

## ABSTRACT

TUGURIAN, LINDA PAYLUN. An Exploratory Investigation of Children's Connectedness with the Natural World. (Under the direction of Dr. Sarah J. Carrier and Dr. Eric N. Wiebe.)

The study examined environmental identity and its relationship to school science in 5<sup>th</sup> grade students ( $N=65$ ) in a suburban public elementary school in the southern US using a mixed methods approach. This research was used to establish a proposed model of children's environmental identity, that may be of value to environmental and science educators seeking to improve children's environmental attitudes, pro-environmental behavior, and interest in school science. Children's environmental identity was viewed as a socio-cultural construct that describes the extent to which the child sees him/herself as part of the natural world.

Qualitative measures included field notes, classroom artifacts, and open-ended survey response items ( $N=65$ ), as well as interviews with children ( $N=17$ ) and a teacher from one class participating in a two-visit field intervention designed to impact children's environmental identity. Quantitative measures included the Connectedness to Nature Scale Revised (CNS-R) and the Children's Inclusion of Nature in Self Scale (INS).

The first manuscript, *Toward a Model of Children's Environmental Identity*, describes a mixed methods analysis of interviews and open-ended survey responses related to children's relationships with the natural world. Student interviews and survey items were coded thematically using Kellert's typology of values of nature and Cobern's views of nature. Several themes emerged from the data, including children's experiences with the natural world, their interests in natural science, and the influence of others including parents,

teachers, and peers that informed the development of a Proposed Model of Environmental Identity in Children. Children with strong environmental identities felt science at school failed to acknowledge their way of knowing about the world. Children's environmental identities were not recognized by the classroom teacher or peers. Children's CNS-R and INS scores reflected an overall positive connectedness to nature and ranged along a continuum. Connectedness to nature was correlated to student interest in school science, self-reported frequency of time spent in nature, and the presence of an adult who enjoyed spending time in nature. Providing opportunities for class experiences in the natural world and/or diagnostic use of the CNS-R and/or INS could give teachers more awareness of the environmental identity of their students that might be leveraged to increase children's interests in and connection with school science.

The second manuscript, *Impacting Children's Environmental Identity in the Context of School Science*, used a control-experimental group design to examine impacts to children's environmental identity associated with an intervention designed to improve children's connectedness with nature. Qualitative data, including observations, teacher and student interviews, and classroom artifacts shed light on specific aspects of the intervention that children felt impacted their thinking about the natural world. The CNS-R and INS, administered pre- and post-intervention to 5<sup>th</sup> grade students ( $N=65$ ), showed non-statistically significant increases in children's connectedness to nature in the experimental group but not in the control group. Strategies that impacted children's relationship with nature included a deliberate focus on children's fears in nature, time for reflection on feelings about the natural world, a class-shared experience situated in the outdoors, and free-choice learning in the

natural world. Class members were more able to recognize and identify the environmental identity of others as a result of the intervention. Participants suggested that school science, as opposed to learning in nature, was constrained by the classroom setting and lack of free-choice learning opportunities for students. Interventions that seek to improve children's relationship to the natural world should be based outdoors. Educators ought to consider including elements that address children's emotional responses to the natural world, especially time for reflection and free exploration to enhance this relationship. Elementary science educators ought to consider benefits of including similar components in their science instruction.

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An Exploratory Investigation of Children's Connectedness with the Natural World

by  
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## **DEDICATION**

To Oscar Garcia Maldonado, a student whose passion for the natural world is a constant reminder that sometimes we, as teachers, miss what is most central to a child's identity. I am forever grateful that Oscar persisted in convincing me to come outside to see that first jumping spider. His continuing enthusiasm for entomology and for science underscores the importance of recognizing and acknowledging children's environmental identities and the depth of their feelings for the natural world.

## **BIOGRAPHY**

Originally from New York City, Linda Tugurian grew up in an urban environment in Nashville, Tennessee. As a child, she had free-range of the neighborhood and spent many hours happily exploring backyards and building dams in drainage ditches. On weekends, her family visited Percy and Edwin Warner Parks outside Nashville and spent time with friends on their 50 acre farm in Dickson County. As a teenager, she was a counselor at Whippoorwill Farm Day Camp, where she led children on numerous creek hikes and fossil hunts. She credits these experiences with fostering her lifelong love of the natural world.

At Oberlin College, Linda was one of the early students in the Environmental Studies Program, which has subsequently blossomed into one of the nation's leading collegiate environmental studies departments. She continued her studies at Cornell University, majoring in Science and Environmental Education. While at Cornell, she became certified to teach science and mathematics. Upon graduation, she began her work as a Biology Teacher in the public schools in South Glens Falls, New York. After a year, she moved to Connecticut, where she accepted a position as a museum educator at the Thames Science Center.

When she moved to North Carolina in 1991, Linda began teaching science at Leesville Road Middle School. She joined Durham Public Schools in 1994, teaching science at R.N. Harris Elementary School. In 1998, she became one of the first certified North Carolina Environmental Educators. She joined the staff at Forest View Elementary in 2002, where she continues to serve as a science/technology facilitator. In 2003, she received her

National Board Certification in Young Adolescent Science, which she renewed in 2013. She entered the doctoral program at North Carolina State University in 2008.

Throughout her teaching career, Linda's passion and interest have been in sharing the natural world with children. She is perhaps proudest of her involvement in the "Creek Week" program she helped initiate at Forest View Elementary School, which has brought the entire school population (some 650 children) to explore the forest and wetlands at nearby New Hope Creek each spring, for each of the past seven years.

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It takes a “village” to complete a dissertation. My village has included the support of many friends, family members, as well as the members of my doctoral committee.

I appreciate the unwavering support and mentoring of my committee chair, Dr. Sarah Carrier, who has encouraged me to engage in a community of research and scholarship and helped me persevere through all aspects of my doctoral work. I also appreciate the feedback and encouragement from the other members of my committee; Dr. Eric Wiebe, whose predilection for models and organization helped me see the big picture; Dr. Meg Blanchard whose critical eye and probing questions helped me focus while considering new ideas; and Dr. Robin Moore, whose shared love and passion for understanding how children interact with the world around them grounded my research and helped me to appreciate how the physical environment itself shapes identity.

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## INTRODUCTION

In the nearly forty years since the Tbilisi Declaration (UNESCO-UNEP, 1978) established the goals of environmental education, researchers have attempted to determine the most effective ways of fostering attitudes, motivation, and commitments that encourage responsible action and behavior in support of the environment (Kollmuss & Agyeman, 2002). Yet, researchers are still struggling to solve the dilemma that Zavestoski (2003) captured in his simple question: “How is it that so many people claim to be concerned about the environment while at the same time making life-style choices that lead to environmental destruction?” (p. 297). With the answer to this question, educators might be better able to develop programming aimed at preparing citizens who make decisions in support of the environment, but also to act accordingly, thereby achieving one of the major goals of both science and environmental education efforts (NAAEE (North American Association of Environmental Educators), 2014; Duschl, 2007).

In the quest to address the well-documented gap between environmental awareness and pro-environmental behavior (Kollmuss & Agyeman, 2002), environmental psychologists and others have recently turned to a consideration of the role of identity in shaping and influencing a person’s thinking and behavior related to the environment (Cervinka, Röderer, & Hefler, 2012; Clayton & Opatow, 2003; Hinds & Kaiser, 2011; Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009; Perrin & Benassi, 2009; Schultz, Shriver, Tabanico, & Khazian, 2004). While identity studies generally have been directed toward discovering how a person organizes information about oneself, environmental identity investigations

focus more specifically on how a person connects to the nonhuman natural environment (Clayton, 2003). By considering environmental identity, environmental psychologists are working to establish the relationship between a person's connection to the natural world and his or her pro-environmental behavior and attitudes.

The roots of this notion are found in the work of Aldo Leopold (1949). Leopold held that the extent to which human beings see themselves as a part of the natural world is of central importance in determining how they will feel and act toward the environment. Environmental psychologists generally refer to this trait as a person's *connectedness to nature* (Mayer & Frantz, 2004).

Connectedness to nature is thought to be an operationalization of a person's environmental identity and therefore, a quantitative measure of connectedness to nature is considered to be an indicator of a person's environmental identity (Mayer & Frantz, 2004; Schultz, 2002). Using a variety of validated instruments, environmental psychologists can now measure connectedness to nature in adults (see Tam, 2013 for a review) and children (Bruni & Schultz, 2010; Cheng & Monroe, 2012; Frantz et al., 2013; Kals & Ittner, 2003; Liefländer et al., 2012) in efforts to explore environmental identity. Two of the many instruments have been used with both adults and children as young as 9 years of age and offer the potential for comparative research that examines how environmental identity changes over time. These instruments are the Connectedness to Nature Scale Revised (CNS-R) (Frantz et al., 2013) and the Children's Inclusion of Nature in Self Scale (Liefländer et al., 2012).

To date, much of the research in environmental identity has focused on adults. Relatively little is known about children's environmental identity. However, the research that exists supports the idea that the critical time for impacting a person's environmental identity is before s/he reaches age 11 (Ernst & Theimer, 2011; Kaplan & Kaplan, 2002; Liefländer et al., 2012; Sobel, 2002; Wells & Lekies, 2006). Therefore, understanding children's environmental identity may be an important first step to determining how to influence attitudes and behaviors toward the natural world.

Science educators have also suggested that acknowledging the way children relate to the natural world in the context of school may be a key to improving children's interest in school science (Calabrese Barton & Yang, 2000; Cobern, 2000). Children typically have a strong interest in natural science especially at the elementary school level, but begin losing interest in school science by the end of elementary school (Osborne, Simon, & Collins, 2003 2003; Thomson & Fleming, 2004). They also have difficulty relating the science they are learning in school to the science in the outdoor world around them (Carrier, Tugurian, & Thompson, 2013). Consequently, educational efforts to improve children's environmental identity in the context of school may simultaneously encourage children's pro-environmental behavior and children's interest in school science.

But, what is children's environmental identity? What are the ways in which children relate to the natural world? How might an educator design programming to improve children's environmental identity? If children's environmental identity potentially holds a key to unlocking ways to improve environmentally-responsible attitudes and behavior as well

as enhance children's interest in science, then seeking answers to these questions is critically important to both environmental and science educators.

## **Purpose of the Research Study**

The goals of the present research were to: 1. Describe children's environmental identity, 2. Develop a model of children's environmental identity, 3. Explore an intervention designed to impact children's environmental identity by examining how particular aspects of the intervention impacted the various identified components of children's environmental identity and 4. Investigate the relationship of children's environmental identity to their experience of science in school. This research fills a void in the current literature by developing a model to better understand how children feel and think about their relationship to the natural world, in such a way that children's environmental identity may be compared to that of adults. By focusing on 5<sup>th</sup> grade children in a suburban American population, the research also has the potential to add to a body of knowledge that may one day compare children's environmental identity across many socio-cultural and geographic variables, including cultures, urban/rural/suburban settings, and age. This research also establishes a new model of children's environmental identity that may help to frame future research related to interventions designed to improve children's environmental identity. Currently there is no model of children's environmental identity. Additionally, by examining environmental identity in the context of schooling, this research seeks to better understand the relationship of environmental identity to children's school science experiences. This will help us to learn more about the potential impacts of school-initiated interventions designed to improve children's environmental identity on children's interests in school science.

## **Research Questions**

Specifically, the present research seeks answers to the following questions:

1. How do children define and describe their own environmental identity? What are the central components of environmental identity in children?
2. What are children's perceptions of the relationship between their environmental identity and their experience of school science?
3. What aspects of interventions designed to improve children's environmental identity appear to be particularly salient for children in terms of their impact on the way children think and feel about the environment?

### **Overview of the Present Research**

To address these questions, the present research examined children's environmental identity in a suburban, ethnically diverse population of 5<sup>th</sup> grade children from a US elementary school using a mixed methods approach. Qualitative analysis relied on coding of student and teacher interviews, classroom artifacts, and observations of seventeen children and their classroom teacher. The Connectedness to Nature Scale Revised (CNS-R) (Frantz et al., 2013) and the Children's Inclusion of Nature in Self Scale (Liefländer et al., 2012) were used as quantitative measures of children's environmental identity ( $N=65$ ). Though each is part of one larger study, the research is presented in two manuscripts that describe distinct components of the larger investigation. The first, *Toward a Model of Children's Environmental Identity*, focuses on describing children's environmental identities, examining factors contributing to children's environmental identity (including experience in the outdoors, gender, age, culture, interest in school science, as well as the influence of peers and significant adults). It concludes by offering a proposed model of environmental identity in children. The second manuscript, *Impacting Children's Environmental Identity in the*

*Context of School Science*, describes a school field intervention designed to impact children's environmental identity and examines the components of that intervention in terms of their impact on children's environmental identity, both by quantitative measures and in the way children qualitatively describe the impact of the program in relation to their environmental identity. The research also describes the relationship between children's environmental identity and children's feelings and interests in school science. This paper concludes with specific recommendations for educational programs seeking to improve children's environmental identity as well as for science educators who want to use such programs to improve children's interests in school science. The dissertation concludes with an executive summary of the findings in the overall study as well as a discussion of the implications of the findings for both science and environmental educators.

MANUSCRIPT:

TOWARD A MODEL OF CHILDREN'S ENVIRONMENTAL IDENTITY: HOW  
CHILDREN DESCRIBE THEIR RELATIONSHIP WITH THE NATURAL WORLD

## **Abstract**

The present study examined children's environmental identity in 5<sup>th</sup> grade children ( $N=65$ ) from a public elementary school in the southeastern U.S. with the goals of describing the factors contributing to children's environmental identity and developing a model of children's environmental identity. The mixed methods investigation captured children's descriptions of their environmental identities through interviews and written responses to survey items. To support these descriptions, the researchers also measured children's environmental identity quantitatively using the Connectedness to Nature Scale, Revised (CNS-R) and the Inclusion of Nature in Self Scale for Children (INS). Children's environmental identity was tied to children's experience in the natural world, especially their feelings of comfort and freedom in nature and was influenced by others, including peers, parents, and other adults who enjoyed spending time in nature. Children's environmental identity was related to children's interest in school science, but children with high connectedness to nature were frustrated that school science did not acknowledge or incorporate their preferred ways learning in the natural world. Children's environmental identities were often unrecognized by their classroom teacher and peers. Class participation in outdoor learning experiences designed to improve children's environmental identity in the context of school may be one way to simultaneously improve children's environmental identity and enhance interest in classroom science.

## **Introduction**

One of the main goals of science and environmental education efforts is to create a citizenry that has a knowledge base from which to make informed decisions about the environment and to take environmentally responsible actions (NAAEE (North American Association of Environmental Educators), 2014; Duschl, Schweingruber, & Shouse, 2007). Yet, nearly four decades after the Tbilisi Declaration (UNESCO-UNEP, 1978), environmental educators are still attempting to identify practices that foster attitudes, motivation, and commitments that lead to responsible action and behavior in support of the environment (Kollmuss & Agyeman, 2002; McBeth & Volk, 2009). It is estimated that perhaps as few as 1%-2% of American adults have enough environmental knowledge to be considered environmentally literate (Coyle, 2005).

One of the impediments to achieving environmental literacy and promoting pro-environmental behaviors in America has been the lack of integration and coordination of environmental and science education efforts (Coyle, 2005). Science educators have tended to focus their efforts on increasing children's content knowledge about the environment through classroom-based instruction. In contrast, environmental educators have tended to focus their efforts on a mix of content knowledge and environmental activism, often situated in the outdoors (Gough, 2002; Stevenson, 2007). Neither approach has been very successful in achieving the goal of developing a citizenry that is well-prepared to make informed decisions and take environmentally responsible actions (Coyle, 2005, IES (Institute of Education Science), 2006). Science educators have long noted students' declining interest in school science, despite children's high interest in the environment (Osborne, Simon, & Collins,

2003; Thomson & Fleming, 2004). Similarly, environmental educators, who are often successful at maintaining student interest (Ballantyne & Packer, 2005), are still struggling to find approaches that increase environmental knowledge while at the same time strengthening a person's choice to act in environmentally responsible ways (Kollmuss & Agyeman, 2002). Additionally, because environmental education has often been excluded or minimally included by schools, environmental educators often have difficulty accessing children in large enough numbers to have widespread impact (Coyle, 2005; Gough, 1997).

One approach that may hold potential for strengthening children's interest in school science as well as impacting children's environmental knowledge and tendency to act in environmentally responsible ways is to focus educational efforts on *environmental identity*. Environmental identity is described by Clayton (2003) as "a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world" (pp. 45-46). For the purposes of the present research, *children's environmental identity* refers to the ways in which pre-adolescent children view themselves in relation to the natural world. In the present research, the *natural world* is considered as a place where people can observe and experience non-human organisms and physical features of the outdoor environment, ranging from backyards to pristine national parks, but typically with only moderate human-built components.

Children's environmental identity, or the way children feel and think about the environment, is thought by some science educators to be related to children's interest in school science (Calabrese Barton & Yang, 2000; Cobern, 2000). These authors contend that

the depth of children's feelings about nature has largely been neglected by traditional school science educators, contributing to children's diminishing interest in school science.

Environmental identity may also hold the key to influencing a person's choice to act in environmentally responsible ways (Frantz & Mayer, 2013b).

The strength of a person's environmental identity has been found to be indicated by his/her *connectedness to nature*, the degree to which the individual feels connected to the natural world (Mayer & Frantz, 2004; Schultz, 2002). The roots of this notion are found in the work of Leopold (1949), who believed that as long as we see land strictly as a commodity rather than viewing ourselves as interconnected to the land, we will continue to abuse it. In his view, coming to understand the environment as a community of which we are members establishes a relationship to the environment and fosters behaviors that demonstrate love, respect, and care of the earth.

Connectedness to nature has been measured in adults using a variety of different instruments (Tam, 2013). Two of these, the Connectedness to Nature Scale (Mayer & Frantz, 2004) and the Inclusion of Self in Nature Scale (Schultz, 2001), recently have been modified for use with both children and adults, allowing for comparative studies of environmental identity as individuals age. These modified versions are known as the Connectedness to Nature Scale, Revised (CNS-R) (Frantz et al., 2013) and the Inclusion of Nature Self Scale (INS) (Liefländer et al., 2012).

Although environmental identity has been well studied with adults (Nisbet, 2009; Clayton, 2003; Schultz, 2001; Mayer & Frantz, 2004), relatively little is known about environmental identity in children. This leaves a large gap in our understanding of how

environmental identity develops and changes as we move toward adulthood. There is reason to think that different factors influence a child's environmental identity as compared to those that influence environmental identity in adults (Kals & Ittner, 2003). Because children's environmental identities emerge as they grow and develop (Bruni, Chance, & Schultz, 2012; Kals & Ittner, 2003; Liefländer et al., 2012), they may be more malleable than those of adults and therefore responsive to intervention.

Since many environmental and science education efforts are directed at children, it is critical to develop an understanding of the components of children's environmental identities, especially if impacting environmental identity may be pivotal in improving children's interests in science as well as their pro-environmental behaviors and attitudes, as some researchers believe (Calabrese Barton & Yang, 2000; Cobern, 2000; Frantz & Mayer, 2013b; Lindemann-Matthies, 2005). A model of children's environmental identity could help researchers and educators consider ways to impact environmental identity, yet currently no such model exists.

The present research used a mixed methods approach to describe the environmental identity of 5<sup>th</sup> grade students by investigating their experiences in and feelings related to the environment. These descriptions were used as the basis for the development of a model of children's environmental identity, with particular interest in examining the relationship of children's interests in school science and their thinking about the natural world. Specifically, the present study attempted to answer the following research questions:

1. How do 5<sup>th</sup> grade children identify with the natural world?

2. What are the central components of children's environmental identities? What other factors contribute to children's environmental identities?
3. Is the way children identify with the natural world recognized by others?
4. How do children's environmental identities relate to their interests in science at school?

Our current approaches to increasing environmental literacy through separate disciplines of environmental and science education does not appear to be working. Children are losing interest in school science (Osborne, 2007; Osborne et al., 2003) and environmental literacy rates are extremely low (Coyle, 2005). As a construct, environmental identity may offer insight into how science and environmental education may be integrated in the context of schooling to help strengthen children's connections to both school science and the natural world. Acknowledging children's environmental identity in the context of school has the potential for helping educators to envision a more mutualistic relationship between science and environmental education (Gough, 2002); one that acknowledges and affirms children's connectedness with the natural world as part of their experience of school science, promoting goals of both science and environmental educators.

## **Literature Review**

The fields of environmental and conservation psychology have contributed greatly to our understanding of environmental identity in adults (Clayton & Opatow, 2003; Saunders, 2003), but our knowledge of environmental identity in children remains limited. Recent work has begun to focus on environmental identity in children, particularly with the development and adaptation of tools with which to quantitatively measure environmental identity in children (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Frantz & Mayer, 2013a; Kals & Ittner, 2003; Liefländer et al., 2012). Following is a description of environmental identity as a general concept with a focus on the current understanding of environmental identity in children.

### **What is Environmental Identity?**

Clayton (2003) describes environmental identity as “a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world; a belief that the environment is important to us and an important part of who we are” (pp. 45-46). An environmental identity is one of multiple identities that comprise an individual’s more general identity (Stets & Biga, 2003). The concept of identity describes the way a person organizes information about the self, determined both externally (how others view us) and internally (the way we see ourselves) (Clayton, 2003). One’s identity changes and develops over time, modified by the social, cultural, political and physical context of one’s lived experience (Ryan & Deci, 2003). Therefore, environmental identity can be viewed both as an object (the current state of how a person relates to the natural world) and a dynamic

process (changing as it is renegotiated by a person's experiences and social interactions) (Clayton, 2012).

Stets and Biga (2003) have described environmental identity as associated with the meaning an individual attaches to the physical environment. In this sense, an environmental identity can define, describe, or place an individual in the world. It varies in importance among individuals. For example, a person with a strong environmental identity typically sees him/herself as member of a community that includes the environment itself as well as the organisms that live there. From this perspective, harming the environment is viewed as harming oneself. In contrast, a person with a weak environmental identity typically views him/herself as completely separate from the environment, perhaps tending to see the environment from a utilitarian perspective, as a place to get needed resources, rather than recognizing the impact retrieving those resources might have on the environment as a whole. In this view, the natural world is a place for animals (not people) to live. As Berry (1999) described it, a person with limited environmental identity sees the world as a collection of objects rather than a communion of subjects.

### **How is Environmental Identity Measured?**

Researchers have generally used *connectedness to nature* as an operational measure of environmental identity (Mayer & Frantz, 2004). There are a number of instruments that have been developed to measure connectedness to nature (see Tam, 2013 for a review) in adults. Only two of these, Frantz and Mayer's (2004) Connectedness to Nature Scale (CNS) and Schultz's (2002) Inclusion of Self in Nature Scale (INS), have been modified and validated for use in children as young as age 9, as well as adults. The revised scales are the

Connectedness to Nature Scale Revised (CNS-R) and the Children's Inclusion of Self in Nature Scale (Frantz & Mayer, 2013a; Liefländer et al., 2012). They are now referred to as the CNS-R and the INS (without the use of "Children's"). These instruments are provided in Appendices B and C.

The CNS-R is a 10-item revision of the original 14-item CNS (Mayer & Frantz, 2004), simplified and validated for use with children as young as age 10 (Frantz et al., 2013). Its authors are now using it with adults and children, allowing for cross-age comparisons of connectedness to nature and impact evaluation of environmental education efforts (Frantz & Mayer, 2013b). It has high test-retest reliability ( $r = .82, p < .01$ ) (Frantz et al., 2013). It also has a strong correlation with the original version of the CNS, a well-established measure in adults ( $r = .85, p < .01$ ) (Frantz et al., 2013). Like the CNS, the CNS-R is positively correlated in adults with environmentally responsible behavior (ERB), environmentalist identity, and life satisfaction and negatively correlated with consumerism (Frantz et al., 2013). Most recently, this instrument has been used to establish a relationship between connectedness to nature and actual conservation behavior related to electricity consumption in college students (Frantz & Mayer, 2013b). In a study with middle school students ( $N=311$ ), Frantz and Mayer (2013b) found a pre-intervention CNS-R mean score of  $M=4.24$ . In two populations of college students, Frantz and Mayer (2013a) found CNS-R mean scores ( $M = 4.84, SD = 1.06$ ) and ( $M = 4.59, SD = 1.22$ ). No other adult data using the CNS-R is currently available.

The directions in the original INS (Schultz, 2002) were slightly modified and the new version, still referred to as the INS, has been used with children, ages 9-13 (Bruni et al.,

2012; Liefländer et al., 2012). The INS is comprised of a single graphic item in which the respondent selects from seven pairs of overlapping circles that represent the degree to which the respondent feels s/he is a part of nature (see Appendix C). It cannot be tested for internal reliability because of its single item construction. Like the CNS-R, the INS has high test-retest correlations (Schultz et al, 2004). It has also been found to be accurate for measuring individual differences in connectedness with nature (Schultz, 2002). In its earlier version, the INS correlated well with the original CNS (Mayer & Frantz, 2004).

### **Children's Environmental Identity**

While environmental identity in adults has been well established (Clayton, 2012; Clayton & Opatow, 2003), relatively little is known about children's environmental identity. Children's environmental identities have been found to emerge as they grow and develop and are impacted by their experiences in the natural world as well as socio-cultural influences (Bruni et al., 2012; Kals & Ittner, 2003; Liefländer et al., 2012). Like adults, children may see themselves as part of the natural world or separate from it (Liefländer et al., 2012). Without referring directly to environmental identity, Kellert (2002) described what he termed a "typology of nature values" in children, which included dominionistic (control over nature), utilitarian (nature as a source of material and physical reward), and negativistic (fear) views of the natural world. Kellert found these views to be prevalent in children ages 3-6. A child holding these views likely sees him/herself as separate from the environment. He also described humanistic (emotional bonding with nature) or moralistic perspectives (spiritual and ethical relation to nature) in older children (ages 6-12). Children holding these views might feel more a part of nature and have stronger environmental identities.

Kals and Ittner (2003) investigated the environmental identities of children associated with learning experiences, focused on two topics: protection of water and bats. They found that children as young as nine had clear indicators of their environmental identities, including a high degree of moral reasoning about the environment as well as strong emotions about the natural world. They refer to the emotional component as a child's *emotional affinity* toward the natural environment. According to Kals and Ittner (2003), a child's emotional affinity includes positive emotions (fascination, curiosity, joy) and negative emotions (fear, disgust about environmental problems) associated with children's experiences in nature.

In work with 9<sup>th</sup> grade students, Cobern (1999; 2000) found that students attached significant meaning to the natural world. He identified spiritual, mystical, aesthetic, and utilitarian views of nature in these students. As a science educator, he noted that these views were absent from the students' experiences of school science. Consequently, he suggested that the failure of school science to address and embrace children's views of the natural world might actually alienate them from their school science experiences (Cobern, Gibson, & Underwood, 1999). By 5th grade, children have been found to have difficulty relating the science they are learning in school to the outdoor world around them and see science as an enterprise disconnected from their experience in the natural world (Carrier, Tugurian, & Thomson, 2013). Some science educators have advocated for the acknowledgment of children's interest in and feelings for the natural world within children's school science experience to improve their interest in school science (Calabrese Barton & Yang, 2000; Cobern, 2000; Lim & Calabrese Barton, 2010; Osborne, 2007). This is particularly critical because elementary-aged children have strong interests in natural sciences, but begin losing

interest in school science as they progress toward middle school (Osborne et al., 2003; Thomson & Fleming, 2004).

### **What are the Components of Environmental Identity in Children?**

Because environmental identity is dynamic, it may be examined both as a state of mind (i.e., what is a person's current environmental identity?) and a process (i.e., what impacts a person's environmental identity over time?). Much of what is known about the components of children's environmental identity is derived from work to develop instrumentation to measure it. There are few direct descriptions that include children's perspectives on what it means to have a strong relationship with the natural world and thus little is known about the components that make up a child's environmental identity. What follows is a brief summary of research from many disciplines related to how children relate to the natural world in order to provide insight into the components of children's environmental identity. The following are explored as potential components of children's environmental identities: experience in natural settings (amount of time, emotional impact, structure, location), age, gender, cultural influences, children's interest in natural science, and the influence of others (adults and peers).

**Experience in natural settings.** Because environmental identity is defined by one's feeling of connection with the natural world, children's experiences in the natural world are essential to their environmental identities. Variation in children's experiences may have direct impact on their environmental identities. Evidence is mounting that children's outdoor time and unrestricted space in the outdoors is diminished over previous generations (Karsten, 2005) and concern is growing in the general public about the possible negative impacts of

this reduction of children's experiences in the natural world (Louv, 2005, 2007). Experiences in nature can be highly variable, differing by duration, frequency, emotional impact, location, and structure.

*Amount of time spent in nature.* Field trips often are used by educators to provide experiences in nature to children (Anderson & Zhang, 2003; DeWitt & Storksdieck, 2008; Rickinson & Dillon, 2004). Although single day field trips have been found to improve children's cognitive and affective development (DeWitt & Storksdieck, 2008), researchers have consistently found that one-day interventions have less impact on connectedness to nature than do longer interventions (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Liefländer et al., 2012; Theimer & Ernst, 2012). In an evaluation of seven field programs for children used in conjunction with the U.S. Fish and Wildlife Service, Ernst and Theimer (2001) found only two of the seven programs fostered connectedness to nature. They attributed increased connectedness to nature in part to the longer duration of the programs. Liefländer et al (2012) also found increases in connectedness to nature using the INS with children ages 9-10 and 11-13 as result of participation in a four-day program at an environmental education center.

Children who have less frequent exposure to natural settings have been found to have lower connectedness to nature and thus weaker environmental identities (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Kossack & Bogner, 2012). In a review of research related to inequity in children's exposure to natural environments, Strife and Downey (2009) found that children's access to and experience in nature likely vary by ethnicity and socio-economic status. Kossack and Bogner (2012) found that experience in nature was particularly important

for increasing connectedness in children with low or medium levels of connectedness, where children with pre-existing high connectedness were more likely to respond to knowledge-based interventions not involving experiences. This suggests frequent experiences in nature are an important part of establishing children's environmental identity, particularly in children with limited prior exposure to nature.

*Emotional impact of experiences in nature.* Connectedness to nature in children appears to be only moderately impacted by knowledge-based interventions in the outdoors that do not address children's emotions and feelings about the natural world (Ernst & Theimer, 2011; Theimer & Ernst, 2012). Children may have both positive (fascination, curiosity, joy) and negative (fear, disgust) emotions related to the natural world (Kals & Ittner, 2003). Positive emotions about nature are characteristic of children with strong environmental identities (Kals & Ittner, 2003). These feelings change as children grow and develop and in response to their experience with nature (Kellert, 2002).

In an examination of the impact of outdoor learning experiences on children's comfort levels in the outdoors, children were found to have a number of fears related to their experiences in the natural world and their comfort levels improved following participation in outdoor learning experiences (Carrier-Martin, 2003). In a qualitative study of Latino children in Kansas City, Van Velsor and Nilon (2006), found that children's lack of positive experiences with wildlife contributed to their disconnect from nature.

The level of direct interaction with nature may also play a role in promoting positive feelings about nature. Kellert (2002) distinguishes between children's direct, indirect, and vicarious experiences in nature. According to Kellert, direct experiences involve physical

contact with natural settings and non-human species in an unstructured format. Indirect experiences may involve physical contact, but that contact is tightly managed or restricted by adults, as in a nature center or zoo. Vicarious experiences involve no physical contact, including videos, photographs, and textbook representations of the natural world. Kellert (2002) has found that indirect and vicarious experiences, more typical of children's experience of natural settings in the context of school, are insufficient to significantly impact a child's affective, cognitive, and evaluative development in a way that contributes to his/her environmental identity. Similarly, Millar and Millar (as cited by Pooley & O'Connor, 2000) suggest that attitudes formed through direct experience are more affectively based, while attitudes formed through indirect experiences tend to be cognitively based. Taken together, research in the field suggests that children's feelings about the natural world associated with their direct experiences in nature are essential components of their environmental identities.

***Structure of experiences in the natural world.*** While it is likely that outdoor (both direct and indirect) experiences are valuable to children (Dillon et al., 2006; Hammerman, Hammerman, & Hammerman, 2001; Rickinson, 2004), the less-structured or "free" aspect of what Kellert describes as direct experience in nature may be most critical to children's environmental identity. Many adults describe their free explorations in natural settings as children as formative or significant life experiences (Chawla, 2001; Chawla & Cushing, 2007; Palmer, Suggate, Robottom, & Hart, 1999; Sobel, 2002). These researchers associate the time spent in nature as children with adult choices related to occupation, academic interests, and hobbies. Supporting this, many professional scientists and naturalists recall

their involvement in extensive free exploration in the natural world as children and link these experiences to their lifelong interests in science (Feynman, 2005; Wilson, 1995).

Direct experiences in natural settings can provide opportunities for *free-choice learning*. Free-choice learning experiences are learning experiences that are self-motivated, voluntary, socially mediated and guided by an individual's interests (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). Free-choice learning experiences in natural settings have the potential to promote pro-environmental behaviors and attitudes in children (Ballantyne & Packer, 2005) as well as hone children's interests in natural science (Lindemann-Matthies, 2005; Renninger, 2007). When children are free to explore the woods, they often discover things of interest to them, make observations, and gather data without being part of a structured science learning experience (Eberbach & Crowley, 2009; Lindemann-Matthies, 2005). Though no direct link has been established between free-choice learning and children's environmental identity, it appears that free exploration in natural settings may be an essential component of direct experiences that contribute to children's environmental identities.

**Location.** The characteristics of the natural setting where experiences occur may also impact children's environmental identity, though there are some contradictory findings with respect to this topic. Children have been documented to enjoy exploring nature in relatively urban settings (Karsten, 2005; Karsten & Vliet, 2006; Moore, 1986a, 1997), as well as more wild ones (Sobel, 2002). However, there may be a desirable level of "naturalness," to generate awe and wonder in children (Hadzigeorgiou, 2012). There may also be a point at which the remoteness of the setting challenges a child's comfort level in such a way to

negatively impact the child's feelings about the experience (Bixler, Carlisle, Hammitt, & Floyd, 1994; Kals & Ittner, 2003). The novelty of the setting of field experiences may also negatively impact children's feelings about nature, particularly if the setting is very new (DeWitt & Storksdieck, 2008). Children can establish meaningful relationships with specific places in nature that may contribute to their environmental identities (Devine-Wright & Clayton, 2010; Gosling & Williams, 2010; Gruenewald & Smith, 2008; Moore, 1986a; Smith, 2002; Sobel, 2004). Schoolyards (urban and otherwise) have been used effectively to promote environmental learning and comfort levels (Carrier-Martin, 2003; Coyle, 2009; Dillon et al., 2006; Lopez, Campbell, & Jennings, 2008; Malone & Tranter, 2003; Moore & Wong, 1997; Rickinson, 2004), but they have not been investigated with respect to children's environmental identity. More research has the potential to clarify our understanding of how the characteristics of natural settings impact children's environmental identity, but current research suggests that children's environmental identity may be enhanced across a continuum of natural environments.

**Age.** Age seems to have a clear connection with children's environmental identity. Children's connection to nature has been found to be strong in younger children, but wanes in adolescence. Children have been generally found to have positive connectedness to nature, in some cases as high as that of adult environmental activists (Bruni & Schultz, 2010). Without intervention or positive experiences in nature, social and cultural interactions may contribute to a decline in children's environmental identities as they age (Phenice & Griffore, 2003). Bruni and Schultz (2010) found a mean INS score of 4.50 in a sample of thirty 5<sup>th</sup> grade students. In a later study, Liefländer (2012) found children ages 9-10 to have

somewhat higher INS scores ( $M = 5.31$ ), while children ages 11-13 had slightly lower INS scores ( $M = 4.45$ ), which may suggest that INS scores decline as children move into adolescence. This is supported by the work of Kaplan and Kaplan (2002), who found that children's connection with the natural world declines in adolescence, but rebounds somewhat in adulthood. Several studies have documented lower INS scores in adult populations, including Bruni and Schultz (2010), who found a INS score of  $M = 3.61$  in a population of college students ( $N = 65$ ).

Researchers have found that an individual's relationship to nature is most positively impacted before age 11 (Kaplan & Kaplan, 2002; Sobel, 2002; Wells & Lekies, 2006). Ernst and Theimer (2011) reported an increase in connectedness in programs serving children in grades 3-6, with no or negligible increases in programs serving children at the high school level. Similarly, Liefländer et al (2012) found that 9-10 year old children had higher connectedness to nature than did children age 11-13. Additionally, they report that although short-term connectedness to nature increased with participation in a four-day environmental education program at a local nature center, younger children retained their connectedness levels four weeks after participation, whereas older children did not.

**Gender.** Research related to gender as a component of environmental identity is somewhat contradictory. In their work with developing the CNS-R, Mayer and Frantz found no significant differences between connectedness to nature in middle school boys and girls, though they find girls tend to score slightly higher than boys on the scale (Frantz, 2013; Frantz et al., 2013). Similarly, Clayton (2003) found that adult women scored slightly higher on measures of environmental identity than men, but those differences are not significant.

Other researchers have found significant gender differences with respect to experience, environmental identity, and attitudes toward the environment (Coyle, 2005). For example, Müller, Kals, & Pansa (2009) found significant gender differences (with girls more connected than boys) in adolescents' emotional affinity to nature, a similar construct to connectedness. They also found girls spent more time in nature and were more willing to act in support of the environment than were boys. But other research suggests boys ages 10-12 and 15-17 spend significantly more time outdoors than do girls, while girls ages 5-6 spend just about the same amount of time outdoors as do boys (Cleland et al., 2010). In the same study, girls' outdoor time decreased by 31% over 5 years. Parental influence was a major factor in encouraging girls' outdoor time, but not in boys. Work in environmental education has demonstrated that females are more likely to adopt pro-environmental attitudes and behaviors than are males (Zelezny, Chua, & Aldrich, 2000). Carrier (2009) found that 4<sup>th</sup> and 5<sup>th</sup> grade boys' attitudes and behaviors were more responsive to environmental education intervention than girls'. To the extent that interest in biology may influence children's environmental identity, females have been found to have significantly higher interests in biology than do males (Osborne et al., 2003). Given the somewhat contradictory data, the role of gender in shaping a child's environmental identity remains an open question for researchers.

**Cultural factors.** Though no research has directly examined the role of culture in pre-adolescent children's environmental identity, culture may play a role in determining a child's environmental identity (Clayton, 2003). Although there is commonality in adults across cultures with regard to preference for natural settings and to concern for the

environment, certain cultures may assign different meaning to the environment than others (Kahn Jr. & Kellert, 2002; Kaplan & Kaplan, 1989; Schultz & Zelezny, 1998; Ulrich, 1993; Van den Berg, Hartig, & Staats, 2007). Because identity is dynamic, parents and society may convey these meanings to children, influencing their environmental identities. For example, Native American cultures traditionally ascribe to a view of interconnectedness with nature (Cajete, 1999). In a comparison of Americans living in Namibia and native Namibians, Chang and Opotow (2009) found Namibians assigned rights to non-human entities, whereas Americans were less likely to do so. The presence, absence, or condition of the environment accessible to certain cultures may also play a role in the way people in that culture relate to the environment. Müller et al (2009) found adolescents in Lithuania to have higher affinity toward nature than did their counterparts in Germany. They attributed this to Germany's more industrialized and urban character. The role of culture in shaping children's environmental identity remains an open question for researchers, but these findings seem to indicate that culture may influence children's environmental identity.

**Children's interest in science.** The relationship of children's interest in natural science and their environmental identity is as yet unknown. However, researchers have found that children have a strong interest in the natural world (Kirikkaya, 2011; Maltese & Tai, 2010; Osborne et al., 2003), and children's experience in the natural world improves their interest in science (Lindemann-Matthies, 2005; Zoldosova & Prokop, 2006). Girls have been found to have particularly high interests in the biological sciences (Baram-Tsabari & Yarden, 2008) that are encouraged by outdoor exploration (Moore, 1986b).

School science educators have sometimes capitalized on children's strong interest in the environment by incorporating experiences in natural settings into their science instruction. Learning in the outdoors has been found to enrich science lessons by providing sensory and contextual information that anchors science lessons in the real world (Ives & Obenchain, 2006; Malone, 2008; Rivkin, 2000). When science is taught in the outdoors, student interest, motivation, emotional development, and cognitive gains may be enhanced (Dillon et al., 2006; Malone, 2008; National Foundation for Educational Research in England and Wales & Dillon, 2005). Schoolyard science lessons have been found to improve student attitudes, behavior, and comfort levels related to the environment (Carrier, 2009). School use of the outdoors as a setting and focus of instruction has also been linked to improved science test scores, increased ability to apply science concepts to real-world situations, as well as increased enthusiasm and interest in science (Lieberman & Hoody, 1998).

Although American schools include a great deal of content related to the natural world (Committee on Conceptual Framework for the New K-12 Science Education Standards, 2012), they rarely connect to children's interests by relocating science instruction outdoors (Burriss & Burriss, 2011; Carrier et al., 2013; Coyle, 2009; Dymont, 2005). Despite high interest in nature, children generally lose interest in school science as they move toward middle school (Osborne et al., 2003; Thomson & Fleming, 2004). Some authors have suggested that one possible reason for children's disengagement with school science is the inability of traditional school science to acknowledge children's way of thinking about nature (Calabrese Barton & Yang, 2000; Cobern, 2000).

Children's environmental identity also diminishes as children approach adolescence (Kaplan & Kaplan, 2002), raising questions about whether enhancing a child's environmental identity before adolescence might also strengthen interests in science, reducing the likelihood of their disengagement from science. Children may not draw connections between their experiences in the natural world and the science they are learning in school, tending to view school science as a classroom-bounded enterprise (Carrier et al., 2013). By failing to enhance children's interest in the natural world and build connections between science and the environment as part of school science, educators may be missing an opportunity to strengthen children's environmental identities and simultaneously improve their interest in school science.

**Influence of others.** Children's environmental identity, like other forms of identity, is impacted by social influences, including parents, teachers, other adult in a child's life, and peers (Stets & Biga, 2003). For example, affirmation and validation of one's environmental identity may reinforce and strengthen one's environmental identity (Clayton, 2003).

**Adults.** The naturalist Rachel Carson (1965) wrote, "If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement, and mystery of the world we live in" (pp. 42-45). Adults in the child's life can contribute to a child's environmental identity through modeling, support, and validation. In particular, parents determine aspects of a children's experience in nature in their support of it, by permitting or restricting certain experiences in the natural world. They also model pro-environmental behaviors and attitudes including comfort in natural settings. In research with children, Cheng and Monroe (2012) found that experiences

that are supported by outreach to encourage environmental values in family members improve children's connectedness to nature.

Similarly, teachers often directly influence children's experience of the natural world by controlling their access to it while children are at school or by taking their classes outdoors for activities like gardening, nature walks, science lessons, or field trips (Dyment, 2005). Even without geographic access to outdoor spaces at school, teachers can communicate a general support for a child's environmental identity simply by sharing their love for it or by exhibiting environmentally responsible behaviors like recycling. Teachers may also enhance a child's interest in natural science by facilitating access to information and resources especially related to those interests. Osborne et al (2003) reviewed findings of several studies and found that the classroom culture can be an important determinant of children's attitudes about science.

*Peers.* As a child moves into adolescence, peers become particularly important in influencing his/her attitudes. Osborne et al. (2003) found that students' attitudes about science are influenced by group norms. They found this influence is particularly strong from age 11, peaking at age 14, which coincides with decreases in children's interest in science more generally (Kirikkaya, 2011; Osborne et al., 2003; Thomson & Fleming, 2004). Therefore, it appears especially important to impact students' attitudes about school science before age 11.

### **Toward A Model of Children's Environmental Identity**

Children's environmental identity appears to be impacted by their experience in the natural world (including the structure of the experience, the amount of time spent in nature,

and children's emotions related to that experience) (Kals and Ittner, 2003). Generally speaking, children have a positive connectedness to nature that appears to change over time, being strongest before age 11 and diminishing as the child approaches adolescence (Bruni & Schultz, 2010; Kaplan & Kaplan, 2002, Liefländer, 2012). Research suggests a limited, if any, role of gender on children's environmental identity. Although ethnicity and socio-economic factors have not been found to be significantly correlated to children's environmental identity, research suggests that cultural influences may impact it (Kahn Jr. & Kellert, 2002; Kaplan & Kaplan, 1989; Schultz & Zelezny, 1998; Ulrich, 1993; Van den Berg, Hartig, & Staats, 2007). Children's interests in natural science may contribute to their environmental identities. Additionally, because children's environmental identity is socially mediated, others (including parents, peers, teachers, and other adults in a child's life) are likely to influence environmental identity in children (Cheng & Monroe, 2012; Kals & Ittner, 2003).

The present research explored several of these aspects of children's environmental identity, in an effort to develop a model of children's environmental identity. This model may be helpful to educators who seek to impact children's environmental identity to increase interests in school science and/or foster pro-environmental behavior and attitudes. The model encompassed quantitative measurement of children's connectedness to nature and children's descriptions of their classmates' as well as their own environmental identities, including their experiences in the natural world, their interests in natural science, and the influence of others on the way children think about and interact with the natural environment.

## Methods

### Research Design

The present study was part of a larger mixed methods investigation designed to explore children's environmental identity. The larger study involved a comparison of control ( $N = 44$ ) and intervention groups of grade 5 children ( $N = 21$ ) to determine the impact of an intervention designed to promote children's connectedness to nature on children's environmental identity. The present study focuses on pre-intervention data to examine factors that contribute children's environmental identity, using qualitative methods to more deeply probe children's environmental identity, including student ( $N = 17$ ) and teacher ( $N = 1$ ) interviews with members of the intervention class and open-ended survey responses with all 5<sup>th</sup> grade participants ( $N = 65$ ). Quantitative measurement ( $N = 65$ ) of children's connectedness to nature using two previously validated instruments, the CNS-R (Frantz, 2013) and the INS (Liefländer et al., 2012; Schultz, 2002), was used to support the qualitative assessment of children's environmental identity. For the purposes of the present investigation, all data were collected prior to the intervention that was part of the larger research study.

### Study Context

The study took place in a suburban public elementary school serving grades K-5 in the southeastern United States. The school served approximately 650 children in grades K-5 and had 20-acre campus, consisting primarily of recovered farmland fields. The ethnicity of the school population was approximately 38% non-White Hispanic, 30% White, 22%

African American, 6% Asian, and 4% Multi-racial. The school had a distinct international population; twenty-eight different nations and thirty languages were represented in the student body.

The school was selected for the study because of its diversity and interest in outdoor learning. The teachers and principal were also willing to participate in the study, making it a convenience sample (Given, 2008). The children at this school participate in an annual school-wide field trip to a local nature preserve, so it was assumed that most children in the study had had at least one and possibly up to five opportunities to spend time in local natural areas, including mixed deciduous forests with minimal views of buildings. Therefore most children had some idea of what was meant by the terms “woods” and “nature” that was linked to experience, though experience levels varied from very limited exposure to daily exploration of natural settings.

### **Study Participants**

The survey (see Appendix A) was administered to all ninety-six 5<sup>th</sup> grade children in the school. From this group, data were harvested from children with study permission ( $N = 65$ ). Twenty-one of the 65 participants were members of the intervention class in the larger study. Seventeen students in the intervention class and their teacher also participated in interviews designed to probe children’s relationship to the natural world, as well as their knowledge of each other’s environmental identities.

Children ( $N = 65$ ) in the present study ranged in age from 9-12; at the beginning of the study, 67.7% of the participants were age 10. Ethnically, the study group was comprised of 18.5% Black, 27.7% non-White Hispanic, 38.5% White and 15.3% Other. By gender, the

study group was 43.1% male and 56.9% female. The percentage of participants qualifying for English as a Second Language (ESL) services was 24.6%. Though no data were available related to participants' socio-economic background, the school was considered a Title 1 school, with just over 50% of its students receiving free or reduced lunch. A summary of demographic data related to study participants is provided in Table 1.

Fifth grade was selected for the investigation for several reasons. First, quantitative instruments have been validated for use with children of this age allowing for comparison of study data with that of other researchers, including populations of adults and children (Frantz et al., 2013; Liefländer et al., 2012). Also, environmental identity in children is thought to decline after age 11 (Ernst & Theimer, 2011; Kaplan & Kaplan, 2002; Wells & Lekies, 2006), so it was important to get a snapshot of children's environmental identity during 5<sup>th</sup> grade, which is primarily comprised of children ages 10-11. Additionally, two of the 5<sup>th</sup> grade curricular units focused on the natural environment, including weather and ecosystems, which meant school educators and administrators were supportive of research related to the topic of how children relate to the natural world. When the study began, children in the study had recently completed their ecosystems unit.

### **Data Analysis and Interpretation**

**Qualitative data sources.** Qualitative data were drawn from all participants using the open-ended item on the survey "To me, nature is..." to which children were asked to write a response. Identifiers were used to track individual responses on the survey, unless the child was also a member of the interview group, in which case a pseudonym was used. The qualitative data also included pre-intervention interviews from the larger study, involving

seventeen children and their teacher in the intervention class. These semi-structured, face-to-face interviews were conducted in a private setting, using a protocol described in Appendix D. Interviews were audio recorded and transcribed. Collectively, these qualitative sources were used to enrich the understanding of the components of children's environmental identity and to more fully describe their relationship to children's environmental identity.

Qualitative data from student survey responses and interviews were coded by two researchers using Dedoose qualitative analysis software (<http://www.dedoose.com/>). For interview data, the lead researcher used a set of a priori codes (Johnson & Christensen, 2008) based on the interview questions and subsequently developed a set of inductive codes based on participant responses to those questions. For example, children were asked to describe a time they went into the woods. For this question, "Experience in nature" served as the a priori code and the experiences children described (observing animals, relaxing, learning about nature, spending time with a friend, tree-climbing, etc.) were coded as they emerged from the data. The codes for children's descriptions of their relationships to nature were developed based on the work of Kellert (2002) and Cobern (2000) and are provided in Table 2. The codes used to describe children's feelings about nature in both interviews and surveys are shown in Table 3. Initial inter-rater reliability was determined to be 86%. The researchers discussed and resolved differences prior to subsequent coding of transcriptions and written survey responses. The data were then analyzed for counts, trends, and themes using Dedoose (<http://www.dedoose.com/>).

**Quantitative data sources.** The survey (see Appendix A) included two instruments, the Connectedness to Nature Scale Revised (CNS-R) (Frantz et al., 2013) and the Children's

Inclusion of Nature in Self Scale (INS) (Liefländer et al., 2012) and also solicited demographic data related to children' age, gender, and ethnicity. Identifiers were used in place of children's names on the survey, unless the child was a member of the intervention class, in which case a pseudonym was used. The survey also included items intended to gather data related to several factors thought to influence children's environmental identity, including the frequency of their time in natural settings, their interest in school science, and the presence of an adult in their life that liked to spend time in natural settings. IBM SPSS Statistics, version 19, was used for the statistical analysis. ANOVA was used to analyze the data from the survey, to assess whether demographic and other factors might relate to children's connectedness to nature, as indicated by their scores on the CNS-R and INS. Pearson's correlation was used to assess the relation of children's frequency of their time in natural settings, their interest in school science, and the presence of an adult in their life that liked to spend time in natural settings, to their connectedness to nature (as indicated by their scores on the CNS-R and INS).

The two instruments included in the survey have been found to be reliable measures of children's beliefs about their connectedness to nature. Though they measure connectedness to nature, they are generally accepted measures of environmental identity in children because connectedness to nature is viewed as an operationalization of environmental identity (Mayer & Frantz, 2004; Schultz, 2002). Both have also been used with adults, providing opportunities for future comparison across age ranges. The CNS and the INS have been found to measure the same general construct (Tam, 2013) and it is presumed that the revised measures are similarly related in children. Though other instruments have been used to

measure environmental identity in children, including Cheng's Children's Connection to Nature Index (2012), Müller, Kals, & Pansa's Emotional Affinity toward Nature scale (EAN) (2009), and a simplified version of Clayton's Environmental Identity Scale (EIS) (2003), only the CNS-R and INS have been validated in English for use with children as young as nine years old. The CNS-R and INS items are provided in Appendix B and C respectively.

## Results

The findings from the present study related to each of the research questions will be presented in this section. The results are organized by research questions.

### **How Do 5<sup>th</sup> Grade Children Identify with the Natural World?**

The present study used both qualitative and quantitative methods to examine how 5<sup>th</sup> grade children identify with the natural world. Children were asked to describe their relationship with nature in interviews ( $N = 17$ ) and open-ended survey responses ( $N = 65$ ). In addition, connectedness to nature was assessed quantitatively using the CNS-R and INS instruments.

**Quantitative measures of connectedness to nature in 5<sup>th</sup> grade students.** Fifth grade children in the present study had mean scores on the CNS-R ( $M = 4.93, SD = 1.10$ ) and INS ( $M = 4.51, SD = 1.70$ ) (see Figure 2 for a distribution of these scores). Both instruments are on a 7-point scale, with a score of 4.0 representing the midline. Therefore, this indicates 5<sup>th</sup> grade children in the present study had a slight connectedness to nature. Additionally, the INS and CNS-R were positively and strongly correlated with each other ( $r = .625, p < .001$ ).

**Children's descriptions of how they identify with the natural world.** Children in the present study described the ways in which they identified with the natural environment during interviews and on responses to the open ended item "To me, nature is..." on the survey instrument. Because the term "environmental identity" is abstract for children, the term "nature person" or "nature kid" was used as a proxy for "environmental identity" in discussions with children. In the interviews, each child was asked if he/she considered

him/herself to be a nature person. If clarification was requested, the researcher asked the child to define what he/she thought this might mean, accepting the child's definition, and asking the child to reframe the response accordingly. Children were subsequently asked to explain their responses.

***Self-identification as a “nature person.”*** Of the seventeen children interviewed, nine children (5 boys and 4 girls) identified themselves as nature kids. Children who self-identified as nature people had CNS-R scores ranging from 5.2-6.8 ( $M = 5.87$ ) and INS scores ranging from 4.0-7.0 ( $M = 5.44$ ), both indicating connectedness to nature scores above the mid-line. Comparison of this qualitative assessment of their environmental identity with quantitative measures revealed that these children had higher CNS-R scores than the mean of the population as a whole ( $M = 4.93$ ,  $SD = 1.10$ ). The same was true for the INS scores of children who self-identified as “nature people” when compared to the population as a whole ( $M = 4.51$ ,  $SD = 1.70$ ). By contrast, children who did not self-identify as nature kids had CNS-R scores ranging from 2.5-5.8 ( $M = 4.6$ ) and INS scores ranging from 1.0-7.0 ( $M = 3.50$ ).

***Children's definition of a “nature kid.”*** Children had a distinct notion of what it meant to be a “nature kid” and in the interviews clearly identified themselves as one or not. For children, “nature kids” like to be outdoors, although what they choose to do in the outdoors varies, including diverse activities like playing sports, exploring the woods, reading, socializing with friends, walking, spending time with family, biking, having some time alone, and watching animals. “Nature kids” also like animals and plants, or as John put it, at least liked them enough “to cope with nature without saying like that's gross.” Elaine described a

relationship between “nature kids” and science knowledge. “I think a nature kid is like they know a lot about animals and plants...And they do good in science.” According to children, “nature kids” seem to consistently recognize beauty in the natural world, are generally comfortable there, and find happiness, freedom, and stress relief when they are able to access nature. Several even described nature in familial terms, like “nature is like a brother to me,” indicating the depth of feeling they had for the natural world.

Children who identified themselves as “nature kids” tended to explain their identification with nature as rooted in their preference to be outdoors and/or in their interest in animals. Sofia put it this way, “Since I love animals and I’m curious, I think that yeah, I am a nature person. I like going in the woods and seeing different stuff and different animals.” Similarly, Steven explained, “It’s because I love to be out in nature and I’ll like climb the trees most of the time up in the branches and I’ll see different types of birds and I’ll just look at them the whole time.” Leo commented, “Yes. I love the outdoors. I don’t like to be inside....playing video games, I don’t like that stuff. I like being outdoors and seeing wildlife.”

***Variation in children’s environmental identity.*** For children, their identification with nature fell along a continuum, with some children having a stronger identification with nature than others. This was evident in qualitative data and supported by quantitative data as well. The CNS-R scores ( $N = 65$ ) ranged from 2.5-7, while INS ( $N=65$ ) scores ranged from 1-7 (see Figure 2). During the interviews, five of the self-identified nature kids described their connection with the natural world as so strong as to be essential to who they felt they were. These children described the impact that not being able to spend time in nature would

have on their lives. Leo put it this way, “If someone said I couldn’t go out there, I’d just go anyway. Because, you know like, nobody can take the woods away from me...I really like the woods and I don’t know what I’d do if I didn’t have the woods.” Similarly, Rachel explained, “If I couldn’t do that...I don’t know, I just don’t think I’d have very much nature in my life and I wouldn’t, well, I think I’d be like a totally different person. Like I wouldn’t like kayaking and...I wouldn’t like climbing trees and I probably wouldn’t have so much interest in animals, water, trees and grasses.”

Several children provided responses to the survey item “To me nature is...” that also emphasized the importance of the natural world in their lives. Said one, “(Nature is) Important. Interesting. I feel without it I could not live.” Said another, “I feel like I belong in nature.” Similarly, another wrote, “(Nature is) Life. Without nature, humans wouldn’t even be here. A lot of people don’t realize how beautiful, wonderful and important nature really is, but I do.”

Children also seemed very clear about what it meant to *not* be a “nature kid.” The four children who identified themselves as “*not* nature kids” articulated this clearly. Said Bill, “(I’m not a nature kid) because I don’t like outdoors that much. I like it some, but not much. I only like it when it’s fall or winter because it’s cold and there are no bugs.” Elaine explained, “To me a nature person is kind of someone who is outdoors like all the time. Before we moved, we had neighbors and they were outside like always outside. They weren’t inside that often. They were nature people. I’m not really a nature person.”

***Children’s association of nature and place.*** It was evident that nature meant more to many children than simply being outdoors, seeing animals and trees, and not seeing

buildings. A number of children described attachments to particular places or experiences in the natural world. Gail shared, “We were swinging on the swing my neighbor built out over the creek. And we decided to go out on this little pile of sand that was out in the middle of the creek. So we did and we tried to make a fort there out of sticks, sort of like a teepee.”

Like eight other interview children, Rachel described a tree or climbing a tree that held particular meaning for her. “It’s this sycamore tree and my dad carved my initials on it when I was like five. And a lot of times I’ll just find a way to climb up, there’s like two branches right next to each other and I get on the higher one and I’ll just look around.”

***Children’s feelings in nature.*** For children, nature evoked a range of emotional responses. These were especially positive in those with strong environmental identities. A summary of the feelings children described in association with nature is provided in Table 3. Notable among these feelings is the strong presence of those that reflect interest (interested, awe/wonder/amazement, excited, alive/active, and connected), comfort (afraid, attached, relaxed, peaceful), and freedom. These feelings appear to be essential elements of children’s experience in natural settings and will be discussed below as central components of environmental identity in children.

### **What Are the Central Components of Children’s Environmental Identity?**

Three prominent themes emerged from the data that appear to be central to children’s environmental identities: children’s interactions with the natural world, children’s feelings about the natural world, and children’s interest in natural science. In this section, findings from interview data are presented alongside supporting quantitative data related these three themes. For convenience, quantitative data are also summarized in Tables 4 and 5.

**Children’s interactions with the natural world.** Children described wide-ranging experiences in the outdoors, including sports as well as exploring, observing animals, jumping in leaves, climbing trees, spending time with friends and family, and generally relaxing. Typically, children described experiences in the natural world associated with home, not school. When prompted, children usually described outdoor time at school in association with recess and free play and rarely with science learning. Within the context of school, several children remarked on how rarely they got a chance to go outside, with the exception of recess. “I don’t think we really do that [go outside for science] that often. Or, like [study] nature,” commented Gail.

***What “nature” means to children.*** Children had broad interpretations of the meaning of the word “nature,” which seemed in part shaped by their experiences in nature, rather than their environmental identity. For some, whose primary contact with nature was in urban parks and playgrounds, all that was required to be in nature was to be outside in a place that had trees and animals. For others, who had had a wider range of experiences in nature, often including woods they could explore near their homes, nature was “Outside areas that have nothing man-made.”

***Amount of time children spend in the natural world.*** Overall, children across varying levels of environmental identity described spending time in nature. Children were asked to report how often they spent time in nature on a 7-point continuum (1 = never, 2 = less than once a month, 3 = once a month, 4 = 2-3 times a month, 5 = once a week, 6 = 2-3 times a week, 7 = daily). Accordingly, 33.8% of children reported spending time daily in nature, while 9% reported never spending time in nature. Using Pearson’s Correlation,

frequency of time spent in nature was significantly and positively correlated with both children's CNS-R ( $r = .383, p < .01$ ) and INS ( $r = .496, p < 0.01$ ). These data are shown in Table 4. The reported frequency of children's time in the outdoors data were supported by interview data in which most children described spending time in nature regularly outside of school. Only two of the seventeen children described spending little or no time in nature.

***Constraints on children's experiences in nature.*** Children who self identified as "nature kids" were subject to a variety of parental rules related to their outdoor experiences. Some children had limited ranges, while others were much less restricted in their movement. In general, children could not roam outside their neighborhoods. Some children were always supervised while outside, while others were not directly supervised by parents so long as they stayed within a proscribed area, were with a friend or sibling, and/or returned home by specific times. Experiences in the outdoors were also limited by busy schedules, homework, and weather. Limits associated with access to children's experiences in nature, did not quash children's self-identification as "nature kids," as long as their parents supported their exploration when possible. Said one, "[Nature] is part of my life...But I sometimes don't experience it much. Because my family is sometimes busy. But we do try to go out as much as possible."

Children who did not self-identify as nature kids had infrequent experiences in the outdoors that were typically associated with severe external limitations by parents. For example, Bill, a "non-nature kid," described his family's experience in nature this way, "My family doesn't go out in the woods. They hate bugs." Often the outdoor experiences of children who did not self-identify as nature kids were limited to sports. All four of the

children who did not self-identify as nature kids in the interviews described parental limitations on where they were allowed to play outside.

**Children's emotions about the natural world.** Children described two distinct emotional responses to the natural world: feelings of freedom and feelings of comfort in the natural world. They associated feelings of freedom with being in the natural world and viewed the natural world as a place to escape from stress. They also described differing comfort levels and numerous fears about the natural world, but varied in their responses to those fears.

*Children's perception of freedom in the natural world.* A prevalent theme in children's descriptions of their experiences in the outdoors was related to the freedom they felt. Freedom was mentioned twenty times by children in interviews and survey responses in association with their experiences in nature. Said Leo, "Nature's like free you know? I can do like basically whatever I want out there. It's really fun, you know?" Wrote one survey respondent, "Whenever it is just me and the forest and animals and when I'm pretty far from commercialization, I feel free." This suggests that for children, the feeling of freedom may be one of the most important aspects of their experiences in the natural world.

Children also viewed the natural environment as a place where they could go to be free from stress and to recoup. Wrote one survey respondent, "(Nature is) something I can connect with. When I need some time to clear my head or relax and be alone, I go to nature." Similarly, Leo described nature as "a place where I am a free bird and don't have to worry about tests or homework." A child identified as an English as a Second Language Learner

wrote, “Life is very hard because we are everyday working job or learning, but nature is not hard. Sometime we need free. So you want free? Go to the nature and you get free.”

***Children’s comfort levels during experience in the natural world.*** Children expressed a number of strong fears about natural settings including fears of spiders, insects, snakes, getting lost, heights, bears, ticks, poison ivy/oak, coyotes and lions (in decreasing order of prominence in data). Despite this, the presence of these fears did not appear to be related to whether or not a child identified as a nature kid. Several children who identified as nature kids also had significant fears related to the outdoors. Fears did not seem to deter their desire to be outdoors. Described one, “Sometimes I think about copperheads and that kind of scares me a little, but I’m not like super scared of spiders or anything. Nothing keeps me from going out.” Conversely, all of the children who said they were not nature kids described personal fears or parental fears about the natural world that inhibited their experiences outdoors. Said one, “I don’t really feel that good about the woods ... There are bugs everywhere...I’m afraid and I don’t like them.”

**Interest in natural science.** Children described strong interests in the natural world, particularly in animals and trees. They also indicated a strong interest in the natural world generally, using the words “interested,” “curious,” and “wonder” to describe their feelings in and about the natural world. Said Steven, “I like to look around trees and see all the bugs and things. I saw this one bug that looked like it had two bodies...It’s really fun to go outside and look at everything. Cause for me, it’s learning something new when I’m outside.” Reed put it this way, “I see a lot of cool animals and stuff. And it’s pretty fascinating to me, just looking at all the diversity of the things.” Specifically, children

mentioned their interest in discoveries they made while exploring, like finding deer bones or strange looking plants or animals. Three children described following-up on these discoveries once they returned home by looking it up on the Internet or in a book.

### **What Other Factors Contribute to Children's Environmental Identities?**

In the present study, several other factors were examined for their possible contribution to children's environmental identity. These include age, gender, ethnicity, culture, and the influence of others (parents, teachers, peers, and other adults in children's lives that like spending time in nature). Findings related to each will be presented in this section.

**Age.** Within the small age range of children in the study (i.e. 9 - 12 years old), no statistically significant differences were identified with respect to age using quantitative (CNS-R:  $[F(3,61) = 3.22, p = .810]$ ; INS:  $[F(3,61) = 4.80, p = .698]$ ) or qualitative analysis. No children in the present study made references to age when describing their environmental identity or their experiences in nature. Thematic coding based on Kellert's typology of nature values (2002) revealed that some children in the study described utilitarian (nature as a source of material and physical reward) views of nature and negativistic (fear) values. Children in the present study also described views of nature that included Kellert's humanistic, aesthetic, and knowledge values, more representative of children in middle childhood, ages 6-12. Two children in the present study who said they were "not nature people" had fear-based views of nature and also had extremely limited experiences in the natural world.

**Gender.** Gender was found to have no statistically significant relationship to either children's CNS-R scores [ $F(1,63) = 2.55, p = .115$ ] or INS [ $F(1,63) = .495, p = .484$ ], although mean scores were slightly higher on both measures for males (CNS-R:  $M = 5.17, SD = 1.01$ ; INS:  $M = 4.68, SD = 1.81$ ) as compared to females (CNS-R:  $M = 4.74, SD = 1.11$ , INS:  $M = 4.38, SD = 1.62$ ).

Similarly, qualitative analysis revealed no comments related to gender among children or the classroom teacher. In the interview group ( $N=17$ ), four girls and five boys self-identified as "nature kids." When describing their classmates, children recognized five girls and seven boys as "nature kids." The teacher only identified two boys as "nature kids."

**Ethnicity/Culture.** Ethnicity was found to have no statistically significant relationship to either children's CNS-R scores [ $F(5,59) = .394, p = .851$ ] or INS scores [ $F(5,59) = 1.273, p = .288$ ]. The three largest ethnic groups' (Black, White, non-White Hispanic) mean scores are given in Table 5. In both scales, the mean scores of White children were the highest. All mean scores fell above the midpoint of the scales, with the exception of the INS score of Blacks ( $M=3.75$ ). The mean score of Non-White Hispanic children on the INS was somewhat higher than that of Black children, whereas the opposite was true on the CNS-R.

In interviews and surveys, children made no references to anything related to ethnicity or culture, with the exception of a student from China who made several comments comparing the natural environment in the Southeastern United States with her home in an urban area of China. She was surprised by the number of trees and was concerned because there were so few trees where she grew up, wondering if this might reduce the oxygen there.

**Influence of others on environmental identity.** Because it is socially mediated (Clayton, 2003; Kals, 2003), environmental identity was expected to be influenced externally by other people in children's lives, including adults (parents, teachers, and other adults in the child's life) and peers (at home and at school). Others have the potential to influence children's environmental identity through modeling, support, and validation (or by the lack of these things).

***Influence of adults.*** In the survey, children were asked to indicate their response to "There is an adult in my life who likes to spend time in nature" on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Pearson's correlation revealed a statistically significant and positive correlation between children's recognition that they had an adult in their life who liked to spend time in nature and both their CNS-R score ( $r = .490, p < .01$ ) and INS score ( $r = .274, p < .05$ ), shown in Table 5.

The role of adults was described in interview data in which eight of the nine children who self-identified as nature kids described interacting with an adult (usually a parent) in nature. Children who self identified as "nature kids" described activities like walking/hiking, camping, gardening, fishing, and exercising with adult relatives. Student comments suggest the experiences with adult relatives may serve to model a preference for being in nature that fostered their environmental identity. For example, Sofia shared, "(My mom) goes with me. I think she likes it in nature, seeing animals. She talks about how we can help the animals that we see and what the animals are doing." Three of the four children who identified themselves as "not nature kids" described limited activities in natural settings with adults.

As previously discussed, parents also influenced children's experience in nature by controlling children's access to the natural world.

***Influence of peers.*** Data related to the influence of peers were drawn strictly from qualitative sources, as there was no related survey question. Outside the context of school, children described many experiences in the natural world with siblings and friends. These activities included walking, playing games, fort building, tree climbing, and exploring. Often these experiences involved imaginative play using the natural world as a setting for pretending to be Native Americans, cavemen, zombies, and characters from children's fiction. But, they also included experiences that indicated a shared love for being in natural settings. For example, one explained, "When my friends come over, we'll just be like sitting by the water enjoying seeing things like sunsets." Having the opportunity to spend time with peers who also enjoy nature may mutually enhance environmental identity.

### **Is the Way Children Identify with the Natural World Recognized by Others?**

Individually, children in the interview group seemed to have a limited awareness of each other's environmental identity. Even when an individual named a classmate as a "nature kid," that student was often hesitant, with explanations like "I haven't really seen him (her) outside except at recess." But, collectively, the children were able to recognize the self-described environmental identity of their classmates in all but one case. This child was a relatively quiet non-White Hispanic girl, Sofia, who had a strong interest in animals. She described going to the park every weekend with her mom and brother to explore and watch the animals. She especially appreciated the peace she felt there. However, her strong

connection to the natural world was not evident to her peers, precluding the possibility for her classmates to reinforce her environmental identity.

The teacher was able to identify two of the children (both boys) in the interview group who had self-identified as “nature kids;” however, she did not recognize the environmental identity of ten other children who self-identified as “nature kids.” Similarly, the children did not seem to be aware of the teacher’s identification with the natural world. Said Leo, “I just don’t really think she has that much interest in wildlife. I’m just not positive she’s like a wildlife person. Not like me.” Many children said she probably liked to be outside because she was a runner, but still thought she didn’t have a strong connectedness to nature in part because she usually taught inside and wasn’t often engaged with them outdoors. Said Bill, “I don’t know maybe, maybe not...I can’t really tell about [her], because since she’s a teacher, she just sits there [when we’re outside], looking at the kids.”

### **How do children’s environmental identities relate to their interests in science at school?**

Children were asked to indicate their response to “I am interested in science at school” on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Children were somewhat interested in science at school ( $M = 3.83$ ,  $SD = .928$ ). Analysis using Pearson’s correlation revealed a statistically significant and positive correlation between children’s interest in science and both their CNS-R score ( $r = .575$ ,  $p < .01$ ) and INS score ( $r = .482$ ,  $p < .01$ ). These data are shown in Table 4.

During interviews, children who identified as nature kids often attributed their interest in science at school in large part to their interest in animals. Despite this, interview data suggest that children with strong environmental identities often felt their school science

experience, in part because of its indoor focus, did not build a connection to the natural world, even though ecosystems and weather were a part of the 5<sup>th</sup> grade curriculum. As Leo put it, “In school, we’ll sit and write a lot of notes and stuff. We don’t really get to go outside. I would like science a ton more if we would like go outside and look at nature and see what kind of plant that is and like measure it and you know? Instead of like, stay in class and you know look at a video of how you digest stuff. It’s just not fun to me.” Said Michael, “Nature is like going out and saying there’s this kind of fungi growing on something instead of like in school, where you can’t really discover things, you learn about things.”

### **Summary**

Overall, children provided rich descriptions of their relationships with the natural world. This was supported by the CNS-R and INS scores of 5<sup>th</sup> grade children in the present study, which indicated they felt a connectedness to nature. Experiences in the natural world, particularly how those activities were characterized by comfort and freedom for children, were central to children’s descriptions of their environmental identities. In the present study, children with strong environmental identities had more frequent experiences in nature than those with weaker environmental identities, though a few children with strong environmental identities also described limited access (by geography or by parents’ restrictions) to the natural world. Children felt a connection to nature in developed as well as less developed locations. There was a correlation between children’s environmental identity and their interest in school science, although when probed, children with strong environmental identities often felt school science did not give adequate attention to the natural world. Additionally, children with strong environmental identities described parental support of

their desire to spend time in the natural world (especially by allowing some degree of freedom as well as not contributing to children's fears). There was a correlation between children's environmental identity and the child's recognition of having an adult in his or her life that was interested in the natural world. Children were able to recognize their own environmental identities but had a limited ability to recognize it in peers. The teacher in the present study had limited ability to recognize children's self-described environmental identities. Children with strong environmental identities also described the importance of spending time in natural settings with siblings and peers. This research did not document a significant contribution associated with gender, age, ethnicity, or culture to children's environmental identity.

## Discussion

The present research enhances our understanding of environmental identity in 5<sup>th</sup> grade students by affirming that 5<sup>th</sup> grade children have positive connectedness to nature that varies in individuals. It adds to our understanding of the components of children's environmental identity by identifying how children describe their relationship with the natural world as well as factors that shape their environmental identity. It also offers a Proposed Model of Environmental Identity in Children (Figure 1). The following section will consider these data in light of other research and focus particularly its implications for educators.

### **How Do 5<sup>th</sup> Grade Children Identify with the Natural World?**

Children in the present study had definite ideas about what it meant to have a strong environmental identity. According to children, “nature kids” spend a lot of time outdoors (especially in natural environments), aren't afraid to be outside in nature, like to be free to roam, explore, and observe living organisms, and are interested in the natural world (especially animals). “Nature kids” often feel they have an adult in their life that likes to spend time in nature. They also tend to like to have the company of peers with whom they can share explorations, but they also value opportunities to have time alone in natural settings.

Conversely, children in the present study were able to describe what it meant to *not* be a “nature kid.” For them, children with weak environmental identities had very limited interest in spending time outdoors, preferring interacting with electronics or engaging in

indoor activities. They often had strong fears about the natural world that limit their time outdoors. Their parents often modeled the same fears about the natural world. They often lacked the freedom from their parents to explore the natural world.

**Connectedness to nature levels scores in 5<sup>th</sup> grade students.** There is relatively little research to provide data with which to compare the INS and CNS-R scores of the 5<sup>th</sup> grade students in the present study. The data in the present study are consistent with other researchers who also found 10-11 year old children's CNS-R and INS mean scores above the mid-line (Bruni & Schultz, 2010; Frantz & Mayer, 2013a; Liefländer et al., 2012). This adds support to the data that suggest overall children ages 10-11 have somewhat positive environmental identities. It also adds to the data that may be used to compare the connectedness to nature as children progress toward adulthood.

**Range in connectedness to nature scores.** The environmental identities of 5<sup>th</sup> grade students in the present study fell along a continuum (see Figure 2), with a few children having very low INS and CNS-R scores, while most scores fell above the midline of both scales. This was affirmed by children's narrative descriptions of their environmental identity, with four children stating they were "*not* nature kids." Nine children in the interview group self-identified as "nature kids," while four others thought they fell somewhere in between. Therefore, while 5<sup>th</sup> grade children in the present study exhibited a positive connectedness to nature, some individual children had CNS-R ( $N=11$ ) and INS ( $N=17$ ) scores that reflected a lack of connectedness to nature. The data also suggest that the INS may better distinguish children's lack of connectedness to nature than the CNS-R. This may be

related to the graphic, one-item design of the INS instrument, which may be easier for children with limited language skills.

### **What Are the Central Components of Children's Environmental Identities?**

The present research supports the notion that there are three central components of children's environmental identities: their interactions with the natural world, their emotions about the natural world, and their interest in the natural world. These three components are situated in children's experiences in natural settings and are inextricably linked to the physical environment in which children are able to experience nature.

**Children's interactions with the natural world.** Children in the present study did not require access to pristine natural environments to develop their connectedness to the natural world. In this sense, access to nearby nature, including urban parks, backyards, and abandoned lots, was more important to establishing their connectedness to nature than having access to remote wilderness. This is consistent with the work of other researchers (Wells & Evans, 2003; Kaplan & Kaplan, 2005). It was important to children's connectedness to nature that interactions with nature take place in the outdoors, be regular in terms of frequency, include direct observation and discovery of animals and/or trees, and not be discouraged by their parents (by rules, limits, or transmission of fears).

**Children's emotions about the natural world.** Children's environmental identities appear to be heavily influenced by their feelings about and in the natural world. This has been noted by other authors as well (Kals & Ittner, 2003). These feelings are strongly associated with children's experiences in the outdoors. Fears related to the outdoors, while they were present in 5<sup>th</sup> grade students, did not appear to play a strong role in ultimately

determining a child's environmental identity. Children who had fears and still self-identified as nature kids seemed to have found a way to manage those fears so that they did not override their strong inclination toward the natural world. Children who had lower environmental identity often expressed fears about being in the outdoors, many of which were shared by a parent. It is assumed, therefore, that measures to reduce children's fears in the outdoors, perhaps through experiences in the outdoors or by addressing similar fears in parents, can serve to strengthen a child's environmental identity.

**Children's interest in the natural world.** Children in the present study indicated a strong interest in the natural world. This is consistent with the findings of other researchers (Kirikkaya, 2011; Maltese & Tai, 2010; Osborne et al., 2003). These interests appeared to be fostered by children's sense of freedom in their experience of the natural world, particularly in their perception that they were free to explore and discover things of particular interest to them. In this sense, the natural world may provide a unique free-choice learning environment that encourages children's interests in natural sciences. Free-choice learning opportunities have been found to stimulate interest in science (Falk & Dierking, 2002; Renninger, 2007).

### **What Other Factors Contribute to Children's Environmental Identities?**

**The impact of others.** The present study examined the role of others in impacting children's environmental identities. Specifically, students were asked about how their relationship with the natural world had been influenced by their parents, siblings, peers, teachers, and other adults in their lives. The presence of an adult in the child's life who likes to spend time in nature, was important in fostering 5<sup>th</sup> grade students' environmental identity

and was correlated to children's connectedness to nature scores. Children also enjoyed spending time in nature with peers and siblings away from adults so long as they had the support of their parents in doing so. In two children, parents had fears about the natural world that appear to have been transmitted to the child so as to inhibit the development of the child's connection to nature. In another, the parents' fears led to restrictions on the child's outdoor experience that kept the child from interacting with nature, despite his strong desire to do so.

The external social reinforcement of environmental identity has been found to enhance one's self-identification (Clayton, 2012; Clayton & Opatow, 2003; Ryan & Deci, 2003), just as the lack of external reinforcement may weaken it (Basu & Calabrese Barton, 2007; Calabrese Barton & Yang, 2000). In this study, the classroom teacher and the children both had difficulty recognizing each other's environmental identity. With respect to environmental identity, this could be particularly damaging to girls whose environmental identity in the present study was not recognized by the teacher. The inability to recognize environmental identities of others was attributed to the lack of shared experience in the natural world. Indeed, in the context of schools, children spend the majority of their time indoors (Burriss & Burriss, 2011). In the present study, children spent little science time outdoors, despite the curricular focus on ecosystems. It would appear that the experience of spending time together in the natural world, together with discussing how individuals feel and think about the natural world may have the potential to provide external reinforcement of children's environmental identities. Research suggests such external reinforcement may

increase an individual's connectedness to nature and strengthen one's environmental identity (Clayton, 2012; Clayton & Opatow, 2003; Ryan & Deci, 2003).

**Age.** Because of its design, the present study was unable to document the role of age in determining children's environmental identity. However, evidence of Kellert's nature values typically associated with children ages 3-6 was found in 5<sup>th</sup> grade children in this study. This suggests age is not likely to be the sole factor in determining how a child's view of the natural world evolves. Other research supports the idea that age may influence a child's connectedness to nature, which appears to decrease as a child moves toward adolescence (Kaplan & Kaplan, 2002; Liefländer et al., 2012). Investigations of connectedness to nature with younger children, perhaps using the graphic INS scale, may tell future researchers whether children younger than 5<sup>th</sup> grade have stronger or weaker connectedness to nature in comparison to 5<sup>th</sup> grade students in the present study.

**Culture.** The present study did not document any impact of ethnicity or culture on children's environmental identity. Work by other researchers suggests that there may be differences in connectedness to nature by culture, particularly collectivist (promoting the group, as opposed to the individual) cultures (Boeve-de Pauw & Van Petegem, 2013; Frantz et al., 2005; Kahn Jr. & Kellert, 2002; Schultz & Zelezny, 1998; Van Petegem & Blicek, 2006). Given this, it seems likely that in the present study, either cultural differences were minimal or ethnicity was an insufficient proxy to capture cultural differences in the student population.

**Gender.** The present study did not document any impact of gender on children's environmental identity. This may be attributed in part to the low number of participants in

this study or its somewhat unequal distribution of females to males. However, the work of other researchers suggests that there are only slight, if any, differences in children's environmental identity by gender (Frantz & Mayer, 2013a; Frantz et al., 2013). The lack of significant differences by gender in environmental identity has also been documented in adults (Clayton, 2003), suggesting gender may not play a significant role in determining environmental identity.

### **Toward A Model of Children's Environmental Identity**

Using the findings in the present study, together with data gathered from the work of other researchers, the researchers in the present study propose a Model of Environmental Identity in Children (see Figure 1). This model suggests three central components of children's environmental identity: children's interactions with the natural world, their emotions about the natural world, and their interest in the natural world. Because these components vary in individual children, the circles in the model may be thought of as varying in size, depending upon the degree to which they are significant to the individual's environmental identity. Additionally, because children's environmental identity varies in individuals, the circle depicting environmental identity may be larger or smaller, depending on the relative importance of environmental identity in the individual's life.

Several other things, depicted in gray boxes, and are seen as factors that may influence environmental identity in children. Of these, the influence of others (parents, peers, teachers and other adults in the child's life that spend time in nature) was documented in the present study. The remaining factors (age and culture) were not specifically identified in the present study. Research supports the idea that age may influence children's environmental

identity (Kaplan & Kaplan, 2002; Liefländer et al., 2012). The influence of culture remains an open question. Because in the present study gender did not impact children's connectedness to nature, a finding also supported by other researchers (Frantz & Mayer, 2013a; Frantz et al., 2013) it has been omitted from the model.

It appears that children's environmental identity has different components than those of adult environmental identity. For example, children in the present study did not describe gender, political, or cultural influences on their environmental identities, whereas some researchers have found these factors to contribute to adult environmental identities (Stets & Biga, 2003). While this does not necessarily mean that these things do not influence children's environmental identities, others have found no significant differences in children's environmental identity related to gender or ethnicity (Frantz, personal communication, September 1, 2013; Clayton, 2003; Frantz et al., 2013; Mayer & Frantz, 2004).

Descriptions of environmental identity in adults also neglect certain components that children describe as being important. In particular, children's environmental identities appear to be influenced by their parents and other adults in the child's life. While children appreciate the freedom to explore the outdoors without adult control, they describe being influenced by their parents' and other significant adults' support of those explorations. Children with low connectedness to nature echoed parental fears about the outdoors and described constraints associated with their experience of the natural world.

The right side of the model depicts some of the things that might be impacted by the degree to which a child sees himself as a part of the natural world. These include environmental behavior, environmental attitudes, imaginative thinking, interest in school

science, science learning, and social affiliations. For example, given the relationship between children's connectedness to nature and their interests in school science identified in the present study, strengthening a child environmental identity may serve to improve their interests in school science.

This model allows for children's environmental identity to be seen as a dynamic construct, one that changes and evolves over time as a result of children's interactions with others and with the world around them (Clayton, 2012; Clayton & Opatow, 2003; Ryan & Deci, 2003). The components of the model, therefore, may be influenced by each other by some degree. For example, as a child's environmental identity is strengthened, it may influence the way the child relates to peers, which in turn may foster the child's interests in science or choice to spend more time in natural settings. Therefore, the model provides insight into specific ways educators may enhance children's environmental identity and strengthen interests in school science. To the extent that school educators are involved in efforts to strengthen children's environmental identity, this may also enhance children's connections to science at school.

### **How Do Children's Environmental Identities Relate to their Interests in Science at School?**

Given the relationship between interest in science at school and children's environmental identity documented in the present study, external reinforcement of a child's environmental identity may augment a child's interest in school science by affirming the child's perception that the natural world has special significance in defining who the child is. Moreover, if the environmental identity of the child remains unknown to the teacher and

classmates (as it might without having shared field experiences in the natural world), the child's interest in school science may be diminished. Calabrese-Barton (2000) found this to be the case with Miguel, a student whose interest in the natural world remained unacknowledged in his experience of school science, resulting in his disengagement with school science despite his involvement in natural sciences outside of school. In the present study, one student who self-identified as a "nature kid" was not acknowledged as such by either her teacher and classmates. Her environmental interest remained hidden and her interest in school science was low. If her environmental identity were to be recognized and nourished, it might help strengthen her interest in school science. More generally, enhancing children's environmental identities in the context of school science may improve the interest in school science for all children who have a strong association with the natural world.

### **Implications for Elementary Science Education**

Understanding the factors related to a child's environmental identity may help science and environmental educators design educational and other programs that focus specifically on fostering a child's connectedness to nature. The present study suggests that in particular, programs that specifically address children's emotions about natural settings, provide opportunities for children's freedom and exploration of animals in the outdoors, include adult role models who value and spend time in nature (and communicate this to children), and set aside time for children to communicate their feelings about the natural world (in a way that classmates and teachers can come to know them) may have the most potential to improve a child's environmental identity.

In terms of the elementary science classroom, the findings in this study suggest a relationship between 5<sup>th</sup> grade students' environmental identities and their interest in school science. This suggests improving a child's environmental identity may be a mechanism to increase a child's interest in school science, which has been found to decline as a child progresses toward middle school (Osborne et al., 2003). By designing and/or seeking programming that improves children's connectedness to nature, science and environmental educators may realize some of the benefits associated with stronger environmental identities for their children, such as heightened environmental awareness, environmentally responsible behavior, ability to make connections to science, and career choices related to the environment (Cervinka, Röderer, & Hefler, 2012; Chawla, 2001; Frantz & Mayer, 2009, Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009; Howell, Dopko, Passmore, & Buro, 2011).

In the present study, the teacher rarely included outdoor learning experiences in natural settings, as is true in many US schools (Burriss & Burriss, 2011). This avenue of increasing a child's interest in science is not often used in traditional elementary school science, possibly resulting in children's disconnection from school science (Calabrese Barton & Yang, 2000; Carrier et al., 2013; Cobern, 2000). Students in the present study had difficulty reconciling their experience of school science and their relationship to the natural world, feeling that science at school did not include or acknowledge their interest in nature. Further, because a child's environmental identity appears to be largely unrecognized by teachers and classmates, as it was in this study, educators may be unable to fully capitalize on a child's interest in the natural world as part of his/her school science experience. Providing

more opportunities for experiences in the natural world, particularly free-choice learning activities, in the context of schooling may increase children's environmental identity by remediating deficits in experience, improving comfort levels in the outdoors (Carrier-Martin, 2003) and by providing external validation of environmental identity by both teachers and classmates (Clayton, 2012; Clayton & Opatow, 2003; Ryan & Deci, 2003). To the extent that the children in the present study did not connect the science they are learning in school with the outdoor world around them, as has been documented in the literature (Carrier et al., 2013), addressing children's environmental identity in the context of school may help them do so by providing a framework of shared experiences and emotions to anchor science content and discussion. The inability of the elementary science experience to acknowledge and embrace the way children think of the natural world may contribute to their disconnect from elementary science as they move into middle school (Calabrese Barton & Yang, 2000; Cobern, 2000).

The potential impact of interventions that address children's environmental identity suggests two things for classroom teachers. First, if the teacher is able to recognize a child's existing environmental identity, it could help the teacher build a connection between the student, classroom science, and the environment. This might be accomplished through diagnostic use of the CNS-R or the INS or by class involvement in activities in the natural world. Second, the teacher should look for ways to enhance a child's environmental identities within the context of school science. This might be done by focusing on environmental content, but this research suggests, as did the work of Ernst and Theimer (2011), it may be best accomplished through the incorporation of outdoor experiences in the natural world,

especially those that give attention to children's comfort in nature and provide free-choice learning opportunities such as exploration. This might include schoolyard science lessons, naturalization of school grounds, or field trips to environmental education centers or parks.

The present research suggests three things for environmental educators. First, it is particularly important to specifically address children's comfort in nature as part of the learning experience. Second, it is optimal to provide opportunities for free-choice learning and exploration within the activities. Finally, it is preferable to include time for reflection within the scope of the program so that children and teachers may come to understand and affirm each other's connectedness to nature.

These strategies could increase children's environmental identities. This has the potential not only to enhance children's pro-environmental attitudes and behaviors but, as seen in the present study, to impact their interests in school science. Without implementing these strategies in elementary schools, the opportunity to use children's environmental identity as a tool to cultivate interest in science may be lost as the child moves into adolescence, as Calabrese Barton & Yang (2000) described it was for Miguel.

## Conclusion and Implications

In the present study, the children in 5<sup>th</sup> grade felt a connectedness to nature. Due to a lack of engagement with the natural world in science class, this connection was largely unnoticed and unacknowledged by the teacher. Children described this connectedness by discussing their experiences in the natural world, their interests in science (in and out of school), and by describing the role of adults, particularly parents, in shaping their environmental identity by modeling and supporting their interactions with the natural world. Children were able to label and define their own environmental identities. However they, like their teacher, had limited opportunities or ability to recognize environmental identity in peers.

Experiences in the natural world, particularly how those activities are characterized by comfort and freedom for children, are central to children's environmental identity. Children with strong environmental identities had more frequent experiences in nature than those with weak environmental identities. Providing children these sorts of experiences in the context of school may serve to enhance children's environmental identities. Specifically, interventions should address the components of children's environmental identity that foster children's connectedness with nature, including the reduction of fears associated with the natural world and encouragement of feelings of freedom, discovery, and attention related to the natural world. Additionally, school-based outdoor experiences in the natural world may provide important opportunities that were lacking the teachers and students in this study to acknowledge and reinforce each other's environmental identities.

Interest in school science is related to children's environmental identity. Both have been found to decline in adolescence. By bridging children's environmental identities and their experience of school before or during 5<sup>th</sup> grade, teachers may be able to help children improve their interest in school science, while at the same time helping them connect their science learning to the world around them.

### **Limitations of the Study**

The present study focused on 5<sup>th</sup> grade students in a suburban elementary school in the United States. As such, it provides a snapshot of children's environmental identity in 5<sup>th</sup> grade. The authors welcome refinement of the proposed model of children's environmental identity that would include children from urban, rural, and international settings. Also, this research was not able to document the contribution of gender, age, or culture to children's environmental identity, but this does not necessarily mean that these do not contribute children's environmental identity.

Table 1

*Descriptive data related to study participants by age, ethnicity, and gender. (N=65)*

	<b>Number (Percentage) of Survey Participants (N=65)</b>	<b>Number (Percentage) of Interview Participants (N=17)</b>
<b>Age</b>		
•9 years old	2 (3.1%)	0
•10 years old	44 (67.7%)	14 (82.3%)
•11 years old	18 (27.7%)	3 (17.7%)
•12 years old	1 (1.5%)	0
<b>Ethnicity</b>		
•Black	12 (18.5%)	3 (17.7%)
•non-White Hispanic	18 (27.7%)	5 (29.4%)
•White	25 (38.5%)	8 (47.0%)
•Other (Asian, Multi-racial)	10 (15.3%)	1 (5.9%)
<b>Gender</b>		
•Male	28 (43.1%)	9 (53.0%)
•Female	37 (56.9%)	8 (47.0%)
<b>Receive English as a Second Language Services</b>	16 (24.6%)	5 (29.4%)

Table 2

*Codes and sample excerpts from interviews related to children's self-described relationships to nature.*

Codes	Sample Excerpt	Application in Interviews (N=17)
Interdependence	We help each other, because trees are something that help us to be, because without them we wouldn't be able to breathe. And we give them the air that comes out of us.	9
Caretaking/moralistic	We take care of nature when it's small. It's kind of like us, you know? When we start getting older, we have more responsibilities.	3
Dominionistic	N/A	0
Humanistic (emotional bonding with nature)	Everything emits its own aura, it's own personality. I felt it.	3
Humans as a part of nature	Well humans are animals. They are the most advanced animals, I think. But we're all equal and stuff I think.	8
Aesthetic/appreciation	Amazing, and beautiful and feels like a part of life to me.	7
Restorative	It's just like the nicest place where you can lean back on and just be able to think to yourself and not have to connect with people, just connect with nature.	3
Separate	I think we would be part of nature, but we changed, we like adapted to modern life with houses and factories and cars.	4
Uncertain about relationship	I'm not sure.	1
Utilitarian	It gives us fresh air and that kind of stuff.	7

Table 3

*Words used by children to describe their feelings about being in the natural world. Data collected from interviews (N=17) and surveys (N=65).*

Theme	Feeling	Interview count	Survey count
Engagement/Interest	Alive/active	4	0
	Attached (to a place)	8	0
	Awe/Wonder/Amazement	3	6
	Connected	4	1
	Excited	3	0
	Interested/Curious	14	20
	Attentive	2	0
Comfort (Lack of Comfort)	Afraid	6	1
	Happy	12	2
	Relaxed	5	2
	Peaceful	3	2
	Safe/Comfortable	4	0
	Less Angry	3	0
	Enjoyment	0	8
Other	Healthier	3	0
	Grateful	0	1
	Spiritual	0	1
Freedom	Free	15	5

Table 4

*Pearson correlations showing correlation between descriptive survey items and 5<sup>th</sup> grade children's pre-intervention INS and CNS-R scores. (N=65)*

<b>Survey Item</b>	<b>Pearson Correlation with INS</b>	<b>Pearson Correlation with CNS-R</b>
I am interested in science at school.	.482**	.575**
There is an adult in my life who likes to spend time in nature.	.274*	.490**
How often do you spend time in nature? (ranging from never to daily)	.496**	.383**
**=Significance at the alpha=0.01 level (1-tailed). *=Significance at the alpha=0.05 level (1-tailed).		

Table 5

*Mean pre-intervention scores on CNS-R and INS scales by ethnicity for the three largest groups of children. Mid-line on both scales is 4.0.*

<b>Ethnicity</b>	<b>N</b>	<b>Mean CNS-R Score</b>	<b>Standard Deviation</b>	<b>Mean INS Score</b>	<b>Standard Deviation</b>
African American	12	4.85	0.87	3.75	2.14
Caucasian/White	25	5.09	1.08	5.00	1.35
Non-White Hispanic	18	4.79	1.19	4.50	1.79

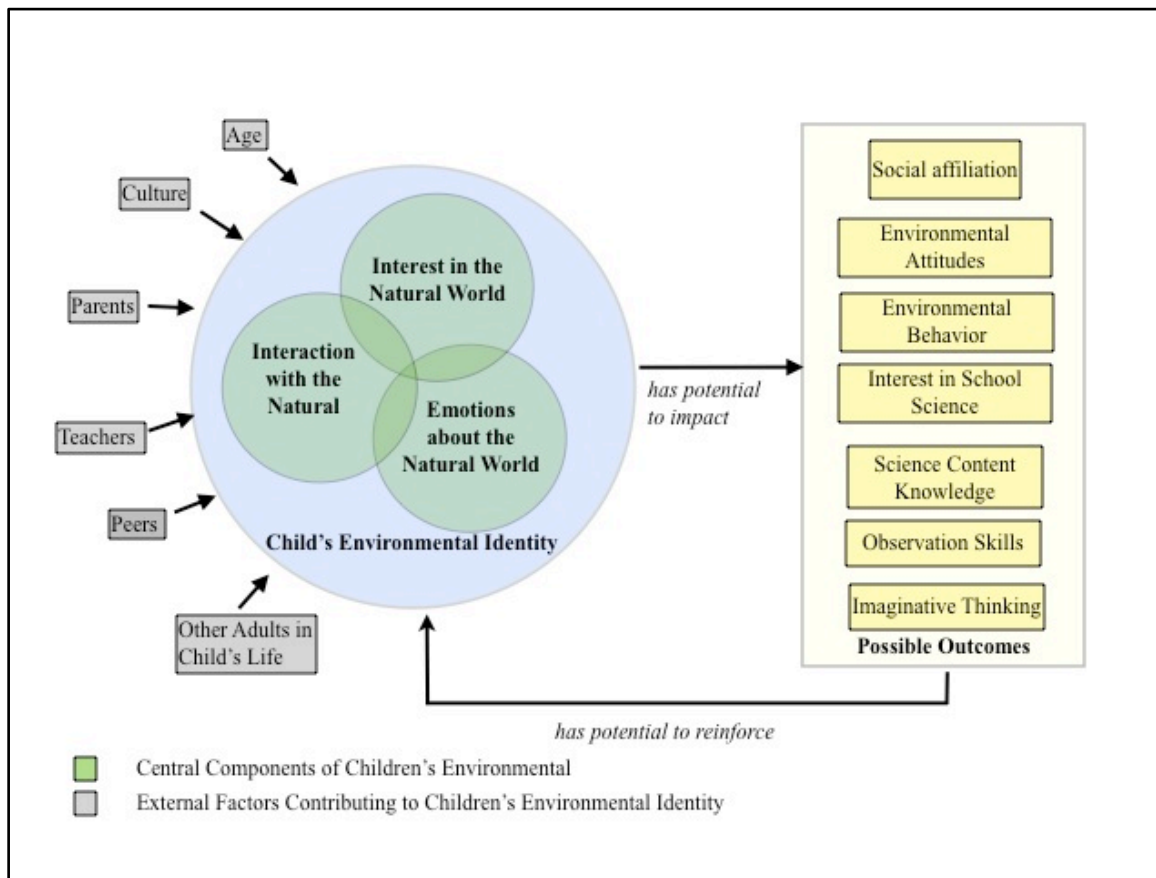
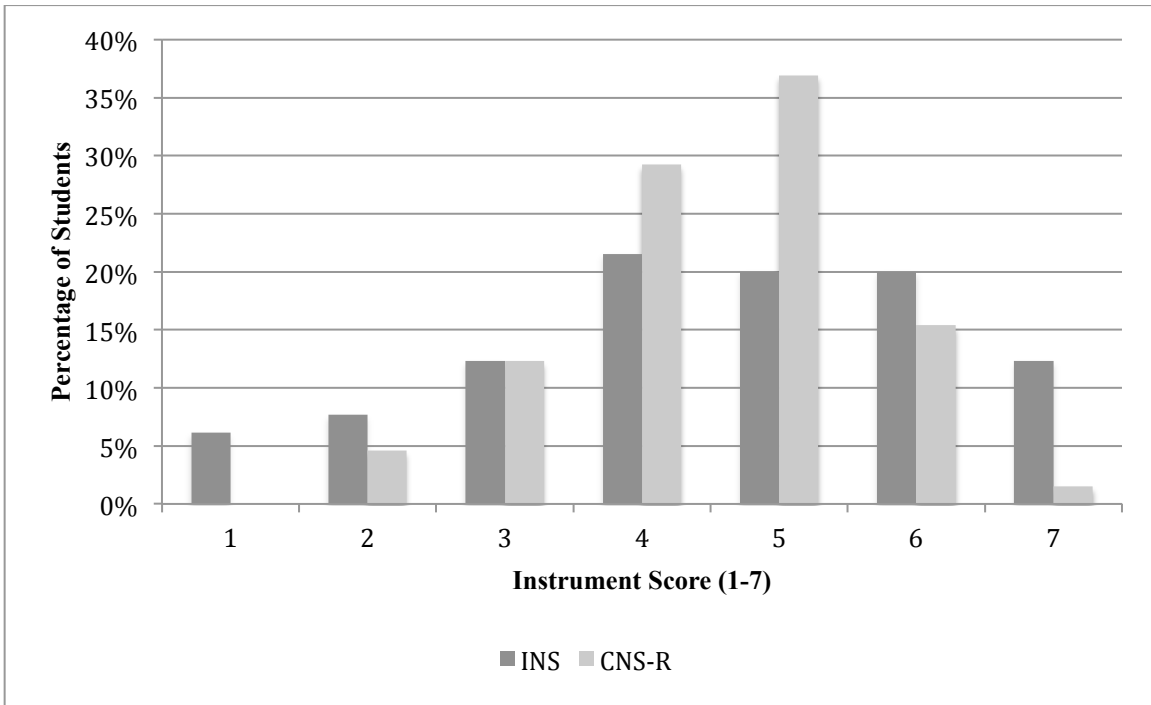


Figure 1: Proposed Model of Environmental Identity in Children



*Figure 2: Distribution of 5<sup>th</sup> Grade Students' INS and CNS-R Scores. Scale ranges from 1-7, in whole number increments. (INS:  $M=4.51$ ,  $SD=1.70$ ; CNS-R:  $M=4.93$ ,  $SD=1.10$ )*

MANUSCRIPT:  
IMPACTING CHILDREN'S ENVIRONMENTAL IDENTITY IN THE CONTEXT OF  
SCHOOL SCIENCE: A CASE STUDY

## **Abstract**

This case study used a mixed methods approach to follow the experiences of children in a traditional public school 5<sup>th</sup> grade class who engaged in a two-visit field program designed to strengthen children's environmental identity. Interviews, classroom artifacts, and observations provided insight into the ways the program influenced children's experiences and were used to identify components of the program that were particularly effective in influencing children's environmental identity. Quantitative measurement of children's environmental identity using two instruments, the Connectedness to Nature Scale, Revised and the Inclusion of Nature in Self Scale for Children, was used to support qualitative analysis by comparing pre- to post-assessment changes in connectedness to nature in an intervention group with a control group that did not participate in the intervention. Impacts of the program included changes in class social structure, reduction of children's fears in the natural world, children's strengthened interest in school science, and changes in science learning related to observation and the natural world. Quantitative measures revealed an increase in mean scores for children's connectedness to nature, though only increases in the INS scores were statistically significant. Findings suggest that interventions that seek to impact a child's environmental identity ought to include opportunities for free-choice learning and exploration, specifically address children's comfort in nature, and include simple, easily accessible practices that encourage quiet observation, appreciation, and reflection. Influencing a child's environmental identity through field-based interventions with school groups may provide a useful strategy for elementary science educators who strive to increase children's interest in science at school.

## Introduction

Environmental educators have long asserted that education about and in the environment is essential to fostering a lifelong care, concern, and interest in the natural world that is necessary to encourage pro-environmental attitudes, behaviors, and decision-making (Rickinson, Dillon, Teamey, Morris, Choi, Sanders, Benefield, 2004). Science educators, recognizing the major environmental challenges facing society, also place a high value on teaching children about the environment (Committee on Conceptual Framework for the New K-12 Science Education Standards, 2012). Science and environmental educators often use very different strategies to accomplish these goals, with school science educators typically focusing on indoor content learning, while environmental educators often address content by incorporating field-based activities and environmental values (Gough, 2002; Smith, 2007; Stevenson, 2007).

However, with some estimates of US environmental literacy rates as low as 1 - 2% (Coyle, 2005), neither approach has been entirely successful. Science educators have been stymied by diminishing student interest in school science as they progress through their schooling, despite their high interest in the natural world (Osborne, Simon, & Collins, 2003; Thomson & Fleming, 2004). Environmental educators continue to be frustrated by the continuing gap between people's environmental knowledge and their willingness to act in pro-environmental ways (Kollmuss & Agyeman, 2002).

In school settings, environmental education has generally been subsumed into the science curriculum (Gough, 2002), without widespread use of outdoor learning experiences

or inclusion of environmental values (Burriss & Burriss, 2011; Carrier, Tugurian, & Thomson, 2013; Stevenson, 2007). This is problematic for two reasons. Without outdoor learning experiences, elementary children may be unable to connect the natural science content they are learning to the world around them (Carrier et al., 2013; Sobel, 2004). In addition, some researchers feel that traditional school science programs have failed to acknowledge children's ways of thinking and feeling about the natural world, contributing to their disconnect from school science programs (Calabrese Barton & Yang, 2000; Cobern, 2000; Hammond, 2001).

One approach that holds potential for simultaneously enhancing children's connection to school science (Calabrese Barton & Yang, 2000; Cobern, 2000; Lim & Calabrese Barton, 2006; Osborne, 2007) and fostering pro-environmental behavior and values (Cervinka, Röderer, & Hefler, 2012; Clayton & Opatow, 2003; Hinds & Kaiser, 2011; Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009; Perrin & Benassi, 2009; Schultz, Shriver, Tabanico, & Khazian, 2004) is for educators to focus efforts on strengthening the way children relate to the natural world within the context of schooling. The way that children relate to the natural world is generally referred to as their "environmental identity."

Environmental identity has been operationalized as *connectedness to nature*. Connectedness to nature has been measured in children and adults using the Connectedness to Nature Scale, Revised (CNS-R) (Frantz et al., 2013) and the Inclusion of Self in Nature Scale (INS) (Liefländer et al., 2012). With these measurements, researchers can now examine specific science and environmental education efforts to determine their impact on connectedness, and thus on children's environmental identity. To date, many such studies

have been done with adults, but there are few examinations of environmental identity in children (Bruni, Chance, & Schultz, 2012; Cheng & Monroe, 2012; Frantz et al., 2013; Kals & Ittner, 2003; Liefländer et al., 2012).

Because there is a great deal more to learn about how children's environmental identities are impacted by intervention, this research study focused on richly describing an intervention with a school group that was designed specifically to enhance children's environmental identity. The present study used a mixed methods case study approach in an effort to more fully understand aspects of programming that are particularly important to enhancing children's environmental identity in the context of schooling. Specifically, the present research sought to understand whether and how the outdoor field trip intervention influenced children's environmental identity by documenting and describing its impact on children in a 5<sup>th</sup> grade class from a public elementary school and exploring the relationship between children's environmental identities and their interest in school science.

The present study investigated the following research questions:

1. What impact does an intervention designed to strengthen children's connectedness to nature have on children's environmental identity?
2. What elements of the intervention impacted children's environmental identity?
3. Does an intervention designed to strengthen children's connectedness to nature impact children's interest in school science?
4. Are there other impacts of an intervention designed to strengthen children's connectedness to nature? If so, what are they?

The goals of this research are two-fold. From a programmatic perspective, it is important to determine which factors foster children's connectedness with nature so that instructional approaches may be designed to increase the general effectiveness of such programs. Secondly, it is important for elementary classroom educators to examine the potential impact that strengthening children's environmental identity may have for enhancing children's interest in school science.

## Literature Review

Long after the Tbilisi Declaration (UNESCO-UNEP, 1978) established the goals of environmental education, researchers are still working to identify the most effective ways of fostering attitudes, motivation, and commitments that encourage responsible action and behavior in support of the environment. A recent popular movement, The New Nature Movement, has suggested that what is most needed to foster pro-environmental behavior and attitudes is simply to get children outside in natural settings (Children and Nature Network, 2013). Advocates for this movement maintain that children's time in the outdoors is greatly diminished, owing to changing residential patterns (toward urban living) and the increasing presence of electronics in children's lives (Clements, 2004; Louv, 2005; Strife & Downey, 2009).

However, research is beginning to suggest that experience in nature alone may not be enough to foster care and concern for the environment (Hinds & Kaiser, 2011; Kals & Ittner, 2003). A growing body of literature supports the idea that changing the way a person relates to and interacts with the environment may be an essential part of modifying behavior and attitudes toward the environment (Cervinka et al., 2012; Clayton & Opatow, 2003; Hinds & Kaiser, 2011; Mayer et al., 2009; Perrin & Benassi, 2009; Schultz et al., 2004). The way a person relates to the natural world has been generally referred to as a person's environmental identity.

## **Environmental Identity**

According to Clayton (2003) environmental identity is “a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world; a belief that the environment is important to us and an important part of who we are” (pp. 45-46). From a theoretical perspective, environmental identity is one of multiple identities that comprise an individual’s more general identity (Stets & Biga, 2003). Identity is generally portrayed as a way of organizing information about the self and is thought to be determined both internally (the way one represents oneself) and externally (the way others see us) (Clayton, 2003). Identities develop over time and change as they are reinterpreted as a product of the social, cultural, political, and physical contexts in which we live (Ryan & Deci, 2003).

A person can have multiple identities (Stets & Biga, 2003). For example, gender can be an identity, comprised of the meaning(s) a person attaches to the societal role of being female, male, transgender, or gender neutral (Stets & Biga, 2003). The physical environment can also be associated with meaning(s) specific to an individual (Stets & Biga, 2003). For example, a person with a strong environmental identity might view him/herself as part of the environment, understanding that his/her actions have direct impact on the environment. Based on this sense of connection with the environment, the individual might choose to limit consumption of resources, drive a hybrid car, or take similar pro-environmental actions. By contrast, a person with low environmental identity might view him/herself as separate from the environment, believing that the natural world is a place for animals and that humans have

little or no impact on it. In this way, environmental identity can serve to define, describe, or place oneself in the world (Clayton, 2003).

### **Children's Environmental Identities**

Children's environmental identities are thought to be emerging as they grow and develop, impacted by their experiences in the natural world as well as socio-cultural influences (Bruni et al., 2012; Liefländer et al., 2012). Children, like adults, may view themselves as a part of the natural world or see themselves as separate from it (Liefländer et al., 2012). According to Kellert (2002), children describe their relationship to the natural world in distinct ways, many of which reflect the extent to which they identify as a part of the natural world. For example, a child expressing dominionistic (control over nature), utilitarian (nature as a source of material and physical reward), and negativistic (fear) views of the natural world may stand apart from the environment, whereas a child holding humanistic (emotional bonding with nature) or moralistic perspectives (spiritual and ethical relation to nature) of the environment may feel more a part of nature (Kellert, 2002).

In research that used structured interviews to examine how sixteen 9<sup>th</sup> grade students and their teachers viewed nature, Cobern (1999; 2000) found that the 9<sup>th</sup> grade students attached substantial meaning to the natural world, including spiritual, mystical, aesthetic, and utilitarian views. He found these views to be largely absent from the students' experience of school science, suggesting that the incongruence of the students' school science and their personal worldviews might alienate them from their school science experience (Cobern et al., 1999). Similar ideas have been proposed by other researchers who advocate that children's interests in and feelings for the natural world should be acknowledged by their science

teachers and embraced especially in their early school science experiences as a way of improving children's interest in school science (Calabrese Barton & Yang, 2000; Cobern, 2000; Lim & Calabrese Barton, 2010; Osborne, 2007). This is relevant because children, who generally have a strong interest in natural science especially at the elementary school level, typically begin losing interest in school science by the end of elementary school (Osborne, Simon, & Collins, 2003; Thomson & Fleming, 2004). They also have difficulty relating the science they are learning in school to the outdoor world around them (Carrier et al., 2013).

### **Components of Children's Environmental Identity**

In unpublished research related to the present study, the author (2014) developed a Proposed Model of Environmental Identity in Children (see Figure 1). This model includes both internal and external factors that appear to shape children's environmental identity. It suggests several components that are significant parts of a child's environmental identity, including the child's experience in the natural world, the child's interest in natural science, and the child's emotional response to the natural world as well as the external influence others (adults and peers). It also includes factors, culture and age, that may influence a child's environmental identity. Efforts to strengthen children's environmental identity typically focus on modifying one or more of these components through some sort of educational intervention.

### **How is Environmental Identity Measured in Children?**

Much of what is known about impacting children's environmental identity has arisen in work focused on the development of instrumentation that can be used to quantify it.

Generally speaking, such work has used the construct *connectedness to nature* as an operational measure of environmental identity (Mayer & Frantz, 2004). The construct of connectedness to nature draws upon the seminal work of the ecologist Aldo Leopold (1949). Leopold maintained that a person's ability to feel responsible for the earth enough to care for it was predicated on the extent to which the individual feels connected to nature as a member of the earth's community. If one feels a part of nature, rather than separate from it, he argued, then one is more likely to protect it. From this perspective, damaging the earth would be perceived as damaging oneself.

While there are a number of instruments that have been developed to measure environmental identity in adults (see Tam, 2013 for a review), two have been validated for use in both children as young as age nine as well as adults. These are Frantz and Mayer's (2004) Connectedness to Nature Scale, Revised (CNS-R) and Schultz's (2002) Inclusion of Self in Nature Scale (INS), subsequently revised with simplified directions for children (Liefländer et al., 2012). Seven of the instruments used with adults (including the CNS-R and the INS) have been found to measure the same general construct (Tam, 2013). Cheng and Monroe's (2012) Children's Connection to Nature Index has also been used to measure children's environmental identity, but has no correlate that has been used with adults, precluding comparison of adults' and children's environmental identities. The Emotional Affinity toward Nature scale (EAN) has been administered in German with 11<sup>th</sup> and 12<sup>th</sup> grade students (Müller et al., 2009), limiting its use in the present study. Similarly, the Environmental Identity Scale (EIS) has been simplified but has not yet been tested in children as young as nine years old (Clayton, 2013).

The CNS-R and the INS have been found to be reliable measures of children's beliefs about their connectedness to nature. Both instruments are accepted measures of environmental identity (see below for validation data) and have been found to measure connectedness to nature as an operationalization of environmental identity (Mayer & Frantz, 2004, Schultz et al, 2002). The CNS-R items are included in Appendix B, while the single INS item is included in Appendix C.

The CNS-R includes 10 items (see Appendix B). This instrument was designed specifically for use with children as young as age 10, has language that is appropriate for children, has been validated for use with low-income populations, and has been shown to have a strong correlation with the CNS, a well-established measure in adults ( $r = .85, p < .01$ ) (Frantz et al., 2013). Like the CNS, the CNS-R is positively correlated in adults with environmentally responsible behavior (ERB), like acting to conserve energy, and support for the environmental movement (Frantz & Mayer, 2013). It has high test-retest reliability ( $r = .82, p < .01$ ) (Frantz et al., 2013).

Similarly, a version of the INS has been used with children, ages 9-13 (Bruni et al., 2012; Liefländer et al., 2012). The INS consists of a single graphic item in which children select from seven pairs of overlapping circles that represent the degree to which the respondent feels he or she is a part of nature (see Appendix C). Due to its construction as a single item scale, it cannot be tested for internal reliability. The INS has high test-retest correlations (1-week:  $r = 0.90, p = 0.05$ , 4-week,  $r = 0.84, p = 0.05$ ) (Schultz et al., 2004). It is correlated with the CNS in its original form ( $r = 0.55, p = 0.001$ ) (Mayer & Frantz, 2004).

In unpublished research with children related to the present study the INS was also found to be correlated to the CNS-R ( $r = .625, p < .001$ ) (Tugurian, 2014).

### **What Impacts Environmental Identity in Children**

Using these various instruments, researchers are beginning to understand more about how to influence children's environmental identity. Several factors have been examined in relation to children's environmental identity, including children's age, the settings of children's experiences, the structure of learning experiences in the outdoors, the duration of outdoor programming, children's emotions about their experiences in natural settings, and the influence of others on children's relationship with the natural world.

**Age and children's environmental identity.** There appears to be an optimal age to impact connectedness to nature in children. For example, in an evaluation of the effects of seven U.S. Fish and Wildlife programs for youth, Ernst and Theimer (2011) reported an increase in connectedness to nature of children in grades 3-6 following participation, with no or negligible increases for children at the high school level. Using the INS, Liefländer et al (2012) found that 9-10 year old children had higher connectedness to nature than did children age 11-13 and that younger children retained gains in connectedness to nature four weeks after a 4-day intervention, whereas older children did not. In his work with children, Kellert (2002) found environmental values emerge at distinct ages with the formation of utilitarian, dominionistic, and negativistic components predominant at ages three to six, while humanistic and moralistic perspectives are more prevalent at ages six to twelve (roughly corresponding to elementary school ages). Given that some researchers believe moral reasoning is important to the development of environmental identity (Kals & Ittner, 2003),

Kellert's work (2002) supports the idea that environmental identity in children between ages six and twelve may be most amenable to intervention. These findings are also supported by other research in environmental psychology suggesting that one's relationship to nature is most positively impacted before age 11 (Kaplan & Kaplan, 2002; Sobel, 2002; Wells & Lekies, 2006). Taken together, this work suggests children's environmental identity may be most successfully strengthened between ages 6-11.

**Outdoors experiences and children's environmental identity.** Given the association of lower connectedness to nature in children with less exposure to nature (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Kossack & Bogner, 2012), it may be particularly critical to provide outdoor experiences in nature to impact connectedness to nature, especially in children with limited experience in the natural world (Kossack & Bogner, 2012). Children's outdoor time has diminished over past generations (Clements, 2004; Louv, 2005; Strife & Downey, 2009). Within a few decades, researchers predict that the majority of US children will reside in urban environments, having greatly restricted access to natural settings (Malone, 2002).

A large body of literature has found that there are many benefits associated with children's experience in the natural world, including improving physical (Frumkin, 2001), psychological (Frumkin, 2001; Taylor & Kuo, 2006), and cognitive well-being (Dillon et al., 2006; Frumkin, 2001; Malone, 2008; Rickinson, 2004; Taylor & Kuo, 2006; Wells & Evans, 2003). With respect to children's environmental identity, Kellert (2002) found that direct physical experience with nature without undue structure and restriction by adults is essential to enhancing children's relationship with the natural world. Connectedness to nature is

strengthened by interaction with nature (Frantz & Mayer, 2013; Liefländer et al., 2012; Russell et al., 2013), especially outdoor activities designed primarily for participants to enjoy and observe nature (Wolsko & Lindberg, 2013). Kossack and Bogner (2012) found that children with lower connectedness are more responsive to interventions centered around experiences in the outdoors, as opposed to strictly content-based indoor interventions. Therefore, research supports the inclusion of field-based activities in nature in interventions to enhance children's environmental identity.

**Structure of outdoor experiences and children's environmental identity.** Though no research has directly evaluated the relationship of the structure of interventions to their impact on children's environmental identity, research from two areas (*significant life experiences* [SLE] and *free-choice learning*) suggest structure may be an important consideration in interventions designed to impact children's environmental identity. A number of scientists and naturalists, including Rachel Carson, E.O. Wilson, Jane Goodall, John Muir, and Richard Feynman attribute their strong relationship to the natural world with the experiences they had as children to freely explore nature (Atkins, 2000; Farber, 2000; Feynman, 2005; The Natural History Museum London, 2007; Wilson, 1995). Chawla (2001, 2006) describes these sorts of free explorations in the natural world as children as having been formative or SLE for many adults who are highly connected to the natural world, impacting their career choices and pro-environmental behaviors and attitudes. Other researchers have described the importance of adventures and exploration of the natural world in children's lives (Cosco & Moore, 2009; Sobel, 1990, 2002).

Exploration in the natural world by children that is relatively free from structure may be considered to be an example of free-choice learning. Free-choice learning is characterized as driven by the interests of the learner, rather than an external authority like a teacher or curriculum (Falk & Dierking, 2002). Environmental educators have found a relationship between free-choice learning experiences and pro-environmental behaviors and attitudes in children (Ballantyne & Packer, 2005). More generally, field trips that provide a moderate amount of structure in combination with free exploration are most likely to maximize cognitive and affective outcomes (DeWitt & Storksdieck, 2008). Therefore, inclusion of free-choice learning experiences in the natural world, like children's exploration and discovery in nature, may also strengthen children's environmental identity.

**Time in natural settings.** Field programs offer a great deal of potential to educators who seek to impact children's environmental identities (Ballantyne & Packer, 2005; Ernst & Theimer, 2011; Frantz & Mayer, 2013; Theimer & Ernst, 2012), but the frequency and duration of them may impact the degree to which they impact children's environmental identity.

The limited research in the field of children's environmental identity suggests that one-day interventions have less impact on connectedness to nature than do longer interventions (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Liefländer et al., 2012; Theimer & Ernst, 2012). Ernst and Theimer (2011) evaluated the impact of seven field programs used in conjunction with the U.S. Fish and Wildlife Service on children's connectedness to nature. They surveyed 385 students, comparing children who participated in environmental education programs to those who did not. Using Cheng and Monroe's

(2012) Connection to Nature Index and an instrument developed for the study, the Nature Connectedness Inventory, they found only two of the seven programs fostered connectedness to nature. They attributed this to differences in duration of the programs (with longer interventions supporting increases in connectedness to nature) as well as the age of the children involved in the intervention. Children in grades 3-6 were found to show increased connectedness to nature as a result of participating in a field program. Similarly, Liefländer et al (2012) found increases in connectedness to nature using the INS with children ages 9-10 and 11-13 as a result of participation in a four-day program at an environmental education center. More generally, repeat visits to the same site have been found to increase the long-term impact of field trips, making them seem more personal and more memorable to students (DeWitt & Storksdieck, 2008). It appears that multiple visits to the same site to foster children's environmental identity.

**Location of outdoor experiences.** Wells and Lekies (2006) have found that while experiences in both “wild” (less obvious human impact) and “domesticated” (obvious human impact) foster pro-environmental behavior and attitudes, engagement with “wild” environments before age 11 shows a stronger correlation with adult's later pro-environmental behaviors and attitudes. They describe activities in “wild” environments as hiking, camping, playing in the woods, and fishing, in contrast to activities in “domesticated environments,” which may involve picking flowers or produce, planting trees or seeds, and caring for plants. Insights from general research related to field programs may also shed light on the possible impact of site selection in enhancing children's environmental identity. The novelty of the trip setting may detract from children's cognitive and possibly affective outcomes, especially

if the setting is very new or very well-known to the participants (DeWitt & Storksdieck, 2008). Children may be overwhelmed if the setting is so remote as to be perceived as threatening to them (Bixler, Carlisle, Hammitt, & Floyd, 1994 & Floyd, 1994). These findings suggest that children benefit from a setting that provides opportunities for safe encounters with wildlife, as these evoke strong emotional responses in children (Ballantyne & Packer, 2005; Ballantyne, Fien, & Packer, 2001). Settings that provide opportunities for safe observation of animals and other organisms in natural setting slightly different and more remote from children's prior experiences may best promote children's environmental identity.

**Addressing children's feelings about nature.** Researchers have suggested that it is extremely important to address children's affective feelings and emotions about the natural world to enhance their experience of it, especially if the goal is to influence children's environmental identity (Hinds & Kaiser, 2011; Iozzi, 1989; Pooley & O'Connor, 2000). Field experiences have generally been found to have strong affective outcomes (Storksdieck, 2011), although such outcomes may be negative, depending on children's particular experience of the setting (Falk & Dierking, 1997). While cognitive impacts on field trips are often short-lived, positive affective impacts tend to be long-lasting (DeWitt & Storksdieck, 2008).

Enhancing children's positive feelings like fascination, curiosity, and joy about nature has been associated with strengthening children's environmental identity (Kals & Ittner, 2003). In practice, environmental connectedness in children appears to be only moderately impacted by strictly knowledge-based interventions that do not address the affective realm

(Ernst & Theimer, 2011; Theimer & Ernst, 2012). Many children have a depth of feeling about the natural world that often includes spiritual, mystical, and aesthetic views (Cobern, 2000). Children's comfort levels in the natural world can be improved by including learning experiences in the outdoors (Carrier-Martin, 2003). Children often have fears about the natural world that may impede their experience of nature (Bixler et al., 1994). Given these fears and the depth of children's emotional attachment to nature, addressing the affective realm may be particularly critical to enriching children's experience in the natural world as well as their environmental identities.

**External influences on children's environmental identity.** A person's environmental identity has been shown to be reinforced by others (Stets & Biga, 2003). For example, a person may come to see nature as more important because others affirm and validate his/her environmental identity (Clayton, 2003). In a child's life, parents, teachers, and peers may all contribute to the child's environmental identity. It seems important for efforts to strengthen children's environmental identity to focus some attention to strategies that might heighten this contribution.

**Parents.** Because parents limit children's access to the natural world, they directly control the location, structure, and amount of time that characterize children's experience in the natural world. Cheng and Monroe (2012) found that experiences that encourage environmental values in family members are more effective at strengthening children's connectedness to nature.

**Teachers.** In the context of school, teachers also directly influence children's experience of the natural world by controlling their access to it. While geographic factors

may also determine a child's access to nature, teachers can communicate a general support for a child's environmental identity by providing outdoors activities like gardening, nature walks, science lessons, or field trips (Ko & Lee, 2003). Likewise, a teacher's enthusiasm for the environment provides a model that may influence a child's thinking about the environment (Carrier, Tugurian, & Thomson, 2013). Teachers may also contribute to a child's interest in natural science by directing them to information and resources especially related to those interests.

Teachers can also have a substantial impact on the degree to which a field program is successful in accomplishing its goals in the way the field trip is presented to students (enthusiasm, apprehension, etc.), the amount of pre-trip preparation, setting expectations for the trip, and the extent of post-trip follow-up (DeWitt & Storksdieck, 2008). It is also important for the field trip host to develop programs aligned to curricular goals to enhance the likelihood of teacher's support of the program (DeWitt & Storksdieck, 2008). Therefore, it may be important to clearly communicate the goal of strengthening children's environmental identity to teachers and help them understand the value of impacting children's environmental identity as part of their instructional objectives.

**Peers.** Though no research has directly assessed the role of peers in determining children's environmental identity, a child's classmates and friends may influence his/her thinking and feelings about the environment. For example, as a child ages, peers become relatively more important in influencing his/her attitudes about science. Osborne et al.'s (2003) review of students' attitudes about science summarized this influence, finding that students are influenced by group norms. The review also found this influence is particularly

strong from age 11, peaking at age 14. In view of this, and given that peer interaction, especially as members of groups, is an important contribution to environmental identity in adults (see Clayton & Opatow, 2003), peers most likely impact environmental identity in 5<sup>th</sup> grade children. It is possible therefore that programs designed to impact children's environmental identity should provide opportunities for social interaction in nature as well as discussion about nature among children when possible.

### **Relationship of interventions to strengthen children's environmental identity to children's experience of school science**

Interest in science is described as a state of heightened affect for science, as well as the willingness to re-engage with science (Hidi & Renninger, 2006). Despite their high interest in the natural world, children have been shown to generally lose interest in school science as they move toward middle school (Osborne et al., 2003; Thomson & Fleming, 2004). In particular, girls, who have strong interests in biology in elementary school, have diminished interests in science at the secondary level (Jones, Howe, & Rua, 2000; Miller, Slawinski Blessing, & Schwartz, 2006). Though many factors may contribute to children's loss of interest in school science, some authors have suggested that one possible explanation for children's disengagement with school science is the inability of traditional school science to acknowledge children's emotional way of thinking about nature (Calabrese Barton & Yang, 2000; Cobern, 2000). Jung (as cited by Kossack & Bogner, 2012) identified emotional experiences in nature as critical to providing motivation for learning natural science.

In unpublished research by the author related to the present study, children's interest in science was found to have a positive correlation with children's environmental identity

(Tugurian, 2014). Children are highly interested in the world around them, particularly in animals (Osborne, 2007; Osborne et al., 2003). Research suggests that interest in biology is augmented by outdoor field lessons (Baram–Tsabari & Yarden, 2008) and that increasing children’s experience in the natural world improves children’s more general interest in science (Lindemann-Matthies, 2005; Zoldosova & Prokop, 2006). In a study of sixth grade students, researchers investigated children’s interest in biology, ecological knowledge, and willingness to consider a career in biology before and after a single-day field program in freshwater, meadow, and woodland habitats (Prokop, Tuncer, & Kvasničák, 2007). They found increases in all three areas in comparison to a control group, measured at 3-days and 1-month post-trip.

Learning in the outdoors also has the potential to enrich science lessons by providing sensory and contextual information that anchors science lessons in the real world (Ives & Obenchain, 2006; Malone, 2008; Rivkin, 2000). When science is taught in the outdoors, student interest, motivation, emotional development, and cognitive gains are enhanced (Dillon et al., 2006; Malone, 2008; National Foundation for Educational Research in England and Wales & Dillon, 2005). Schoolyard science lessons have been found to improve student’s environmental attitudes, behavior, and outdoor comfort levels (Carrier, 2009). Incorporating outdoor experiences in science lessons has also been linked to improved science test scores, increased ability to apply science concepts to real-world situations, as well as increased enthusiasm and interest in science (Lieberman & Hoody, 1998). Free-choice learning environments, like those that children may encounter in outdoors settings, have been found to improve middle school students’ scientific reasoning abilities (Gerber,

Cavallo, & Marek, 2001). They have also been linked to fostering children's interests in science (Renninger, 2007), asking and seeking answers to questions (Renninger, 2000) as well as science learning (Falk, 2001, 2005).

Despite the benefits of outdoor experiences, traditional elementary schools rarely include outdoor learning opportunities (Burriss & Burriss, 2011; Carrier et al., 2013; Smith, 2007; Sobel, 2004). Instead of designing science activities that relocate learning from the classroom to the outdoors, teachers tend to base instruction indoors (Dyment, 2005), often relying on print and web-based media to teach children about the natural environment. Perhaps as a result, children often fail to connect their experiences in science class to the outdoor world around them (Carrier et al., 2013).

Interventions that target children's environmental identity have the potential to help children build connections between the science they are learning in school and the science integral to understanding the natural world. Such interventions could provide experiences that help anchor concepts addressed in the classroom to observable phenomena in nature. Further, they could help science educators recognize and enhance children's environmental identity in the context of school, fostering students' perception that science is inclusive of their interests and their preferred ways of knowing about the natural world.

### **Brief summary**

Our current understanding of the relationship of interventions to environmental identity suggests that in order to fully contribute to children's connectedness to nature: experiences in the outdoors must be supplemented by strategies that specifically address the affective domain as their primary emphasis or as a supplement to cognitive elements (Ernst

& Theimer, 2011), experiences should be frequent or occur over a sustained period, including repeated visits to the same site (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Liefländer et al., 2012; Theimer & Ernst, 2012), the impact of experiences are enhanced by inclusion of family outreach efforts (Cheng & Monroe, 2012), and experiences should optimally occur before the child reaches age 11 (Liefländer et al., 2012; Wells & Lekies, 2006).

Additionally, research related to field trips suggests that a combination of free-choice and structured activities, visits to sites slightly more remote than those to which children are accustomed, together with use of outreach to teachers may be particularly effective in enhancing the goals of the program (DeWitt & Storksdieck, 2008).

Teachers may miss an important opportunity to enhance children's interest in school science because of their lack of orientation to children's environmental identity by locating instruction indoors and their lack of focus on the emotional components of how children relate to the natural world. It appears that the use of field interventions to strengthen children's environmental identity in the context of elementary school science may have the simultaneous benefit of improving children's environmental identity while positively impacting children's interests in school science.

The present study explored the relationship of children's environmental identity and interests in school science by using a case study to investigate and describe the impact of a two-visit outdoor-based program on children's environmental identity alongside children's perceptions of school science. The case study is used to highlight aspects of intervention that were particularly effective at impacting children's environmental identity. It concludes with a discussion of implications for science and environmental educators.

## Methods

### Research Design

A mixed methods approach was used in the present research study. The design involved both quantitative instruments to assess children's connectedness to nature and a qualitative case study (Yin, 2009) on a field trip intervention designed to improve children's environmental identity. The case study data included qualitative analysis of interviews, classroom artifacts, and observations of field experiences with a class of 5<sup>th</sup> grade children who participated in programming that was designed to strengthen their connectedness to the natural world. As is frequently done in case studies (Yin, 2009), and because of the small size of the intervention group, the quantitative measures were used to support qualitative findings. The quantitative measures, the CNS-R (Frantz, 2013) and the Children's INS (Liefländer et al., 2012; Schultz, 2001, 2002), were combined in a single survey that was administered prior to and immediately following the intervention. Quantitative data in the intervention group of children ( $N = 21$ ) were compared to a control group of children ( $N = 44$ ) who did not participate in the intervention.

### Study Context

The research was conducted with all ninety-six 5<sup>th</sup> grade children, ages 10-12, from a suburban public elementary school serving grades K-5 in the Southeastern United States. The school's overall population was diverse with just over 50% of the children receiving free-reduced lunch, indicating low socio-economic status. The 5<sup>th</sup> grade population was

generally reflective of the overall school population: 25.0% Black, 29.1% non-White Hispanic, 31.3% White and 14.6% Other. The 5th grade was 52% female and 48% male.

The school was selected for its diversity and interest in outdoor learning as well as the willingness of its staff members to be involved in the research investigation. Each year, children in this school at every grade level participate in a school-wide field trip to a local nature preserve, so it was assumed that the majority of 5<sup>th</sup> grade children had experienced at least one and possibly four class field trips into the forest.

### **Study Participants**

Fifth grade was selected as the focus grade of the present study for three reasons. First, the age of children in this grade level corresponds to the age of children appropriate to the instrument design (Frantz et al., 2013; Liefländer et al., 2012). Second, research suggests children under the age of eleven are most likely to respond to an intervention focused on strengthening connectedness to the natural world (Ernst & Theimer, 2011; Wells & Lekies, 2006). Third, two of the major units of study in the 5<sup>th</sup> grade science curriculum relate to the environment: weather and ecosystems. Therefore, all children in the study (control and intervention groups) had exposure to classroom-based instruction specifically related to the natural world, with the 5<sup>th</sup> grade children in the three remaining classes providing a control for the intervention class.

During this study, fifth grade teachers at the study school planned together using state-mandated science standards as a framework. Although there were slight differences in instructional delivery, the content of classroom science instruction was fairly uniform across

the grade level, as indicated by artifacts of classroom planning. Science was taught for approximately 45 minutes a day in this school.

The entire 5<sup>th</sup> grade was invited to participate in the collection of survey data. Written parental permission was requested (in English and in Spanish). All 5<sup>th</sup> grade children participated in the pre- and post-intervention survey (see Appendix A) as part of regular classroom instruction. Pre- and post-intervention surveys were administered six weeks apart. Parental permission to use survey data were obtained from 65 children (67.7% of the entire 5<sup>th</sup> Grade). Descriptive data related to the study participants is provided in Table 1.

One of the fifth grade classes (24 children) and its teacher were involved in the field trip-based intervention designed specifically to impact children's relationship with the natural world. The intervention class participated in two full-day field programs at the Center, separated by approximately three weeks. This group formed the treatment group for the present study. The class was selected as a convenience sample (Given, 2008) because of the teacher's willingness to participate in the field study. Twenty-one of these children returned parental permission for the researcher to use data from the survey. Seventeen of these children also had permission to be interviewed by the researcher. The remaining 5<sup>th</sup> grade children took the pre- and post-surveys without participating in the field trip.

The intervention group participated in two field trip experiences (separated by three weeks) that took place at the Center for Education, Imagination, and the Natural World (the Center) (Center for Education Imagination and the Natural World, 2012). The Center is situated in a mixed woodland habitat with trails and a few buildings (relatively minimal human influence). The Center is identified as a North Carolina environmental education

center (<http://www.eenorthcarolina.org/ee-centers.html>); however, it is best described as an eco-contemplative program that seeks to foster children's connectedness to nature. Its mission is somewhat different than that of traditional environmental education centers, which typically focus on developing both content knowledge and attitudes toward the environment. Instead, the Center offers a unique program that focuses on cultivating children's connectedness with the natural world. The work of the Center is based in the teachings of Thomas Berry (1988, 1999), who was a noted ecotheologian or geologian, the term Berry preferred.

On each visit to the Center, the 5<sup>th</sup> grade children in the intervention group participated in a program called "Awakening to Nature" (<http://beholdnature.org/awakeningtonature.php>). Each program lasted approximately four hours. The program was developed around a threefold practice of "being, beholding and belonging." Being is described on the Center's website as "bringing ourselves into stillness, quieting the chatter of our own minds" (<http://beholdnature.org/programsforchildren.php>). Beholding is considered to be "engaging in practices that bring us into relationship with the natural world." Belonging involves "feeling a sense of oneness with the source of our own being." In the program, children began their day as a group in a circle around a campfire with the practice of being. This was designed to settle, calm, and focus the children's attention on the natural world around them. At the fire circle, the Center leader played music on a Native American flute.

During the beholding practice, the class was divided into groups of approximately eight children, with each group led by an adult leader or earth guide, as they are called at the

Center. During this portion of the program, children were given a chance to directly experience the natural world by participating in guided earth walks that involved independent exploration as well as group discoveries of natural wonders encountered along the walk. In general, children were given wide berth to explore the woods within a general geographic area along the trail and within sight of an adult associated with their small group.

During the earth walk, children participated in several different activities and practices. For example, children experienced an activity called the “Trail of Beauty.” Children began this activity with the practice of being. The leader centered the children and called their attention to the quiet of the forest surrounding them. She explained the activity would be done in silence, but children could use gestures to point out anything of beauty to a partner as they walked along the trail. Children were asked to behold whatever their partner had discovered by observing it closely, quietly, and respectfully and then returning it to its place in the natural world (if it had been held). The leader started down the trail alone and the first pair started shortly after her; the three other student pairs followed behind, with enough space between the pairs to give a sense of being somewhat isolated in the woods as they walked. The leader waited for the pairs to arrive at a designated spot down the trail. This activity took about thirty minutes and concluded with group reflection.

Each day’s program also ended with a period of whole group reflection. During this reflection, children shared the experiences and organisms from the day that were meaningful to them. This was intended to bring the children into community with each other and with the life that surrounded them.

One of the intentions of the program at the Center was to intentionally address children's comfort in natural settings. This was accomplished in two ways. First, fears were specifically discussed during the opening circle on the first day before children embarked on their walks through the forest. The other method of addressing children's comfort levels was to introduce the land at the Center as a sanctuary, where the animals, plants, and land itself was protected and safe. This sense of sanctuary was extended to the children by explaining that they too were members of the natural community and would also be safe in the sanctuary and that worries could be left behind.

At the Center, the classroom teacher was encouraged to participate in the program as a learner. She was asked to defer classroom management to the Center educators. This had the dual purpose of giving the teacher an opportunity to share the experience with her students while at the same time helping the Center educators redefine the experience of the natural world in the context of schooling by encouraging exploration, freedom of movement, and expression of emotions.

### **Data Sources and Analysis**

**Qualitative data sources.** Qualitative data included pre- and post-intervention interviews with the 17 children in the intervention class from whom interview permission had been received; interviews with the classroom teacher before, between and after the field trips; a post-visit interview with the lead educator at children's environmental identity; researcher observations and field notes; and classroom artifacts including field trip responses. These qualitative data illuminated the components of the experience at the Center impacted children's connectedness to nature and were augmented by quantitative measures of changes

to environmental identity. Pseudonyms were assigned to interviewed students post-analysis to maintain children's anonymity.

The researcher observed both field trips and documented the experience using photographs and field notes. Field notes were reviewed separately with the lead teacher at the Center and with the classroom teacher to ensure they were an accurate representation of the field experiences. All children in the intervention group with parental consent (17 children) were interviewed prior to the first visit to the Center and again immediately following the second field trip. The student interviews were conducted in a private setting with minimal disruption to instructional time using a face-to-face, semi-structured format. The researcher used a set of prepared questions as the frame of the semi-structured interviews with children (see Appendix D). The pre-intervention interviews probed children's initial relationship with the natural world, providing a deeper understanding of children's baseline environmental identity. The post-field trips interviews specifically examined the impact the program may have had on children's thinking about the natural world. Interviews were audio recorded, transcribed, and coded by two researchers using qualitative analysis software Dedoose (<http://www.dedoose.com/>). The first author used a set of a priori codes with the interview questions as a frame, then developed a set of inductive codes based on participant responses to those questions (Johnson & Christensen, 2008). For example, children were asked to recall experiences they had on the field trip. "Experience in nature" served as the a priori code, while the actual experiences children described (e.g., observing animals, relaxing, learning about nature, spending time with a friend, tree-climbing) were coded as they emerged from the data. Examples of codes are provided in Tables 2 and 3. Using Dedoose,

initial inter-rater reliability was 86%. Researchers discussed and resolved differences, then coded transcriptions and written survey responses. The data were then analyzed for counts, trends, and themes using Dedoose. Coding data revealed trends and themes related to children's developing relationship with the natural world as well as their interest in and feelings about school science before and after the field experiences.

**Quantitative data sources.** The quantitative survey (see Appendix A), which included the Connectedness to Nature Scale Revised (CNS-R) (Frantz et al., 2013) and the Inclusion of Nature in Self Scale (INS) (Liefländer et al., 2012) was administered approximately six weeks apart pre- and post-intervention by the researcher during science class in written format to all 5<sup>th</sup> grade students, though data were only gathered from children from whom parental permission had been received. IBM SPSS Statistics, version 19, was used for the statistical analysis. ANCOVA was used to analyze the pre-post survey, comparing the intervention group against the control group to quantify the impact of the intervention.

In addition to the two instruments embedded in the survey, demographic information was collected including gender, ethnicity, and age. As part of demographic data collection, children also were asked to respond to one Likert scale item related to their self-described interest in elementary school science, "I am interested in science" (1=strongly disagree, 5=strongly agree). Identifiers were used in place of names on the survey in the control group for anonymity and to match pre-post responses. Student names were replaced by pseudonyms in the intervention group, post-analysis.

### **Limitations of the Study**

Because the present research focuses on 5<sup>th</sup> grade children, it is intended to provide only a snapshot children's relationship to the natural world and the impact of the present intervention. Conclusions are limited by the small size of the study population. Children in this study live in a suburban area of the southeastern United States. Therefore, this data may not be representative of children from urban area schools, sparsely populated rural areas, or underdeveloped nations. The present study is not intended as a program evaluation, and cannot be used to generalize the impact of the intervention beyond this study.

## **Results**

The class involvement in the program at the Center resulted in several distinct changes that were documented both qualitatively and quantitatively. They included impacts to children's environmental identities and their interests in school science, but also some impacts that were unanticipated, like changes in the class social structure. The results are presented in relation to the study's research questions, using examples from observations of children's field trip experiences as well as from their descriptions of the experiences harvested from writings, drawings, and interviews. In addition, data from teacher interviews (including the leader of the Center program and the classroom teacher) were used to support these findings. The results conclude with a presentation of impacts of the intervention related to children's general interests in science at school.

### **What Impact Does an Intervention Designed to Strengthen Children's Connectedness to Nature Have on Children's Environmental Identity?**

**Overall environmental identity.** Children's environmental identity was assessed qualitatively prior to and following the intervention using interviews (with the teacher and children), field notes, and classroom artifacts. In interviews with children, the term "nature person" or "nature kid" was used as a proxy for environmental identity. Children were asked to define the term "nature person" and to describe themselves as a "nature person" or "not a nature person." They were also asked to identify any classmates that they viewed as "nature people" and explain why they felt these children were "nature people." These data were

supported by quantitative measurements of children's connectedness to nature using the CNS-R and the INS.

***Quantitative measurement of connectedness to nature.*** Sixty-five 5<sup>th</sup> grade children ages 9-12 participated in the pre- and post-intervention survey, which also solicited responses to several descriptive items (including age and science interest at school) as well as the two study instruments (the Connectedness to Nature Scale (CNS-R) and the Children's Inclusion of Nature in Self Scale (INS)). Paired t-tests were used to examine statistical significance of differences between pre- and post-intervention scores in the control ( $N=44$ ) and intervention groups ( $N=21$ ). ANCOVA was also used to analyze differences in scores on the pre-and post-survey, comparing the intervention group ( $N=21$ ) to the control group ( $N=44$ ) to look for impact of the intervention, not predictable by the pre-test (Knapp and Schafer, 2009).

*CNS-R.* The mean of the intervention group CNS-R scores increased by 0.19 points from pre- to post-intervention, whereas the control group CNS-R scores remained nearly constant. Paired t-tests revealed no statistically significant differences in pre- and post-intervention CNS-R scores in the control ( $t(43) = .157, p = .876$ ) or intervention [ $t(20) = -1.848, p = .079$ ] groups. In ANCOVA, the main effect of the intervention on CNS-R score was not significant [ $F(1, 62) = 2.31, p = .13$ ]. A summary of pre/post-differences on the CNS-R is provided in Figure 2.

*INS.* The mean scores for the intervention group INS increased by 0.33 from pre- to post-intervention, while the control group INS scores declined. Paired t-tests revealed statistically significant differences in pre- and post-intervention INS scores in the intervention group ( $t(20) = -2.092, p = .049$ ) but not in the control group [ $t(43) = 1.564, p =$

.125]. Using ANCOVA, the main effect of the intervention on INS score was not statistically significant [ $F(1, 62) = 3.44, p = .07$ ]. Pre- and post-test data from the INS are provided in Figure 3.

***Qualitative description of children's environmental identity.*** Of the 17 children interviewed, nine children (five boys and four girls) identified themselves as “nature people” prior to the field experiences at the Center. After the field experiences, 15 of the 17 children (including the nine children above) described themselves as either “sort of nature kids” or “nature kids,” suggesting that the intervention impacted the children’s self-identification with nature.

Four of the 17 children interviewed described themselves as “not nature kids” before the intervention. After the intervention only two of these children continued to describe themselves as “not nature kids.” One of these children, Bill, who had been reluctant to go on the first field trip, was an eager participant on the second trip. He accounted for his enthusiasm by saying “It’s different at the Center” than what he expected. This change in his thinking surprised his classmates and his teacher, who thought Bill would not enjoy being in the woods. Carla, in contrast, remained quiet and reserved during the trips. It is unclear that the experience changed either child’s willingness to seek out other opportunities to be in the natural world, but both expressed a desire to return to the Center.

The impact of the intervention on children’s environmental identity can be illustrated by describing the transformative experience of one child. At the time of the study, Eliza was a ten-year old White female who had some prior experiences in natural settings, which she said was “right behind our house.” She described that her parents “like nature and they enjoy

being outside,” but she had “never really seen them go outside, just to be in the woods or just wander around.” She described her sister as “more of a nature kid than me,” and most of her experiences in natural settings as time spent reading, walking the dog, picnicking with her family, or playing with her sister. She liked to go outside to sit or play under a tree and “have some quiet.”

In the pre-intervention interview she described herself as “not really” a nature person. Similarly, her teacher and her classmates did not identify her as a nature person. After the field experiences, she described herself as a nature person. “Well, not totally, but kind of, but more than I was before I went on the trips...before I was about the gross bugs and stuff...I was kind of like-- spiders, bugs, ooh, but then after I went, I was like, that’s not even a third of what nature really is.” The evolution in Eliza’s relationship to the natural world was also evident to both her teacher and her peers, who recognized her as a “nature person” after the trips.

On the pre-intervention survey, Eliza wrote, “To me, nature is a big part of the world because it gives you oxygen.” In contrast, on the post-intervention survey, she described nature as “a place where I can feel safe and know that I am free.” This demonstrates an evolution in her thinking and feeling about nature, from a utilitarian view to a relational knowing about the world around her. In her field trip reflection after the second trip, she wrote “When I say [I went into the woods], you think gross, all there is is a [w]hole lot of bugs. That is true. But [it is] the last thing I would think of [now]. This place makes me wonder about every little thing...This was a great moment to reflect on my life and to see that nature is more than gross bugs and spiders. That is why I love nature now!”

### **Central components of children’s environmental identity.**

*Emotions about the natural world.* The program at the Center involved a deliberate effort to address children’s emotional connection to the natural world by fostering the idea that natural world was a safe place for the children. Children were encouraged to discuss their fears openly, offered models of how they might respond to those fears, and introduced to the Center as a sanctuary. Children referred to these efforts specifically in post-intervention reflections and interviews. Additionally, many children expressed a post-intervention pride in their accomplishments related to increased comfort in natural settings.

*Fears.* For the children in the intervention class, their lack of comfort in natural world was primarily centered around fears about animals (particularly snakes, spiders, and insects). Several children attributed a change in their fears directly to their experience at the Center. For example, John said:

This isn’t minor. I used to be really afraid of things like daddy long legs. And spiders. Like I didn’t want to touch any of them. And I still don’t want to touch spiders...But I used to not want to like be in the presence of one. And last time [at the Center], I took a close look at a spider that was really big. And normally, I would have just covered away.

According to the lead Center educator, an unusual conversation arose in the opening circle during the class’ second field trip. Rachel, a self-described “nature kid,” spontaneously asked the Center leader “Have you ever conquered a fear?” This question led to a 25-minute discussion of fears, largely focused on, but not limited to, the natural world. Reed, also a self-described “nature kid,” described a lifelong fear of water, admitting to his classmates that he

was afraid to swim. Several other children shared their fears as well. The child-initiated discussion was “deep for ten year-olds” (according to their teacher) and led to children offering suggestions on how their classmates might be able to overcome fears, including “just doing it,” “try it by yourself where no one can laugh,” and “learning more about it because if you know more maybe you won’t be afraid.” It also appeared to have impacted the children beyond their experience at the Center. Rachel directly attributed her ability to conquer her fear of heights at an amusement park, a few weeks later, to this discussion. “I was scared I might fall. And I was scared I might like break my head on the drop. But I was like, ok, I’m just going to have to conquer this fear. I’m going to do it, I’m going to do it. I did it...I was just so proud that I conquered my fear.”

*Safety/sanctuary.* The idea of the forest as a sanctuary resonated in several ways with children in the intervention group. John and three other children valued the sanctuary as a place where not only the animals were protected, but they could also feel safe. “I felt... at home almost. Because I liked being out there. I felt safe...But if someone threw me out in the middle of the city, I wouldn’t feel as safe.” For Ramon, this meant feeling safe to face new challenges. His teacher described his fear about jumping across the creek. “He jumped. And the look on his face was I can’t believe I just did that. And I don’t think I would have ever seen that look in a classroom.” At the Center, children also felt safe enough to share personal issues publically with other children, as evidenced by their discussions of fears.

After the intervention, children demonstrated their new comfort by risking participation in new activities on the playground that they had experienced while at the

Center. For example, the experience of jumping in leaves at the Center, a first for several children, inspired a similar event several weeks later. The teacher described the following incident during recess:

We were out at recess and I see Liliana and Alejandra, and Steven carrying leaves...I walked over to them and said, "Hey, what are you doing?" I mean, I knew exactly what they were doing. And they looked at me like, oh man, we're in trouble. And Liliana says, "We're making a pile of leaves." And Alejandra blurts out, "We're going to jump in them." [Soon], the kids were picking up the leaves and throwing them in the air and watching them spin. The kids were twirling around in them...I've never seen them make a leaf pile before at recess.

For children, the sanctuary also was a place of quiet and relaxation in nature. The teacher noted that several children who were either more quiet than usual or especially appreciative of the quiet on the trip. For example, of Lacey, she commented, "She's said a lot about the stillness of being there. And the calmness of being there...So peaceful. Serene." Children frequently used the words "peaceful" and "quiet" in written reflections to describe their experiences at the Center. They also described how the experience of being in the woods at the Center helped them deal with stress they were feeling.

Activities that were designed specifically to reduce stress were described as meaningful by children in post-intervention interviews. For example, one activity involved a solo walk along a low, wooden bridge that crossed a marsh. Liliana recalled, "The earth guides said to think about things you don't want to, or that you want to change about yourself. Like if you're mad about something, just to get over it. And we just walked slowly

over it (the bridge), and get to the end, and leave those things behind. I let go of kind of getting disappointed about things like all the time...I felt good at the other side.”

Some children had never previously experienced the natural world as a place for reflection and restoration. Said Michael, “I found that nature can be a good place to be when you’re trying to get something off your mind. Because I had a lot of things going on and like, so, it was good to like get a break. And not like play video games. Getting out, having new experiences.” Children especially appreciated the time in the fire circle to express their thoughts, listen to others, and hear the flute music. Post-intervention, several children described just being silent as something they like to do in nature.

*Freedom.* One of the words frequently used by children before and after the intervention to describe their experience in nature was “free” (see Table 3). The perceived freedom associated with the intervention seemed to be empowering to the children by fostering a feeling that they were directing the learning experiences, discovering things that interested them. One student reflected on the experience, “Everything is led by the students and what the students wanted to do and the adults said they could do it.”

Though the structure of activities at the Center was perceived by the children as much less constrained than school, children were generally calm, even quiet when in the woods. This quiet was surprising to many. Said one, “It was so quiet. It was very weird because no one was talking and that does not ever happen.” Given the degree of freedom given to children, the teacher also expected more unruliness. She said, “They were just so different out there. I can’t really quantify it...They were so appreciative, so free.”

*Interest in the natural world.* Although the program at the Center was not intended as an intervention to improve children's interest in natural science, it was evident that children were highly interested in the animals, plants, and other organisms that they encountered in the woods. While some of this interest pre-existed the field experiences, qualitative data suggest that the intervention impacted children's interest in the natural world by narrowing their focus to specific organisms and phenomena that they had observed at the Center, fostering a sense of wonder about the natural world as indicated by their use of the words "awe," "wonder," and "beauty" in reflections and interviews and by encouraging their free-choice exploration and investigation.

In post-intervention interviews, children often described how interested they were in what they had seen and heard during the field trips. They also mentioned having excitement and a sense of wonder about the natural world more frequently after the intervention. Steven captured it this way, "I could see that everybody was like searching around and exploring and discovering new things that they never saw before and they're like feeling and touching and using your senses to do that you don't usually do. And they all had a great feeling about it." Similarly, Reed felt the field trip changed his interest in the outdoors. "I go in nature a lot more. Because at that place I saw how cool it is. It's more interesting to go out now." According to the teacher, some of the children pursued these interests upon returning to school by asking to go look things up on the Internet or checking out books from the library. After the intervention, a group of children also initiated a "science explorers" club during recess.

Although the teacher had been unsure whether some of her students would participate in activities at the Center, all children participated in almost all activities while at the Center. Children were engaged in the activities at the Center as indicated by their on-task behavior and participation in discussions. There were no observed behaviors in children that disrupted activities; only minimal behavior re-directions were given to the children by the classroom teacher and Center educators during the time at the Center. In the exceptional case where a child chose not to participate in a portion of an activity, the Center leaders encouraged, but did not compel participation. The child returned to the activity of his own accord.

The class also became more interested in spending time outdoors after the intervention. For example, with their teacher's support, the class opted for outdoor recess several times when inclement weather prevented the other 5<sup>th</sup> grade classes from choosing to play outdoors. Similarly, the experience with the children in the natural world also inspired the teacher to consider redesigning some of her lessons to situate them outdoors. "I have thought about teaching them outside more. Like, what could I teach them outside? What could I move outside that they might have some of those same experiences. Particularly in writing. Can we eat lunch outside when it's nice? Can we bring some of that to school?" Because of her children's strong interests in the natural world, the teacher also solicited and received grant funds to support a third trip to the Center after the conclusion of the research project.

**External influences on children's environmental identity.** The field trips provided an opportunity to enhance both teacher and peer reinforcement of children's environmental

identity through modeling, support and validation. Each will be discussed briefly as they relate to the intervention.

***Classroom teacher.*** The field trips provided an opportunity for the children and their teacher to have a shared experience in the natural world that they had not previously had together. The teacher was able to defer leadership of the activity to the earth guides at the Center. In doing so, she was able model her relationship with the natural world for the children. She reflected, “I feel like I got to participate with them...I felt like I was learning with them.”

The shared experience also helped the classroom teacher learn more about her students so she could better support them as individual learners. She explained, “I feel like I know the kids better. I feel like I saw small moments for each of them.” Among other things, she learned about how strongly some of the children felt about nature, how differently some of them engaged as learners outdoors, their interests in living organisms, as well as their fears about the outdoors. In each of the interviews, the teacher was asked identify the children who she felt were especially interested in the natural world. Before the trips, she identified only two boys as “nature people.” After the trips, she recognized seven members of the class (three boys and four girls) as “nature people.” Back in the classroom, she was able to leverage this knowledge to encourage specific interests. She also described ways she was able to reference experiences that they’d shared during subsequent science lessons, such as in discussions of seasonal changes and weather.

***Other adults.*** It was also evident the earth guides at the Center served as models for the children, especially in how they valued and respected the earth and its creatures. In the

opening circle, the Center leader modeled a way of facing a fear. She described her own fear of spiders and sharing how she had learned to co-exist with spiders like the black widow by trying to understand that the spider had no intent to harm her; if she left the spider alone, it was likely to leave her alone. The modeling of how to deal with fears impacted many children. Angel's remark was representative of several direct references to the discussion during the opening circle. "When we were talking about like how...we're afraid of some animals but they are more afraid of us. Like the spiders, hide. Like when they told that story. They're afraid of us. And we're afraid of them."

*Peers.* Children's support of each other was documented throughout the intervention. As discussed previously, children offered suggestions to others in relation to overcoming their fears about the natural world. The teacher contrasted the discussions at the Center with those children had had at school, "They were not scared to share. They listened to each other...They were pretty respectful to each other." In reflections, children readily offered appreciations for things they felt others accomplished during the time at the Center. For example, Calvin wrote, "I think Steven did a great job. He found lots of cool things and shared it with the group."

Similarly, the field experience gave children a chance to learn more about each other through a shared experience in the natural world, improving the children's recognition of each other's environmental identities. Before the trips, the children identified twelve children (five girls and seven boys) as "nature people." After the trip, sixteen members of the class (seven of the eight girls and all nine boys) were identified as "nature people" by their peers. Children's environmental identities were likely more evident to their peers in

post-intervention interviews because they had been able to see their classmates in a natural setting and talk over the experience with them. Explained one, “When you asked me who is a nature person... I said I don’t think they go in nature like at all, but (on the field trip) I noticed they had a really good time and they were interested in all the things.”

### **Does an Intervention Designed to Strengthen Children’s Connectedness to Nature Impact Children’s Interest in School Science?**

Although science learning occurred in at the Center, children viewed the experience at the Center as very different from their experience of school science. Eliza captured it this way. “ On the field trip, we just walked around and pointed things out. And tried to see, like oh, I’ve never seen this before. What do you think it is? But not necessarily like ok, we’re going to learn about this...On the trip, it’s more like “That’s really cool, I wonder what it is.” It was more about questions than answers. In class, it’s like question-answer. This was more like question-question.” Despite this perceived difference, the field trip experiences appeared to have made an impact on children’s interest in science in school, perhaps because the intervention was undertaken as part of school. This was documented both quantitatively and qualitatively.

#### **Quantitative measurement of changes in children’s interest school science.**

Changes (see Figure 4) in the science interest from pre- to post-intervention were not statistically significant in the intervention ( $t(20) = -2.019, p = .057$ ) or control group ( $t(43) = .313, p = .756$ ). Despite this, changes in mean scores were positive in the intervention group ( $\Delta M = 0.39$ ), while in the control group science interest remained nearly static ( $\Delta M = -0.05$ ).

Additionally, ANCOVA no statistical differences in science interest [ $F(1, 62) = 2.47, p = .12$ ].

**Anecdotal changes in children’s interest in school science.** During between- and post-field trip interviews, the classroom teacher expressed how impressed she was by the number of times children made connections between things they had observed on the field trips and the content she was discussing in class. For example, during a lesson on convection, the children recalled the way the smoke from the fire moved upward and into their faces. She also noted her class’ voluntary participation in an optional Saturday Science Academy. Of the 19 children who initially signed up to participate, 13 were from her class, as compared to six from the remaining three 5<sup>th</sup> grade classes.

### **Are There Other Impacts of an Intervention Designed to Strengthen Children’s Connectedness to Nature?**

**Social impacts of the intervention.** The intervention had several impacts on social interactions in the class. These involved learning about each other and developing a sense of community around their shared experience in the natural world during their time at the Center.

***Learning about each other.*** Many children remarked that they learned about themselves or others in nature as a result of the intervention (see Table 2). Children were surprised to discover each other’s interests in the natural world, sometimes reflecting that they hadn’t had a chance before to see “that side” of their friends. Reed put it this way, “I realized how they’re just like me and really like nature.” New friendships developed related to these newly identified shared interests. For example, six girls and two boys in the class

who don't usually play together formed a science club to observe animals and other organisms in the schoolyard during recess.

Seeing each other in an outdoor setting contributed to seeing individual children in a new light. This was particularly apparent in the case of children who normally had a hard time managing their behavior in the classroom. These children were generally still active in the natural setting, but their behavior was no longer so noticeable or disruptive to others. The experience at the Center gave these children an opportunity to be seen in a new way to members of the class, without the stigma of the distractedness so obvious in the classroom. The teacher remarked:

When I first got back from the trip, I was telling everybody about Thomas. Normally he's very la la landish. He's not hyperactive, but he's often distracted...He'll try hard if I call him out on it. But, without that, he doesn't really care too much. Out there, he was like a different kid. He was totally engaged...He noticed a lot of things. His face was animated. His eyes were lit up. I've never seen him like that.

***Sense of community.*** According to the teacher, the class developed a sort of "all-in" ethos, a sense the class together as a unit, which impacted the classroom culture upon return to school. Many children commented on how glad they were to have been on the trip just as a class and without the rest of the school's 5<sup>th</sup> grade students as typically happened on field trips at the school. This provided a more intimate setting in which the class played together during breaks as opposed to breaking up into establish friend groupings as previously typical at recess. To the teacher's surprise, the games the children played during breaks at the Center were initiated by the children and involved all members of the class. Several children

drew pictures of the tag game as part of their written reflections, showing classmates holding hands across the field, indicating the importance of this experience.

**Children's science learning.** After the field trip, children frequently described engaging in science learning activities in nature, as opposed to general "exploring." They talked specifically about things they noticed, especially the fungi, trees, insects, and spiders. They also noted changes in the way they observed things in nature. Students attributed changes in their ability to observe directly to the practice of beholding and the part of the earth walk called "The Trail of Beauty," during which children silently pointed out things to their partner that they thought were beautiful. Wrote one, "It surprised me (on the Trail of Beauty) when everyone was quiet and Ramon and I could hear, see, and feel so much more! It surprised me because I thought it would just be quiet. But it was more than quiet. We were more susceptible to sounds." After the field trips, several children initiated a "Science Explorers" club during their at-school recess period. They began to regularly use their free time to observe animals and plants together in the schoolyard and to share their discoveries with classmates.

**Imaginative thinking.** The less rigid structure of the activities, perhaps in combination with the richness of the learning environment, seemed to encourage imaginative thinking. At least five of the children described a willingness to think imaginatively during their time at the Center that was uncharacteristic of their usual thinking. For example, at school, the classroom teacher described Michael as a very strong science student and a very compliant, literal thinker. He tended to follow rules and stick to literal and purely descriptive interpretations in science, but the experience at the Center gave him an opportunity to push

beyond this type of thinking. Michael wrote, “During the walk, we noticed a lot of things. I noticed a tree that was bent like an arch and the top was touching the ground. I pretended it was the mirror from *Alice in Wonderland*.” When asked about to reflect on this experience, he said, “I don’t actually pretend that much usually. Not much. It felt pretty good, actually. I know, like my sister, she likes to do that a lot. So, I was surprised that I don’t do it as much. I take things pretty careful I guess. But out there was freer.” According to the teacher, this manifested in a new tendency for Michael to ask more questions in science class, often beginning with the phrase “I wonder if...”

### **Summary of Results**

The intervention at the Center impacted the 5<sup>th</sup> grade children in several ways. After participating in the program, children’s environmental identities were stronger. Mean scores on the CNS-R and INS increased in the intervention group as compared to the control group (see Figures 2-3). Additionally, six more children self-identified as “nature kids” in the interviews after the intervention than they did prior to it.

The stronger environmental identities were also reflected in changes in children’s comfort in the natural world. Several children overcame fears of animals, particularly spiders. Children tried new activities, like climbing trees and jumping in leaves. Additionally, children relaxed in the outdoor setting. They had a new appreciation for the quiet, peaceful setting offered to them by the woods. Children’s interests in the natural world were enhanced by the experience at the Center. For Bill and at least one other student, the field trips greatly enhanced their extremely limited experiences in the natural world, fostering a connection to the natural world they experienced at the Center. For a couple of children

like Leo, the field trips provided an opportunity to “be a kid” and get away from the stress of traditional school experiences. The free-choice structure of some of the activities at the Center fostered children’s positive feelings about nature, especially their sense of freedom in the natural world.

For the nine children who already felt a connectedness to nature, post field trip interviews and reflections indicated the experience enhanced these feelings, giving them an opportunity to explore their own interests and to share their previously less known interest in the natural world with others. In other words, participation in field trips at the Center with their classmates appeared to raise the visibility of their strong but often hidden enthusiasm for the natural world. The shared experience in combination with opportunities for discussion and reflection at the Center appear to provide a basis for external reinforcement of children’s environmental identity through modeling, support, and validation of ways of relating to the natural world.

Children’s interest in science at school increased in the intervention group following their participation in the program at the Center (see Figure 4). This was evident, despite the fact that children made distinctions between their experience at the Center and their experience of school science. The field trips provided a shared experience that the teacher used to anchor classroom science learning.

Several other impacts of the intervention were also documented. The intervention at the Center also impacted the social dynamics of the class. New friendships were established and children appeared to bond over their shared experiences in nature. Science learning took

place at the Center, though it was not the direct focus of the activities there. Imaginative thinking was encouraged by children's experience at the Center.

## Discussion

The research in the present study documented the impact of an intervention designed to strengthen children's environmental identity through a mixed methods case study approach involving a 5<sup>th</sup> grade class, examining strategies that were effective at enhancing children's relationship with the natural world. Data from written reflections and interviews with children and the teacher detailed the specific positive impacts of the program on children's environmental identity and quantitative data supported these findings. This discussion focuses on identifying effective practices and addressing the ways those practices may have been particularly effective at impacting children's environmental identity. Finally, it considers the relationship between efforts to improve children's environmental identity and school science.

### **What Elements of the Intervention at the Center Impacted Children's Environmental Identity?**

The intervention included several strategies that seemed to be particularly important to impacting children's environmental identity. These included locating the program in a natural outdoor setting, specifically addressing children's comfort in the natural world, providing time for shared reflections about feelings about nature, incorporating free-choice learning opportunities with simple activities, and fostering social interactions between children as well as between the children and adult leaders, including the classroom teacher.

**Outdoor setting.** In the present study, it was critical that the intervention to strengthen children's environmental identity took place in the outdoors. By locating the

program in the outdoors, children had opportunities for direct contact with the natural world, enabling them to see, feel, touch, smell, hear, and appreciate the life around them, which was important in helping them develop positive feelings about nature as well as fostering their interests in the organisms they encountered. The shared experience in the outdoors also served as an anchor for the teacher and children to connect science in the classroom with science in the natural world. This is consistent with other research in the field of children's environmental identity (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Frantz & Mayer, 2013; Kals & Ittner, 2003).

The teacher, realizing some of the benefits of the outdoors for her children after witnessing their interactions there, expressed a desire to relocate some of her instruction outdoors and sought grant funding to return to the Center after the conclusion of the study. While the benefits of outdoor learning have been described by other researchers (Coyle, 2009; Hammerman, Hammerman, & Hammerman, 2001; National Foundation for Educational Research in England and Wales & Dillon, 2005; Rickinson, 2004), science teachers remain reluctant to relocate their instruction in outdoor settings (Dyment, 2005). This study suggests that a teacher's intent to situate science learning in the outdoors may be influenced by seeing her students' interaction with the natural world as well as coming to understand the importance children place on their relationship with nature.

Although it is not clear that the program needed to be in a remote setting to impact children's environmental identity, the quiet (relatively free of the intrusion of mechanical noise) made a large impression on the children in the present study. This suggests it may be

ideal for programming to be situated in outdoor settings, remote enough to have limited mechanical noise.

**Addressing children’s emotional responses to the natural world.** The program at the Center fostered children’s positive feelings about the natural world by directly addressing children’s comfort in the outdoors. This was accomplished by holding a discussion about fears, adult modeling of appropriate responses to fears, sharing information about some of the animals that were particularly worrisome (in this case, spiders), and letting the children experience the natural world as a sanctuary from the stress they felt in their lives. In particular, the bridge walk seemed to be a powerful experience for children, giving them an opportunity to “let go” of the stress they had carried with them from school, including the pressure of testing. In addition to children’s descriptions of their emotional responses to the intervention, children demonstrated a post-intervention increase in their comfort in the outdoors as evidenced by their desire to be outdoors at school even during inclement weather.

It is important to note that the practices in which the children engaged at the Center were not stress-inducing; success in every activity was easily achievable for each child. For example, on the Trail of Beauty, each child was asked to quietly point out things to a partner that were of special interest. This may have contributed to the high degree of student participation in activities at the Center, as well as the lack of behavior issues during the outdoor programs. Though children associated the natural world with freedom before the intervention, the opportunity for “free-choice” exploration in the natural world at the Center appeared to reduce stress and enhance children’s feelings of freedom in the natural world.

Some researchers suggest impacting the affective domain is among the most important elements of interventions to strengthen children's relationship with the natural world (Cheng & Monroe, 2012; Hinds, 2008; Ernst & Theimer, 2011; Iozzi, 1989). In particular, enhancing positive feelings about nature has been found to be essential to fostering environmental identity in children (Kals & Ittner, 2003).

**Time for reflection and group sharing.** In the present study, intentional time was provided for children and adults to reflect on their experiences in nature and their relationship with the natural world. This provided critical opportunities for learning about each other's environmental identities. Children became more aware of shared interests in nature among peers and new friendships grew from this awareness. Knowing about each other's interests in nature may provide an opportunity for peers to affirm and reinforce developing environmental identities. Similarly, the teacher was better able to identify children's interests in nature and use this information to foster children's classroom interests and access to media resources. Over time, this may enhance children's environmental identity by providing external validation. The time devoted to this sharing also slowed the pace of the day and may have contributed to children's feelings of comfort.

**Combination of free-choice learning and simple activities.** Children valued the free-choice learning opportunities at the Center. Although the boundaries of the children's movement were clearly defined by the Center, on the Trail of Beauty the children were able to locate and share things in nature that were of specific interest to them. Falk (2005) has described free-choice learning as experiences in which the learner has choice and control over what and when learning occurs. Consistent with the findings of research in free-choice

learning (Renninger, 2007), the ability to choose their experiences at the Center heightened children's interest in the things they observed in nature. In addition, the practices of the Center, including "beholding" and "being" were simple enough as to be non-threatening to children, fostering positive feelings about nature while at the same time encouraging scientific observation (Eberbach & Crowley, 2009; Lindemann-Matthies, 2005). Children demonstrated a willingness to re-engage with science (Hidi & Renninger, 2006), by articulating the desire to return to the Center, seeking out media upon their return to school to pursue information about things they had seen, participating in an optional Saturday Science Academy, and initiating the science explorers' club during their free time.

**Opportunities for social interaction.** At the Center, the teacher was instructed to let the Center educators manage student behavior, should problems arise. To the classroom teacher's and children's surprise, such intervention was not required and children were atypically quiet and respectful of each other. Children shared observations with friends and discussed their feelings about nature openly during time at the fire circle.

The design of the program also included lunch in the outdoors, during which children had a chance to sit with friends, and after which, children had some outdoor free time. Children used this opportunity to initiate tag games that involved all the children. As a result, the teacher noted the development of a sense of community among class members that had not been present before the intervention. Other things that likely contributed to the sense of community were the small groupings of children on the trail as well as the involvement of a single class (as opposed to a whole grade level) in the intervention.

## **Why Aren't Children with Strong Environmental Identities More Interested in School Science?**

In the present study, five of the nine children who described themselves as “nature people” did not feel they had a strong interest in school science. Said one simply, “I’m a nature person, but I’m not a science person.” This raises concerns about why children who feel a strong relationship to nature do not have stronger interests in school science. It seems for these children in particular, the constraints of the traditional elementary science classroom may marginalize their interests and serve to disconnect them from school science, much as they did in the case of Miguel, a student who dropped out of science classes despite a strong interest in natural sciences outside the classroom setting (Calabrese Barton & Yang, 2000).

In the present study, children described the experience of learning science in the natural world at the Center as very different than learning science in the classroom. They especially valued the self-directed nature of their learning in the outdoors and the perception that they were “allowed” to investigate things they discovered and in which they were interested. Elaine captured the sentiment, “I don’t know why [the field trips don’t feel like science] exactly, but I think that maybe because [at the Center] we aren’t sitting down in school with a notebook, writing everything down and stuff like that. They didn’t say like you have to notice this, you have to notice that, make sure you pay super close attention.” The use of free-choice learning in science has been found to foster children’s interests in the natural world (Renninger, 2007) and encourage pro-environmental behavior (Ballantyne &

Packer, 2005), but opportunities for free-choice learning typically occur outside of school settings (Falk, 2005; Falk, Storksdieck, & Dierking, 2007).

School educators rarely relocate their instruction from the classroom to the outdoors (Burriss & Burriss, 2011; Carrier et al., 2013; Smith, 2007; Sobel, 2004). Direct observation of local species in the outdoors has been shown to improve children's interests in those animals as well as their observation skills (Lindemann-Matthies, 2005). Consistent with this, in interviews and written reflections children repeatedly described how the practices (beholding, silence, the trail of beauty, listening) in which they participated at the Center helped them to be more careful observers in the natural world. "I saw and heard so much more," said one. In many ways, the woods rewarded careful observers with even more "cool things to discover," providing motivation for paying attention to detail. Student descriptions of the things they saw in nature on the trips were very detailed during the interviews, even when describing things they had seen a month earlier. Students were self-aware of these changes in their ability to notice and describe things in the natural world, perhaps beginning the transition from being everyday observers to scientific observers (Eberbach & Crowley, 2009).

Children in the present study articulated this as contributing to their disconnect from school science. In the present study, children who identified with the natural world perceived classroom science as only minimally related to their particular way of relating to the natural world. As Leo, a student who felt the natural world was absolutely essential to his identity explained, "In school...we don't really get to go outside. I would like science a ton more if we would like go outside and look at nature and see what kind of plant that is and like

measure it?” Naturalists make careful scientific observations in the natural world, often over extended periods of time, in the tradition of Thoreau, Muir, and Goodall. This field of science is characterized primarily by observation together with extensive sketching and documentation. Yet, in the context of school science, time to develop scientific observation skills in natural settings or of living things often falls victim to pressures to cover content quickly as well as lack of access to adequate space or specimens (Eberbach & Crowley, 2009).

### **How Does an Intervention Designed to Strengthen Children’s Connectedness to Nature Impact Children’s Interest in School Science?**

If children saw their experience at the Center as distinct from their experience of school science, why did the intervention increase children’s interests in school science? The increased interests in science were documented qualitatively and supported by increased mean science interest scores in the intervention group. However, it is important to acknowledge that the quantitatively measured increase in science interests in the intervention group was not statistically significant. It is possible that this measurement was limited by the small size of the intervention group, by the low number of visits to the Center, or by a ceiling effect.

The opportunity to explore science interests in the natural world, outside of the science classroom but still as a part of a school enterprise, may have expanded children’s vision of what science at school could be. It helped the teacher make connections between the science they were learning in school and the natural world children experienced at the Center. The experience may also have connected the children with the Center as a place,

fostering a concern for the animals and plants that served to strengthen their interest in science at school (Gruenewald & Smith, 2008; Kudryavtsev, Stedman, & Krasny, 2011; Smith, 2002; Sobel, 2004).

Based on the interviews with children, another possible explanation may also account for observations of children's increased interest in science at school. The opportunity to be outside in nature, make observations, discuss feelings, and reflect upon their experiences in the natural world in the social context of their class. This may have allowed children who had relatively silent feelings and interests in nature to share these with the class in a way that they were outwardly acknowledged and appreciated by the classroom teacher as well as by peers. Physically being outside in learning situation changed how some children were viewed by both the teacher and other children partly because being outside freed many children from the stress they felt in the science classroom. Discussions of feelings about the natural world changed how some children viewed themselves in relation to the natural world, especially their comfort levels and concern for the organisms at the Center. These changing feelings may have had the effect of strengthening the child's environmental identity in the context of schooling, possibly improving their interest in school science.

Children's environmental identities are in part determined by their feelings about the natural world (Kals & Ittner, 2003). Researchers have suggested that neglecting the way children feel about the natural world may contribute to their alienation from school science (Calabrese Barton & Yang, 2000; Cobern, 2000; Hammond, 2001). Though time constraints often limit science in elementary classrooms (Carrier et al., 2013), it may be especially important to address children's environmental identity at the elementary level, given the

long-term goal of abating children's declining interests in science as they approach middle school.

### **Simultaneously Growing Children's Environmental Identities and Interests in School Science**

Because of their interest in the natural world, it seems that children with strong environmental identities ought to be among our most-interested science students. But, sometimes they are not (Calabrese Barton & Yang, 2000). The present research reveals several strategies used by environmental educators that hold potential for simultaneously strengthening children's environmental identities as well as their interests in school science. The strategies include: relocating some instruction outdoors, particularly in natural settings; incorporating free-choice learning opportunities into science instruction; allowing for time and opportunities for social interaction; addressing children's comfort levels in the natural world, and giving children a chance to discuss and reflect upon their feelings about the natural world within the context of a school science experience. In this study, these strategies seemed to foster children's interest in science. Perhaps this is a step toward pursuing more scientific information over the course of their lifetime.

## Conclusion and Implications

The present research builds our understanding of some of the critical features of educational experiences that seek to improve children's environmental identity. Interviews with children and the teacher, field notes, and classroom artifacts demonstrate that the intervention at the Center strengthened children's environmental identity. Though measurable increases to children's environmental identity were small, perhaps due to the small size of the intervention group or a ceiling effect, they generally affirm this finding. Research also suggests that the impact of the intervention may have been enhanced had it involved more visits to the Center (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Liefländer et al., 2012; Theimer & Ernst, 2012).

The present research suggests that interventions designed to impact a child's environmental identity should be situated in outdoor natural settings with limited mechanical noise. They should include opportunities for free-choice learning and exploration in combination with easy practices (like Being and Beholding) that facilitate detailed observation. They should also take time to specifically address children's comfort levels in natural settings, allowing for children to discuss, observe, and practice strategies to overcome these fears in a safe, relaxed environment. They should also include time for reflection about participants' relationship with the natural world.

In the present study the experience at the Center also fostered imaginative thinking in children. Surprisingly, this was true for five children described by their teacher as very literal thinkers, including a strong science student who, according to his teacher, rarely risked

“outside the box” thinking in class. Science educators in particular may want to encourage this sort of “out of the box” thinking, as it may encourage novel solutions to technological challenges and push the boundaries of how we think about the world around us. In this sense, outdoor learning experiences focused on enhancing a child’s connectedness to nature may encourage more imaginative thinking that may also enrich the science classroom.

The present research also suggests that there is a compelling reason for teachers to develop an awareness of children’s environmental identities in order to leverage their interests in natural science and foster their interests in school science. The teacher in the present study was largely unaware of her students’ environmental identities prior to the intervention. As she gained an awareness of the strength of their connectedness to nature, she was more willing and able to direct resources, incorporate activities, and consider relocating her science instruction outdoors to build upon children’s interest in the natural world. As short, easily administered tools, the CNS-R or INS might offer teachers insight into children’s environmental identities if used diagnostically to determine the strength of children’s interests in the environment. This would be especially useful where access to outdoor environments and nature programs may be limited.

Even if they can’t feasibly bring their class to a environmental education center or park where they can experience a program led by a trained environmental educator in a natural setting, classroom science teachers may be able to incorporate some of the strategies employed by the Center to simultaneously improve children’s environmental identity and children’s interests in school science. For example, where possible teachers may relocate some of their science instruction to the schoolyard (Broda, 2007, 2011; Carrier et al, 2013;

Cronin-Jones, 2000; Danks, 2010; Moore & Wong, 1997). This strategy has been shown to be very effective at improving children's affective and cognitive learning, as well as motivating children's interests in science (Dillon et al., 2006; Malone, 2008; National Foundation for Educational Research in England and Wales & Dillon, 2005). It can be accomplished in urban settings with limited outdoor resources (Lopez, Campbell, & Jennings, 2008 2008).

Because barriers sometimes impede teacher's use of the outdoors (Dyment, 2005), another approach might be to include some of the teaching strategies of the Center in classroom-based science instruction. For example, teachers should consider integrating free-choice learning opportunities in their science instruction. In the present study, science content knowledge (particularly about organisms children observed at the Center) seems to have been enhanced through children's free-choice learning experiences in the natural world. This, in fact, has been suggested by other authors and is affirmed by the present study (Falk, 2001; Falk et al., 2007; Lindemann-Matthies, 2005; Renninger, 2007; Zoldosova & Prokop, 2006). Further, there is some evidence in the present study that strict structure, as the children associate with their experience of school science, may actually disincentivize children's interest in science. Freedom to explore and learn about organisms in the natural world they find interesting may be particularly conducive to fostering 5<sup>th</sup> grade students' interest in school science.

Future research should address the question of how persistent the impacts of interventions designed to improve children's connectedness to the natural world are in terms of their ability to impact environmental identity as well as school science interests as children

progress through adolescence into adulthood. It would also be interesting to know if limited experiences such as the ones the children in the present study had at the Center have the potential to serve as significant life experiences (Chawla, 2001) that impact children's care and concern of the environment, and/or career choice into adulthood.

While this study contributes to data on children's connectedness to the natural world, studies that involve more children in similar interventions can further inform the impact of such interventions on operational measures of children's environmental identity, including the CNS-R and INS. In the present study, the lack of statistically significant gains on the CNS-R and INS may be due to small sample size in the intervention group, a ceiling effect due to pre-existing higher connectedness to nature, or the limited period of the intervention. Alternatively, it may suggest that these children had reached an age above that which is optimal for modifying their connectedness (Liefländer et al., 2012). Though there were gains in mean scores of children's science interest, the lack of statistical significance may indicate that children in this study had already become indoctrinated in their experience of school science as testing, vocabulary, and note-taking, negatively impacting students' interest in science. Comparative studies should be conducted with children in lower grades to examine the impact of age.

Outdoor learning experiences like the ones at the Center that strengthen children's environmental identity may be of interest to environmental educators who strive to foster children's learning about the environment as well as their pro-environmental behavior. When carried out in the context of schooling, such efforts have the potential to encourage teacher and peer recognition and acknowledgment of children's environmental identities so

that children's feelings and interests in the natural world may be affirmed in their experience of school science. In doing so, outdoor learning experiences that strengthen a child's children's environmental identity, may also encourage children's interests in science at school.

Table 1

*Descriptive data related to study participants by age, ethnicity, and gender. (N=65)*

	<b>Intervention Group (N=21)</b>	<b>Control Group (N=44)</b>	<b>All Participants (N=65)</b>
<b>Age</b>			
•9 years old	0	2 (4.5%)	2 (3.1%)
•10 years old	16 (76.2%)	28 (63.6%)	44 (67.7%)
•11 years old	5 (23.8%)	13 (29.6%)	18 (27.7%)
•12 years old	0	1 (2.3%)	1 (1.5%)
<b>Ethnicity</b>			
•Black	4 (19.05%)	8 (18.2%)	12 (18.5%)
•non-White Hispanic	5 (23.8%)	13 (29.6%)	18 (27.7%)
•White	8 (38.1%)	17 (38.6%)	25 (38.5%)
•Other (Asian, Multi-racial)	4 (19.05%)	6 (13.6%)	10 (15.3%)
<b>Gender</b>			
•Male	11 (52.4%)	17 (38.6%)	28 (43.1%)
•Female	10 (47.6%)	27 (61.4%)	37 (56.9%)
<b>ESL Services</b>	8 (38.1%)	8 (18.2%)	16 (24.6%)

Table 2

*Thematic and related inductive code counts related to children's experiences in natural settings.*

<b>Theme</b>	<b>Inductive Code</b>	<b>Pre-Intervention Count</b>	<b>Post-Intervention Count</b>
Social/ other learning	Learning about self/others	0	10
	Spend time with others	20	8
	Study/read	1	0
Science learning	Observation (see/hear/touch/smell) nature	25	35
	Trail of Beauty	0	9
	Beholding	0	1
	Exploration	21	5
	Science Learning (general)	14	25
Reflection	Bridge Walk	0	2
	Silence	0	3
	Relaxation	4	5
	Spend time by myself	9	1
	Imagination/dream	0	2
	Flute/music	0	3
	Campfire/Circle	0	3
Other physical activity	Play	18	9
	Hiking/walking	2	1
	Have "fun"	3	3
	Tree-climbing	13	2
	Fort-building	2	0
	Sports/games	1	14
Don't spend time in nature		4	1

Table 3

*Thematic and related inductive code counts related to children's feelings about their experience in natural settings.*

<b>Theme</b>	<b>Inductive Code</b>	<b>Pre-Intervention Count</b>	<b>Post-Intervention Count</b>
Well-being	Happy	11	4
	Healthier/Feel good	2	2
	Angry	2	0
	Sad	1	1
Freedom	Free	12	6
Comfort	Safe/Comfortable	4	3
	Fear	6	6
	Relaxed	4	8
	Peaceful	4	6
Interest/Engagement	Alive/active	3	0
	Interested/Curious	10	10
	Connected	7	8
	Awe/wonder	4	8
	Place attachment	5	2
	Attentive	1	2
	Excited	3	4

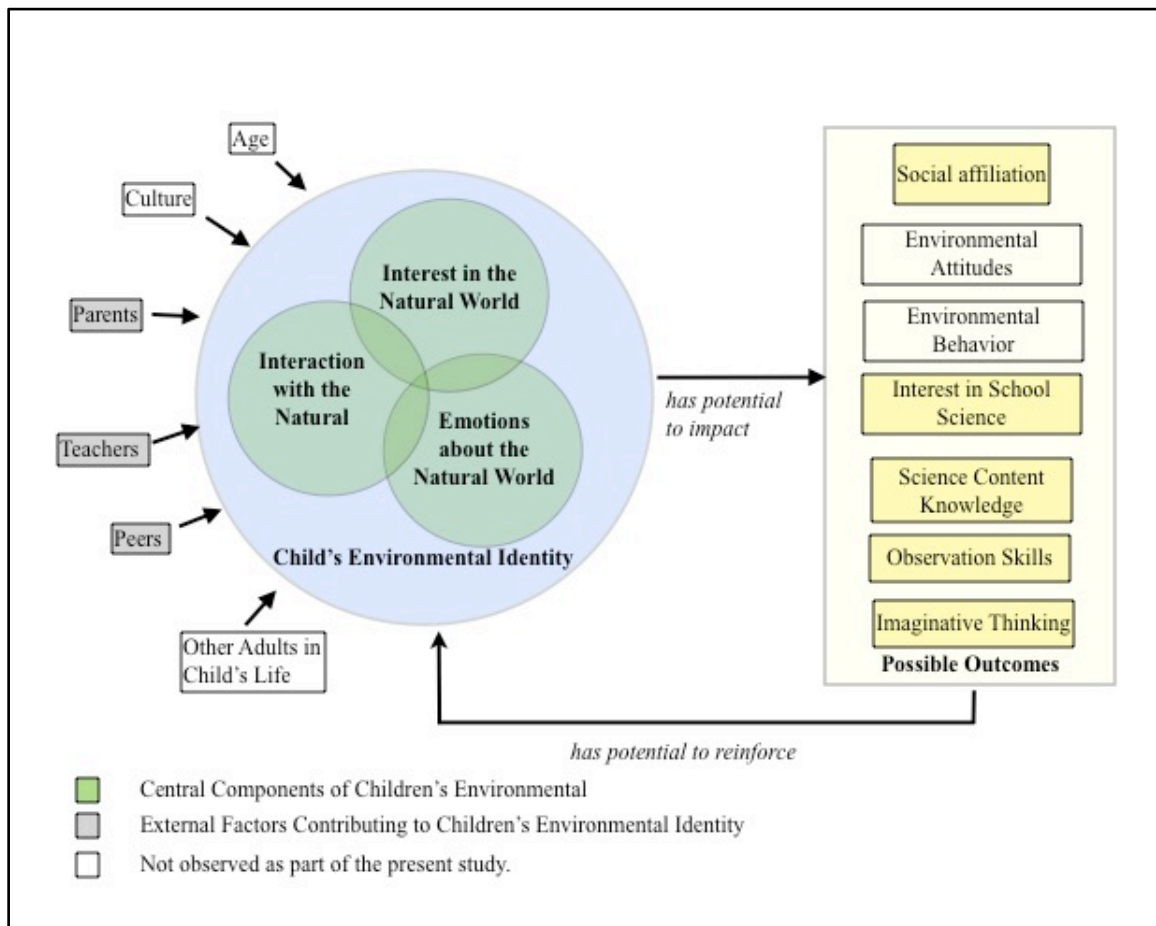
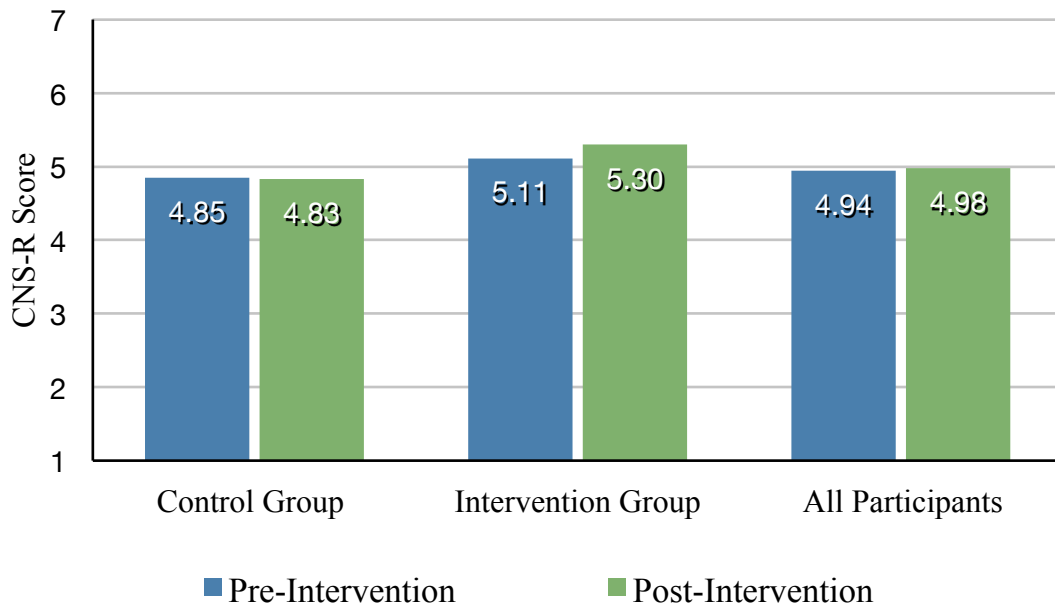
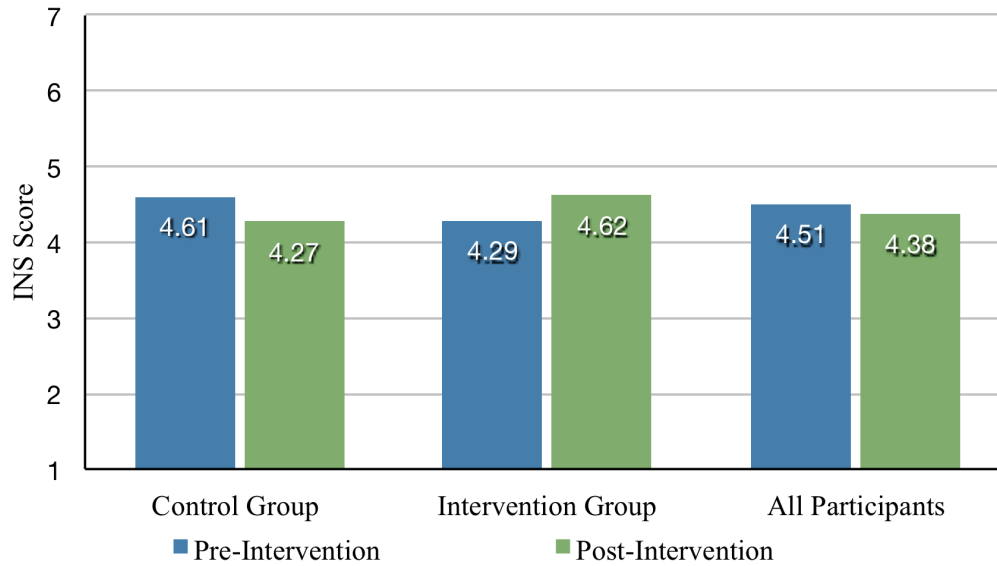


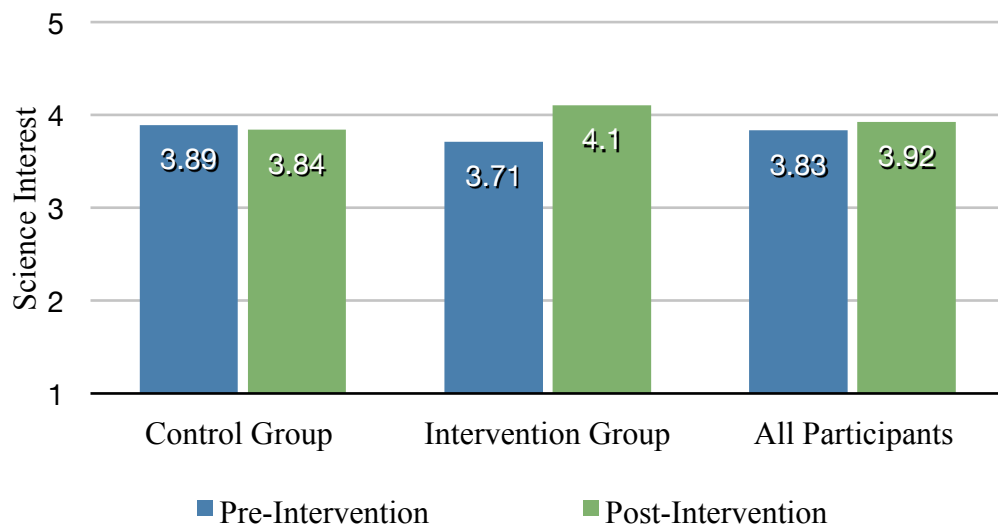
Figure 1: Proposed Model of Environmental Identity in Children (Tugurian, 2014).



*Figure 2:* CNS-R mean scores for pre-post intervention. CNS-R is based on a 7 point Likert scale, with 4.0 representing mid-line. In ANCOVA the main effect of the intervention on CNS-R score was not significant,  $F(1, 62) = 2.31, p = .13$ . Control Group ( $N=21$ ), Intervention Group ( $N=44$ ), and All Participants ( $N=65$ )



*Figure 3: INS mean scores for pre-post intervention. INS is based on a 7 point Likert scale, with 4.0 representing mid-line. In ANCOVA, the main effect of the intervention on INS score was not significant,  $F(1, 62) = 3.44, p = .07$ . Control Group ( $N=21$ ), Intervention Group ( $N=44$ ), and All Participants ( $N=65$ )*



*Figure 4:* Science Interest mean scores for pre-post intervention. Science Interest is based on a 5 point Likert scale (1=strongly disagree, 5=strongly agree). In ANCOVA, the main effect of the intervention on science interest was not significant,  $F(1, 62) = 2.47, p = .121$ . Control Group ( $N=21$ ), Intervention Group ( $N=44$ ), and All Participants ( $N=65$ )

## EXECUTIVE SUMMARY

The purpose of this dissertation research was to explore children's environmental identity by describing children's relationship with the natural world and developing a model of children's environmental identity. The model was used to inform the analysis of an intervention designed to impact children's connectedness to nature and determine which strategies used in the intervention appeared to impact children's environmental identity. The final goal of the research was to investigate the relationship of children's environmental identity and children's experience of elementary school science. Student and teacher interviews, classroom artifacts, and observations were used to examine and describe the children's environmental identity of suburban, US 5<sup>th</sup> grade students, as well as better understand the relationship of children's environmental identity to children's experience of school science. Two quantitative instruments, the Connectedness to Nature Scale Revised (CNS-R) (Frantz et al., 2013) and the Children's Inclusion of Nature in Self Scale (Liefländer et al., 2012), were used to support qualitative analysis and to measure environmental identity, examine relationships between children's environmental identity and other factors, as well as quantify the impact of an intervention designed to improve children's environmental identity. The findings are presented in two manuscripts and provide a more complete understanding of children's environmental identity than previously existed. Together, both documents offer recommendations for focused interventions that seek to improve children's environmental identity and enhance our understanding of the relationship between children's environmental identity and their experience of school science.

## Overview of Specific Findings

The first manuscript, *Toward a Model of Children's Environmental Identity*, focused on a broad examination of children's environmental identity in 5<sup>th</sup> grade students using both quantitative measures (CNS-R and INS,  $N = 65$ ) and qualitative [student interviews ( $N = 17$ ) and open-ended survey item responses ( $N = 65$ )]. In interviews, children were asked whether or not they considered themselves to be "nature kids." Quantitative measures of environmental identity supported children's descriptions of their environmental identity and their self-identification as "nature kids." Overall, children's CNS-R ( $M = 4.51$ ,  $SD = 1.70$ ) and INS ( $M = 4.93$ ,  $SD = 1.10$ ) scores reflected a positive connectedness to nature, above the midline (4.0) of both scales. Environmental identity in 5<sup>th</sup> grade students ranged from 2.5-7 on the CNS-R and from 1-7 on the INS 7-point scales.

Using a priori codes and subsequent thematic analysis (Johnson & Christensen, 2008) of interviews and open-ended survey responses by two researchers, several factors were found to contribute to children's environmental identity, including children's experience in the natural world, children's interest in science, children's emotions about the natural world, and the influence of others in the child's life (parents, teachers, and peers). Children's experiences in nature were shaped by the amount of time children spent in natural settings as well as by children's comfort in nature. Children had strong interests in the natural world, especially in animals and trees. Children with strong environmental identities had more frequent experiences in nature than those with weak environmental identities, though a few children with strong environmental identities also described limited access (by geography or by parents' busy schedules) to the natural world. Most children described some sort of fears

associated with their experience of the natural world. However, the fears in children with stronger relationships with nature did not inhibit their outdoor experiences in nature. By contrast, children with weak environmental identities tended to express fears about the outdoors (sometimes echoing parents' fears) and parental rules that impeded their experiences in nature.

There was also a correlation between children's environmental identity and the child's recognition of having an adult in his or her life that was interested in the natural world. Children with strong environmental identities often described parental support related to the child's desire to spend time in the natural world. In addition, children with strong environmental identities frequently described spending time in natural settings with siblings and peers.

In interviews, children were able to describe and recognize their own environmental identity, labeling themselves as "nature kids" or not, but the classroom teacher and peers were often not able to recognize environmental identity in class members. In other words, the environmental identity of children who labeled themselves as "nature kids" was often hidden to others, especially the teacher. Acknowledgement of children's environmental identity by teachers and peers has the potential to enhance children's environmental identity (Clayton, 2003), which may in turn foster children's interest in school science, science learning, as well as pro-environmental behaviors and attitudes.

In the present study, a positive correlation was found between children's environmental identity and their interest in school science. However, some children with strong environmental identities indicated they felt school science did not give adequate

attention to natural science or have a structure that was inclusive of their feelings about and experience of the natural world. This is consistent with the findings of others (Calabrese Barton & Yang, 2000; Cobern, 2000).

The Proposed Model of Environmental Identity in Children includes both internal and external components that contribute to children's environmental identity. The present research suggests environmental identity in children is formed by three central components: children's experience in the natural world, children's emotions about the natural world, and children's interest in natural science. Similar to what other researchers have found, children's environmental identity was found to be externally influenced by adults (including parents and to a lesser extent their teacher) and by their peers (Clayton, 2003; Kals & Ittner, 2003).

Though not specifically a part of this study, two influences that are supported by the literature, age (Ernst & Theimer, 2011; Kaplan & Kaplan, 2002; Liefländer et al., 2012; Sobel, 2002; Wells & Lekies, 2006) and culture (Kahn Jr. & Kellert, 2002; Kaplan & Kaplan, 1989; Schultz & Zelezny, 1998; Ulrich, 1993; Van den Berg, Hartig, & Staats, 2007), were also added to the model. The proposed model of children's environmental identity may help educators develop programming especially designed to impact children's environmental identity that may be used to foster pro-environmental behaviors and if done in the context of school, foster children's interests in school science.

The second manuscript, *Impacting Children's Environmental Identity in the Context of School Science*, focused on a case study of an intervention with 5<sup>th</sup> grade students designed to impact children's connectedness with nature. One class of 5<sup>th</sup> grade students ( $N = 21$ ) participated in two days of programming at the Center for Imagination and the Natural World

(the Center). The remaining 5<sup>th</sup> grade students ( $N = 44$ ) at the same school served as a control group for this intervention. Qualitative analysis of the impact of the intervention included coding of pre- and post-intervention interviews with children ( $N = 17$ ), field notes, classroom artifacts, and pre-, between-, and post-field trip interviews with the classroom teacher. Children's descriptions of the impact of the intervention included reduction of fears related to the outdoors, appreciation of freedom and quiet in the natural world, and increased tendency toward imaginative thinking. In interviews, fifteen of the seventeen children self-identified as "nature kids" after the intervention, whereas only nine did so prior to the intervention. In addition, after sharing the outdoor experiences with each other, the teacher and children were better able to recognize and acknowledge the environmental identity of class members after the intervention than they were prior to it. Though quantitative analysis found only significant pre- to post-intervention gains in environmental identity using the INS (not the CNS-R) in the intervention group, the mean scores in the intervention group increased on both the CNS-R (+0.19 points) and the INS (+0.33 points), while remaining nearly constant in the control group, supporting qualitative findings.

Participation in the programming at the Center also provided an opportunity for children to share an experience in an outdoor setting with their teacher and peers. This alternative setting was conducive to improved behavior and focus for some children, helping others to see them in a new light. Similarly, Kuo and Taylor (2004; 2009) have found experience in the natural world can be helpful for those with attention deficit disorder. In the present study both children and the teacher remarked on how differently some children

behaved during the outdoor programs, attending longer, disrupting less, asking more questions, and appearing more engaged with the learning experience.

In the present study, as students' relationship with the natural world became more known to others, new friendships and social affiliations emerged in the class related to children's shared interests in the natural world. Children initiated a science explorers club during their free time at school and supported each other's efforts to overcome fears. The teacher's increased awareness of the way her students' related to the natural world led her to seek funds to support additional field experiences for her class. Seeing how her students responded to the natural world prompted her to also consider relocating some of her own science instruction outdoors.

With respect to school science, the self-described interests in school science of the children in the intervention group grew as a result of the intervention. This finding was supported by quantitative gains in school science interest post-intervention ( $\Delta M = 0.39$ ) as compared to the school science interest in the control group ( $\Delta M = -0.05$ ) over the same time period. Anecdotally, back at school, the field experiences led children to pursue information about some of the animals they had seen, to increase their frequency of time in the outdoors (by choosing outdoor recess over indoor recess), to volunteer to participate in supplemental Saturday Science Academy, and to initiate a "science explorers" club during recess. The shared experience also served to anchor science lessons after the field trips, helping the teacher build connections between the natural world and her science lessons.

Despite these changes, the children had difficulty reconciling the experience on the field trips with their experience of school science. For them, the science learning in the

natural world wasn't "science," primarily because it did not have the structure they associated with science learning, including note-taking, vocabulary, tests, videos, a focus on physical and chemical science, and teacher-directed and constrained activities. In contrast, the learning experience in the natural world was perceived as less structured than school science, allowing opportunities for children to explore and pursue their own science interests. Although children generally liked science at school, by comparison, the natural world was "fascinating," "awesome," and "interesting."

### **Implications of Findings**

**How can children's environmental identity be strengthened by environmental educators?** Certain aspects of the intervention program at the Center were especially critical to children's environmental identity. From the children's perspectives, these included the opportunity to freely explore the woods and make discoveries of things of interest to them, to be in a relaxed outdoor atmosphere, largely removed from the structured demands of school, and to openly discuss their fears about the outdoors and have adults model ways of coping with those fears.

Children in the present study had substantial fears about the outdoors, including fears related to a variety of animals as well as some plants. The program at the Center specifically addressed those fears by modeling strategies for facing fears, sharing information about animals that were worrisome to children, and giving children an opportunity to discuss their fears. The strategic approach to address children's fears had a strong influence on children in the present study. Children were also given ample opportunities to have personal interactions with the natural world that fostered their positive feelings about the natural world.

Children's interview comments document the influence of parent support (or lack thereof) toward the natural world has on children's feelings about nature. This suggests that environmental educators should consider extending their outreach efforts to include parents and families. This approach has also been suggested by other researchers (Cheng & Monroe, 2012).

The program at the Center featured easily achievable practices that were taught, modeled, and repeated with children. This led to a high degree of student participation. There was no deliberate focus on structured science content learning, rather that learning seemed to emerge from children's experience through focused observation, discovery, and subsequent discussion. This seemed to foster children's interest in the natural world and led children to initiate efforts to gather more information about the things they saw at the Center. Also, the classroom teacher was able to participate in the experience with her students, which enabled her to learn new things about her students and foster a deeper understanding and recognition of the importance of being outdoors in the natural world with her students.

**How can children's environmental identity be strengthened by elementary classroom teachers?** Elementary classroom teachers can foster children's environmental identity by coming to better understand the ways their students relate to the natural world. Increasing the teacher's awareness of her children's relationships with nature could be accomplished in the classroom by school-based administration of the CNS-R and/or INS to diagnostically assess children's connectedness to nature. It could also be achieved by including opportunities for children to experience the natural world as a part of children's schooling. Classroom teachers may also be able to foster children's environmental identities

by facilitating discussion of children's emotional responses to the natural world in the context of their teaching.

***Diagnostic use of the CNS-R and/or INS.*** The CNS-R and INS instruments are both short, non-proprietary, and research-validated assessments of children's connectedness to nature. The INS may have some advantages for students with limited reading abilities or English language proficiency, as it consists of a single graphic item. In the present study, these instruments were supplemented with a single open-ended response item, "To me, nature is..." This item provided additional insight into the ways in which children thought about the natural world in part because it gave children to express their thoughts about nature in written language with limited response bias.

***Increase opportunities for exploration in the natural world.*** Ideally, elementary classroom teachers should also consider taking students outside for some activities and provide opportunities for children to explore and discover things of interest to them in the natural world. In the present study, the shared experience in the outdoors gave the teacher a chance to learn about her student's interest in the natural world and reinforce these interests once back in the classroom. Outdoor lessons can take place in school settings where schoolyards may accommodate it and schoolyards can be renovated to enhance student interactions with nature (Broda, 2007, 2011; Danks, 2010; Moore & Wong, 1997). Though this may be more challenging in urban settings, large cities like Boston have initiated such programs (Lopez et al., 2008), highlighting the fact that urban settings do not preclude such initiatives.

Alternatively, with appropriate structure, field trips may be used effectively to improve children's environmental identity (Ernst & Theimer, 2011; Frantz & Mayer, 2013; Liefländer et al., 2012; Theimer & Ernst, 2012) where space, teacher willingness to teach in the outdoors, or other barriers limit teachers' use of the schoolyard (Dyment, 2005). In the present study, participation in the program at the Center gave the teacher an opportunity to witness her children's interactions with the natural world, without the pressure of being responsible for managing their behavior. She was surprised by children's responses to the outdoors and the degree to which her children engaged with the activities. For teachers with limited experience teaching in the outdoors, the incorporation of field trips can provide an opportunity to see outdoor educators model effective teaching strategies with students. As in the present study, this may lead the classroom teacher to be more willing to consider relocating science instruction to outdoor settings.

Though not necessarily distinguished in this study, research also suggests that interventions designed to impact children's environmental identity should ideally occur over several days (Cheng & Monroe, 2012; Ernst & Theimer, 2011; Liefländer et al., 2012; Theimer & Ernst, 2012). This provides repeated opportunities for children to become comfortable in the natural settings. Therefore, classroom teachers should be encouraged to take their students into the outdoors on multiple occasions, whether using field trips or schoolyard-based lessons.

**Enhancing children's school science experience by addressing components of children's environmental identity.** The present study suggests that children's experience of

school science may be enhanced by incorporating elements that foster children's environmental identity.

***Building connections to science learning through shared outdoor experiences.***

Classroom teachers should strive to help students understand the relationship of the science they are learning inside the classroom to the world around them by relocating some of their science instruction to outdoor settings. The children in the present study clearly articulated the feeling that school science was not connected to the natural world before the outdoor intervention, as has been seen in other research (Carrier et al., 2013). The shared experience in the outdoors provided an opportunity for the classroom teacher to anchor classroom science lessons to things the class had observed in the outdoors. Children and students referenced things they had seen in subsequent discussions and connected things they saw outdoors to science lessons they had had prior to the field experiences.

***Inclusion of free-choice learning activities.*** Elementary science teachers should include some activities that allow students to investigate science by following their own interests. Children in the present study articulated their appreciation of the free-choice learning opportunities at the Center that gave students a chance to identify things that were of interest to them and make inquiries into those specific interests. Children followed-up on their interests in things they observed at the Center with research in the school's media center, initiated a science club during their free time, and volunteered to participate in an optional Saturday Science Academy when they returned to school, suggesting that the activities at the Center promoted their interests in science. This is consistent with the work of other researchers, who have found that self-directed exploration offers an opportunity for

free-choice science learning (Dierking et al., 2003; Falk, 2001). Free-choice science experiences also stimulate cognitive conflict and promote social interactions that may improve scientific reasoning ability (Gerber et al., 2001).

***Set aside time for observation and noticing.*** Science educators should make time for children to observe and wonder about things in the natural world. The practice of “beholding” used at the Center encouraged children’s more careful observation of the world around them. Children described noticing more, being more aware, and especially hearing things (because of the quiet) they hadn’t before. At the Center, children made detailed observations of fungi, insects, spiders, plants, and birds and noted life cycle changes, adaptations, convection, camouflage, and weather patterns, among other things. This reflected a progression from the type of everyday observation that children had typically done before participating in the program toward scientific observation, a skill critically important in science (Eberbach & Crowley, 2009).

***Provide opportunities for reflection.*** Elementary science teachers should provide opportunities for children to discuss their emotional responses to the natural world as part of their school science experience. In the present study, children had a strong emotional response to the natural world. The opportunities for reflection and discussion fostered children’s comfort in the natural world and encouraged their willingness to engage with insects and aspects of the natural world. Children began to have a new appreciation for the complexity of life around them and wanted to learn more about organisms they encountered. Researchers have suggested that the failure to acknowledge the way children think and feel

about the natural world has contributed to their disconnect from school science (Calabrese Barton & Yang, 2000; Cobern, 2000).

### **Recommendations for Future Research**

Environmental identity in children, by definition, is likely to be closely tied to the environment that a child has experienced. But, because the present research was limited in its scope by focusing on 5<sup>th</sup> grade children in a suburban public school setting, it cannot describe environmental identity in strictly urban or rural settings. It is important for future researchers to incorporate these perspectives into the model of children's environmental identity.

While this research was not able to document the contribution of gender, age, ethnicity, or culture to children's environmental identity, perhaps because of the small size of its study population, literature indicates that it is reasonable to assume that some of these factors, particularly cultural perspectives, influence children's environmental identity. Researchers have established that it is optimal to impact children's environmental identity before age 11 (Ernst & Theimer, 2011; Kaplan & Kaplan, 2002; Liefänder et al., 2012; Sobel, 2002; Wells & Lekies, 2006), but it would be interesting to know if there is a lower limit to this optimal period. Longitudinal studies of environmental identity in children would also provide valuable insight into how children's environmental identity emerges and develops into adulthood.

With respect to the influence of others, it would be useful to determine if a correlation exists between children's environmental identity and that of their parents. For example, if a strong correlation exists, it may be particularly important to include information and/or opportunities for parent participation in interventions directed at impacting children's

environmental identity. The present research suggests that parental limits and fears do impact children's experience of and feelings about the natural world and supports the findings of Cheng and Monroe (2012) who recommend intervention be accompanied by parental outreach.

## **Conclusion**

Knowing more about children's environmental identity not only suggests ways to develop focused efforts to improve environmental identity in children, but it also opens up new possibilities for teachers to connect children with science at school. However, given the current indoor nature of elementary school science (Burriss & Burriss, 2011; Carrier et al., 2013; Smith, 2007; Sobel, 2004), there are limited opportunities for teachers to get to know their students' environmental identity within the context of schooling.

Ideally, elementary teachers might consider relocating some of their science experiences outdoors. Outdoor science experiences may be particularly important in children with strong environmental identities to help them relate to school science. When science is taught effectively in the outdoors, student interest, motivation, emotional development, and cognitive gains are enhanced (Dillon et al., 2006; Malone, 2008; National Foundation for Educational Research in England and Wales & Dillon, 2005). Outdoor learning experiences may also be especially helpful for children who struggle with attention issues in the classroom (Kuo & Faber Taylor, 2004; Taylor & Kuo, 2009).

In addition to enhancing children's interest in school science, shared class participation in outdoor science activities also gives teachers and students a chance to recognize, acknowledge, and affirm children's environmental identities. This may serve to

strengthen children's environmental identities, which may in turn strengthen their pro-environmental attitudes and behaviors, as it has been found to with adults (Cervinka et al., 2012; Clayton & Opatow, 2003; Hinds & Kaiser, 2011; Mayer et al., 2009; Perrin & Benassi, 2009; Schultz et al., 2004).

However, in some cases, it may not be realistic to expect teachers to relocate their science instruction outdoors. For example, the outdoors may be inaccessible in urban settings. Teachers may lack the skills they feel necessary to teach in the outdoors. For these teachers, field trips to environmental education centers offer an alternative approach that still provide the benefits of increased experience in natural settings to children. Incorporation of environmental education center programs can relieve the teacher of pressures related to feeling unprepared to teach outdoors and can provide the teacher the additional benefit of participating alongside students, enabling new insights into the ways students interact with the natural world.

Another alternative might be to use the CNS-R or the INS diagnostically to identify children with strong environmental identities that may otherwise be hidden in the context of school. Once recognized, the teacher could focus on these interests and build connections to the local environment in such a way that children begin to view science at school in relation to the world around them.

Although much attention has been given to the incompatibility of environmental and science education (Smith, 2007; Stevenson, 2007), it seems science educators should perhaps consider embracing some of the approaches used by educators in outdoor settings. Children in the present study described science at school as stressful, constrained, structured, and

sometimes boring. They viewed it as not connected to their experience in the natural world. At the Center, children appreciated the freedom of self-discovery, opportunities for observation of living things, the chance to express feelings about the natural world, and the time to reflect on their experiences. Clearly, their feelings about their experience of science learning in the two settings are very different. Yet, science learning occurs in both places. Perhaps by embracing some of the outdoor teaching methodologies, even within the classroom, elementary school science teachers could simultaneously achieve their objectives while fostering children's environmental identity and their interests in science. As Gough (2002) suggests, it may be time for science and environmental educators to rethink their relationship, learning from each other, toward a mutualistic approach that enhances student connection with science and helps foster children's connectedness to nature.

### **Limitations of the Study**

Because the present research focused on 5<sup>th</sup> grade children, it was intended to provide only a snapshot of children's relationship to the natural world, rather than an understanding of how children's connectedness to nature changes as they progress toward adulthood. The analysis was limited in some regards by the small size of the study population. In addition, children in this study largely lived in suburban areas of the United States. Therefore, these data were not necessarily representative of children in densely inhabited urban areas, sparsely populated rural areas, or underdeveloped nations. The present study was not intended as a program evaluation, and cannot be used to generalize impact of the intervention beyond this study.

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## APPENDICES

# Appendix A: Research Survey

How old are you?

- 9 years old     
  10 years old     
  11 years old     
  12 years old

Gender

- Male     
  Female

Ethnicity

- African American   
  American Indian   
  Asian   
  Caucasian/White   
  Hispanic   
  Multi-racial   
  Other   
  Prefer not to answer

I am interested in science at school.

- Strongly Disagree   
  Disagree   
  Neither Agree nor Disagree   
  Agree   
  Strongly Agree

I am a science person.

- Strongly Disagree   
  Disagree   
  Neither Agree nor Disagree   
  Agree   
  Strongly Agree

There is an adult in my life who likes to spend time in nature.

- Strongly Disagree   
  Disagree   
  Neither Agree nor Disagree   
  Agree   
  Strongly Agree

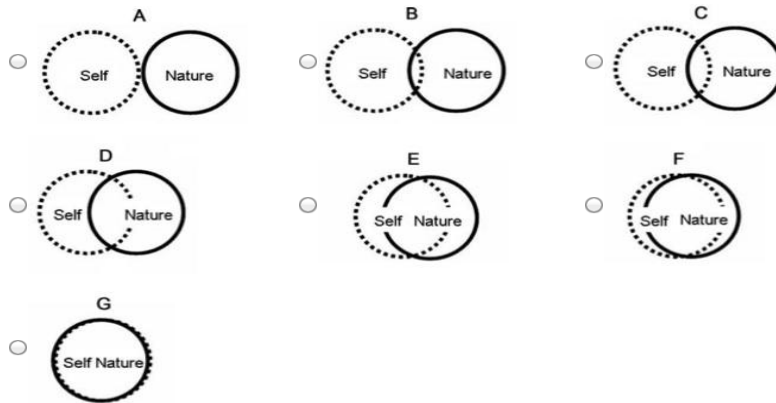
How often do you spend time in nature?

- Never   
  Less than Once a Month   
  Once a Month   
  2-3 Times a Month   
  Once a Week   
  2-3 Times a Week   
  Daily

How far away from your home is the nearest park or other natural area where you can see wildlife?

- I don't know of a place like that near my home.
- It would more than 30 minutes to walk there.
- I could walk there in 15-30 minutes.
- I could walk there in 5-10 minutes.
- It is right outside my home.

How interconnected are you with nature? Choose the picture which best describes your relationship with nature.



---

**I often feel a strong connection to nature.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**I think of nature as a family that I belong in.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**I see myself as a part of the greater circle of life.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**Humans are more important than plants and animals.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**I feel related to animals and plants.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**I feel I belong to the Earth and the Earth belongs to me.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**I feel that all living things in this world are connected and I am a part of that.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**There is something that every living thing shares.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**Like the tree in the forest, I feel I belong to nature.**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

---

**I don't feel part of nature**

Strongly Disagree    Disagree    Somewhat Disagree    Neither Agree nor Disagree    Somewhat Agree    Agree    Strongly Agree

## Appendix B: Connectedness to Nature Scale-Revised (Frantz et al., 2013)

	<b>I often feel a strong connection to nature.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>I think of nature as a family that I belong in.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<b>I see myself as a part of the greater circle of life.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(R)	<b>Humans are more important than plants and animals.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>I feel related to animals and plants.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>I feel I belong to the Earth and the Earth belongs to me.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>I feel that all living things in this world are connected and I am a part of that.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>There is something that every living thing shares.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>Like the tree in the forest, I feel I belong to nature.</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(R)	<b>I don't feel part of nature</b>						
	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

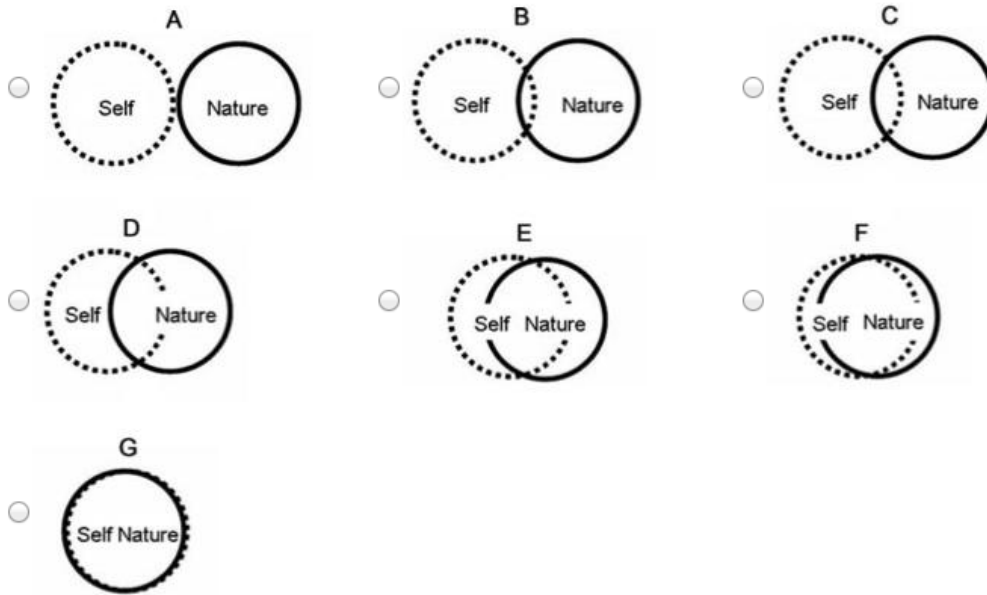
Reverse scored items are indicated with an R.

## Appendix C: Children's Inclusion of Self in Nature Scale (Liefländer et al., 2012)

Select one answer for each item.

---

How interconnected are you with nature? Choose the picture which best describes your relationship with nature.



## **Appendix D: Interview Protocol**

### **General Procedure:**

Interviews will take place with individuals in a mutually agreed upon separate setting. Interviews will be audio taped. Interviews will follow a semi-structured format, using the questions as a guide, to allow for conversational style. Student interviews will be conducted either before or after school or during teacher-identified free time in class. Students will not miss instruction time at schools and students' availability will be at the teacher's discretion. Teacher interviews will take place at their convenience. Interview time is estimated to be 20 minutes.

### **Introduction to Interviewee:**

*Say:* I am conducting a research study to learn more about children's relationship with the natural world. I'm going to ask you several questions. Your answers will be confidential because I will never use your name in my research. If you are uncomfortable answering any question, we can skip it, and if you want to stop the interview at any time, you may tell me to do so. I'd like to make an audio recording of our interview so that I will have a record of exactly what you say to me. Do I have your permission to begin?

*\*Post-intervention questions are noted in italics.*

### **Student Interview Questions**

1. What do you like to do when you are outside?
2. Do you have a special place you like to go when you are outside? Can you describe this place? Why do you go to this place (these places)?

3. Are there any places that you aren't allowed to go outside? Why or why not?
4. Tell me about a time when you went into the woods. (*Tell me about your experiences at the Center.*)
5. Are you afraid of anything in the woods? If so, what? Why?
6. Do your parents like to be outside in nature? Why or why not?
7. Are there any kids you would call nature people in your class? Why/why not? (*Are there any kids you would call nature people in your class? Why/why not?*)
8. Is your teacher a nature person? Why/why not? (*Is your teacher a nature person? Why/why not?*)
9. Do you see yourself as a connected to nature or separate from it? Explain. (*Do you see yourself as a connected to nature or separate from it? Explain.*)
10. *Has your experience at the Center changed anything about the way you feel about nature?*
11. *Has your experience at the Center changed anything about the way you feel about yourself?*
12. *Has your experience at the Center changed anything about the way you feel about your classmates?*
13. *Did you learn anything at the Center? If so, describe something you learned. If not, why not?*

### **Teacher Interview Questions**

1. How would you describe the class' connectedness to nature overall?

2. Are there any students who stand out (*stood out*) for you in terms of their connectedness to nature? If so, how so?
3. Are there any students for whom you expect (*you found*) the experience in natural settings to be particularly challenging? If so, why/how so?
4. Are there any students for whom you expect (*you found*) the experience in natural settings to be particularly beneficial? If so, why/how so?
5. How do you think the experience in natural settings may impact the culture, social dynamics, and/or content knowledge of your class as a whole? (*How do you think the field experiences at the Center impacted your class in terms of its culture, social dynamics, and/or content knowledge?*)

**Appendix E: Pre-Intervention Statistics**

**Pre-Intervention Control Group vs. Pre-Intervention Intervention Group**

**INS**

**ANOVA**

INS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.529	1	1.529	.527	.471
Within Groups	182.718	63	2.900		
Total	184.246	64			

**CNS-R**

**ANOVA**

CNSR

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.061	1	1.061	.880	.352
Within Groups	75.960	63	1.206		
Total	77.021	64			

**Gender:**

1=Male, 2=Female

**Descriptive INS**

INS

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
1	28	4.68	1.806	.341	3.98	5.38
2	37	4.38	1.622	.267	3.84	4.92
Total	65	4.51	1.697	.210	4.09	4.93

**ANOVA INS****ANOVA**

INS

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.436	1	1.436	.495	.484
Within Groups	182.810	63	2.902		
Total	184.246	64			

**Non-Parametric INS****Hypothesis Test Summary**

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of INS is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.484	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

## Descriptive CNS-R

CNSR

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
1	28	5.171	1.0136	.1915	4.778	5.564
2	37	4.738	1.1339	.1864	4.360	5.116
Total	65	4.925	1.0970	.1361	4.653	5.196

## ANOVA CNS-R

ANOVA

CNS-R

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.996	1	2.996	2.550	.115
Within Groups	74.024	63	1.175		
Total	77.021	64			

## Non-Parametric CNS-R

### Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of CNSR is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.160	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

**Ethnicity:**

1=Black, 3=Asian, 4=White, 5= non-White Hispanic, 6=Multi-racial, 7=Other

**Descriptive Data**

		Descriptives					
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
SciInterest	1	12	3.92	.900	.260	3.34	4.49
	3	5	4.00	1.000	.447	2.76	5.24
	4	25	3.76	.970	.194	3.36	4.16
	5	18	3.78	1.003	.236	3.28	4.28
	6	4	4.00	.816	.408	2.70	5.30
	7	1	4.00	.	.	.	.
	Total	65	3.83	.928	.115	3.60	4.06
INS	1	12	3.75	2.137	.617	2.39	5.11
	3	5	3.80	1.924	.860	1.41	6.19
	4	25	5.00	1.354	.271	4.44	5.56
	5	18	4.50	1.790	.422	3.61	5.39
	6	4	4.25	.957	.479	2.73	5.77
	7	1	6.00	.	.	.	.
	Total	65	4.51	1.697	.210	4.09	4.93
CNSR	1	12	4.850	.8702	.2512	4.297	5.403
	3	5	4.780	1.3572	.6070	3.095	6.465
	4	25	5.092	1.0816	.2163	4.646	5.538
	5	18	4.794	1.1889	.2802	4.203	5.386
	6	4	4.625	1.4975	.7487	2.242	7.008
	7	1	5.900	.	.	.	.
	Total	65	4.925	1.0970	.1361	4.653	5.196

## ANOVA

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
SciInterest	Between Groups	.551	5	.110	.119	.988
	Within Groups	54.588	59	.925		
	Total	55.138	64			
INS	Between Groups	17.946	5	3.589	1.273	.288
	Within Groups	166.300	59	2.819		
	Total	184.246	64			
CNSR	Between Groups	2.487	5	.497	.394	.851
	Within Groups	74.533	59	1.263		
	Total	77.021	64			

## Non-parametric Tests

**Hypothesis Test Summary**

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of SciInterest is the same across categories of Ethnicity.	Independent-Samples Kruskal-Wallis Test	.994	Retain the null hypothesis.
2	The distribution of INS is the same across categories of Ethnicity.	Independent-Samples Kruskal-Wallis Test	.276	Retain the null hypothesis.
3	The distribution of CNSR is the same across categories of Ethnicity.	Independent-Samples Kruskal-Wallis Test	.740	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

## Correlations (Science Interest, Adult Who Likes to Spend Time in Nature, Amount of Time Spent in Nature, INS, CNSR)

### Descriptive Statistics

	Mean	Std. Deviation	N
SciInterest	3.83	.928	65
AdultNature	3.48	1.120	65
TimeNature	5.17	1.884	65
INS	4.51	1.697	65
CNSR	4.925	1.0970	65

### Correlations

		SciInterest	AdultNature	TimeNature	INS	CNSR
SciInterest	Pearson Correlation	1	.169	.222*	.482**	.575**
	Sig. (1-tailed)		.089	.038	.000	.000
	N	65	65	65	65	65
AdultNature	Pearson Correlation	.169	1	.376**	.274*	.490**
	Sig. (1-tailed)	.089		.001	.014	.000
	N	65	65	65	65	65
TimeNature	Pearson Correlation	.222*	.376**	1	.496**	.383**
	Sig. (1-tailed)	.038	.001		.000	.001
	N	65	65	65	65	65
INS	Pearson Correlation	.482**	.274*	.496**	1	.625**
	Sig. (1-tailed)	.000	.014	.000		.000
	N	65	65	65	65	65
CNSR	Pearson Correlation	.575**	.490**	.383**	.625**	1
	Sig. (1-tailed)	.000	.000	.001	.000	
	N	65	65	65	65	65

\*. Correlation is significant at the 0.05 level (1-tailed).

\*\*. Correlation is significant at the 0.01 level (1-tailed).

**Correlations**

		SciInterest	AdultNature	TimeNature	INS	CNSR
SciInterest	Pearson Correlation	1	.169	.222	.482**	.575**
	Sig. (2-tailed)		.178	.075	.000	.000
	N	65	65	65	65	65
AdultNature	Pearson Correlation	.169	1	.376**	.274*	.490**
	Sig. (2-tailed)	.178		.002	.027	.000
	N	65	65	65	65	65
TimeNature	Pearson Correlation	.222	.376**	1	.496**	.383**
	Sig. (2-tailed)	.075	.002		.000	.002
	N	65	65	65	65	65
INS	Pearson Correlation	.482**	.274*	.496**	1	.625**
	Sig. (2-tailed)	.000	.027	.000		.000
	N	65	65	65	65	65
CNSR	Pearson Correlation	.575**	.490**	.383**	.625**	1
	Sig. (2-tailed)	.000	.000	.002	.000	
	N	65	65	65	65	65

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

## Non-parametric Correlations

			Correlations				
			Sci Interest	Adult Nature	Time Nature	INS	CNSR
Spearman's rho	SciInterest	Correlation	1.000	.142	.087	.446**	.575**
		Coefficient					
		Sig. (1-tailed)	.	.130	.245	.000	.000
		N	65	65	65	65	65
	AdultNature	Correlation	.142	1.000	.324**	.277*	.455**
		Coefficient					
		Sig. (1-tailed)	.130	.	.004	.013	.000
		N	65	65	65	65	65
	TimeNature	Correlation	.087	.324**	1.000	.419**	.297**
		Coefficient					
		Sig. (1-tailed)	.245	.004	.	.000	.008
		N	65	65	65	65	65
	INS	Correlation	.446**	.277*	.419**	1.000	.619**
		Coefficient					
		Sig. (1-tailed)	.000	.013	.000	.	.000
		N	65	65	65	65	65
	CNSR	Correlation	.575**	.455**	.297**	.619**	1.000
		Coefficient					
		Sig. (1-tailed)	.000	.000	.008	.000	.
		N	65	65	65	65	65

\*. Correlation is significant at the 0.05 level (1-tailed).

\*\* . Correlation is significant at the 0.01 level (1-tailed).

**Correlations**

			SciInterest	AdultNature	TimeNature	INS	CNSR
Spearman's rho	SciInterest	Correlation Coefficient	1.000	.446**	.575**	.446**	.575**
		Sig. (2-tailed)	.	.000	.000	.000	.000
		N	65	65	65	65	65
AdultNature	AdultNature	Correlation Coefficient	.142	.277*	.455**	.277*	.455**
		Sig. (2-tailed)	.260	.025	.000	.025	.000
		N	65	65	65	65	65
TimeNature	TimeNature	Correlation Coefficient	.087	.419**	.297*	.419**	.297*
		Sig. (2-tailed)	.490	.001	.016	.001	.016
		N	65	65	65	65	65
INS	INS	Correlation Coefficient	.446**	1.000	.619**	1.000	.619**
		Sig. (2-tailed)	.000	.	.000	.	.000
		N	65	65	65	65	65
CNSR	CNSR	Correlation Coefficient	.575**	.619**	1.000	.619**	1.000
		Sig. (2-tailed)	.000	.000	.	.000	.
		N	65	65	65	65	65

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

## Appendix F: Pre-Post Intervention Statistics

### Paired t-tests

#### Intervention Group:

#### INS Scores

Paired Samples Test				
		Paired Differences		
		Mean	Std. Deviation	Std. Error Mean
Pair 1	INS Pre - INS Post	-.333	.730	.159

Paired Samples Test						
		Paired Differences		t	df	Sig. (2-tailed)
		95% Confidence Interval of the Difference				
		Lower	Upper			
Pair 1	INS Pre - INS Post	-.666	-.001	-2.092	20	.049

There were significant differences in the pre-post intervention INS scores in the experimental group ( $t(20)=-2.092, p=.049$ ).

#### CNS-R Scores

Paired Samples Test				
		Paired Differences		t
		95% Confidence Interval of the Difference		
		Lower	Upper	
Pair 1	CNS-R Pre - CNS-R Post	-.4156558	.0251796	-1.848

Paired Samples Test		
		Sig. (2-tailed)
Pair 1	CNS-R Pre - CNS-R Post	.079

There were no significant differences in the pre-post intervention CNS-R scores in the experimental group ( $t(20)=-1.848, p=.079$ ).

Science Interest

**Paired Samples Test**

		Paired Differences		t
		95% Confidence Interval of the Difference		
		Lower	Upper	
Pair 1	Science Interest-Pre - Science Interest-Post	-.775	.013	-2.019

**Paired Samples Test**

		df	Sig. (2-tailed)
Pair 1	Science Interest-Pre - Science Interest-Post	20	.057

There were no significant differences in the pre-post intervention science interests in the experimental group ( $t(20)=-2.019$ ,  $p=.057$ ).

## Control Group

### INS Scores

**Paired Samples Test**

		Paired Differences		
		Mean	Std. Deviation	Std. Error Mean
Pair 1	INS Pre - INS Post	.341	1.446	.218

**Paired Samples Test**

		Paired Differences		t	df	Sig. (2-tailed)
		95% Confidence Interval of the Difference				
		Lower	Upper			
Pair 1	INS Pre - INS Post	-.099	.780	1.564	43	.125

There were no significant differences in the pre-post intervention science interests in the control group ( $t(43)=1.564, p=.125$ ).

### CNS-R Scores

**Paired Samples Test**

		Paired Differences		t
		95% Confidence Interval of the Difference		
		Lower	Upper	
Pair 1	CNS-R Pre - CNS-R Post	-.1888220	.2206401	.157

**Paired Samples Test**

		df	Sig. (2-tailed)
Pair 1	CNS-R Pre - CNS-R Post	43	.876

There were no significant differences in the pre-post intervention science interests in the control group ( $t(43)=.157, p=.876$ ).

## Science Interest

### Paired Samples Test

		Paired Differences		t
		95% Confidence Interval of the Difference		
		Lower	Upper	
Pair 1	Science Interest-Pre - Science Interest-Post	-.247	.338	.313

### Paired Samples Test

		df	Sig. (2-tailed)
Pair 1	Science Interest-Pre - Science Interest-Post	43	.756

There were no significant differences in the pre-post intervention science interests in the control group ( $t(43)=.313, p=.756$ ).

## ANCOVA

### CNS-R

#### Tests of Between-Subjects Effects

Dependent Variable: CNS-R\_Post

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	58.164 <sup>a</sup>	2	29.082	79.090	.000	.718
Intercept	1.691	1	1.691	4.598	.036	.069
CNSR_Pre	55.076	1	55.076	149.780	.000	.707
Group	.850	1	.850	2.313	.133	.036
Error	22.798	62	.368			
Total	1698.970	65				
Corrected Total	80.962	64				

In ANCOVA the main effect of the intervention on CNS-R score was not significant,  $F(1, 62) = 2.31, p = .13$ .

### INS

#### Tests of Between-Subjects Effects

Dependent Variable: INS\_Post

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	98.402 <sup>a</sup>	2	49.201	35.070	.000	.531
Intercept	11.603	1	11.603	8.270	.006	.118
INS_Pre	96.697	1	96.697	68.925	.000	.526
Group	4.822	1	4.822	3.437	.068	.053
Error	86.982	62	1.403			
Total	1435.000	65				
Corrected Total	185.385	64				

In ANCOVA, the main effect of the intervention on INS score was not significant,  $F(1, 62) = 3.44, p = .07$ .

## Science Interest

### Tests of Between-Subjects Effects

Dependent Variable: Science Interest-Post

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14.022 <sup>a</sup>	2	7.011	10.709	.000	.257
Intercept	15.790	1	15.790	24.116	.000	.280
ScienceInterestPre	13.103	1	13.103	20.013	.000	.244
Group	1.617	1	1.617	2.469	.121	.038
Error	40.593	62	.655			
Total	1055.000	65				
Corrected Total	54.615	64				

In ANCOVA, the main effect of the intervention on science interest was not significant,  $F(1, 62) = 2.47, p = .121$ .