanding scientific concepts and without a follow-up test the long-term gains cannot be ascertained. This lack of follow-up in the field makes it difficult to judge the true influence non-formal environmental education is having on increasing environmental literacy (Ardoin et al., 2017).

Bogner (1998) recommended quantitative assessments to measure how much participants learn. The subjective assessments used by many in the field are difficult to decipher and harder to compare. Also recommended was delaying the post-test for a month so things like inclement weather or interpersonal problems in the group become less prominent in students’ minds and
they will think more about the overall experience and what they learned. Therefore, post-tests immediately administered are inconclusive and without a follow-up test it cannot be seen if the effects of the program persist long-term (Bogner, 1998).

The lack of comparison groups in studies is another limitation in the current literature. Having a follow-up test prevents some internal integrity issues, but without a comparison group any change in environmental literacy cannot be attributed solely to the program being evaluated (Sanacora, 2017). As a psychologist, Sanacora (2017) studies what influences people to change their behavior. Determining effects of environmental education on people’s environmental literacy uses similar strategies. Research in these fields often does not happen in laboratory conditions, but out in the world with confounding variables. Participants’ knowledge and attitude can be influenced by outside factors which can be monitored using a comparison group (Sanacora, 2017).

The literature shows environmental education is important for an environmentally literate public (Bhattacharyya et al., 2011). Studies overwhelmingly show gains in knowledge after environmental programs (Ardoin et al., 2017). Whether increasing knowledge increases attitude is still debated, but focusing on both aspects does seem to increase pro-environmental behaviors (Pothitou et al., 2016).
CHAPTER 3: METHODS

STUDY PROGRAM SELECTION

The ESF summer SCIENCE program is administered under the umbrella ESF Science Corps program. Science Corps is a collection of staff and volunteers that bring science teaching to the Syracuse City School District (SCSD) with a variety of programs and events. In 2003, SCIENCE initiated instruction during the summer.

The main goals of SCIENCE are to:

1. enrich student science learning and career exploration using inquiry, experiential, and critical thinking approaches in the urban environment,
2. strengthen partnerships between ESF, SCSD, and community organizations, and
3. improve communication and teaching skills for Science Corps participants.

Most of the groups each summer are tied in a way to a SCSD school, however, any group can book the program. In past years SCIENCE has worked with New York State Parks and non-governmental non-profits. The summer of 2017 had two groups from SCSD schools, one from a Syracuse charter school, two from Syracuse-based non-profits, and one from a New York City (NYC) non-profit.

Syracuse University’s Institutional Review Board (IRB) approval of tests (Appendix A), interview questions (Appendix B), consent and assent forms (Appendix C), and recruitment materials (Appendix D) was not granted until after the first week of SCIENCE had been completed (Syracuse IRB Case Number 17-208). Therefore, sampling started during the second week.
All SCIENCE partner groups that were part of this study were managed through the ESF SCIENCE program. SCIENCE is not a camp; the partner organizations oversee the welfare and registration of participants while SCIENCE provides counselors to teach a curriculum to the group. This year each group paid $3,000 to SCIENCE (however that was not passed on to participants) to cover the cost of staff, supplies, and travel.

Summer 2017 partner organizations had participants that ranged in age from 11-17. The participants surveyed in the study were all from Syracuse and were going into grades 6-11. The partner groups surveyed were Father Champlin’s Guardian Angel Society (Guardian Angels), Expeditionary Learning Middle School (ELMS), and Syracuse Academy of Science Charter School (SAS).

Guardian Angels is a Catholic charity that runs a free summer-long education camp for Syracuse students. Student participants are US-born children of immigrants attending SCSD schools. Parents enroll children to give them somewhere to go during the work day and because the program provides free breakfast and lunch to attendees.

ELMS is a Syracuse public school that draws students from across SCSD. The school serves students who need more attention because of a learning disability, problems with bullying, or behavior issues. ELMS has a mandatory orientation for its incoming sixth grade class. The first week of orientation involves getting to know the school, its schedule, teachers, and team building. No instruction occurs. The second week of orientation is run by SCIENCE.

SAS is a Syracuse charter school that has a specialized STEM-focused curriculum. However, most parents send their children to SAS because of its graduation rates and test scores, which surpass SCSD and the New York state-wide average. SAS runs a summer camp for
students, one week of which is run by SCIENCE. Parents enroll children so they have somewhere to go during work hours.

The SCIENCE counselors include four ESF undergraduates from a variety of departments, and one graduate student leader. The counselors designed the summer’s programming with guidance from the SCIENCE Program Coordinator. The SCIENCE summer curriculum varies from year to year based upon the unique interests and strengths of each year’s counselors. In 2017, the counselors studied environmental resource engineering, environmental biology, environmental studies, forest and natural resources management, and environmental education. Their interests and strengths were just as varied, from exposing urban youth to natural areas to understanding the hydrology of watersheds.

For 11 years SCIENCE has deployed a survey on the last day to ask participants what activities they liked the most. A recent study Garramone (2014) did analyzed those responses, and determined the survey did not help investigate the program’s impact on environmental literacy since it does not measure participants’ knowledge of topics covered or their attitude towards the science (Garramone, 2014). The ESF Outreach Department wanted a more formal and outside evaluation of their program. They were interested in the efficacy of the instruction and wanted to know if their goal of increasing environmental literacy was being achieved.

COMPARISON GROUP PROGRAM SELECTION

SCIENCE participants were not self-selecting. They attended as part of another summer program that was not science focused. Most were required to attend by their school and others
were enrolled by parents or guardians. Therefore, it was not a concern that SCIENCE participants would have pre-existing higher level of environmental literacy. The comparison group was not science-related for this reason. To be able to sample children during the summer, and control for the outdoor nature of SCIENCE, a recreation summer program was used. The comparison group was comprised of children attending the Town of Onondaga Parks and Recreation “Playgrounds” program. Playgrounds has been organized each summer for over 30 years. It is a recreation program without an education focus of any kind. It does not teach science or have any educational mandate. The object of Playgrounds is to let kids have fun. Activities range from playing games outside to arts and crafts projects. Most of the participants come from the SCSD, just like SCIENCE.

Each week children come for the day to play games and have fun outside. There is a $75 fee for the summer that covers all 6 weeks. Most participants come each week. Playgrounds’ participants reside in the Town of Onondaga, city of Syracuse, and other small towns. The children at Playgrounds are between 6 and 17 years of age, but only those 10 and older were included in this study. Playgrounds ran throughout the summer but only one week was sampled since the same children came each week.

SURVEY INSTRUMENT

Environmental Literacy (EL) tests were created (Appendix A). The EL test had two sections; one to test Environmental Attitude (EA) and one for Environmental Knowledge (EK). The EA portion was the same for all age groups and throughout the study. Since the EA portion was to diagnose changes in attitude and behavior it was easy to create questions understandable by the wide age range of participants, negating the need for two grade levels. Since answers are
not “right” and “wrong” and needed to be compared for changes, analyses were more consistent with only one version. The first set of EA questions were answered using a Likert scale. Participants could select least interested or likely (0) to most interested or likely (4).

The EK tests, however, were prepared for two age classes: sixth to eighth grade and ninth to eleventh grade. It was decided that questions appropriately challenging for ninth graders would be too difficult for sixth graders. The two levels had similar questions but phrased differently with increased levels of terminology or depth of knowledge. The EK test also needed different versions for the pre-, post-, and follow-up rounds to prevent participants from remembering questions in previous rounds. They could have discussed or looked up the answers before the next test. An identical online version of the follow-up test was created so it could be administered remotely after the programs ended. All versions had ten questions and were scored as right or wrong with participants’ EK score being a percentage of correct answers.

SCIENCE shared a schedule of a past camp to help determine test question topics. Once the curriculum for the 2017 camp was solidified, the rough draft of the EL test was given to the SCIENCE coordinator and counselors for review. They gave more updated feedback so the questions best reflected what would be covered in the camp. Questions were not pulled directly from curriculum activities nor were counselors instructed to teach what was on the test. The input was only to ensure topics mentioned on the EL test were covered during the camp and the tests did not focus on topics not mentioned. Asking about topics not covered could skew scores negatively.
STUDY PARTICIPANT SELECTION

Data were collected from children that participated in three of the six SCIENCE programs during summer 2017. Each program lasted one week with instruction happening from 9:00 am to 3:00 pm. Of the six weeks of SCIENCE, the programming for weeks four and six differed from all others and therefore were excluded from sampling. Specifically, week four included a different curriculum focused solely on engineering rather than environmental science. Week six participants also had a different curriculum created and taught by ESF faculty rather than SCIENCE counselors and that focused on environmental justice and urban planning. Additionally, the participants were from New York City not Syracuse, stayed overnight, and had longer hours of instruction. This made the tests created for the other weeks inapplicable and therefore data comparisons were not valid.

Guardian Angels was the first scheduled participant group. Participants were visited the week before, during the normal program hours, to distribute the forms and explain the study. The researcher was present on the first day of SCIENCE, when participants were dropped off, to collect forms and answer questions from parents and guardians. Participants were surveyed on the morning of the first day (pre-test) and the afternoon of the last day (post-test) ensured that no instruction happened outside of testing.

These pre- and post-tests were administered in person by the researcher and were conducted on paper. Guardian Angels’ follow-up tests were mailed out October 16th, 2017 (Table 1). Each envelope contained a link to the online version, a paper version of the test, and a self-addressed stamped envelope for the test to be mailed back to the researcher. School information was not available for this group and they were spread across multiple schools. Their only contact information was the mailing address provided to the program. The last day for a response was
November 10th, 2017. This allowed for participants to have one week to fill out the survey before they had to mail it back. The mailed-out tests were only accepted if received within four weeks of being mailed. Follow-up test participation fell due to difficulties finding participants after the program ended and relying on mailed responses (Table 2).

Table 1: Follow-up test were either administered or mailed out to participants. The dates mark when those two options happened for each group.

<table>
<thead>
<tr>
<th>Follow-up Test Group</th>
<th>Tests Administered on</th>
<th>Tests Mailed Out</th>
<th>Tests Accepted Until</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guardian Angels</td>
<td>n/a</td>
<td>October 16th, 2017</td>
<td>November 10th, 2017</td>
</tr>
<tr>
<td>SAS</td>
<td>October 23rd, 2017</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>ELMS</td>
<td>October 27th, 2017</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>n/a</td>
<td>November 13th, 2017</td>
<td>December 8th, 2017</td>
</tr>
</tbody>
</table>

Table 2: Sample sizes for the different partner groups who participated in surveying while attending a week-long summer program, either SCIENCE or Playgrounds. The bolded values are the total sample sizes for the experimental and comparison groups.

<table>
<thead>
<tr>
<th>Partner Group</th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>Follow-up Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guardian Angels</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>ELMS</td>
<td>57</td>
<td>53</td>
<td>49</td>
</tr>
<tr>
<td>SAS</td>
<td>14</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>SCIENCE Total</td>
<td>75</td>
<td>68</td>
<td>58</td>
</tr>
<tr>
<td>Comparison</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>53</td>
<td>49</td>
<td>20</td>
</tr>
</tbody>
</table>
The second group of SCIENCE participants was ELMS. Participants were visited the week before, during the first part of orientation, to distribute the forms and explain the study. The researcher was present at the first day of the week drop-off to collect forms and answer questions from parents and guardians. Participants were surveyed the morning of the first day and the afternoon of the last day (Table 2). The pre- and post-tests were administered in person by the researcher and were conducted on paper. Follow-up tests were administered to ELMS by computer using the online version link. Participants completed the test online during school hours and the researcher was not present on October 27th, 2017 (Table 1).

The third group of SCIENCE participants was from SAS. SAS’s organizer distributed forms to parents in advance. The researcher was present at the first day of the week drop-off to collect forms and answer questions from parents and guardians. Participants were surveyed the morning of the first day and the afternoon of the last day (Table 2). These pre- and post-tests were administered in person by the researcher and were conducted on paper. SAS participants were given the follow-up test on paper during the school day. The researcher administered the test to participants on October 23rd, 2017 (Table 1).

Playgrounds participants were visited the week before to distribute the forms and explain the study, and the researcher was present at the first day of the week drop-off to collect forms and answer questions from parents and guardians. Participants were surveyed at the beginning of the week in the morning and at the end of the week in the afternoon (Table 2).

The Playgrounds’ follow-up tests were mailed out November 13th, 2017 (Table 1). Each envelope contained a link to the online version, a paper version of the test, and a self-addressed stamped envelope for the test to be mailed back to the researcher. School information was not
available for this group and they were spread across multiple school districts. The only way to contact them was through provided mailing addresses. Twenty surveys were returned by mail and none were completed using the online link. The last day for a response was December 8\textsuperscript{th}, 2017. This allowed for participants to have one week to fill out the survey before they had to mail it back. The sample size decreased during the week for sampling and less than 40\% of participants returned the mailed follow-up surveys.

\textbf{DATA COLLECTION- PROGRAM GROUPS}

The Playgrounds group was split over three campuses: Santaro Park, Wheeler Elementary, and King Park in the Town of Onondaga. They were visited in succession but could not be simultaneously tested. Some campuses were tested later in the morning or earlier in the afternoon. However, since no instruction was being administered it was not necessary to be as consistent with the timing. Pre-tests were given as early as possible on Monday and post-tests as late as possible on Friday.

After each week all the survey answers were entered into an Excel spreadsheet. EA and EK tests were kept paired for each participant. Participants created codes based on their initials and the year they were born (for example Joan Gabrielle Smith born 2007 would be JGS07). This allowed participants pre- post- and follow-up tests to be matched while maintaining confidentiality. Answers were identified by this code on all research material. Not all participants followed the code convention, and some used different codes on the three tests. Five pre-tests from ELMS had no names on the EK portion and were randomly paired on entry. Two follow-up tests from Playgrounds did not have the EK portion.
DATA COLLECTION- SCIENCE COUNSELORS

SCIENCE had five counselors, who created the program curriculum with the help of the Program Coordinator. The counselors were solely in charge of leading activities and teaching curriculum. They did have specialties that shaped this year’s curriculum. For example, an activity on wind power was spearheaded by a counselor with a background in renewable energy. Each counselor gave some instruction every day and many activities were lead in groups or by all five. Two undergraduate counselors had program experience from the prior summer. The two remaining undergraduate counselors and head graduate counselor were new in 2017.

Counselor interview questions were also decided before SCIENCE started (Appendix B). After the last week of the camp, over the span of a week, the researcher interviewed each counselor. Interviews were done separately and privately; the answers were written down by the researcher on separate papers. Answers were not discussed with other counselors or SCIENCE coordinators.

SCIENCE counselors’ answers were not associated with their names to maintain confidentiality. Their answers were recorded in an Excel spreadsheet without a code to distinguish them since they were only interviewed once, and answers did not need to be matched to the individual.

OBSERVATIONS

SCIENCE was observed throughout the week and notes were taken about weather, student participation, curriculum covered, and teaching ability. If weather was rainy one week and sunny another, student enjoyment could be impacted. Students were monitored to see if any
were disruptive and impacted other students’ learning. The curriculum changed slightly each week and was recorded to make sure the topics on the tests were still covered. Teaching ability was noted to see if competency changed throughout the summer, making it possible for later weeks to score differently than earlier weeks.

The Playgrounds were not observed during the week since curriculum was not administered, but weather was monitored. Playgrounds do not meet during inclement weather, but they did not miss a day during the study week.

DATA ANALYSIS- QUANTITATIVE

Summary statistics (average and standard error) of EA and EK scores were generated for the SCIENCE and Playground groups for the pre-test, post-test, and follow-up test. For EK scores, an unbalanced model I two-way ANOVA with an interaction term in ‘R’ was used to test for differences between the test means of the pre-, post-, and follow-up tests for SCIENCE and Playgrounds. To see if the data satisfied the assumptions of the test and were normally distributed, quantile-quantile plots were made for each group.

For the EA ANOVA Likert scores were the response variable. Test type and participant group were the predictors. An interaction term was included and simple effects were then tested. Interaction plots were made to show the distribution of mean scores for both programs over the three tests.
DATA ANALYSIS- QUALITATIVE

Open-ended questions on the EA portion and counselor interview answers were coded for analysis (Appendix E). Coding was done independently by two researchers. Any differences in coding were discussed and resolved in order to yield consistent results from both researches. The final inter-coder reliability was 100%. Coded categories were tallied for each question and the distributions were compared. The percentage of participants who responded to these questions was lower than the EA Likert scale questions or the EK questions. Because of the varying sample size for each group, test, and question, results were computed into percentages for comparison.

EA open ended questions were used to better understand the attitude participants had towards science, environmental causes, and nature. Their answers had four coding categories that were the same throughout: blank, no/none, unintelligible, and non-response. Participants were not required to answer any of the survey questions and many skipped the open-ended ones. These were recorded as “blank,” as nothing written at all. If a participant wrote a negative response such as “no” “none” “n/a” it was recorded as “no/none.” Answers that were confusing, illegible, or inappropriate for the question asked were categorized as “unintelligible.” A “non-response” was for participants that did not fill out one or two of the three tests. This showed how the sample sizes decreased throughout the study. The other categories were not always consistent for each question, but were the same for both SCIENCE and Playgrounds.

The first question asked participants to list future career aspirations. Responses were coded into the three previous categories (like all questions) as well as the following: “science,” “non-science,” and “mix of science/non-science.” Careers were categorized into “science” if they involved environmental, medical, animals, computer coding, or other science fields. “Non-
“science” were any other career such as sports, media, teaching (unless specified as science teacher), or law. If the participant listed more than one career and included both science and non-science, it was coded as “mix of science/non-science.”

The second question asked if participants took actions to conserve water. Responses were coded into the following categories: “don’t know,” “yes (unspecified),” “conserving water action,” “cleaning water action,” and “incorrect action.” The “don’t know” category distinguished participants who wrote they did not do action from those who were unsure if they did. The participants who answered yes, but who did not elaborate on what actions they took were placed in the “yes (unspecified)” category. Students who did explain what actions they took were grouped into either “conserving water action” or “cleaning water action” depending on if the action was preventing water waste and reusing water or preventing or cleaning up polluted water. “Wrong” were responses that claimed they helped conserve water, but it was an inappropriate or unhelpful action. For example, one participant said they conserved water by “putting it in the fridge,” this does not conserve water.

The third and fourth question asked if participants volunteered or donated money to charity, the same categories were used. Responses were coded into the following categories: “don’t know,” “science,” “non-science,” “mix of science/non-science,” and “interested but don’t.” “Don’t know” followed the same guidelines as above. Answers that gave places participants volunteered were categorized into “science” if they involved environmental, medical, or other science related activities, “non-science” if it was centered on non-science actions such as humanitarian efforts or helping domestic animals. If the participant included volunteering in more than one place and included both science and non-science, it was coded as “mix of science/non-science.” Some participants expressed a desire to volunteer, but explained
they did not yet or did not have the ability to on their own, these were coded into “interested but don’t”.

Counselors were interviewed to see how they viewed the impact SCIENCE and their own teaching had on environmental literacy. The first question counselors were asked was if SCIENCE increased EL, the second was if the program increased EL more than a comparison group. The third question had two parts, it asked the counselor to project a participant’s post-test score and then their follow-up score. The fourth questions asked if the counselors’ personal teaching methods increased participants’ EL. The first, second, and fourth questions in the counselor interviews were coded in the following categories: “yes,” “maybe,” and “no.” These represent an affirmative answer, “yes,” a negative answer, “no,” or an unsure or non-committal answer, “maybe.” The third question’s first part was coded into the categories “higher” if they expected it to increase, “lower” if they expected a decrease, and “same” if they expected no change. The third question’s second part was coded into the categories “highest” if they expected the score to increase from an already higher post-test, “in between” if they expected the score to decrease compared to the post-test but stay higher than the pre-test, “baseline” if they expected it to return to the pre-test score, and “lowest” if they expected it to fall below the pre-test score.
CHAPTER 4: RESULTS

DEMOGRAPHICS

Both groups had male and female participants and a range of ages (Figure 2). Participants in Playgrounds’ program had a greater age range of 10-17 years, whereas the ages of those participating in SCIENCE spanned 11-15 years. Both groups had a similar, almost even, ratio of female to male participants, SCIENCE had 55% female and 45% male and Playgrounds had 54% female and 46% male.

Figure 2. Age distribution for SCIENCE (n=75) participants (top circle) and Playgrounds (n=53) participants (bottom circle).
QUANTITATIVE DATA- ENVIRONMENTAL ATTITUDE

On the EA portion of the tests participants answered questions on a Likert scale of 0-4 with 0 indicating ‘least interested’ and 4 indicating ‘most interested’ and their individual EA score were the average of their Likert responses to twelve questions (Table 3). SCIENCE participants had a pre-test EA score mean (±1 SE) of 2.6 ± 0.1, a post-test mean of 2.7 ± 0.1, and a follow-up test mean of 2.6 ± 0.1. Playground participants had a pre-test EA score mean (±1 SE) of 2.3 ± 0.1, a post-test mean of 2.3 ± 0.1, and a follow-up test mean of 2.6 ± 0.2.

Table 1. Summary statistics for the Environmental Attitude portion of the EL tests. SCIENCE and Playgrounds are individually broken down in pre-, post-, and follow-up tests.

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Mean Test Score</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SCIENCE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>2.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Post-test</td>
<td>2.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Follow-up test</td>
<td>2.6</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Playgrounds</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>2.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Post-test</td>
<td>2.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Follow-up test</td>
<td>2.6</td>
<td>0.2</td>
</tr>
</tbody>
</table>

The 2x3 factorial ANOVA with an interaction term compared the EA data for significant differences between participant groups and test types (Table 4). A main effect was found between the two participant groups, with the average SCIENCE EA scores being 10% higher than Playgrounds. The SCIENCE EA score was higher independent of the test type. An interaction was detected between test type and participant group. The simple effect between participant groups for each test type was highest for the post-test with and lowest for the follow-up test (Figure 3). The simple effects between test types within each participant group were not significant. SCIENCE EA scores were higher than Playgrounds for the pre-test and post-test, but they were the same for the follow-up test.
Table 2. ANOVA for the EA results. Test type refers to the three tests (pre-, post-, and follow-up) and participant group science and playgrounds. Test: group is the interaction within those two categories.

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Type</td>
<td>2</td>
<td>1.34</td>
<td>0.67</td>
<td>1.18</td>
<td>0.31</td>
</tr>
<tr>
<td>Participant Group</td>
<td>1</td>
<td>11.25</td>
<td>11.25</td>
<td>19.82</td>
<td>&lt;0.00</td>
</tr>
<tr>
<td>Test:Group</td>
<td>2</td>
<td>4.09</td>
<td>2.05</td>
<td>3.61</td>
<td>0.03</td>
</tr>
<tr>
<td>Residuals</td>
<td>305</td>
<td>173.07</td>
<td>0.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. Interaction plot of the mean (±1 SE) EA scores of the three test types (pre-, post-, and follow-up) for the two participant groups (SCIENCE and Playgrounds). Points are connected to show the trend within the group. P-values next to the means report the simple effects of participant groups for each test. To better show the data trends, the full y-axis (0-4) is not displayed.
QUANTITATIVE DATA- ENVIRONMENTAL KNOWLEDGE

On the EK portion of the tests participants answered ten questions. Their score was the percentage of correct answers. Some questions could get partial credit (Table 5). SCIENCE participants overall on the pre-test had an EK score mean (±1 SE) of 0.43 ± 0.02, on the post-test the mean was 0.69 ± 0.02, the follow-up test mean was 0.63 ± 0.02. The Playground EK score mean (±1 SE) for the pre-test was 0.48 ± 0.02, the post-test mean was 0.62 ± 0.02, and the follow-up test had a mean of 0.73 ± 0.03.

Table 3. Summary statistics for the Environmental Knowledge portion of the EL tests. SCIENCE and Playgrounds are individually broken down in pre-, post-, and follow-up tests.

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Mean Test Score</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCIENCE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.42</td>
<td>0.02</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.69</td>
<td>0.02</td>
</tr>
<tr>
<td>Follow-up test</td>
<td>0.63</td>
<td>0.03</td>
</tr>
<tr>
<td>Playgrounds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.48</td>
<td>0.02</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.62</td>
<td>0.02</td>
</tr>
<tr>
<td>Follow-up test</td>
<td>0.73</td>
<td>0.03</td>
</tr>
</tbody>
</table>

The 2x3 factorial ANOVA with an interaction term compared the EK data for significant differences between participant groups and across test types (Table 6). A main effect was found across test type; the EK post-tests and follow-up tests for both groups were 50% higher than the pre-tests, independent of participant group. Participants gained knowledge regardless of instruction. SCIENCE scores increased from pre-test to post-test, then decreased partially for the follow-up test. Playground scores increased from pre-test to post-test and post-test to follow-up test.
Although an interaction was detected between test type and participant group, none of the simple effects between participant groups for each test type were significant. The simple effects between the pre-test and post-test were significant for both SCIENCE (p=0.00) and Playgrounds (p=0.01). Also, the simple effects between the pre-test and follow-up test for both SCIENCE (p=0.00) and Playgrounds (p=0.00) were significant. Figure 4 shows the interaction between test type and participant groups for EK scores.

Table 4. ANOVA read out for the EK results. Test Type refers to the three tests (pre-, post-, and follow-up) and Participant Group to SCIENCE and Playgrounds. Test:Group is the interaction within those two categories.

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Type</td>
<td>2</td>
<td>3.35</td>
<td>1.67</td>
<td>47.84</td>
<td>&lt;0.00</td>
</tr>
<tr>
<td>Participant Group</td>
<td>1</td>
<td>0.03</td>
<td>0.03</td>
<td>0.80</td>
<td>0.40</td>
</tr>
<tr>
<td>Test:Group</td>
<td>2</td>
<td>0.32</td>
<td>0.16</td>
<td>4.52</td>
<td>0.01</td>
</tr>
<tr>
<td>Residuals</td>
<td>303</td>
<td>10.60</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 4. Interaction plot of the mean (±1 SE) EK scores of the three test types (pre-, post-, and follow-up) for the two participant groups (SCIENCE and Playgrounds). Points are connected to show the trend within the group. P-values next to the means report the simple effects of the interaction between participant groups for each test. To better show the data trends, the full y-axis (0.0-1.0) is not displayed.

QUALITATIVE DATA- ENVIRONMENTAL ATTITUDE

The EA portion of the tests had four open answer questions, Q1, Q2, Q3, and Q4. Of the participants who took the tests, a varying percentage responded to these questions.

Question 1:

Participants were asked “What science careers have you considered? Write all the careers you have considered, write none if you have not considered a career in science.” The coded categories are explained in Table 7.
Table 5. Example responses for coded categories for Question 1: “What science careers have you considered? Write all the career you have considered, write none if you have not considered a career in science.” The sample size for each category are listed for comparison.

<table>
<thead>
<tr>
<th>Career Response Categories</th>
<th>Category Sample Sizes</th>
<th>Example Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td>Pre 60 Post 38 Follow-up 4</td>
<td>(nothing written)</td>
</tr>
<tr>
<td></td>
<td>SCIENCE</td>
<td>Playgrounds 13</td>
</tr>
<tr>
<td>No</td>
<td>Pre 0 Post 1 Follow-up 7</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>SCIENCE 4</td>
<td>Playgrounds 11</td>
</tr>
<tr>
<td></td>
<td>Follow-up 1</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Unintelligible</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Pre 2 Post 1 Follow-up 3</td>
<td>ESF</td>
</tr>
<tr>
<td></td>
<td>SCIENCE</td>
<td>Playgrounds 1</td>
</tr>
<tr>
<td></td>
<td>Follow-up 1</td>
<td>Science (teacher) no</td>
</tr>
<tr>
<td></td>
<td>Mix of Careers</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Pre 4 Post 11 Follow-up 10</td>
<td>NHL, teaching, or engineering</td>
</tr>
<tr>
<td></td>
<td>SCIENCE</td>
<td>Playgrounds 9</td>
</tr>
<tr>
<td></td>
<td>Follow-up 3</td>
<td>WNBA, nurse, lawyer, or teacher</td>
</tr>
<tr>
<td></td>
<td>Mix of Careers</td>
<td>Police department, marine biology, aquatics</td>
</tr>
<tr>
<td></td>
<td>Pre 9 Post 16 Follow-up 16</td>
<td>Vet, it requires science</td>
</tr>
<tr>
<td></td>
<td>SCIENCE</td>
<td>Playgrounds 5</td>
</tr>
<tr>
<td></td>
<td>Follow-up 5</td>
<td>Science teacher</td>
</tr>
<tr>
<td></td>
<td>Mix of Careers</td>
<td>Mechanical engineering</td>
</tr>
<tr>
<td></td>
<td>Pre 5 Post 8 Follow-up 18</td>
<td>Singing/dancing/actor</td>
</tr>
<tr>
<td></td>
<td>SCIENCE</td>
<td>Playgrounds 16</td>
</tr>
<tr>
<td></td>
<td>Follow-up 4</td>
<td>Army, police</td>
</tr>
<tr>
<td></td>
<td>Mix of Careers</td>
<td>Teacher, cake decorator, artist, model, fashion designer</td>
</tr>
<tr>
<td></td>
<td>Pre 0 Post 7 Follow-up 17</td>
<td>(did not complete test)</td>
</tr>
<tr>
<td></td>
<td>SCIENCE</td>
<td>Playgrounds 0</td>
</tr>
<tr>
<td></td>
<td>Follow-up 33</td>
<td></td>
</tr>
</tbody>
</table>

The SCIENCE follow-up test had the highest response rate and also the largest percentage of “unintelligible” responses. Of the pertinent answers, the ratio of science to non-science was different between each test and group. The Playgrounds’ post-test had the highest ratio of “science” careers to “mix” or “non-science.” The Playgrounds’ pre-test had the lowest ratio.

Question 2:

Participants were asked “What actions (if any) do you do to conserve water?” The coded categories are explained in Table 8. The SCIENCE follow-up test had the highest response rate.
and also the largest percentage of “unintelligible”, “don’t know”, and “wrong” responses. The SCIENCE pre-test and Playgrounds post-test only had “conserve water” pertinent answers and no “clean water” or “general yes”. SCIENCE’s post-test had the highest percentage of “clean water” responses and Playgrounds’ had the highest percentage of “general yes” responses.

Table 6. Example responses for each coded category for Question 2: “What actions (if any) do you do to conserve water?” The sample size for each category are listed for comparison.

<table>
<thead>
<tr>
<th>Water Conservation Response Categories</th>
<th>Category Sample Sizes</th>
<th>Example Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td>Pre: 58 Post: 34 Follow-up: 2</td>
<td>(nothing written)</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 16 Playgrounds: 18</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Pre: 4 Post: 4 Follow-up: 10</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 4 Playgrounds: 6</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Unintelligible</td>
<td>Pre: 0 Post: 0 Follow-up: 2</td>
<td>Work with scientific</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 1 Playgrounds: 0</td>
<td>Put it in the fridge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Build a giant water dome</td>
</tr>
<tr>
<td>Don’t know</td>
<td>Pre: 1 Post: 0 Follow-up: 3</td>
<td>I don’t know</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 2 Playgrounds: 0</td>
<td>I have no idea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I don’t know what that means</td>
</tr>
<tr>
<td>Wrong</td>
<td>Pre: 2 Post: 4 Follow-up: 4</td>
<td>Don’t drink it</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 1 Playgrounds: 1</td>
<td>Drink water bottles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I pour extra water down the drain so it goes to the lake</td>
</tr>
<tr>
<td>Conserve water</td>
<td>Pre: 10 Post: 22 Follow-up: 32</td>
<td>Take short showers</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 25 Playgrounds: 19</td>
<td>Turn off the sink while brushing teeth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collect rain water in buckets</td>
</tr>
<tr>
<td>Clean water</td>
<td>Pre: 0 Post: 3 Follow-up: 3</td>
<td>Not throw trash in the water</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 1 Playgrounds: 1</td>
<td>Take out trash that is in the water at my camp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Help stop polluting</td>
</tr>
<tr>
<td>General yes</td>
<td>Pre: 0 Post: 1 Follow-up: 2</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 1 Playgrounds: 3</td>
<td>A lot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any actions</td>
</tr>
<tr>
<td>Non-response</td>
<td>Pre: 0 Post: 7 Follow-up: 17</td>
<td>(did not complete test)</td>
</tr>
<tr>
<td></td>
<td>SCIENCE: 0 Playgrounds: 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
</tr>
</tbody>
</table>
Question 3:

Participants were asked “With what scientific causes do you volunteer (if any)?” The coded categories are explained in Table 9. The SCIENCE follow-up test had the highest response rate and percentage of pertinent answers, and the largest percentage of “unintelligible” and “no” responses. Both the SCIENCE follow-up test and Playground pre-test had over 50% respond “no”. The Playground post-test and follow-up test also had a large percentage of “no” responses. All the SCIENCE pre-test pertinent answers were “science cause”. Playgrounds’ post-test had the highest percentage of “other cause” but it was still a high ratio of “science cause” to “other cause”.
Table 7. Example responses for each coded category for Question 3: “With what scientific causes do you volunteer (if any)?” The sample size for each category are listed for comparison.

<table>
<thead>
<tr>
<th>Volunteering Response Categories</th>
<th>Category Sample Sizes</th>
<th>Example Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 61 Post 37 Follow-up 4</td>
<td>(nothing written)</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 14 Post 20 Follow-up 8</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 6 Post 18 Follow-up 35</td>
<td>No</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 30 Post 24 Follow-up 8</td>
<td>n/a</td>
</tr>
<tr>
<td>Unintelligible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 1 Post 0 Follow-up 3</td>
<td>Exseloshons</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 1 Post 1 Follow-up 0</td>
<td>I going to leak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hgyufrecv</td>
</tr>
<tr>
<td>Future</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 1 Post 0 Follow-up 1</td>
<td>I like science so I might volunteer</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 0 Post 0 Follow-up 0</td>
<td>I want to volunteer but I think my answer is wrong</td>
</tr>
<tr>
<td>Science cause</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 6 Post 11 Follow-up 12</td>
<td>Saving a forest</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 7 Post 3 Follow-up 3</td>
<td>To find a cure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Picking up trash</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Planting</td>
</tr>
<tr>
<td>Other cause</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 0 Post 2 Follow-up 3</td>
<td>Help people in need</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 1 Post 1 Follow-up 1</td>
<td>Protests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls world expo</td>
</tr>
<tr>
<td>Non-response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 0 Post 7 Follow-up 17</td>
<td>(did not complete test)</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 0 Post 4 Follow-up 33</td>
<td></td>
</tr>
</tbody>
</table>

**Question 4:**

Participants were asked “What environmental cause do you support with your money? If you do not support any environmental causes, do you support other causes? If so which ones?” The coded categories are explained in Table 10. The SCIENCE follow-up test had the highest response rate and also the largest percentage of “unintelligible”, “don’t know”, and “wrong” responses. SCIENCE’s follow-up test was the only one with “mix causes” given and had the lowest ratio of “science causes” to “other causes”. SCIENCE’s post-test had the largest
percentage of “science causes”. Playgrounds’ percentage of “science causes” decreased from pre-test to post-test and post-test to follow-up test.

Table 8. Example responses for each coded category for Question 4: “What environmental cause do you support with your money? If you do not support any environmental causes, do you support other causes? If so which ones?” The sample size for each category are listed for comparison.

<table>
<thead>
<tr>
<th>Charity Response Categories</th>
<th>Category Sample Sizes</th>
<th>Example Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td></td>
<td>(nothing written)</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 62 Post 40 Follow-up 4</td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 12 Post 19 Follow-up 9</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 5 Post 12 Follow-up 26</td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 20 Post 21 Follow-up 3</td>
<td></td>
</tr>
<tr>
<td>Unintelligible</td>
<td></td>
<td>Exitron</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 0 Post 2 Follow-up 4</td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 1 Post 0 Follow-up 0</td>
<td></td>
</tr>
<tr>
<td>No money</td>
<td></td>
<td>No money, sorry</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 1 Post 1 Follow-up 3</td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 4 Post 1 Follow-up 1</td>
<td></td>
</tr>
<tr>
<td>Science cause</td>
<td></td>
<td>I support environmental protection</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 5 Post 10 Follow-up 8</td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 11 Post 3 Follow-up 2</td>
<td></td>
</tr>
<tr>
<td>Other cause</td>
<td></td>
<td>Adoptions charity</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 2 Post 3 Follow-up 11</td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 5 Post 5 Follow-up 5</td>
<td></td>
</tr>
<tr>
<td>Mix Cause</td>
<td></td>
<td>Church, cancer</td>
</tr>
<tr>
<td>SCIENCE</td>
<td>Pre 0 Post 0 Follow-up 2</td>
<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td>Pre 0 Post 0 Follow-up 0</td>
<td></td>
</tr>
<tr>
<td>Non-response</td>
<td></td>
<td>(did not complete test)</td>
</tr>
</tbody>
</table>
QUALITATIVE DATA- COUNSELORS

The five SCIENCE counselors were interviewed and asked the following questions. Their responses were coded for better analysis (Table 11). Question 1 had two different responses, “yes” and “maybe” but both were positive responses. No counselor said “no”. Questions 2 and 3b had the greatest variety of responses, with three coding categories. Questions 3a and 4 had the same responses for all counselors. Counselors had less confidence in the program changing environmental literacy than their own teaching methods doing so.

Table 9: Summary of counselor responses to interview questions. For the first row of Question 3, “Higher” means they said the post-test score would be higher than the pre-test. In the second row, “Highest” means they thought the follow-up score would be higher than both the pre- and post-test, “In between” means the score would be higher than the pre-test but lower than the post-test, and “Baseline” means the follow-up score would be back at the pre-test level of 50%.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Counselor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does ESF SCIENCE increase kids’ environmental literacy?</td>
<td></td>
<td>Yes</td>
<td>Maybe</td>
<td>Yes</td>
<td>Yes</td>
<td>Maybe</td>
</tr>
<tr>
<td>2. Can ESF SCIENCE increase environmental literacy by a significant degree (compared to kids who do not attend the program)?</td>
<td></td>
<td>Maybe</td>
<td>Yes</td>
<td>Maybe</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3. If a kid gets a 50% on a pre-test, a) Estimate what their score would be on post-test.</td>
<td>Higher</td>
<td>Higher</td>
<td>Higher</td>
<td>Higher</td>
<td>Higher</td>
<td></td>
</tr>
<tr>
<td>b) On the follow-up test?</td>
<td>Highest</td>
<td>In between</td>
<td>In between</td>
<td>Highest</td>
<td>Baseline</td>
<td></td>
</tr>
<tr>
<td>4. Do you predict your teaching this week will increase students’ environmental literacy?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
OBSERVATIONS

Activities were never canceled or held inside due to inclement weather for both SCIENCE and Playgrounds. Participants were not enthusiastic about completing the tests. The post-test was given at the end of the last day of the week and was not allowed as much time to complete. On average only 20 minutes was set aside, compared to the 30 for the pre-test.

While observing SCIENCE, participants never seemed to lack enthusiasm because of weather (for example not wanting to play a game because it was too hot). Participants across all weeks looked engaged and interacted well with counselors and each other. Often participants approached counselors to ask further questions about a topic that interested them. For example, after learning about composting, a participant asked a counselor where to put the compost she had collected during lunchtime. The counselors taught well for all weeks, there was not a noticeable difference in competency as the program progressed. From the first week observed to the last, counselors were knowledgeable and good at conveying information to participants. Only minor inconsistencies happened with information.

The biggest difference in program weeks was the amount of time spent with participants. Guardian Angels had shorter days, with only 3-4 hours of instruction compared to 5-6 with ELMS and SAS. ELMS only had four days of SCIENCE compared to five for Guardian Angels and SAS. The programming each week was different as well because of time constraints. Also, ELMS and SAS both went on an extra fieldtrip to Onondaga Lake Park while the majority of Guardian Angel instruction happened on the property of the church who organizes the camp. There were some discrepancies between what partner organizations expected SCIENCE to do and what SCIENCE was planning. For example, Guardian Angel’s organizer thought any activity materials would be left behind so instruction could continue the following weeks without
SCIENCE. However, SCIENCE reused the same teaching materials for each participant group and had to take them when they left. Also, partner organizers sometimes expected the same programs from previous years, not realizing the curriculum changes each year.
CHAPTER 5: DISCUSSION

OVERVIEW

The results were not expected and revealed some interesting trends within the data. Some study limitations could have impacted the results and should be considered for future studies. Even with the unexpected outcomes, conclusions can be drawn and there are recommendations that can improve the impact SCIENCEn has on environmental literacy.

ENVIRONMENTAL ATTITUDE

The EA scores were different between SCIENCEn and Playgrounds, as seen in Table 4 and Figure 3. SCIENCE had a higher EA score than Playgrounds at the beginning of the study, indicating SCIENCEn participants came to the program with an elevated EA compared to Playgrounds’ participants. This pre-existing difference was unexpected since participants of neither group self-select. SCIENCE is an environmental camp; however, participants do not choose to go because of an interest in environmental science. The three partner organizations hired SCIENCE as part of larger summer camp programming that participants are enrolled in by parents out of need or requirement. Only the SAS participants had a choice to attend the SCIENCE summer program, but they accounted for about 20% of the total participants, so if they possessed higher pre-existing environmental attitude it is possible that they may have influenced the pre-test estimate.

SAS is a science focused school and students could be more interested in science than the general SCSD school population. To see if SAS was skewing the EA score it was separated from the SCIENCE participant group into its own and the ANOVA was redone. This analysis revealed that SAS actually had a lower EA average than the rest of SCIENCE participants and therefore
did not positively skew the SCIENCE EA score. Despite being the only science-inclined and voluntary group, SAS participants do not explain the elevated EA score.

Guardian Angels was focused on science learning during the 2017 summer. However, the focus changes each summer, and advertising did not stress it was science-based. The four participants from Guardian Angels in this study had a lower EA average score than ELMS, indicating Guardian Angels also did not positively skew the SCIENCE EA score.

The largest subset of SCIENCE participants, ELMS, requires incoming students to attend their orientation, which includes a week of the SCIENCE program. ELMS is not a science magnet school and it does not do any preparatory teaching before SCIENCE that would influence environmental literacy. Even still, the ELMS participants must account for the elevated pre-test scores in environmental attitude.

These results do not support the hypotheses that environmental attitude post-test scores of SCIENCE participants will be higher than their pre-test score and their post-test scores will not be significantly different from their follow-up score. The EA scores for SCIENCE were not different across the three tests. Therefore, the SCIENCE program did not increase the EA for participants. SCIENCE participants did have an elevated EA before the program. Playgrounds EA scores also did not increase across the three tests. The current data cannot explain this.

The short timeframe limits the impact on environmental attitude (Antink-Meyer et al., 2016). Antink-Meyer et al. (2016) found influencing attitude and behavior changes should be long term goals and even small increases in environmental attitude are encouraging.

The hypothesis that the change in environmental attitude between pre- post- and follow-up test scores of SCIENCE participants will be higher than scores of those who did not attend,
was partially supported. The test for simple effects, in Table 4 and illustrated in Figure 3, did show a difference between SCIENCE and Playgrounds’ post-test scores. SCIENCE participants’ attitude increased more throughout the week than Playgrounds.

The qualitative data is summarized in Tables 7, 8, 9, and 10. It also shows the program did not increase participants’ interest in science careers or pro-environmental behaviors. There were no trends in responses to the open-ended questions across the test types or between participant groups. Bhattacharyya et al. (2011) found a summer camp does not steer participants towards careers in science. They did find it can open up their imaginations around science and engender a better attitude towards science (Bhattacharyya et al. 2011). Some anecdotal data from counselors agreed with this, but the data analysis did not show an increase in pro-environmental attitude.

The biggest challenge with the open-ended questions was the varying sample size that was consistently smaller than the quantitative data set. With such small sample sizes, a few responses can skew percentages. None of the test questions were compulsory on the EA or EK sections, but the added effort to think of responses probably contributed to the lower response rate (Reja, Manfreda, Hlebec, & Vehovar, 2003).

Pooley and O’Connor (2000) found it difficult to study environmental attitude because it is hard to quantify or qualify. Despite the difficulties, environmental attitude is essential to understanding how to influence behavior (Manoli et al., 2007). Knowledge alone does not affect behavior and the two in tandem must be studied to affect change (Pothitou et al. 2016).
ENVIRONMENTAL KNOWLEDGE

SCIENCE and Playgrounds EK scores both increased by the end of the program and stayed higher into the school year. However, there was no difference between the participant group scores at each test (Table 6, Figure 4) even when the simple effects were examined. The hypothesis that the change in environmental knowledge among pre-, post-, and follow-up test scores of SCIENCE participants will be higher than Playgrounds participants was not supported by the results of this study. Both participant groups’ test scores increased over time despite only SCIENCE participants getting environmental programming. The testing effect is an increase in future test performance due to exposure to previous, similar testing (Hartley, 1973). The potential for the testing effect to increase both groups’ scores is high. Hartley (1973) explained giving a pre-test influences the performance on a post-test, but acknowledged it is an ongoing debate. Even with changing the test questions each time, participants are still more familiar with the structure of the test and type of questions asked (Hartley, 1973). More recently, Kromann, Jensen, and Ringsted (2009) studied how assessing skills helped develop them and found testing did increase knowledge of the material.

Focusing on SCIENCE scores, the EK post-test scores were higher than the pre-test scores. Their follow-up test score was not different from the post-test but higher than the pre-test. This does support the hypotheses that environmental knowledge post-test scores of SCIENCE participants will be higher than their pre-test score and post-test scores will not be different from their follow-up score. SCIENCE participants’ EK did increase at the end of the program. This elevated EK did not diminish months after the program either; it stayed at the higher level. However, the comparison group had similar results. Playgrounds scores increased from pre-test to post-test. Their follow-up test score was also higher than the pre-test, but not
different than the post-test. This makes it impossible to state the SCIENCE program was what increased participants’ EK.

The testing effect could have increased the post-test scores (Hartley, 1973). The follow-up test scores could have been influenced by both the testing effect and the start of the school year. Being back in the school environment could have increased performance, participants might have taken the test more seriously in a school setting (von der Embse & Hasson, 2012). The percentage of open-ended responses was highest for ELMS, who took the follow-up test during school hours, administered by teachers, in the classroom. This could indicate the test was taken more seriously.

COUNSELOR INTERVIEWS

The second study question tested the hypothesis that counselors will not accurately predict how well their students do on environmental literacy post-tests or follow-up tests. Their accuracy changed for the different interview questions.

For question one, all the counselors thought the role of SCIENCE would improve environmental literacy. However, they felt overall it is more about showing kids by example and getting them outside to experience things themselves, not memorizing the material taught. Counselor 1 said participants will not “retain all the concepts but [SCIENCE] exposes them to new natural areas and ideas.” This was supported by the data, EA and EK did increase in SCIENCE participants throughout the week. However, the data do not show SCIENCE as the only reason for this increase and counselors were unsure if the impact SCIENCE has on participant’s EL is significant. Counselor 3 thought “one week probably not enough for long-term change” however, Counselor 2 drew on personal experience and said SCIENCE could
cause significant increase in EL because “I went to summer camp that changed my attitude and interests towards nature.” Counselors did expect SCIENCE to increase environmental literacy, but would not commit to it being a significant result.

All the counselors expected an increase in the EK score throughout the week, counselor 5 even expected participants to get a 100% “if they were paying attention”, but the rest expected a score around 75%. Expectations for follow-up scores were more varied with some counselors thinking the score would increase more, some thinking it would fall below the post-test but still be higher than the original pre-test score. One counselor thought participants would lose any knowledge gained throughout the program and their follow-up test score would be the same as their pre-test score. There was less confidence in longevity of the program’s effectiveness at increasing EL in participants. Counselor 1 said “I hope for significant improvement but don't expect a perfect score/retention there is a lot of material” and Counselor 4 explained “the goal is to introduce a wide range of topics, they can investigate further on their own” if participants do not take this initiative the EL gained can dissipate. Here the counselors did not have realistic expectations; the scores did not increase as much as they predicted.

Despite not being confident in SCIENCE’s ability to impact EL in the long term, all the counselors believed their teaching style would increase EL in participants. Most counselors explained what skills they taught participants and how those could help them in future learning, a lot focused on experiential learning or making participants think more critically. Counselors said the hands-on activities have a more lasting impression. Many brought up the first experiences participants were exposed to such as fishing or hiking. Counselor 4 said “Many of my activities were the bigger topics and more general. A lot were new experiences which have a higher chance of impact.” Counselors thought these experiences along with improved critical thinking
skills could impact knowledge, but probably not attitude. However, counselor 5 hoped for small attitude changes, “I wanted to make them realize the woods aren't scary. There are good things in the woods.” Counselors were confident they had impacted participants’ feelings towards nature and science in general. They attributed their ability to connect with participants to focusing on experiential learning. This focus complements the theoretical framework. They focused on giving participants fun experiences in nature, instead of memorizing information. The counselors hoped to make participants more likely to seek out environmental activities and delve deeper into any topics they found interesting on their own.

Through the interviews, it can be seen counselors cannot specifically predict how well participants will do. However, they have realistic expectations of not significantly increasing environmental literacy in a short time, and the long-term impacts of the program. What may be less accurate is their personal contributions to increasing environmental literacy. A counselor can influence a few participants, but to assume they significantly impacted all attendees is not supported (Brandt & Arnold, 2006). But most counselors were confident in their personal impact on the group’s environmental literacy. Overall the hypothesis was partially supported, counselors understood the program might not increase EL significantly, but they overestimated how much SCIENCE and their personal impacts would increase EL. The counselors all focused on the experiential learning impacts of SCIENCE. That goes along with the theoretical framework, by exposing participants to nature their attitude towards the environment could be changed more readily.
STUDY LIMITATIONS

The three test study design attempted to prevent limitations. Bogner (1998) explained the importance of giving follow-up tests months after the program to lessen some of the bias from the experience from influencing responses. He also emphasized how short-term impacts can dissipate over time and follow-up tests prevent incorrect analysis of a program’s efficacy (Bogner, 1998). The inclusion of a follow-up test in this study was to measure the lasting power of any increase in EL from the program. Bogner (1998) also recommended not saying there would be a second test until after the first one was completed. This was not possible because of the assent requirements for participant participation. The EK questions were changed to prevent this. However, participants might have memorized their responses on the EA portion so they could easily regurgitate them at the end of the week without reanalyzing their attitude. Including a comparison group also avoided some limitations. Sanacora (2017) explains without a comparison group, one cannot claim any behavior changes from a treatment. However, including a comparison group creates other potential internal integrity issues. Assuming two separate groups represent similar populations when they are not randomly selected can lead to selection bias (Mulder, 1996). A true control group was not possible for this study because participants could not be sorted in SCIENCE and Playgrounds by the researcher.

One problem with the EK portion being changed each time is that it is possible the different tests did not have the same level of difficulty. Pilot test would be needed to investigate the evenness of the tests, which was not possible with the time frame of this study but could be included in the future. If all test questions were given to a group before attending any program their scores could be analyzed to see if some questions were easier than others.
Another internal integrity issue that could have influenced latter test performances was the history effect (Mulder, 1996). The pre-test could have sparked interest in environmental science and the participants could have done their own research into the topics presented and therefore an increase in EK would not be solely from SCIENCE. History effect could include other outside events that only one group went through that influenced their performance on the tests. These could explain the increase in EK seen with the comparison group. Both an easier test and outside initiative could have inflated their scores.

Inaccurate representation of the topics covered in SCIENCE on EK tests could have influenced results. Due to time constraints and site changes, some of the test topics were not covered. This could negatively impact performance on the post-test. For example, the topic of native and non-native species was not covered in depth and only one week had a tree identification walk. If the material was not taught, then SCIENCE participants would not be expected to score higher than the Playground participants. If post-tests could have been designed each to cater to what was taught the scores might more accurately reflect how much was learned. However, the current approval process necessitates all test materials must be approved before the study starts. In the future, a database of test questions could be created with multiple questions for each topic and a larger array of topics. All these questions would be submitted for approval. Then at the end of program only those questions pertaining to the materials covered that week would be selected. The percentage of correct responses was calculated for each question to see if there were problem questions. Though a few questions had a small number of correct responses, these were on topics that were covered during SCIENCE. The questions on topics not covered still had a portion of participants who answered them correctly.
Getting sufficient follow-up test participation was difficult to obtain for those not surveyed in person. Guardian Angels’ and Playgrounds’ participants were sent follow-up tests in the mail with a paper copy and link to an electronic copy. No responses were received from Guardian Angels. However, since they were a small portion of the SCIENCE participants this probably did not skew those results. Playgrounds’ mailed out tests’ response rate could have skewed results. All responses were paper copies; no one from Playgrounds completed the online version. Despite the ubiquity of computers and phones, Mcleod, Klabunde, Willis, and Stark (2000) found most researchers still rely on paper surveys and they generally get a better response rate than electronic ones. Schuldt and Totten (1994) found people are less likely to return electronic surveys than paper surveys (assuming postage paid envelopes are included). But another study found electronic and paper response rates are becoming more similar, assuming the population has access to computers (Truell, Bartlett, & Alexander, 2002). The population surveyed might have a lower access rate to computers which prevented the electronic version from helping to increase the response rate. It is also possible emailing the link for the electronic version, instead of mailing it on paper, would increase the probability of it being used.

Though 20 is a small sample size, which could have affected results, the response rate for Playgrounds was higher than expected at 38%. Surveys without an incentive usually get a response rate less than 27% and without a reminder mailing the response rate is generally less than 15% (Mcleod et al., 2000). Even with a higher than expected response rate, another internal integrity issue, experiential mortality, could be represented. The people who returned the mailed tests could be more interested in science and therefore different from the ones who did not complete the follow-up test. The follow-up sample for Playgrounds might not accurately represent the previous test participants.
Future studies should attempt to survey all follow-up groups in person. If that is not possible, getting email addresses for parents of participants or participants could increase the use of the electronic version and supplement the mailed responses. Obtaining phone numbers could give participants a third option of completing the survey over the phone. Mailing out tests more than once or sending reminders could also increase the response rate. Under current Syracuse IRB regulations an incentive is allowed only if participation is not necessary. Including an incentive that participants are eligible for, whether they return the follow-up test or not, might not increase the response rate.

The difference in time allotted to the SCIENCE pre-test and post-test could have influenced scores. The tests were designed to be competed in 20 minutes and most participants finished in under 15 minutes on all tests. However, some participants could have felt rushed and not completed the test properly. The EK portion was generally completed first, but the thoughtfulness of answers on the EA portion could have been impacted. This could also be one of the reasons the open-ended questions were left blank at higher rates since they are at the end and more time consuming to answer. However, a larger percentage of SCIENCE participants answered them on the post-test compared to the pre-test. It would be better to have a more structured, consistent, timeframe set aside for tests during the program.

RECOMMENDATIONS

Despite not increasing environmental literacy, SCIENCE did a good job of exposing participants to new experiences. Participants were Syracuse youth, many not used to exploring natural areas, and this was the first time they participated in activities such as hiking and fishing. SCIENCE also kept fieldtrips to local natural areas which showed participants they can find
nature nearby and visit it on their own. By having ESF students as counselors it also showed participants the range of science career options. Counselors also normalized these new activities and made natural areas seem less foreboding. Small changes in the programming of SCIENCE could increase its long-term impact and help increase the environmental literacy of participants.

**Partner organization relationships**

There were discrepancies between what some of the partner organizations and SCIENCE staff expected. The most notable was with Guardian Angels, who shortened the time of instruction, did not procure a bus for transportation to off-site locations, and expected lesson materials to be left behind so activities could continue the following week. Because the group thought any activity materials were theirs to keep it lessened the urgency to get through all the lessons on time and the organizer frequently interrupted activities.

The other groups, ELMS and SAS, also had some inconsistent expectations from SCIENCE staff. These included what topics would be covered and the schedule for each day. A more explicit schedule and explanation of activities would help prevent such miscommunications.

**Inconsistencies in programming**

The programming was very different between the weeks. Some inconsistencies were due to partner organization miscommunications (such as not scheduling a bus), but not all. Frequently, time limitations were observed for morning activities which led to afternoon activities being shortened or cut. Logistics were not always accounted for in timing. The most obvious example was when ELMS and SAS visited Onondaga Lake Park. SCIENCE had multiple stations spread throughout a wide area, but they did not plan an efficient route from one
to another. Staff switched groups with whomever else was finished and not in a specific pattern. Some stations went over time which made other stations need to come up with filler lessons on the spot and also made later groups rush through stations.

Having a better schedule in advance and better communication amongst staff would prevent such logistical problems. Using walkie-talkies to know when to switch, for example, would prevent bottlenecks at one station. Having chaperones walk participants between stations would prevent counselors from running back and forth and give them time to reset activities.

**Focus on new experiences**

One week is a short time to increase environmental literacy (Antink-Meyer et al., 2016). Studies show novel experiences have a larger impact on long-term affinity for nature (Bogner, 1998; Ozdemir, 2010). Exposing participants to new activities and showing them how to recreate those experiences on their own could better achieve SCIENCE’s goals. Some activities, such as fishing in Onondaga Lake or hiking in Clark Reservation, are great examples of this. Not every group did these activities. The priority should be to ensure the larger experiences are covered every week in some way.

**Use interpretive methods**

Environmental interpretation focuses on connecting people to nature while teaching them about it (Beck & Cable, 2011). By using interpretive methods, such as themes and lesson planning, even short lessons can have an impact. Participants are more likely to come away with the main message and feel more connected to nature (Beck & Cable, 2011). Incorporating interpretive methods during the counselor training and curricula development could increase the impact of lessons.
**Counselor training**

In addition to interpretive methods, counselors should be told to focus on experiential learning. Counselors should not stress memorizing facts over participants enjoying new experiences outside in nature. Most counselors did try to use this approach, but the curriculum was still information focused. Counselors seem to overestimate how much the program affects participants’ knowledge but have a better understanding of their personal impact. Cultivating that focus on experiential learning can increase their impact even more.

**CONCLUSION**

ESF’s summer program, SCIENCE, does expose Syracuse children to environmental science and scientists. However, the impact it had on increasing environmental literacy was not significant for attitude or knowledge. The theoretical framework for this study did not predict an increase in EK or EA from the comparison group. It also expected EA to increase for participants involved in the experiential science program. Despite this, the theoretical framework should not be changed. Many of the results were not expected and did not follow the literature. Confounding variables and internal integrity issues could have affected the results and need to be better controlled for in subsequent studies.

Future studies should examine why the comparison group gained EK and why the SCIENCE participants had elevated EA from the start. Identifying potentially confounding variables will enable better analysis from future results. In order to shed light on the controversy between knowledge, attitude, and behavior, and better investigate the accuracy of the theoretical framework, future studies could evaluate different science camps that use different teaching
methods. If they focus on the same topics in different ways, formal and non-formal, it could show which teaching methods can best increase retention of material.
LITERATURE CITED


**APPENDICES**

**APPENDIX A: ENVIRONMENTAL LITERACY TESTS**

*Environmental Attitude Questions:*

*Answer the following marking the box for 0, 1, 2, 3, OR 4 with 0 being not interested, not likely, or not at all and 4 being very interested, very likely, or very much (only mark one box per question)*

<table>
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<tr>
<th>Question</th>
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<tr>
<td>1. How interested are you in science?</td>
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<td>2. How likely are you to do a science related activity outside of school?</td>
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<td>3. How likely are you to consider a career in science?</td>
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<td>4. How likely are you to go outside for fun?</td>
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<td>5. How likely are you to recycle?</td>
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<td>6. How likely are you to support scientific causes with your time?</td>
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<td>7. How likely are you to agree with laws that protect the environment?</td>
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<td>8. How likely are you to take actions to conserve water?</td>
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<td>9. How likely is it for you to read science books or watch science shows on your own time?</td>
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<td>10. How likely are you to donate money to an environmental cause?</td>
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<td>11. How much do you think about environmental issues?</td>
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<td>12. How likely are you to have a conversation about the environment with your friends and family?</td>
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Further Questions:
What science careers have you considered? Write all the career you have considered, write none if you have not considered a career in science.

What actions (in any) do you do to conserve water?

With what scientific causes do you volunteer (if any)?

What environmental cause do you support with your money? If you do not support any environmental causes, do you support other causes? If so which ones?
Pre-Test

*Environmental Knowledge Questions (Grades 6-8):*

1. Can you use insects to determine how clean a stream or river is?
   True  False

2. What is the name of the big lake in Syracuse?

3. How do trees prevent erosion?
   a. They stabilize the soil with their roots
   b. They absorb any loose soil with their roots
   c. Their leaves tie the soil down
   d. All of the above

4. What is a hypothesis?
   a. A theory the scientist creates to explain a phenomenon
   b. The expected outcome of a scientific experiment
   c. The question a scientist plans to investigate and gather evidence about
   d. A proposed explanation based on some evidence that needs further investigation

5. Where is the majority of freshwater on Earth?

6. Is biomagnification in food chains a good thing or a bad thing?
   Good  Bad

7. Is a deer a predator or prey species?

8. Name one tree species native to New York State.

9. Is porous pavement or cement an example of green infrastructure?

10. Which of these are the basic parts of an ecosystem
    a. Predators and prey
    b. Animal, vegetable, and mineral
    c. Producer, consumer, and decomposer
    d. Trees, shrubs, and flowers
Pre-Test

Environmental Knowledge Questions (Grades 9-11):

1. If there are pollution tolerant macroinvertebrates in a stream that means it is polluted.
   True          False

2. What are three major streams that flow into Onondaga Lake?

3. What is the process of soil or rock gradually wearing away called?

4. In scientific experimentation, what is a proposed explanation based on some evidence that needs further investigation called?

5. What percentage of the current water on Earth is from when the planet was first formed?

6. If a toxin biomagnifies, where in the food chain are higher concentrations found?

7. Does a balanced food web have more predator or prey species?

8. Name one characteristic of white pine that can be used for identification?

9. Name one example of green infrastructure.

10. What are the three categories of organisms that make up an ecosystem?
    ● ______________________
    ● ______________________
    ● ______________________
Post-Test

Environmental Knowledge Questions (Grades 6-8):

1. Can the presence of specific insects help you determine if a stream is clean?
   Yes  No

2. Where is the final destination for the water from Onondaga Lake?

3. How does erosion impact a habitat?
   a. Less nutrients available to the plants
   b. More difficult for plants to grow in shallower soil
   c. Water bodies become less clear from the run-off
   d. All of the above

4. Do you form a hypothesis at the beginning or during an experiment?

5. Is a larger portion of Earth land or water?
   Land  Water

6. If a toxin biomagnifies, would you expect to find a high concentration in a fish that eats plants, or a fish that eats other fish?
   a. Herbivore fish
   b. Carnivore fish

7. Are predators producers, consumers, or decomposers?
   Producers  Consumers  Decomposers

8. Are sugar maples native to New York State?
   Yes  No

9. Can green infrastructure prevent water run-off?

10. Are ecosystems with only animals complete?
**Post-Test**

*Environmental Knowledge Questions (Grades 9-11):*

1. Can macroinvertebrates help you to determine if a stream is clean?  
   Yes  No

2. Where does the water in Syracuse’s watershed end up?

3. Does erosion affect the amount of nutrients available to plants?  
   Yes  No

4. What is the difference between a theory and a hypothesis?

5. What percentage of Earth is covered in water?

6. If a toxin biomagnifies, would you expect to find a high concentration in a fish that eats plants, or a fish that eats other fish?  
   a. Herbivore fish  
   b. Carnivore fish

7. Are predators higher or lower in the food chain than producers?  
   Higher  Lower

8. Are sugar maples deciduous or coniferous trees?  
   Deciduous  Coniferous

9. State one benefit of green roofs.

10. Can you have a complete ecosystem without decomposers?
Follow-up Test

Environmental Knowledge Questions (Grades 6-8):

1. Can a polluted stream support the same variety of insect species as a clean one?
   Yes  No

2. Does water from the Atlantic Ocean flow into Onondaga Lake?
   Yes  No

3. Can erosion on land impact a river ecosystem?
   Yes  No

4. Which of the following are benefits of a green roof?
   a. Keeps the building cooler inside during hotter weather
   b. Prevents run-off of rain
   c. Adds habitat for pollinators
   d. All of the above

5. Is the majority of water on Earth saltwater or freshwater?
   Saltwater  Freshwater

6. Does a toxin biomagnify as it moves up the food chain or down the food chain?
   Up  Down

7. Do predators eat plants or other animals?
   Plants  Animals

8. Do deciduous trees lose their leaves?
   Yes  No

9. Does an ecosystem include only living things?
   Yes  No

10. Are a theory and hypothesis the same thing?
    Yes  No
Follow-up Test

Environmental Knowledge Questions (Grades 9-11):

1. Can a polluted stream support the same variety of macroinvertebrate species as a clean one?
   Yes  No

2. Does water leaving Onondaga Lake flow towards or away from the Atlantic Ocean?
   Towards  Away

3. Is erosion on a problem for land ecosystems?

4. How does porous pavement prevent water pollution?

5. Is there more water in the ocean or in glaciers?
   Ocean  Glaciers

6. Does a top predator have a higher concentration of a biomagnifying toxin compared to an herbivore?
   Yes  No

7. What type of food do predators eat?

8. Do we have deciduous trees in New York State?
   Yes  No

9. Number the following steps of the scientific method in order from first to last.
   __ Making observations
   __ Analyzing results
   __ Forming a hypothesis
   __ Creating an experiment

10. Does an ecosystem include abiotic factors?
    Yes  No
APPENDIX B: COUNSELOR INTERVIEW QUESTIONS

1. Does ESF SCIENCE increase kids’ environmental literacy (environmental literacy being how well versed they are in environmental science and environmental attitude)?
2. Can ESF SCIENCE increase environmental literacy by a significant degree (compared to kids who do not attend the program)?
3. If a kid gets a 50% on a pre-test, estimate what their score would be on post-test. Follow-up test?
4. Do you predict your teaching this week will increase students’ environmental literacy?
   a. If no, why not?
   b. If yes, to what degree?
My name is Marissa Nolan, and I am a grad student at SUNY College of Environmental Science and Forestry (ESF). I am inviting you to participate in a research study. Involvement in the study is voluntary, so you may choose to participate or not. This sheet will explain the study to you and please feel free to ask questions about the research if you have any. I will be happy to explain anything in detail if you wish.

I am interested in learning more about environmental literacy. You will be asked to be interviewed one-on-one about your impacts on ESF SCIENCE students’ environmental literacy. Your name will never be associated with your answers. This will take approximately 10 minutes of your time. All information will be kept anonymous.

This means that your name will not appear anywhere and your specific answers will not be linked to your name in any way.

The benefit of this research is that you will be helping us to environmental literacy. This information should help us to better understand how non-formal education affects environmental literacy. There are no personal benefits to you by taking part. The risk to you of participating in this study is fearing repercussions from your boss due to honest interview answers. These risks will be minimized by me acknowledging none of your answers will not be associated with your name and none will be given to your supervisor.

If you do not want to take part, you have the right to refuse to take part, without penalty. If you decide to take part and later no longer wish to continue, you have the right to withdraw from the study at any time, without penalty. You may refuse to answer any questions during the interview or stop the interview at any time.

If you have any questions, concerns, complaints about the research, contact Dr. Beth Folta at efolta@esf.edu (315) 470-4938 or me, Marissa Nolan at mnolan01@syr.edu (774)688-9182.

If you have any questions about your rights as a research participant, you have questions, concerns, or complaints that you wish to address to someone other than the investigator, if you
cannot reach the investigator, contact the Syracuse University Institutional Review Board at 315-443-3013.

All of my questions have been answered, I am 18 years of age or older, and I wish to participate in this research study. I have received a copy of this consent form.

Signature of participant  ____________________________  Date

______________________________
Printed name of participant

Signature of researcher  ____________________________  Date

______________________________
Printed name of researcher
Effects of Environmental Literacy from Non-Formal Education

My name is Marissa Nolan, and I am a graduate student at State University of New York College of Environmental Science and Forestry (SUNY ESF). I am inviting your child to participate in a research study. Involvement in the study is voluntary, so you may choose to let your child participate or not. This sheet will explain the study to you and please feel free to ask questions about the research if you have any. I will be happy to explain anything in detail if you wish.

I am interested in learning more about environmental literacy. Your child will be asked to take a series of short surveys (three over the next four months) to judge their environmental literacy. This will take 30 minutes of their time. All information will be kept confidential.

Your child will not put their name on the surveys but a code that will be used to match their surveys but will not be associated with their name or information.

The benefit of this research is that your child will be helping us to understand how summer camps impact environmental literacy. There are no direct benefits to your child by taking part in this study. There are no risks to take part in this study.

If your child decides to stop after we begin, that’s okay. They can also skip any of the questions they do not want to answer. There will be no punishment or negative consequences if you decided they will not participate at the beginning or if you or they decide not to finish participating in this study and withdraw early.

If you would like to see the surveys your child would be answering or have other questions about the study you can contact me at mnolan01@syr.edu or (315)470-4938. If you have any questions, concerns, complaints about the research, contact Dr. Beth Folta at efolta@esf.edu (315) 470-4938.

If you have any questions about your rights as a research participant, you have questions, concerns, or complaints that you wish to address to someone other than the investigator, if you cannot reach the investigator, contact the Syracuse University Institutional Review Board at 315-443-3013.
All of my questions have been answered, I am 18 years of age or older, and I wish or my child to participate in this research study. I have received a copy of this consent form.

__________________________________
Signature of participant’s parent or guardian

________________________
Date

_______________________________________
Printed name of participant’s parent or guardian

_______________________________
Printed name of participant

________________________________________
Signature of researcher

________________________
Date

________________________________________
Printed name of researcher
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All of my questions have been answered, I am 18 years of age or older, and I wish or my child to participate in this research study. I have received a copy of this consent form.

_________________________________________  ___________________________
Signature of participant’s parent or guardian  Date

_________________________________________  ___________________________
Printed name of participant’s parent or guardian  Printed name of participant

_________________________________________  ___________________________
Signature of researcher  Date

_________________________________________
Printed name of researcher
Informed Assent Form for:
Effects of Environmental Literacy from Non-Formal Education

My name is Marissa Nolan, and I am from the State University of New York College of Environmental Science and Forestry (ESF). I am asking you to participate in this research study because you are attending the ESF SCIENCE Camp.

**PURPOSE:** A research study is a way to learn more about people. In this study, I am trying to learn more about environmental literacy. Environmental literacy is how much people know about environmental science and nature. I am also trying to learn how much students like science and nature. I am going to give participants a survey that asks knowledge questions to evaluate their environmental literacy and general attitude questions to see how much they like science and nature. A version of the survey will be given on the first day of camp, last day of camp, and in the school year. The last survey will be delivered by email and you will have time to fill it out online and submit your answers.

**PARTICIPATION:** If you decide you want to be part of this study, you will be asked to fill out three environmental literacy surveys. All of this should take at most 30 minutes per survey.

**RISKS & BENEFITS:** There are some things about this study you should know. You may feel upset or frustrated if you do not know the answers to some of the questions.

Not everyone who takes part in this study will benefit. A benefit means that something good happens to you. We think these benefits might be learning more about science and nature.

**REPORTS:** When I am finished with this study I will write a report about what was learned. This report will not include your name or that you were in the study.
**VOLUNTARY:** Voluntary means that you do not have to be in this study if you do not want to be. I have already asked your parents if it is ok for me to ask you to take part in this study. Even though your parents said I could ask you, you still get to decide if you want to be in this research study. You can also talk with your parents, grandparents, guardians, and teachers before deciding whether or not to take part. No one will be mad at you or upset if you decide not to do this study. If you decide to stop after we begin, that’s okay too. You can also skip any of the questions you do not want to answer. There will be no punishment or negative consequences if you decided you do not want to participate at the beginning or if you decide you do not want to finish participating in this study and want to withdraw early. Participating is your decision.

**QUESTIONS:** You can ask questions now or whenever you wish. If you want to, you may call me at (774)688-9182 and email me at mnolan01@syr.edu, or you may call Dr. Beth Folta at (315) 470-4938 and email her at efolta@esf.edu. If you are not happy about this study and would like to speak to someone other than me, you or your parents may call the Syracuse University Institutional Review Board (IRB) at 315-443-3013.

Please sign your name below, if you agree to be part of my study.

Signature of Participant ____________________________ Date __________________

Name of Participant ______________________________

Signature of Investigator or Designee ________________________ Date _____________
My name is Marissa Nolan, and I am from the State University of New York College of Environmental Science and Forestry (ESF). I am asking you to participate in this research study because you are a student in the Syracuse School District.

**PURPOSE:** A research study is a way to learn more about people. In this study, I am trying to learn more about environmental literacy. Environmental literacy is how much people know about environmental science and nature. I am also trying to learn how much students like science and nature. I am going to give participants a survey that asks knowledge questions to evaluate their environmental literacy and general attitude questions to see how much they like science and nature. A version of the survey will be given at the end of the school year and again in September. The last survey will be delivered by email and you will have time to fill it out online and submit your answers.

**PARTICIPATION:** If you decide you want to be part of this study, you will be asked to fill out two environmental literacy surveys. All of this should take at most 30 minutes per survey.

**RISKS & BENEFITS:** There are some things about this study you should know. You may feel upset or frustrated if you do not know the answers to some of the questions.

Not everyone who takes part in this study will benefit. A benefit means that something good happens to you. We think these benefits might be learning more about science and nature.

**REPORTS:** When I am finished with this study I will write a report about what was learned. This report will not include your name or that you were in the study.
**VOLUNTARY:** Voluntary means that you do not have to be in this study if you do not want to be. I have already asked your parents if it is ok for me to ask you to take part in this study. Even though your parents said I could ask you, you still get to decide if you want to be in this research study. You can also talk with your parents, grandparents, guardians, and teachers before deciding whether or not to take part. No one will be mad at you or upset if you decide not to do this study. If you decide to stop after we begin, that’s okay too. You can also skip any of the questions you do not want to answer. There will be no punishment or negative consequences if you decided you do not want to participate at the beginning or if you decide you do not want to finish participating in this study and want to withdraw early. Participating is your decision.

**QUESTIONS:** You can ask questions now or whenever you wish. If you want to, you may call me at (774)688-9182 and email me at mnolan01@syr.edu, or you may call Dr. Beth Folta at (315) 470-4938 and email her at efolta@esf.edu. If you are not happy about this study and would like to speak to someone other than me, you or your parents may call the Syracuse University Institutional Review Board (IRB) at 315-443-3013.

Please sign your name below, if you agree to be part of my study.

Signature of Participant _____________________________ Date ________________

Name of Participant _______________________________

Signature of Investigator or Designee _________________________ Date ________________
APPENDIX D: RECRUITMENT MATERIAL

State University of New York
College of Environmental Science and Forestry

ENVIRONMENTAL AND FOREST BIOLOGY
1 Forestry Dr. Syracuse, NY 13210
214 Illick Hall ◦ (315) 470-6743

To whom it may Concern:

My name is Marissa Nolan and I am a graduate student from the Environment and Forest Biology Department at the State University of New York College of Environmental Science and Forestry (SUNY ESF). I am writing to invite you to participate in my research study about environmental literacy called “Effects of Environmental Literacy from Non-Formal Education”. You are eligible to be in this study because you are a counselor at ESF SCIENCE. I obtained your contact information from ESF SCIENCE.

If you decide to participate in this study, you will be interviewed one-on-one and I will be asking questions about your perceived impact on the students’ environmental literacy.

Remember, this is completely voluntary. You can choose to be in the study or not. If have any questions about the study, please call me at (774)688-9182 or email me at mnolan01@syr.edu. You can also contact the primary investigator as well:

Dr. Beth Folta efolta@esf.edu (315) 470-4938

Thank you very much.

Sincerely,

Marissa Nolan

[Signature]
To whom it may Concern:

My name is Marissa Nolan and I am a graduate student from the Environment and Forest Biology Department at the State University of New York College of Environmental Science and Forestry (SUNY ESF). I am writing to invite your child to participate in my research study about environmental literacy called “Effects of Environmental Literacy from Non-Formal Education”. Your child is eligible to be in this study because they are attending the ESF SCIENCE summer program. I obtained your contact information from ESF SCIENCE.

If you decide to allow your child to participate in this study, they will fill out three surveys asking questions about environmental literacy.

Remember, this is completely voluntary. You can choose for your child to be in the study or not. If you would like to see the surveys your child would be answering or have other questions about the study you can contact me at mnolan01@syr.edu or (315)470-4938. You can also contact the primary investigator:

Dr. Beth Folta efolta@esf.edu

(315) 470-4938

Thank you very much.

Sincerely,

Marissa Nolan
To whom it may Concern:

My name is Marissa Nolan and I am a graduate student from the Environment and Forest Biology Department at the State University of New York College of Environmental Science and Forestry (SUNY ESF). I am writing to invite your child to participate in my research study about environmental literacy called “Effects of Environmental Literacy from Non-Formal Education”. Your child is eligible to be in this study because they are a student attending the Town of Onondaga Playgrounds program. I obtained your contact information from the Town of Onondaga.

If you decide to allow your child to participate in this study, they will fill out three surveys asking questions about environmental literacy.

Remember, this is completely voluntary. You can choose for your child to be in the study or not. If you would like to see the surveys your child would be answering or have other questions about the study you can contact me at mnolan01@syr.edu or (315)470-4938. You can also contact the primary investigator:

Dr. Beth Folta efolta@esf.edu

(315) 470-4938

Thank you very much.

Sincerely,

Marissa Nolan
### APPENDIX E: CODE BOOK

<table>
<thead>
<tr>
<th>Participant Code Categories</th>
<th>Explanation</th>
<th>Example Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank</td>
<td>Nothing written in the space provided</td>
<td>“ “</td>
</tr>
<tr>
<td>No</td>
<td>Any negative response</td>
<td>“n/a”</td>
</tr>
<tr>
<td>Unintelligible</td>
<td>The motive behind it was unclear or when it did not answer the question given</td>
<td>“Put it in the fridge”</td>
</tr>
<tr>
<td>Wrong</td>
<td>The person gave what they thought was an environmental behavior, but it was incorrect</td>
<td>“I pour extra water down the drain so it goes to the lake”</td>
</tr>
<tr>
<td>Don’t Know</td>
<td>The response indicates the person does not understand the question or says they don’t know</td>
<td>“I have no idea”</td>
</tr>
<tr>
<td>Mixed</td>
<td>A response that had both scientific and non-scientific career/volunteer/charity options</td>
<td>“Police department, marine biology, aquatics”</td>
</tr>
<tr>
<td>Science Only</td>
<td>Only careers/volunteering/charities that are science related</td>
<td>“Mechanical engineering” “saving a forest” “church, cancer”</td>
</tr>
<tr>
<td>Non-Science Only</td>
<td>Only careers/volunteering/charities that are not science related</td>
<td>“Singing/dancing/actor” “Protests” “help immigrants with life”</td>
</tr>
<tr>
<td>Conserve Water</td>
<td>A response that correctly explained actions they took to conserve water</td>
<td>“Turn off the sink while brushing teeth”</td>
</tr>
<tr>
<td>Clean Water</td>
<td>A response that correctly explained ways to prevent or clean-up pollution in water</td>
<td>“Not throw trash in the water”</td>
</tr>
<tr>
<td>General Yes</td>
<td>A positive answer that did not give any further explanation</td>
<td>“A lot”</td>
</tr>
<tr>
<td>Future Plan</td>
<td>A response indicating the person would like to volunteer but did not or could not at this time</td>
<td>“I like science so I might volunteer”</td>
</tr>
<tr>
<td>No Money</td>
<td>A response indicating the person would donate to charity if they had money</td>
<td>“none, I have no money”</td>
</tr>
<tr>
<td>Counselor Code Categories</td>
<td>Explanation</td>
<td>Example Response</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Yes</td>
<td>Strong positive response</td>
<td>“It definitely does”</td>
</tr>
<tr>
<td>No</td>
<td>Negative response</td>
<td>“Probably not significant”</td>
</tr>
<tr>
<td>Maybe</td>
<td>Weak positive response</td>
<td>“I think so, probably”</td>
</tr>
<tr>
<td>Higher</td>
<td>Higher than 50%</td>
<td>75%</td>
</tr>
<tr>
<td>Highest</td>
<td>Higher than predicted post-test score</td>
<td>100%</td>
</tr>
<tr>
<td>In Between</td>
<td>Higher than 50% but lower than predicted post-test score</td>
<td>70%</td>
</tr>
<tr>
<td>Baseline</td>
<td>Back to 50%</td>
<td>50%</td>
</tr>
</tbody>
</table>
# RESUME

Name: Marissa Nolan

Date and Place of Birth: May 6th, 1989 Saint Louis Park, MN

<table>
<thead>
<tr>
<th>Name and Location</th>
<th>Dates</th>
<th>Degree</th>
</tr>
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<tbody>
<tr>
<td>High School:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Franklin High School</td>
<td>August 2003-</td>
<td>High School Diploma</td>
</tr>
<tr>
<td>Franklin, MA</td>
<td>June 2007</td>
<td></td>
</tr>
<tr>
<td>College:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>McGill University</td>
<td>August 2007-</td>
<td>BSc. Agriculture and Environmental</td>
</tr>
<tr>
<td>Montreal, QC Canada</td>
<td>May 2011</td>
<td>Sciences</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employer</th>
<th>Date</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUNY ESF</td>
<td>August 2016-present</td>
<td>Graduate Assistant</td>
</tr>
<tr>
<td>Prospect Park</td>
<td>May 2016-August 2016</td>
<td>Horticulture Apprentice</td>
</tr>
<tr>
<td>Clemson University</td>
<td>January 2016-May 2016</td>
<td>Naturalist</td>
</tr>
<tr>
<td>WildCare Foundation</td>
<td>May 2015-November 2015</td>
<td>Wildlife rehabilitation apprentice</td>
</tr>
<tr>
<td>Central Park</td>
<td>May 2013-May 2015</td>
<td>Woodland Zone Gardner</td>
</tr>
<tr>
<td>Peace Corps</td>
<td>November 2011-October 2012</td>
<td>Agroforestry Specialist</td>
</tr>
<tr>
<td>McGill University</td>
<td>September 2007-October 2011</td>
<td>Field and Lab Technician</td>
</tr>
</tbody>
</table>